The role of attention control in biased attention for internal and external threats in trait anxiety

By

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Summary

Trait anxiety is an established risk factor for anxiety disorders and is associated with uncontrollable negative thoughts and impaired functioning. Attention to threat, whether internal (e.g., negative thoughts) or external (e.g., pictures), has been proposed to contribute to anxiety. Models of attention indicate that attention control may influence attentional reactions to threat in anxiety. Although these models have been widely applied to external threats, an understanding of how these frameworks apply to thoughts is less established. One potential reason for this is that thought processes are more difficult to capture compared to behavioural reactions to external stimuli. This thesis investigated the moderating role of attention control on reactions to external and internal stimuli in trait anxiety, and whether laboratory measures of external attention bias were related to thought suppression ability and cognitive avoidance strategies.

Chapter 1 provides theoretical background for the relationship between trait anxiety and threat processing by outlining models of attention, working memory, and cognitive models of anxiety. The literature review established a link between biased attention and anxiety, but the nature of these biases is inconsistent. Some studies show that anxious individuals engage with threat more readily compared to controls, and that they become "stuck" on threat. However, other studies found that anxious individuals avoid threat and shift away from it faster than controls. Attention control has the potential to account for these mixed findings, both in relation to external and internal stimuli.

In **Chapter 2**, Study 1 aimed to shed light on the moderating effects of attention control on anxiety and attention biases to external threats. The results indicated that attention control moderates the relationship between anxiety and disengagement from, but not engagement with threat. Unexpectedly, as control increased the relationship between anxiety and the time taken to disengage from threat increased. In addition, the results did not support

the idea that external attention biases correspond with self-reported habitual cognitive avoidance strategies (e.g., using suppression to avoid negative thoughts) in daily life. This indicates that findings from laboratory-based tasks using external stimuli may not generalise to the use of cognitive avoidance in real-life contexts.

In **Chapter 3**, Study 2 used a cross-sectional design to investigate whether attention control moderated the relationship between anxiety and internal threat stimuli using a thought-suppression task. Attention control did not moderate the effect of anxiety on the frequency or duration of negative thoughts in this study. Further, exaggerated attentional reactions on external and internal attention tasks were not related. This study highlighted that self-report methods of thought recurrence may be vulnerable to under-reporting.

To address potential under-reporting of thoughts **Chapter 4** (Study 3) self-caught recurrence (i.e., where participants must press a button when they are thinking the thought) was compared to other caught methods. Other-caught recurrence was obtained by coding stream of consciousness transcripts. The results indicated that self-caught methods resulted in underreporting of target thoughts compared to other-caught methods. In a replication and extension of Study 2, attention control moderated the relationship between anxiety and disengagement from threat. As attention control increased, the time taken to disengage from target thoughts decreased.

Overall, the research supports the notion that attention control moderates the relationship between anxiety and attentional reactions to internal and external stimuli. However, there was limited support for the notion that attention bias for external stimuli corresponds to reactions to thoughts both inside and outside of the laboratory. **Chapter 5** discusses the implications of these findings from theoretical, methodological, and therapeutic perspectives.

Declaration

I certify that this thesis:

1) Does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university
2) And the research within will not be submitted for any other future degree or diploma without the permission of Flinders University; and
3) To the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.
4) I confirm that I was a recipient of RTP support and acknowledge the contribution of an Australian Government Research Training Program Scholarship

Signed: 

Jessica Howe, B. Behavioural Science. (Hons.). Date: 23/11/2023

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Chapter 1 - General Introduction

Biased Attention for Threat in Trait Anxiety: Underlying Processes

Anxiety as an emotional state can serve an adaptive function, but high levels of dispositional anxiety can have debilitating consequences (Baxter et al., 2014; Wittchen et al., 2011). Rachman (2004, p. 3) defined anxiety as “the tense, unsettling anticipation of a threatening, but vague event; a feeling of uneasy suspense”. Anxiety can be separated into two dimensions. *State* anxiety reflects current anxiety levels, influenced by situational stressors and individual differences in trait anxiety. *Trait* anxiety represents a stable propensity to perceive information as threatening, and experience more intense anxious reactions compared to those low in trait anxiety (Balsamo, 2013). It is an established risk factor for anxiety disorders (Sandi & Richter-Levin, 2009) and is marked by uncontrollable and intrusive thoughts, exaggerated attentional responses to threat, and impaired functioning (Herren & Grös, 2018). These symptoms, at their most debilitating, are key features of anxiety disorders. Moreover, they implicate cognitive processes in the aetiology and maintenance of anxiety. This thesis explores the relationship between trait anxiety and exaggerated attentional reactions towards internal (thoughts) and external threats. This introductory chapter provides an overview of cognitive models of anxiety, and models of attention and working memory, to provide a theoretical background for the relationship between trait anxiety and threat processing. Second, the research to date regarding exaggerated attentional reactions towards threat in trait anxiety and anxiety disorders is reviewed. Finally, the chapter concludes with the aims and outline of the thesis.

Cognitive Models of Anxiety

Anxiety is associated with genetic and early environmental influences (Legrand et al.,1999; Lau, et al., 2006; Gray, 2010; Moser et al., 2012), however cognitive models propose that emotional and behavioural reactions are ultimately determined by an individual's worldview (Beck et al., 1985). Seminal work by Beck and colleagues suggested that anxious experiences are the result of the appraisal of an event or situation, and appraisals are determined by dysfunctional beliefs about threat and safety. Dysfunctional beliefs and assumptions are part of schemata. Schemata are a set of core beliefs regarding the self, world and future that are used to understand and respond to situations. Threat-related schemata bias information processing in a way that is consistent with them (Beck & Clark, 1997). Indeed, anxiety is associated with cognitive biases across a variety of domains such as attention, interpretation, and memory (Jones & Sharpe, 2017; Martinelli et al., 2022; Mathews & MacLeod, 2002; MacLeod & Mathews, 2012). This thesis focusses on the processes that underlie biased *attentional* reactions to internal (e.g., thoughts) and external sources (e.g., negative images) of threat.

Working Memory and Attention

Working memory and attention are crucial components of information processing (Oberauer, 2019), governing the ability to handle multiple inputs from external (i.e., perceptual) and internal sources (e.g., thoughts and memories). Attention is critical in the selection and prioritization of information, enabling us to effectively complete tasks by focussing on relevant information while disregarding irrelevant information. External attention refers to processes that select and modulate information from perceptual modalities (e.g., vision), whereas internal attention operates over the contents of working memory (Chun et al., 2011).

Working Memory

Working memory is a limited capacity cognitive system that temporarily stores and manipulates information (e.g., thoughts, perceptions, interpretations, and memories). Early formulations by Baddeley and Hitch (1974) described it as a mental workspace that contains two temporary storage systems (i.e., phonological loop and visuospatial sketchpad) and a central executive system that manages these stores. Theories of working memory acknowledge the role attention in the activation, maintenance, and manipulation of short-term mental representations or further processing (Baddeley & Hitch, 1974; Cowan, 1988; Oberauer, 2009; Oberauer, 2019). Thus, cognitive symptoms of anxiety (e.g., unwanted thoughts or memories), and reactions to these internal experiences (e.g., thought suppression) may be understood within an attentional framework.

Attention

Attention comprises three components: alerting, orienting and attention control (Posner & Boies, 1971, Posner & Cohen, 1984; Posner et al., 1988; Posner & Petersen, 1990, Petersen & Posner, 2012). The *alerting* system initiates and maintains vigilance, keeping individuals prepared and responsive to incoming stimuli. The *Orienting* system shifts attention to align with signal sources and selects attentional targets from competing inputs. Selection can occur through two processes, both of which are implicated in attention biases. Stimulus-driven orienting occurs when salient, unexpected, or potentially threatening events capture attention at the expense of other activities (Corbetta & Schulman, 2002; Petersen & Posner, 2012). However, external orienting can also be guided by current goals, expectancy, and knowledge (i.e., strategic processes; Corbetta & Schulman, 2002; Petersen & Posner, 2012). For example, when searching for targets in a scene, attention rapidly shifts to locations known to contain that object (Torralba et al., 2006).

In contrast, attention to internal events, like thoughts, is argued to be internally driven and not the result of stimulus-driven processes (Chun et al. 2011). Nevertheless, not all internal orienting is under strategic control. Unintentional cognitive events, including negative thoughts, can divert attention away from current tasks (Kane et al., 2017), suggesting a form of involuntary internal orienting. Automatic and strategic orienting can be in opposition (i.e., attempt to select different targets at the same time), and conflicts are resolved by a mechanism known as executive attention, or *attention control*. These terms are used interchangeably throughout the literature and this thesis will refer to attention control for simplicity.

Models of working memory and attention describe attention control as the set of cognitive functions responsible for detecting and resolving conflict among competing mental processes (Bush et al., 2000). Attention control is the voluntary control of attention in line with task demands and current goals and is subsumed under the umbrella of cognitive control (Mogg & Bradley, 2018). In contrast to top-down orienting, which filters out incoming task-irrelevant information, attention control directs cognitive resources in favour of task-relevant processes and responses when there is conflict (Mackie et al., 2013). For example, top-down orienting is responsible for ignoring the chime of an incoming text message to continue listening to a lecture. In this case, bottom-up orienting towards the phone must be inhibited because it conflicts with the overarching task demand. In sum, when there is conflict between the two orienting systems, the activation of attention control will determine whether orienting is directed in a top-down or bottom-up fashion.

Attention Control Theory

It has been suggested that elevated trait anxiety is associated with generalised deficits in attention control functions, leading to impaired functioning (Eysenck et al., 2007; 2023). Attention Control Theory (ACT) explains how trait anxiety can reduce cognitive task performance in nonclinical populations (Eysenck et al., 2007; 2023). ACT distinguishes between performance effectiveness (outcome quality, e.g., accuracy) and processing efficiency (level of effort or resources expended to achieve the outcome). Anxiety primarily reduces processing efficiency while minimally impacting performance effectiveness (Eysenck et al., 2007; Eysenck & Derakshan, 2011; Eysenck et al., 2023). For instance, an anxious student's thesis may be of similar quality to their non-anxious counterpart but take longer to complete due to reduced processing efficiency. Anxiety impairs processing efficiency by biasing attention and working memory resources toward anxious thoughts, increasing distractibility, and depleting attention regulation resources (Bishop, 2009; Eysenck, 2007; Stefanopoulou et al., 2014).

Attention control, however, can counteract bottom-up processing in anxiety by inhibiting prepotent responses (Friedman & Miyake, 2017; Eysenck et al., 2007). This protection against functional impairments arises from the ability to focus on task-relevant processes and responses while inhibiting irrelevant information, aligning with top-down goals (Eysenck et al., 2007). Some studies support the association between anxiety and impaired inhibitory control and reduced working memory (Airaksinen et al., 2005; Cohen et al., 1996; Eysenck & Derakshan, 2011; Mantella et al., 2007; Moran, 2016; Snyder et al., 2010, 2014, while others find no evidence (Airaksinen et al., 2005; Boldrini et al., 2005 Price & Mohlman, 2007). This suggests that anxious individuals may compensate for attentional deficits by recruiting additional cognitive resources (Basten et al., 2011, 2012; Berggren & Derakshan, 2013). Such compensation aligns with ACT's prediction that anxiety impairs processing efficiency rather than performance effectiveness (Eysenck et al., 2007).

Neuroimaging studies have found evidence of compensation, with anxious individuals showing lower activation of the dorsolateral prefrontal cortex (DLPFC) at rest, associated with attention control, but exhibiting greater activation during challenging tasks (Basten et al., 2011, 2012; Fales et al., 2008; Oschner & Gross, 2005). Control differences between anxious and non-anxious groups depend on motivation, task difficulty, and cognitive load

(Hayes et al., 2009; Berggren, 2012; Eysenck et al., 2005; MacLeod & Donnellan, 1993). Nevertheless, substantial evidence supports anxiety's association with attention control deficits.

While ACT provides a framework for how anxiety can affect processing and account of functional impairments, it does not explain how inefficient processing impacts anxiety. Notably, the tasks used to investigate the relationship between attention control and anxiety often use neutral stimuli (e.g., colour-word Stroop, Stroop 1935; see p.18 - 19 for further details), and such tasks may be unable to elicit reliable differences in information processing between anxious and low-anxious samples. That is, reliable differences in attentional processing may only emerge in the presence of potential threat.

Attention to Threat and Trait Anxiety

Substantial research has refined cognitive theories on biased information processing in anxiety, suggesting that biases contribute to the development and maintenance of anxiety (Bar-Haim et al., 2007; Beck & Clark, 1997; Cisler & Koster, 2010; Eysenck et al., 2007; Derakshan, 2020; Mathews & Mackintosh, 1998; MacLeod et al., 2002; Mogg & Bradley, 1998, 2016; Williams et al., 1997). There is also evidence that anxiety influences attention bias, indicating that the relationship is reciprocal (Van Bockstaele et al., 2014). Fear conditioning studies found that state anxiety preceded attention bias for conditioned stimuli paired with an aversive unconditioned stimulus (CS+), compared to conditioned stimuli that were not (CS- ; Koster et al., 2004; 2005; Van Damme et al., 2004a; 2004b). Additionally, reductions in anxiety following cognitive behaviour therapy coincided with decreased attention bias (Hadwin & Richards, 2016). Nevertheless, research in this area typically focusses on attention biases as contributing to anxiety, rather than anxiety contributing to attention bias (Van Bockstaele et al., 2014).

Chapter 2 provides a review of attention biases in anxiety; however, it highlights that although anxiety is often associated with attention bias, these biases differ across individuals. Researchers have attempted to delineate the precise nature of biased attentional responses to threat and have identified three biases: engagement bias, disengagement difficulties, and attentional avoidance. There is considerable evidence that anxiety is associated with hypervigilance to threat (Bar-Haim et al., 2007; Beck & Clark, 1997; Cisler & Koster, 2010; Eysenck et al., 2007; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998, 2016; Williams et al., 1997). However, research using external stimuli has found that after attention has been captured by threat, some anxious participants sustain attention towards threat cues, that is, *disengagement difficulties* (e.g., Fox et al., 2001; Miltner et al., 2004; Rinck et al., 2003). Yet, others rapidly direct their attention *away* from threat showing attentional *avoidance* following vigilance (Calvo & Avero, 2005; Garner et al., 2006; Mogg & Bradley, 1998; Mogg et al., 2004; Pflugshaupt et al., 2005). Similarly, meta-analyses note there is conflicting evidence that anxious individuals have difficulties directing attention away from negative thoughts (Abramowitz et al., 2001; Magee et al., 2012; Wang et al., 2020; see Chapter 3 for review). These inconsistent findings regarding biased attention to threat using external and internal tasks may be explained by individual differences in attention control.

Attention Control as a Moderator

Once threat captures attention, subsequent processes sustain attention toward the threat, or redirect attention away from it. These processes relate to individual differences in attention control (Gorlin et al., 2015; Mogg & Bradley, 2016; Taylor et al., 2016), task demands and motivation (Berggren & Derakshan, 2013). Individual differences in attention control may explain the variations in the relationship between trait anxiety and disengagement or avoidance of internal and external stimuli. Investigating attentional reactions towards threat may enhance our understanding of anxiety, as the specific nature of attention bias is debated (Cisler & Koster, 2010; Mogg & Bradley, 2018). Furthermore, if we understand how these biases operate to cause and maintain anxiety, it follows that manipulating these biases would also alleviate anxiety. Therefore, investigating the nature of attention biases not only sheds light on the causes of anxiety, but also has implications for treatments, such as attention bias modification (ABM).

The objective of ABM is to reduce attention to threatening external stimuli. Early research supported the therapeutic effects of ABM (e.g., Bar-Haim, 2010; MacLeod & Mathews, 2012), however initial excitement was dampened following a growing number of studies indicating small, or null effects (Dennis-Tiwary, 2023; MacLeod, 2023). One potential explanation for small effect sizes is that biased attention may not manifest consistently across anxious individuals. While attentional responses may be exaggerated in anxiety, this may look different across individuals (e.g., one person becomes stuck on threat, while another avoids it; Cisler & Koster, 2010). Thus, this thesis investigates attention control as a factor that could explain individual differences in attention biases, and the potential implications with respect to treatment approaches.

The Relationship Between External and Internal Attention

This thesis also addresses the relationship between attention to internal and external stimuli, and their relevance to anxiety. The distinction between the processes responsible for regulating attention and working memory systems is debated, although they share cognitive resources and neural regions, and interact (Awh et al., 1998; Courtney et al., 2007; Cowan, 1995; Duncan & Owen, 2000; Oberauer, 2019; Theeuews et al., 2009). Yet, they are dissociable (Grattery, 2023; Roth et al., 2009). The clinical literature often investigates external and internal attention separately (Ruimi, 2023), but some researchers suggest that external attention tasks can generalise to thoughts (Amir & Bernstein, 2022; Heeren, 2018; Hollingworth & Maxcey-Richard, 2013).

The relationship between attentional reactions to external threat, suppression of negative thoughts, and cognitive avoidance strategies has not been extensively explored. Given that negative thoughts, and attentional reactions to them are a core feature of anxiety, it is crucial that the processes underlying them are identified. If external attention tasks do not reliably correspond to internal attention processes or outcomes, conclusions regarding the processes underlying negative thoughts in anxiety are less robust. Additionally, it may also signal that interventions that mechanistically alter attention bias to external stimuli will not be effective at relieving cognitive symptoms of anxiety.

Measuring Attention to Thoughts

The understanding of processes that underly attention to thoughts is in its infancy, and one potential barrier to furthering this understanding are the currently available measures. Due to their inherent internal and subjective nature, there are multiple challenges in measuring attentional reactions to thoughts. Various techniques and methodologies have been developed, such as self-report questionnaires, thought sampling, experience sampling techniques, behavioural observations, and physiological responses (Pope & Singer, 1978). While each approach has its own strengths and limitations, very few studies have compared these measures directly (Fikretoglu, 2003). Therefore, the final aim of this thesis was to compare measures of thought suppression using questionnaires, self-caught thoughts (i.e., self-reports through button press), and more objective measures (i.e., experimenter caught thoughts) with the view to making recommendations for future research.

Research Aims and Thesis Outline

The role of attention control in the manifestation of attentional biases to threat stimuli and thoughts in trait anxiety remains a topic of debate. This thesis investigates the moderating effect of attention control on attention biases to external stimuli and thoughts in trait anxiety. Previous research found that attention control can counteract external attention biases to threat. The specific components of attention bias affected by attention control (i.e., engagement, disengagement, and avoidance) remain unclear, and have the potential to explain past mixed findings. Additionally, no studies have explored the moderating effects of attention control on attention biases to thoughts in trait anxiety. Therefore, this study examined the influence of attention control on attention biases to external stimuli (Study 1) and thoughts (Study 2 and Study 3).

Furthermore, while internal and external stimuli are typically studied separately, they are believed to rely on the same attention components. The second aim of this thesis was to investigate whether attentional reactions to external threat correspond to the habitual use of cognitive avoidance strategies (Study 1) and reactions to internal stimuli, (i.e., thoughts; Study 2). Currently, attention bias modification procedures primarily target attention biases to external stimuli in anxiety treatment. However, if these attention biases do not align with reactions to internal threat and habitual cognitive avoidance strategies, it may explain the limited effectiveness of attention bias modification procedures in anxiety treatment.

One obstacle to advancing our understanding of attention to thoughts is the lack of robust measures available. The internal and subjective nature of thoughts poses several challenges in accurately assessing attentional reactions to thoughts. Thus, the final objective of this thesis was to compare different measures of thought suppression, such as questionnaires, self- and other-caught thoughts, to provide recommendations for future research (Study 2 & Study 3). By addressing these research questions, this thesis aims to contribute to a better understanding of the interplay between attention control, attention biases, and anxiety. This will provide insights into the potential implications for treatment approaches targeting attention biases.

Chapter 2 – Study 1:

Attention Control as a Moderator of the Relationship Between Anxiety, Attention Bias and Cognitive Avoidance

Overview

A longstanding proposition is that anxious individuals have difficulties regulating their attention to potentially threatening information (Bar-Haim et al., 2007; Beck & Clark, 1997; Cisler & Koster, 2010; Eysenck et al., 2007; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998, 2016, 2018; Williams et al., 1997). Despite significant research into anxiety and attention biases, evidence of a specific pattern of bias (e.g., being stuck or on avoiding threat) in anxiety is mixed (Kruijit et al., 2019). Attention control may explain different patterns in attention bias in anxiety. While this proposition is garnering further attention, to date the results are again mixed, and may be related to methodological limitations of previous studies described below. Therefore, further investigation of the role of attention control in attention bias in anxiety is warranted.

Attention biases are typically assessed using tasks that use external stimuli (e.g., threatening images on the dot-probe task; or negative words on the emotional Stroop task; Gorlin et al., 2015; Mathews & McLeod, 2002; Rudaizky et al., 2013; Taylor et al., 2016). The extent to which those tasks also capture attentional reactions to internally generated threats (e.g., thoughts) has received little attention. This is important because if the processes underpinning responses to external and internal stimuli are unrelated, then conclusions based on external tasks cannot generalise to internal events. Therefore, the relationship between external attention tasks and habitual reactions to negative thoughts was investigated.

Biased Attention and Trait Anxiety

Exaggerated attentional responses to threat are implicated in the aetiology and maintenance of anxiety disorders (Bar-Haim et al., 2007; Beck & Clark, 1997; Cisler & Koster, 2010; Eysenck et al., 2007; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998, 2016, 2018; Williams et al., 1997). Attention bias contributes to anxiety by maintaining beliefs that the world is unsafe (Beck & Clark, 1997). But anxiety itself can bias attention towards threat as a strategy to detect and respond to threat to maintain safety (Beck & Clark, 1997). Therefore, threat-related attention biases can precede anxiety (e.g., Van den Hout et al., 1995), and anxiety can precede attention bias (e.g., Koster et al., 2004; 2005; Van Damme et al., 2004a, 2004b). Reductions in attentional bias can reduce anxiety and vice versa (see Van Bockstaele et al., 2014, for review). Attention bias can manifest in three ways: engagement bias, disengagement difficulty, and attentional avoidance (Cisler et al., 2009; Cisler & Koster, 2010; Mogg & Bradley, 2016; 2018). However, there relative role of these biases in anxiety is debated, largely due to mixed findings (Kappenman et al., 2021).

Engagement Bias and Anxiety

Engagement bias refers to the relative ease with which attention is captured by a threat stimulus. It is automatic, and results from stimulus driven, bottom-up orienting (Cisler & Koster, 2010; Corbetta & Schulman, 2002; Mogg & Bradley, 2018; Petersen & Posner, 2012). Cognitive models propose that anxiety is linked to an exaggerated threat-detection mechanism (Bar-Haim et al., 2007; Beck & Clark, 1997; Cisler & Koster, 2010; Eysenck et al., 2007; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998, 2016; Williams et al., 1997). This maintains anxiety because attention is preferentially allocated to threat instead of neutral or safety-signalling stimuli; reinforcing the perception that the world is unsafe (Mogg & Bradley, 1998, 2016, 2018). It may also be responsible for functional impairments, because even mild threat cues capture attention and disrupt goal-directed activity (Eysenck et al., 2007; Mogg & Bradley, 1998, 2016, 2018).

Across a variety of tasks, a meta-analysis found that anxious individuals disproportionately directed their attention towards threat compared to neutral stimuli and had impaired performance when threatening distractors were presented (Bar-Haim et al., 2007). Importantly, low anxious controls did not show enhanced threat detection (Bar-Haim et al., 2007). However, more recent studies indicate engagement bias in anxiety is inconsistent, and null or reversed effects have been found (Kappenman, et al., 2021; Mogg & Bradley, 2016; Shechner & Bar-Haim, 2016; Salum et al., 2013; Yiend et al., 2015; Waters et al., 2014). Therefore, the relationship between engagement bias and anxiety may be less reliable than proposed by Bar-Haim et al. (Van Bockstaele et al., 2014). Supporting this, a more recent meta-analysis investigating attention biases in anxiety and post-traumatic stress disorder did not find evidence of a consistent attention bias to threat (Kruijt et al., 2019). Given the unreliable association between anxiety and engagement bias, researchers have been interested in processes that may influence the relationship (Cisler & Koster, 2010; Mogg & Bradley, 2018; Gorlin & Teachman, 2015; Taylor et al., 2016).

Strategic Attention Biases and Anxiety

One process which may contribute to the inconsistent relationship between engagement bias and anxiety is variations in subsequent attention regulation processes (Mogg & Bradley, 1998; 2016; 2018; Cisler & Koster, 2010). Once attention is captured, it can be maintained towards threat or shifted away from it. An inability to disengage attention from threat and shift towards another stimulus may prolong anxious states (Fox et al., 2001). Tasks that can differentiate early and late attention biases have supported the presence of *disengagement difficulties* in anxiety (e.g., Fox et al., 2001; Miltner et al., 2004; Rinck et al., 2003; Rudaizky et al., 2014; Taylor et al., 2016). This occurs when attention is shifted away from neutral stimuli faster than threat stimuli or when anxious participants are slower to shift attention away from threat compared to controls (Rudaizky et al., 2014).

However, top-down processes can redirect attention away from threat cues to minimise state anxiety as an emotion regulation strategy (Cisler & Koster, 2010; Mogg & Bradley, 1998, 2016, 2018). When attention is shifted away from threat faster than neutral stimuli, this is called *attentional avoidance,* and maintains trait anxiety (Cisler & Koster, 2010; Mogg & Bradley, 1998; 2016; 2018). When attention is allocated *away* from threat, cues maintain their anxiety-provoking properties because habituation is prevented (Foa & Kozak, 1986; Mogg & Bradley, 1998; 2016; 2018). This is similar to the way avoidance of thoughts, emotions and bodily sensations maintains anxiety (Riskind, 2005; Salters-Pedneault et al., 2004). Research supports attentional avoidance in anxiety (Garner et al., 2006; Kappenman, 2021; Koster et al., 2005; Mogg et al., 2004; Pflugshaupt et al., 2005). However, this raises the question of whether anxiety is characterised by disengagement difficulties or attentional avoidance, as they appear to be opposite sides of the same coin.

Conflicting evidence for sustained attention versus attentional avoidance does not seem to reflect different attention tasks. Both disengagement difficulties and attentional avoidance have been demonstrated across a variety of tasks (Cisler & Koster, 2010). While disengagement difficulties and attentional avoidance are juxtaposing biases, they both rest on later stages of processing and are strategic, conscious, and controllable (Cisler & Koster, 2010). They are the consequences of *attention control* processes.

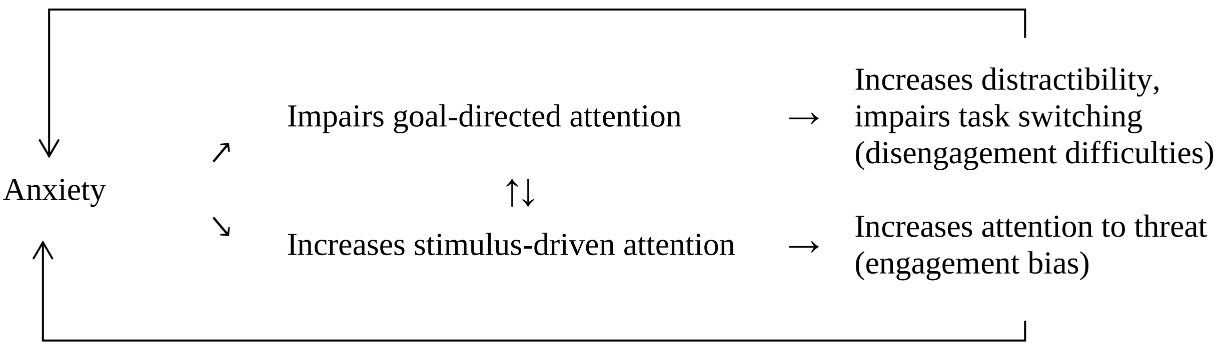
Attention Control and Anxiety

Attention Control (AC) refers to a set of top-down processes that regulate attention, thoughts, emotions, and behaviours in line with superordinate goals (Corbetta & Schulman, 2002; Miyake & Friedman 2012; Petersen & Posner, 2012). Inhibitory control is the suppression of dominant, habitual, and automatic responses to allow for a more appropriate response (Miyake & Friedman, 2012). It is a core function underlying AC and cognitive control processes generally (Friedman & Miyake, 2017; Miyake & Friedman, 2012). It is associated with the top-down orienting of attention (Petersen & Posner, 2012). The colour-word Stroop (Stroop, 1935) is an attention task that requires inhibition, as participants are asked to label the font colour (e.g., blue) that a colour-name (e.g., "red") is written in. It requires the suppression of the automatic response to read the colour-name if it conflicts with the font colour. When the font colour (e.g., blue), and colour-name (e.g., blue) are consistent, inhibition is not required.

Pre-existing anxiety can reduce the efficiency of AC as because working memory and attentional resources are allocated towards anxious cognitions instead of towards goal directed activity (Cohen et al., 2014; Eysenck et al., 2007; 2023; Hayes et al., 2008, Sari et al., 2016). Once threat is detected by early processes, pre-existing anxiety can cause disengagement difficulties as it limits the resources available to initiate AC (Eysenck et al., 2007; 2023; Moran, 2016, see Figure 1).

Figure 1

The Relationships Between Anxiety, Bottom-Up and Top-Down Processing and Attention Bias to Threat



Note. Adapted from Mogg & Bradley (2016)

Nonetheless, AC can modify responses to threat following attentional capture. AC is presumed to protect against anxiety, because it enables one to ignore irrelevant information such as negative thoughts. Yet, evidence for a direct relationship is mixed. Some studies found that impairments in AC are associated with anxiety (e.g., Ansari & Derakshan, 2010; Armstrong et al., 2011; Basanovic, 2018; Booth & Tekes, 2019; Cohen et al., 1996; Eysenck & Derakshan, 2011; Mantella et al., 2007; Snyder et al., 2010; 2015; Zetsche et al., 2018), but other studies did not (Purcell et al., 1998; Boldrini et al., 2005; van den Heuvel et al., 2005; Van der Linden et al., 2005; Price & Mohlman, 2007). To account for these mixed results, researchers suggest that the impairments in attention control in anxiety may be attenuated by motivation, effort and compensatory strategies, such that reliable differences only emerge when cognitive load is high (Berggren & Derakshan, 2013; Bretherton et al., 2020). Under high-load conditions, the cognitive resources necessary to engage in compensatory strategies are exhausted, and this reduces performance effectiveness and efficiency (Berggren & Derakshan, 2013; Hepsomali et al., 2019).

Attention Control as a Moderator

Regardless of whether weaker AC is conceived as a cause or consequence of anxiety, its relationship with anxiety is attributed to a failure to override biased automatic processing of threat stimuli. Logically, therefore, the relationship between trait anxiety and attention bias should be attenuated by stronger AC. High trait-anxious individuals with lower AC may be particularly vulnerable to further depletions in control in the presence of threat due to state anxiety, resulting in difficulties in disengagement. Two studies have found that stronger AC attenuates attention bias in trait anxiety (Derryberry & Reed 2002; Reinholdt-Dunne et al., 2009).

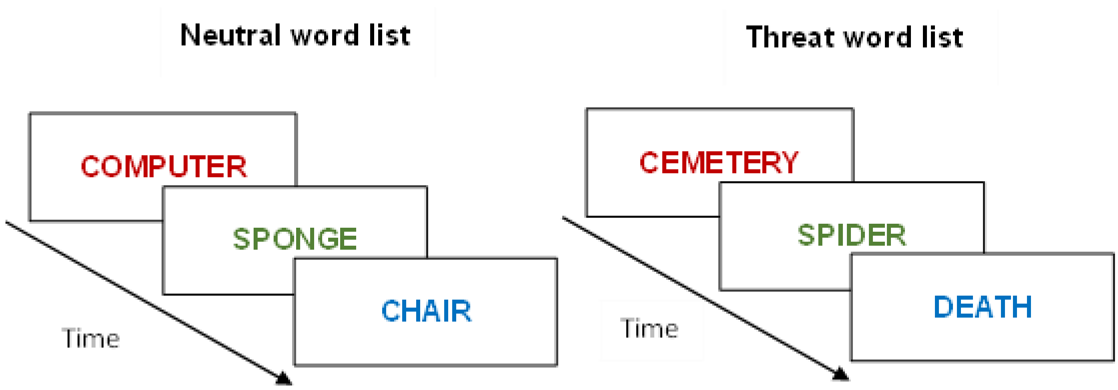
Derryberry and Reed (2002) investigated the effect of attention control on early and late-stage attention biases using a spatial orienting task. AC was measured through self-reported endorsements of statements such as "*my concentration is good even if there is music in the room around me".* Attention control did not moderate the relationship between early attention bias and anxiety, indicating that AC had limited effect on engagement (Derryberry & Reed). However, weaker AC combined with high trait anxiety resulted in late-stage attention biases in the form of disengagement difficulties. Furthermore, high anxiety combined with stronger control did not show disengagement difficulties. Taken together these findings suggest that AC influences disengagement from, but not orienting towards threat in anxiety. One caveat with these findings is that AC was self-reported, and may only reflect confidence in attention control ability, rather than AC performance (Quigley, et al., 2017; Reinholdt-Dunne et al., 2013).

Considering this methodological limitation, Reinholdt-Dunne et al. (2009) used an objective measure of AC (i.e., Attention Network Task) and found high trait anxiety combined with lower control resulted in cognitive interference from threatening (angry) faces relative to neutral faces during an *emotional* Stroop task. Participants with high anxiety and stronger control did not demonstrate interference. This suggests that anxious participants with weaker control experienced greater difficulties initiating AC. These results support the idea that individual variations in attention control may explain the mixed findings regarding the relationship between anxiety and attention bias.

While the colour-word Stroop is a widely accepted measure of AC, the use of an emotional Stroop to elicit *attention biases* has been criticised. The emotional Stroop asks participants to name the font colour while ignoring the word, which can be negative (e.g., cemetery) or neutral (computer). Figure 2 provides an example of negative and neutral words on an emotional Stroop Task.

Figure 2

Examples of Neutral and Threat Words on an Emotional Stroop Task



Note. Naming the font colour of neutral words should occur more quickly compared to threat words, as participants have difficulty disengaging with the semantic meaning of the word.

Slower responses on threat trials are presumed to reflect interference from threat information. Wingenfeld et al. (2006) argue that the emotional Stroop cannot differentiate between types of attention bias (i.e., shifting towards versus away from threat) because task relevant and irrelevant information are in the same location. The semantic content of the word is irrelevant, but the font colour is relevant (see Figure 2 for examples). Slowed responses on threat trials could be the result of different processes: (i) automatic orientation towards threat information (engagement bias); (ii) challenges inhibiting and attention from the negative content (disengagement difficulty). Consequently, conclusions about the influence of AC on specific attention biases are limited (Wingenfeld et al., 2006).

Furthermore, two studies found opposite moderation effects at higher levels of control in social anxiety, using objective measures of control ability (Gorlin & Teachman, 2015; Taylor et al., 2016). In both studies, consistent with predictions, for participants with lower inhibition/shifting ability, the relationship between disengagement difficulties and trait anxiety was positive (Gorlin & Teachman, 2015; Taylor et al., 2016). However, at stronger attention control, the relationship between disengagement difficulties and trait anxiety was *negative* (Gorlin & Teachman, 2015; Taylor et al., 2016). In other words, ironically, both studies found that stronger control was associated with faster disengagement from threat, but higher levels of anxiety.

This faster disengagement may represent attentional avoidance of threat, which can occur in high trait anxiety (Garner et al., 2006; Gorlin & Teachman, 2015; Taylor et al., 2016). This mirrors the proposition that avoidance (e.g., of anxious thoughts, or places that provoke anxiety) maintains anxiety by preventing attenuation of anxious responses (Salters-Pedneault et al., 2004). While this explanation for the unexpected negative relationship is plausible, it is important to note that Gorlin and Teachman (2015) and Taylor et al. recruited participants who were high in trait social anxiety. Therefore, a non-anxious control group is needed to establish whether reduced disengagement bias at higher levels of control meant that there was no bias (i.e., anxious, and non-anxious participants disengaged from threat at similar speed) or whether it created attentional avoidance. Attentional avoidance in this context would present as anxious participants being faster at disengaging from threat than controls (e.g., Reinholdt-Dunne et al., 2009; Derryberry & Reed, 2002).

The first aim of Study 1 was to clarify the effect of AC on the anxiety–attention bias relationship, by using a sample with a wider range of trait anxiety and objective measures of AC. Objective AC measures (e.g., colour-word Stroop Task) are advantageous because they capture AC *performance*, rather than self-reported *confidence* in AC ability. That is important because confidence can be impacted by mood states (Bucarelli & Purdon, 2016; Culot et al., 2021; Massoni 2014), and may not accurately reflect AC performance (Quigley et al., 2017).

A methodological consideration is that the attention bias task needs to be able to distinguish between the different types of bias. Although the dot-probe task is commonly used to assess attention bias, some versions cannot provide measures of engagement and disengagement bias due to the way they are configured (Rudaizky et al., 2013). When investigating attention control's effects, this distinction is important. Engagement bias is the result of bottom-up orienting to threat, whereas disengagement bias and attentional avoidance are the consequences of top-down orienting (Petersen & Posner, 2012). From a theoretical perspective, engagement bias may not be associated with AC because control processes are initiated after task-irrelevant threat has been detected (i.e., after engagement has occurred). However, AC may contribute to attentional shifts away from threat (i.e., reduce disengagement bias) when attention to threat conflicts with task demands. Therefore, a dot-probe task (Rudaizky et al., 2013) that could distinguish between engagement and disengagement biases was selected to measure attention bias in the current study.

Avoidance of threat inside and outside of laboratory tasks.

Results from Gorlin and Teachman (2015) and Taylor et al. (2016) indicate that AC has the potential to reduce the *immediate* impact of automatic processing by reducing state anxiety and/or interference with task performance. Yet, multiple theories predict that avoidance is detrimental in the longer term (Borkovec et al., 2004; Foa & Kozak, 1986; Mogg & Bradley, 1998; Roemer et al., 2005; Skinner et al., 2003). While attention control can facilitate disengagement on external attention tasks within laboratory settings (e.g., Gorlin & Teachman; Taylor et al.), it is unclear how AC contributes to threat outside of the laboratory.

Laboratory tasks provide an incentive to ignore threat stimuli because attending to them impairs performance (e.g., on the emotional Stroop, dot-probe, or similar tasks). These findings may extend to habitual reactions to *internal* stimuli, such as thoughts, as anxious individuals may be motivated to suppress them (e.g., to reduce state anxiety). Laboratory tasks typically measure attentional avoidance of *external* threat-stimuli, but anxiety is also linked with the avoidance of *internal threats*, which take the form of thoughts, memories, emotions, images or physical sensations (Chawla & Ostafin, 2007; Hayes et al., 2004).

A common assumption is that, because attention bias correlates with cognitive symptoms of anxiety (e.g., worry; Goodwin et al., 2017), external attention tasks also reflect internal attention processes (e.g., to thoughts). However, only one study has tested that presumption directly. In a sample of anxious youth, Price et al. (2016) found that attention bias predicted greater avoidance (e.g., suppression and distraction) in response to negative events. Notably, however, attention bias was assessed using a version of the dot-probe where attentional engagement and disengagement could not be disentangled, therefore conclusions regarding the relationships between types of attention bias (i.e., engagement, disengagement, and attentional avoidance) and reactions to negative events and thoughts could not be drawn.

The link between attention bias tasks and reactions to negative thoughts or events outside of the laboratory is important as it has implications for treatment approaches that modify attention biases to reduce anxiety. If visual attention tasks are *not* linked to reactions to internal stimuli, the extent to which findings from laboratory tasks can be applied to anxious thought processes is limited.

Negative thoughts may motivate anxious individuals to engage in *cognitive* a*voidance* to reduce state anxiety or maintain goal pursuits. Cognitive avoidance refers to strategies that are used to inhibit attention to thoughts or mental images. Examples are thought suppression, distraction, worry, rumination and thought substitution (Gosselin et al., ,2002; Sexton & Dugas, 2008). Cognitive avoidance strategies are related to trait anxiety and Generalized Anxiety Disorder (GAD; Dickson, Ciesla, & Reilly, 2012; Gosselin et al., 2002; Olatunji et al., 2010). The relationship between AC and cognitive avoidance is important because intrusive thoughts are a pervasive debilitating symptom of anxiety; and the role of AC processes in relation to habitual reactions (e.g., cognitive avoidance) to these thoughts is unclear.

Attention Control and Cognitive Avoidance. Logically, AC should facilitate cognitive avoidance as it allows for the manipulation of thought content. Two studies have investigated whether AC facilitates worry, a form of cognitive avoidance, in GAD samples, with conflicting results. Worry is conceptualised as form of avoidance as verbal-linguistic processing inhibits the processing of more emotionally evocative imagery (Borkovec, 1994). Price and Mohlman (2007) found that in a GAD sample, but not aged-matched controls, AC measured by the colour-word Stroop was strongly positively correlated with trait-worry. In contrast, Hallion et al. (2017) found that trait-worry did not predict colour-word Stroop performance after controlling for GAD status. However, Hallion et al.'s finding may be explained by their method of analysis. As worry is a core feature of GAD (APA, 2022), controlling for GAD status might have reduced the variance explained by trait worry, as the shared variance was partialled out.

To date, separate bodies of research have focussed on immediate reactions to threat (i.e., laboratory tasks) and self- reported cognitive strategies that are used to ameliorate the effects of negative thoughts. Theoretical models in both areas propose that attentional disengagement and cognitive avoidance maintain trait anxiety by circumventing emotional processing (Borkovec et al., 2004; Mogg & Bradley, 1998; Riskind, 2005; Salters-Pedneault et al., 2004). These immediate reactions and cognitive strategies are believed to be related to AC (Mogg & Bradley, 2016). Investigating immediate reactions and habitual cognitive strategies and their relationship may bridge these areas of research and contribute to understanding the relationship between attention control and anxiety. Therefore, the second aim of this study was to investigate whether attention tasks (i.e., dot-probe and Stroop task) are related to self-reported cognitive avoidance (Cognitive Avoidance Questionnaire: CAQ, Gosselin et al., 2002; Sexton & Dugas, 2008).

Hypotheses

In summary, attention control is proposed to facilitate attentional shifting away from irrelevant information on external attention tasks. As engagement bias is presumed to rest on automatic processes and attention control is effortful and strategic, attention control would not be expected to influence the relationship between anxiety and engagement bias. Conversely, attention control is implicated as a core process in disengagement and avoidance. Disengagement bias occurs when there is slower disengagement from threat compared to neutral stimuli, whereas attentional avoidance occurs when disengagement from threat is faster compared to neutral stimuli. Attention control, while presumed to be protective in anxiety, may present as a double-edged sword. If AC is indeed protective against attention bias, the relationship between anxiety and disengagement difficulties should be less positive (i.e., the time taken to disengage from threat and neutral stimuli should be more similar). However, if stronger attention control is maladaptive, a reversed relationship would be seen, such that at stronger control, anxiety would be associated with attentional avoidance (i.e., disengagement from threat would be faster for threat compared to neutral stimuli).

Based on the assumption that anxiety is characterised by avoidance of negative thoughts, we expected that trait anxiety would be positively correlated with self-reported cognitive avoidance (CAQ scores). Regarding the relationships between attention control and cognitive avoidance, no a priori predictions were made. If attention control facilitates disengagement from thoughts, participants with stronger control would be expected to report more cognitive avoidance, presumably because they would be more successful at it.

1. Attention Control will attenuate the relationship between trait-anxiety and disengagement from threat. At weaker control (higher Stroop interference), trait

anxiety will be positively related to the time taken to disengage from threat stimuli. As control increases (lower Stroop interference), the relationship will become weaker.

2. Trait anxiety and self-reported cognitive avoidance (CAQ scores) scores will be positively correlated.
3. As Stroop interference increases (i.e., attention control decreases), self-reported cognitive avoidance will decrease.
4. Disengagement bias will be negatively correlated with CAQ.

Method

Participants

One hundred and twenty-five participants (99 female; aged 18 – 67 years, *M* = 21.93, *SD* = 5.56) were recruited through the Flinders University School of Psychology, where first year psychology students may volunteer to participate in research for partial course credit, or payment of $15.00. An undergraduate sample was appropriate as attention biases associated with trait-anxiety have been demonstrated in this population (Rudaizky, Basanovic, & MacLeod, 2014). Participants were included if they reported normal colour vision, with normal, or corrected to normal visual acuity.

Design

This study employed a correlational design. The predictor variables were trait-anxiety and attention control (i.e., based on Stroop Interference). Attention control was calculated based on reaction times on the Colour-Word Stroop. Trait-anxiety was assessed via self-report questionnaire. The outcome variables were engagement bias, disengagement bias (disengagement difficulties or attentional avoidance), and cognitive avoidance. Attention biases were calculated based on reaction times on the modified dot-probe. Cognitive avoidance strategies were self-reported using the Cognitive Avoidance Questionnaire (Gosselin et al., 2002; Sexton & Dugas, 2008). Participants also completed a thought suppression task which is presented in Study 2 (Chapter 3).

Materials

Stimulus materials and equipment

Apparatus. Participants completed computerised versions of the colour-word Stroop, modified dot-probe and thought suppression tasks on a Dell OptiPlex 3010/3020 on a 22-inch desktop computer display. The experimental tasks were performed using Presentation® software (Version 18.1, Neurobehavioral Systems, Inc., Berkeley, CA, www.neurobs.com). Responses for the Colour-Word Stroop, Dot-probe and Thought Suppression Task were recorded using a standard QWERTY keyboard. Participants completed each measure in the order that they are described.

Colour –Word Stroop. The colour-word Stroop (Stroop, 1935) was used to objectively measure attention control. Participants were presented with words that were written in coloured font, and their task was to name the font colour as quickly and accurately as possible. Participants responded by pressing corresponding keys set on a keyboard. The stimuli consisted of four colour words— “red,” “green,” “yellow,” and “blue”—presented in either a congruent or incongruent font colour. Incongruent trials are presumed to tap into AC as the automatic response to read and name the word on the screen (e.g., “blue”) must be inhibited to name the colour of the font (e.g., red). Participants completed 12 practice trials, with congruent and incongruent trials occurring equally. The critical block consisted of 96 colour-word stimuli, presented in quasi-randomised order, such that congruent trials are presented at twice the frequency of incongruent trials. Following Gorlin and Teachman

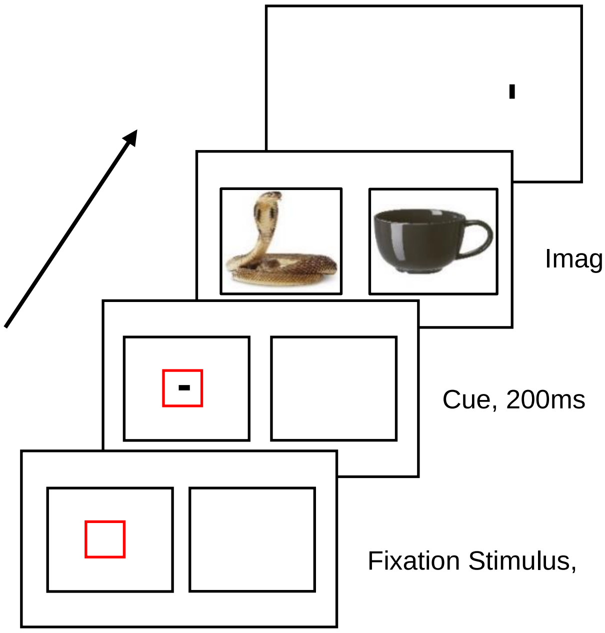
(2015), the ratio of congruent to incongruent trials was imbalanced to make the task more difficult and produce greater variation in scores in the sample (Engle, 2002).

Each trial began with a white fixation cross on a black screen for 250ms, followed by a blank black screen (250ms). Then, the colour word appeared in the centre of the screen in lower case and remained on screen until the participant responded with a keypress. Response times were recorded from stimulus onset to response completion. An index of attention control, hereon referred to as Stroop Interference, is calculated by subtracting the mean response latency of congruent from incongruent trials. Higher Stroop Interference indicates lower attention control.

Modified dot-probe. Attention biases towards threat were assessed using a modified dot-probe task (Rudaizky et al., 2013), which allows separate assessments of engagement and disengagement biases. Attention biases are inferred by response times taken to identify probes that replace negative compared to neutral images. Briefly, attention is anchored to one side of the screen and then participants are presented with a pair of images (negative-neutral or neutral-neutral). The images disappear, and participants are required to identify and respond to a probe that replaced one of the images. An example trial is presented in Figure 3.

Figure 3

Example of a disengagement bias assessment trial on the modified dot-probe task. Figure not to scale. Images are example stimuli.



Note. In this trial, the cue and probe lines do not match (i.e., one is vertical, and one is horizontal), therefore the participant would indicate "no".

Each trial began with the presentation of two white square outlines on alternate sides of the screen, identifying the locations where images would appear. A cue in the form of a smaller red square (20 mm x 20 mm; 1000 ms) appeared in one of the white squares with equal frequency, to indicate the area of the screen where the cue-line (i.e., red 5mm line: vertical or horizontal) would appear (200 ms). This anchored attention to one side of the screen.

The cue disappeared and two images appeared for 500ms. Image pairs were negative-neutral (e.g., snake vs mug), or neutral-neutral (e.g., ball vs chair). As stimuli disappeared, the probe (5mm red line: vertical vs horizontal) replaced one of the images. The probe-line matched (i.e., both vertical) or mismatched (i.e., one was vertical, the other was horizontal) the cue-line, and remained on screen until participants responded. Participants identified whether the probe matched the cue-line using keys marked "Y" (match) and "N" (non-match) on a QWERTY keyboard. Following a response, the screen was cleared for 1000ms before the next trial commenced. Table 1 outlines the different configurations of locations where cues and probes are presented in relation to the target image.

Table 1

Configurations of Cue Locus, Image Valence and Probe Locus for Each Dot-probe Condition

Condition	Cue locus	Target valence	Probe locus
Engagement trials			
a	Distal	Negative	Distal
b			Proximal
c		Neutral	Distal
d			Proximal
Disengagement trials			
e	Proximal	Negative	Distal
f			Proximal
g		Neutral	Distal
h			Proximal

Note. Proximal = appearing at the same location as the target image; Distal = appearing on the opposite side as the target image

Engagement bias. Trials that measured engagement bias were conditions in which both the target image (whether negative or neutral) and probe were presented as distal (i.e., opposite) to the original locus of attention. On trials with negative-neutral image pairs, the negative image is always the target. When the target image and probe are presented distal to the initial locus of attention, the speed with which attention is shifted to engage with threat relevant information, relative to maintaining attention in the vicinity of neutral information, can be assessed. That is, target images and probes that are distal to the initial locus measure how quickly attention is shifted from the initial locus towards threat. Engagement with threat is evidenced by faster responding to probes that appear in the location of negative images on negative-neutral trials, compared to target images on neutral-neutral trials. On the dot probe-task, engagement was calculated according to Rudaizky et al. (2014), using reaction times on trials where cues were presented distal to target images (Table 1, $a – d$):

$$Engagement\ Bias = (a - b) - (c - d)$$

Higher engagement scores represent selectively enhanced shifting of attention towards initially unattended distal images when these are negative rather than neutral in emotional tone.

Disengagement. Trials that measured disengagement were conditions where the target image (whether negative or neutral) was presented in the same (proximal) locus as the initial focus of attention, but the probe was distal to the initial focus of attention. An example disengagement trial is presented (as per Figure 3). On negative-neutral trials, the negative image was always the target image. The speed with which attention is shifted to engage with neutral information relative to maintained attention in the vicinity of threat can be assessed. Therefore, trials where the negative image is proximal to initial locus of attention, but the probe is distal to the initial locus, measure the extent to which attention is maintained to or 'stuck' on threatening information. Disengagement difficulties would be evidenced by slower responses on negative-neutral trials to identify probes that appeared distal to the initial locus of attention, compared to neutral-neutral trials. Faster responses to identify probes on negative-neutral trials compared to neutral-neutral trials where the probe is distal to the initial locus of attention would indicate attentional avoidance. Disengagement was calculated using reaction times on trials where the cue probe was proximal to the target image (negative or neutral, i.e., Table 1: e- h), based on Rudaizky et al. (2014).

$$Disengagement\ bias = (e - f) - (g - h)$$

Higher scores represent a heightened tendency for attention to be held in the locus of initially attended proximal images when they are negative rather than neutral in emotional tone. Positive scores indicate disengagement difficulties from negative compared to neutral stimuli. Negative scores indicate attentional avoidance of negative compared to neutral stimuli.

The purpose of using neutral-neutral image pairs, in addition to negative-neutral pairs, is to determine baseline levels of attentional shifting (i.e., how quickly they can shift attention in the presence of neutral information; Cisler et al., 2009). It also allows the measurement of biases towards threat to be disentangled from general shifting ability. This is necessary as differences between low- and high anxious groups should only occur for threat-related stimuli.

Anchoring attention is done for two reasons. First, anchoring to one side of the screen controls for individual differences in the allocation of attention (Rudaizky et al., 2013; Clarke et al., 2013). The use of probe identification (i.e., match vs mismatch) is an objective measure of whether participants followed attention anchoring instructions (i.e., errors indicated that attention was not anchored). As the cue-line was only presented for 200 ms, its orientation could only be detected if participants' attention was already oriented in the location before its onset. Second, anchoring attention allowed us to observe how quickly participants were able to shift their attention to identify the probe, when their attention was initially focussed on the locus of negative or neutral images.

The stimulus set contained 64 images selected from the International Affective Picture System (IAPS: Lang, Bradley & Cuthbert, 2008). The IAPS comprises images pre-rated for affective valence on a nine-point scale, where 1 = *unpleasant* and 9 = *pleasant*). Images are also pre-rated on arousal (9-point scale, where 1 = *calm* and 9 = *excited*) and dominance/control (9-point scale where 1 = *out of control* and 9 = *in control*). There were 32 image pairs (16 negative-neutral and 16 neutral-neutral). None of the neutral images in the negative-neutral pairs were used in neutral-neutral pairs. Based on these pairings, there were four image types 1) negative target image in the negative-neutral pair, 2) neutral non-target image in the negative-neutral pair, 3) target image in the neutral-neutral pair, 4) non-target in the neutral-neutral pair.

Images were selected on the premise that negative images would differ from all neutral image groups on pleasantness (i.e., affective valence), but not on arousal or dominance. One-way ANOVAs confirmed that the image types did not differ on arousal or dominance ratings (see Table 2 for descriptive and inferential statistics) but did differ on affective valence. Games Howell post-hoc tests revealed that negative images were significantly lower on pleasantness than neutral images in the negative neutral pair ($p < .001$, $d = 4.77$), targets in the neutral-neutral pair ($p < .001$, $d = 4.55$) and non-targets in the neutral-neutral pair ($p < .001$, $d = 4.63$). For negative images the mean affective valence was below the mid-point of the scale (i.e., 5) and neutral items were close to the mid-point. Neutral images in the negative neutral pair did not differ in valence ratings from the target neutral image ($p = .311$, $d = 0.66$), and the non-target neutral image ($p = .577$, $d = 0.44$). For neutral-neutral pairs, the target image did not differ in valence from the non-target ($p = .956$, $d = 0.22$).

The dot-probe consisted of 256 experimental trials divided into four blocks, with 2 buffer trials at the commencement of each block. Buffer trials were not included in the analyses. Prior to the commencement of the experimental blocks, participants completed 12 practice trials with feedback using images that were not included in the experimental trials (e.g., beach ball). Across each experimental trial and block, the order and presentation of the images and condition was randomised.

Table 2

Descriptive and Inferential Statistics for Comparisons of Dot-Probe Image Types

Image Type	*M* (SD)	Inferential statistics
Affective valence		
Negative (negative/neutral)	2.88 (0.64)	
Neutral (negative/neutral)	5.13 (0.19)	$F(3,60) = 150.95$, $p < .001$
Target (neutral/neutral)	5.01 (0.17)	
Non-target (neutral/neutral)	5.05 (0.17)	
Arousal		
Negative (negative/neutral)	4.28 (0.91)	
Neutral (negative/neutral)	4.50 (1.22)	$F(3,60) = 2.66$, $p = .06$
Target (neutral/neutral)	5.26 (1.09)	
Non-target (neutral/neutral)	4.99 (1.13)	
Dominance		
Negative (negative/neutral)	5.32 (0.93)	
Neutral (negative/neutral)	5.73 (0.93)	$F(3,60) = 1.86$, $p = .15$
Target (neutral/neutral)	5.64 (0.41)	
Non-target (neutral/neutral)	5.91 (0.40)	

Spielberger Trait Anxiety Inventory. Trait anxiety was assessed with the 20-item trait subscale of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger et al., 1983). Scores can range from 20-80, with higher scores indicating greater trait-anxiety. The STAI-T has been shown to have good reliability and validity (Gros et al, 2007). In the present study, the STAI-T demonstrated good internal consistency ($\alpha = .93$).

Cognitive Avoidance Questionnaire. The Cognitive Avoidance Questionnaire (CAQ; Gosselin et al., 2002; Sexton & Dugas, 2008) is a 25-item self-report measure of the tendency to employ cognitive avoidance strategies when dealing with threatening intrusive thoughts. The CAQ comprises five subscales measuring Thought Suppression (e.g., "I have thoughts that I try to avoid", Thought Substitution (e.g., "I think about things that concern me as if they were occurring to someone else"), Distraction (e.g., "Sometimes, I throw myself into an activity so as to not think about certain things"), Avoidance of Threatening Stimuli (e.g., "I avoid actions that remind me of things I do not want to think about", and the Transformation of Images into Thoughts (e.g., "When I have mental images that are upsetting, I say things to myself in my head to replace the images". Statements describing the use of these strategies are rated on a 5-point Likert scale, ranging from 1 (*not at all typical*) to 5 (*completely typical*). Scores on the 5 subscales were summed to provide an overall measure of cognitive avoidance. Scores could range from 25 – 125, with higher scores indicating greater cognitive avoidance.

In the present study the CAQ and its subscales had good internal consistency (CAQ total $\alpha = .95$; suppression $\alpha =.90$; substitution $\alpha =.77$; distraction $\alpha = .91$; avoidance $\alpha =.89$; transformation $\alpha =.85$) and it has demonstrated high test-retest reliability ($r = .85$; Sexton & Dugas, 2008). The CAQ has demonstrated convergent validity with questionnaire measures of worry (i.e., Penn State Worry Questionnaire and Catastrophic Worrying Questionnaire, $r = .57$ and $r = .64$, respectively; Sexton & Dugas, 2008) and self-report measures of thought suppression (White Bear Suppression Inventory-Thought Suppression, *r* = .72; Sexton & Dugas, 2008).

Procedure

The experiment took place in a laboratory in the College of Education, Psychology and Social Work at Flinders University, South Australia. Ethics approval was gained from the Social and Behavioural Research Ethics Committee. Experimental sessions took approximately 45 minutes to complete, with up to three participants attending at one time. Participants completed tasks individually during one session. The experimental procedure is outlined in Appendix A.

Results

Data preparation and descriptive statistics

Outliers were identified at the intra-participant (across trials) and inter-participant level for Stroop and dot-probe data. Following Mogg et al. (1993), response latencies that were errors and intra-participant outliers (<100 ms or >4000ms, or >3 *SDs* away from a participant's mean latency within a given condition) were excluded from the calculations of the Stroop Interference (5.39% of trials). Stroop Interference was calculated by subtracting the mean RT for incongruent (e.g., "blue" written in red font) trials from congruent trials (e.g., "green" written in green font). Higher scores indicated greater colour-word interference and thus weaker attention control.

For the dot-probe task, mean response latencies in each condition (i.e., location of cue and probe relative to target image, see Table 3) were used to calculate engagement and disengagement bias. Consistent with Rudaizky et al. (2013), errors and intra-participant outliers identified using a 99% confidence interval (i.e., greater than 2.58 *SDs* away from the participant’s mean latency within a given condition) were excluded from attention bias calculations.

Table 3

Mean Response Latencies (Reaction Time, ms) for Each Experimental Condition of the Dot-probe

Condition	Cue locus	Image valence	Probe locus	*M* (SD)	Range
Engagement trials					
a	Distal	Negative	Distal	750.62(141.67)	490.23 – 1097.45
b			Proximal	739.96(140.69)	491.25 – 1070.41
c		Neutral	Distal	735.91(133.86)	489.04 - 1100.99
d			Proximal	723.86(134.39)	457.56 – 1077.65
Disengagement trials					
e	Proximal	Negative	Distal	741.36(147.87)	478.45 - 1087.85
f			Proximal	757.06(146.89)	469.57 – 1146.93
g		Neutral	Distal	734.61(145.65)	469.22 – 1094.93
h			Proximal	745.21(154.67)	426.73 – 1131.19

Note. Distal indicates that the cue or probe was presented on the opposite side of the target image. Proximal indicates that the cue or probe was presented on the same side as the target image.

Distribution characteristics

Reaction times were screened for non-normality. Stroop interference (Stroop Task), engagement and disengagement biases (dot probe) were non-normally distributed. See Table 4. Stroop interference and engagement bias were positively skewed, and both engagement and disengagement bias were leptokurtic. STAI-T and CAQ scores were normally distributed.

Table 4

Distribution Characteristics for the Distribution of Stroop Interference, Engagement, and Disengagement Indices

Variable	Skewness	SE Skewness	Skewness z-score	Kurtosis	SE Kurtosis	Kurtosis z-score
Stroop Interference	1.00	.23	4.57**	0.80	.43	1.87
Engagement †	7.44	.23	3.43**	71.56	.43	164.73**
Disengagement †	-0.17	.23	-0.80	1.90	.43	4.42*

Note. N = 125; †N = 124. *p<.01 **p<.001

Stroop Interference was calculated based on the Stroop Task

Engagement and Disengagement were based on the dot-probe

To reduce the impact of outliers and improve normality, inter-participant outliers were rescaled prior to analyses. Outliers were defined as values deviating by more than three times the interquartile range from the lower or upper quartile of a variable's distribution (Gorlin & Teachman, 2015). They were rescaled by reassigning outlying values to the nearest value lying in the valid distribution plus one (Tabachnick & Fidell, 2013). This strategy, referred to as Winsorizing, was selected as it reduces the influence of extreme scores whilst maintaining all data points, which promotes accuracy and power (Price et al., 2015). Following Winsorization, engagement and disengagement biases derived from the dot-probe were normally distributed. Stroop interference remained positively skewed but was closer to a normal distribution than raw scores. See Table 5 for distribution characteristics of the rescaled Stroop interference, engagement, and disengagement.

Table 5

Distribution Characteristics for the Rescaled Stroop Interference, Engagement, and Disengagement Indices

Variable	Skewness	SE Skewness	Skewness z-score	Kurtosis	SE Kurtosis	Kurtosis z-score
Stroop Interference	.616	.217	2.84*	-.277	.430	-0.64
Engagement †	.035	.217	.16	.176	.431	0.91
Disengagement †	.050	.217	.23	1.26	.431	2.92

Note. *N* = 125; †*N* = 124. **p*<.001

Stroop Interference was calculated based on the Stroop Task

Engagement and Disengagement were based on the dot-probe

Table 6 displays the means, standard deviations and inter-correlations for attention control and attention biases, trait anxiety and cognitive avoidance strategies. The mean Stroop Interference score was positive indicating participants were faster at naming the font colour when the colour-name was congruent (e.g., “red” written in red font) compared to incongruent (e.g., “red” written in blue font). A one sample t-test confirmed that differences in font-naming latencies (i.e., Stroop Interference scores) were significantly larger than zero, $t(124) = 13.53$, $p < .001$, $d = 1.21$, and the effect was large. Threat-related images did not capture attention more readily than neutral images, as the mean engagement bias score for the whole sample was not significantly different from zero, $t(123) = -0.27$, $p = .40$; $d = -0.02$. Overall, participants shifted their attention away from negative and neutral stimuli at similar speeds, as the mean disengagement bias score for the whole sample was not significantly different from zero for the whole sample, $t(123) = -0.74$, $p = .23$, $d = -0.07$.

Trait anxiety was moderately positively correlated with the CAQ and its subscales, indicating that higher trait anxiety was linked to greater self-reported use of cognitive avoidance. Engagement and disengagement were not correlated with each other (as observed elsewhere, e.g., Rudaizky et al., 2013). There were no significant correlations between trait anxiety, attention bias or Stroop interference. Against predictions, CAQ scores were not correlated with AC or attention bias.

Table 6

Means (Standard Deviations) and Correlations Between Trait Anxiety, CAQ Subscales, Stroop Interference Engagement and Disengagement Bias

Variable	M (SD)	1	2	3	4	5	6	7	8	9	10
1. STAI-T	48.55(11.07)	-									
2. Suppression	15.62(5.17)	.47**	-								
3. Substitution	11.71(4.43)	.46**	.62**	-							
4. Distraction	14.99(5.40)	.47**	.77**	.71**	-						
5. Avoidance	13..82(5.35)	.56**	.76**	.61**	.73**	-					
6. Transformation	12.30(4.80)	.36**	.52**	.59**	.59**	.60**	-				
7. CAQ Total	68.45(21.39)	.53*	.87**	.82*	.90**	.88*	.77**	-			
8. Stroop Interference	90.43(74.74)	-.03 $^{\rho}$	-.15 $^{\rho}$	-.08 $^{\rho}$	-.10 $^{\rho}$	-.17 $^{\rho}$	.02 $^{\rho}$	-.11 $^{\rho}$	-		
9. Engagement Bias †	-1.39(57.90)	.05	-.13	-.04	-.12	-.03	-.07	-.03	.04 $^{\rho}$	-	
10. Disengagement Bias †	-5.1(76.24)	.04	-.03	-.11	.01	.04	.01	-.13	.04 $^{\rho}$	.11	-

Note. Minimum – Maximum: STAI-T 24 - 77; Suppression: 5 – 25; Substitution: 5-25; Distraction: 5 – 25; Avoidance: 5-25; Transformation: 5-23; CAQ Total: 25-121; Stroop Index: -41.94 – 251.03; Engagement Bias: -142.22 – 149.30; Disengagement Bias: -235.17- 270.24; Engagement and disengagement bias were derived from the dot-probe, Stroop interference was derived from the Stroop task

N = 125; $^{\dagger}N$ = 124

* p < .05; ** p < .01; *** p < .001; ρ = Spearman's rho

Moderation Analyses

To test whether attention control moderated the effect of trait anxiety on attention biases, separate moderation analyses (PROCESS, Model 3, with 10,000 bootstraps; Hayes 2018) were performed on the dependent variables of engagement and disengagement bias. In each model, trait anxiety (STAI-T scores) and attention control (Stroop interference) were predictors. All predictors were centred (Akien & West, 2000). The residuals for the predictors and dependent variables were normally distributed. One participant's data was missing (i.e., computer error) and excluded from analyses. All analyses were tested using an alpha level of .05.

Attention Control and Disengagement Bias

Table 7 presents the results of the regression predicting disengagement bias. Neither anxiety nor attention control predicted disengagement, however the interaction was significant. We predicted that at lower attention control (i.e., higher Stroop interference), there would be a positive relationship between trait anxiety and the time taken to disengage from threat; and that at higher attention control (lower Stroop interference) the relationship would be weaker. Contrary to the hypothesis, at lower control (higher Stroop interference) anxiety did not have an effect on disengagement (see Figure 4, small dashed line). At mean (large dashed line) and high attention control (i.e., lower Stroop interference, solid line), the relationship appeared to be positive. This indicated overall that as attention control increased, increases in anxiety corresponded with slower disengagement from threat.

Table 7

Hierarchical Regression Analyses for Individual Differences in Trait Anxiety and Attention Control Predicting Disengagement Bias Scores for Threat Stimuli

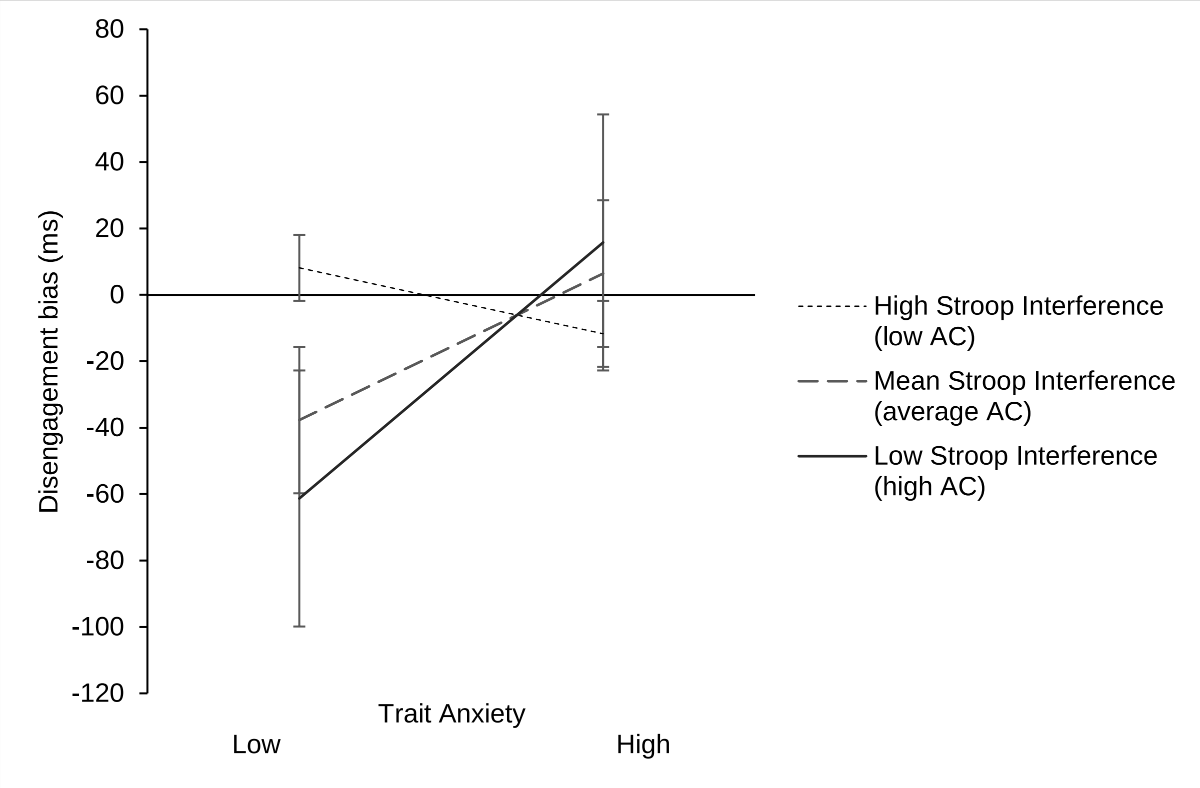
Predictor	*b*	*SE b*	*t*	*p*	sr^2	*95% CI*
	R^2 = .05, F(3,120) = 2.15, p =.10					
Constant	- 6.40	6.80	- 0.94	.35		[- 19.83, 7.02]
STAI-T	0.19	0.62	0.30	.76	.03	[- 1.04, 1.41]
Stroop Interference	0.08	0.09	0.91	.37	.08	[- 0.10, 0.26]
STAI-T x Stroop Interference	- 0.20	0.01	- 2.17	.03*	.19	[- 0.03, - 0.001]
	ΔR^2 = .04, F (1,120) = 4.72, p = .03*					

Note. N=124; sr^2 = semi-partial correlation coefficient; STAI-T = Trait anxiety.

* p <.05. ** p <.01. *** p <.001.

Figure 4

Interaction Between Trait Anxiety and Stroop Interference on Disengagement from Negative Stimuli



Note. Simple regression slopes for levels of interference (Low = *16th percentile;* Mean = *50th percentile;* and High = *84th percentile* from the mean) predicting disengagement bias for negative stimuli at low (*16th percentile*) and high (*84th* percentile) levels of trait anxiety. The bars represent standard errors. Positive values indicate disengagement difficulties; negative values indicate attentional avoidance.

Despite the significant interaction, simple slopes analysis revealed that none of the conditional effects were significant. At low and medium control, anxiety did not predict disengagement, b= -1.46, t(120) =1.41, p = .16; and b = 0.51, t(120) = 0.82, p = .41, respectively. The positive relationship between trait anxiety and disengagement RT from threat was marginally significant at high control (low interference), b = 1.53, t(120) = 1.87, p =.07. Follow up analyses indicated that the study was significantly underpowered. The observed power of the current study was α = .395, which is well below the recommended power of α =.80 (Cohen, 1992). This may explain why, although the slopes were significantly different from each other, individually, they did not differ significantly from zero, indicating there was no effect.

Attention control and engagement bias.

Table 8 presents the results of the regression predicting engagement bias. Trait anxiety, attention control, ang the interaction were not significant predictors of engagement with threat. Thus, attention control did not moderate the relationship between anxiety and engagement. No interaction was predicted as attentional engagement is presumed to be an early process, and thus its relationship with trait anxiety is unlikely to be affected by AC.

Table 8

Hierarchical Regression Analyses for Trait Anxiety and Attention Control Predicting Engagement Bias for Threat Stimuli

Predictor	*b*	*SE b*	*t*	*p*	sr^2	*95% CI*
	R^2 = .02, *F* (3,120) = 0.68, *p* =.57					
Constant	- 0.73	5.24	- 0.14	.89		[- 11.11, 9.64]
STAI-T	0.31	0.48	0.66	.51	.06	[- 0.63, 1.26]
Stroop Interference	- 0.01	0.22	- 0.22	.83	.20	[- 0.12, 0.15]
STAI-T x Stroop Interference	- 0.01	1.34	- 1.34	.18	.12	[- 0.004, 0.02]
	ΔR^2 = .01, *F* (1,120) = 1.79, *p* = .18					

Note. *N*=124; STAI-T = Trait anxiety; sr^2= the semi-partial correlation coefficient squared

* *p* <.05. ** *p* <.01. *** *p* <.001.

Discussion

This study investigated the relationship between trait anxiety, attention control (AC) and attention biases. We sought to test whether AC would be linked to different attention biases in trait anxiety, and whether stronger AC weakened the relationship between anxiety and attention biases. AC moderated the relationship between trait anxiety and attentional disengagement from, but not engagement with, threat. We predicted that at lower control (high interference), anxiety would be positively related to the time taken to disengage from threat compared to neutral stimuli, but the relationship would be weaker at stronger control (low interference). Unexpectedly, the opposite pattern emerged. At lower control (high interference), anxiety did not predict disengagement from threat. At higher control (low interference), disengagement was slower at higher levels of anxiety, but not significantly so.

Although the interaction between anxiety and attention control was significant, the non-significant conditional effects make the results difficult to interpret. Post-hoc power analyses conducted in G* Power Version 3.1.9.6 (Faul et al., 2009) indicated that the study was underpowered based on the variance explained by the total model (α =.587) and interaction term (α = .395). Furthermore, to detect an effect of the magnitude observed in this study, a total sample size of N = 277 would be required. Therefore, it is possible that the sample was too small to detect a significant effect of anxiety on disengagement at higher control. The sample size of the current study was based on other studies that have investigated the same constructs and relationships (e.g., Gorlin et al., 2015; Taylor et al., 2016), and was capped through the university research participant pool. Although the current effect size was similar to those with smaller (N = 75, Taylor et al., 2016) and larger (N = 159, Gorlin et al., 2015) sample sizes, significant relationships were not found in this study. One difference between our sample and other studies is that they recruited participants with elevated anxiety scores, and they measured social anxiety rather than trait anxiety (Gorlin et al., 2015; Taylor et al., 2016). Therefore, it is also possible that relationship between anxiety and disengagement is only significant in high anxious samples, or that these effects are characteristic of social anxiety specifically.

Nevertheless, the pattern of the interaction contradicts Attention Control Theory (Eysenck et al., 2007; 2023) and previous studies which indicate that attention control weakens the relationship between anxiety and slowed disengagement from threat (Derryberry & Reed, 2002; Gorlin & Teachman 2015; Reinholdt-Dunne et al., 2009; Taylor et al., 2016). However, similar to the current study, Schoorl et al. (2014) found that in a clinical sample of Post-Traumatic Stress Disorder (PTSD) patients, trait-anxiety was negatively related to attention bias in participants with lower control, indicating avoidance, whereas trait anxiety was positively related to attention bias in participants with stronger control, indicating disengagement difficulties. Regardless of the speculation regarding the direction of the moderating effect that AC has on the relationship between anxiety and attention biases, our results add to a growing body of evidence that AC influences the expression of strategic attention biases in anxiety (Derryberry & Reed, 2002; Gorlin & Teachman 2015; Reinholdt-Dunne et al., 2009).

A methodological consideration of this study is that our dot-probe task required a higher cognitive load compared to other studies. Participants indicated whether the probe matched the previous cue, whereas other studies asked participants to name the probe letter (i.e., Taylor et al., 2016) or its location (e.g., Reinholdt-Dunne et al., 2009). Our participants had to hold the orientation of the cue-line in working memory until the probe was presented to decide whether they matched. The increased working memory load may have increased the difficulty of the dot-probe and impaired the deployment of AC (Jonides, 1981; Engle, 2010). Studies that have manipulated working memory load on the dot-probe have found that at increased load, the relationship between anxiety and attention bias became more positive (i.e., Booth et al., 2017; Judah et al., 2013). These findings indicate that increased working memory load, and thus difficulty of the dot-probe can influence the relationship between anxiety and disengagement bias.

Trait anxiety was not directly related to engagement bias in the present study, which contrasts with meta-analytic evidence that anxiety is characterised by an automatic bias *towards* threat (Bar-Haim et al., 2007). A potential caveat is that the images were presented for 500ms in the current study in order to capture later-stage attention biases (i.e., disengagement and avoidance). Studies comparing the effects of stimulus duration on engagement bias in anxiety have found evidence of the bias at 100ms, but not at longer stimulus presentations (Carlson & Reinke, 2008; Koster et al.2006; Koster et al., 2004. Salemink et al., 2007). Thus, attention may have been influenced by later top-down control processes (i.e., attention maintenance or attentional avoidance; Cisler & Koster, 2010; Mogg & Bradley, 2016, 2018).

The current research also supports theories that suggest attentional engagement and disengagement are differentially influenced by top-down control (Carrasco, 2011). AC did not moderate the relationship between trait anxiety and engagement bias, consistent with past research (Taylor et al., 2016). As noted earlier, due to the presentation time on the current dot probe (500 ms), attention may have been influenced by later top-down control processes. Nevertheless, the lack of moderation is consistent with other studies (e.g., Derryberry & Reed, 2002; Taylor et al., 2016). Derryberry and Reed (2002) found that self-reported AC only moderated the relationship between anxiety and attention bias at longer (500 ms) but not shorter (250 ms) delays; indicating attention control influences strategic, but not automatic attention biases. To determine whether AC moderates the relationship between anxiety and engagement bias, future studies may wish to modify the dot-probe methodology reported here, using shorter (< 250 ms) and longer (500 ms – 1000 ms) stimulus presentations. To summarize, based on the methodological consideration of stimulus presentation time, conclusions regarding the automaticity of engagement bias and its relationship to attention control cannot be drawn. Nevertheless, regardless of the direction of disengagement bias (i.e., disengagement difficulties or avoidance) the present data clearly showed the role of AC in their expression.

Heterogeneity regarding the direction of the relationships between anxiety, attention control and attention bias continues to challenge researchers. Concerns have been raised regarding the reliability of mean-based measures of attention bias based on the dot-probe task, particularly as recent research suggests that there are considerable within-subject variations on these measures (Price et al., 2015; Macleod et al., 2019; Van Bockstaele et al., 2020). Contrary to theories where attention bias is conceptualized as a stable individual-difference characteristic (e.g., Mogg & Bradley, 1998; Williams et al., 1997), Zvielli et al. (2014) found that anxiety was linked to varied patterns of attention bias. In that study, 34% of participants demonstrated attention both towards *and* away from various categories of threat (e.g., threatening animals, faces, violence). This intra-individual variability may suggest that expressions of attention bias are the consequence of dynamic processes (Zvielli et al., 2015).

To address low reliability of traditional bias measures derived from the dot-probe, and the proposed dynamic nature of attention bias, newer measures have been developed (Price et al., 2015; Zvielli et al., 2015). Dot-probe and other attention bias tasks (e.g., spatial-cueing, Stroop, anti-saccade) repeatedly sample attention bias to threat over multiple trials. Traditional mean-based measures of attention bias are unable to capture dynamic shifts in attention bias over time, whereas newer calculation methods can capture attention bias variability. Attention bias variability refers to the fluctuations in attention bias over time (e.g., shifts from disengagement difficulties to avoidance). It is derived from multiple indices of attention bias captured over time (Zvielli et al., 2015; Iacoviello et al., 2014). Attention bias variability has been shown to have improved reliability compared to traditional measures of attention bias (Zvielli et al., 2015; Carlson & Fang, 2020), and has been linked to trait-anxiety and attention control (Clarke et al., 2020). Therefore, it may be useful to replicate the current study and compare the moderating effects of attention control on the relationship between anxiety and different attention bias measures (e.g., traditional vs attention bias variability).

Can Laboratory Tasks Predict Habitual Cognitive Avoidance?

Our second aim was to determine whether attentional reactions to external threat mapped onto the habitual use of cognitive avoidance strategies. A longstanding proposition is that anxious individuals avoid threat to reduce their immediate distress, yet in the long-term this avoidance prevents habituation, ultimately maintaining anxiety (Mogg et al., 1987; Riskind, 2005; Salters-Pedneault et al., 2004). In support of this, we found moderate positive correlations between anxiety and self-reported cognitive avoidance strategies such as thought suppression and distraction.

Logically, AC should facilitate the use of, and thus be positively correlated with, cognitive avoidance as it can be used to direct attention away from unwanted thoughts. However, AC was not correlated with self- reported cognitive avoidance. Similarly, cognitive avoidance was unrelated to engagement with or disengagement from threat stimuli. This may reflect that, despite an individual's (in)ability to direct attention generally or in the face of threat, they still attempt to avoid unwanted thoughts as a strategy to reduce distress. To gain a more comprehensive understanding of how AC and attention bias may relate to responses to internal threats, we employed a thought suppression task in Study 2. This allowed us to determine whether performance on external attention tasks (i.e., Stroop and dot-probe) could extend to internal attention tasks (i.e., thought suppression).

A potential caveat for the lack of correlations between cognitive avoidance and AC or attention bias is that cognitive avoidance was measured by retrospective self-report and may not accurately reflect behaviour when experiencing unwanted thoughts. There is evidence that attention bias predicts the subsequent use cognitive avoidance strategies (i.e., suppression and distraction; Price et al., 2016). Price et al. found that threat-related attention bias was associated with greater use of cognitive avoidance, measured by real-time report, outside of the laboratory. While they did not distinguish between attentional engagement and disengagement, this nonetheless supports the proposition that reactions to external threat correspond with reactions to unwanted thoughts (Price et al., 2016).

Conclusion

The findings of this study indicate that the extent to which attention is allocated to threat in anxiety is influenced by individual differences in attention control. Moreover, attention control contributes specifically to later stages of attentional processing, indicating that disengagement difficulties or avoidance are the result of (un)successful attempts to regulate attention to threat. The disparity between the pattern of these results compared to other studies, indicates that the role of AC on the anxiety – attention bias relationship is nuanced, and may depend on contextual factors such as task difficulty and the way that attention bias is calculated. In the context of internal threats (thoughts, mental images, memories), high trait anxiety corresponds to greater self-reported use of cognitive avoidance strategies. However, tasks that measure attention to threat (i.e., dot probe) and attention control do not correspond to the use of cognitive avoidance, indicating that laboratory tasks may be poor predictors of emotion regulation strategies outside the laboratory.

Chapter 3 – Study 2:

Anxiety, Attention Control and Thought Recurrence

Overview

Anxiety is associated with increased use of cognitive avoidance strategies, such as thought suppression (Berman et al., 2010; Fialko et al., 2012; Olatunji et al., 2010; Muris et al. 1996; Szczepanowski et al., 2021, Yapan, et al., 2022; Study 1). Thought suppression refers to intentional attempts to stop thinking a thought and is maladaptive. Suppression attempts, regardless of anxiety, can increase thought frequency both during the suppression process and afterward (Magee et al., 2012; Wang et al., 2020; Wenzlaff & Wegner, 2000). Suppression also maintains anxiety by hindering emotional processing and habituation (Foa & Kozac, 1986). It also limits opportunities to engage in cognitive restructuring, which is an essential component in cognitive-behavioural treatments for anxiety (Barlow et al., 2004; Clark & Beck, 2010; Craske & Barlow, 2007; Foa et al., 2007). Therefore, suppression may not only prevent processes that can resolve anxious responses to thoughts but increase the presence of the thoughts themselves.

The relationship between anxiety, attention and thought suppression processes has been of interest. A common assumption is that trait anxiety is associated with greater thought recurrence compared to non-anxious controls due to impaired attention control (Gorlin et al., 2016; Wegner, 1994). However, methodological limitations in previous research mean that the processes underlying thought suppression remain elusive. Therefore, the interplay between anxiety, attention control and thought suppression processes was investigated in Study 2. Additionally, whether attentional reactions to external stimuli extended to internal attention tasks was also tested.

Anxiety and Attention to Thoughts

Thought suppression can be conceptualised as an attentional exercise as thoughts are internal cognitive events that reside in working memory when brought to awareness (Johnson & Hirst, 1993; Chun et al., 2011). Just as attention selects information from the environment, it also plays a role in determining which thoughts are experienced. Attention control selects which thought to focus on at any given moment, making it central to goal directed activity (Corbetta & Shulman, 2002; Diamond, 2013; Petersen & Posner, 2012). It detects conflicts when irrelevant thoughts capture attention and interfere with task-related processing, and re-orients attention towards goal-relevant information through top-down processes (Diamond, 2013; Friedman & Miyake, 2017; Miyake & Friedman, 2012; Petersen & Posner, 2012).

Difficulties in controlling thoughts and impairments in functioning often reported by anxious individuals may represent deficits in attention control for internal stimuli (Hirsch & Mathews, 2012). Supporting this, Hoshino and Tanno (2016) found that high trait anxious participants exhibited larger interference effects from salient distractors in working memory than low trait anxious participants. This suggests that anxious individuals may struggle with conflict resolution in working memory, which may explain symptoms such as difficulty ignoring task irrelevant thoughts (e.g., maintain attention to thoughts about the current chapter compared to problem-solving sample size issues for the subsequent experiment).

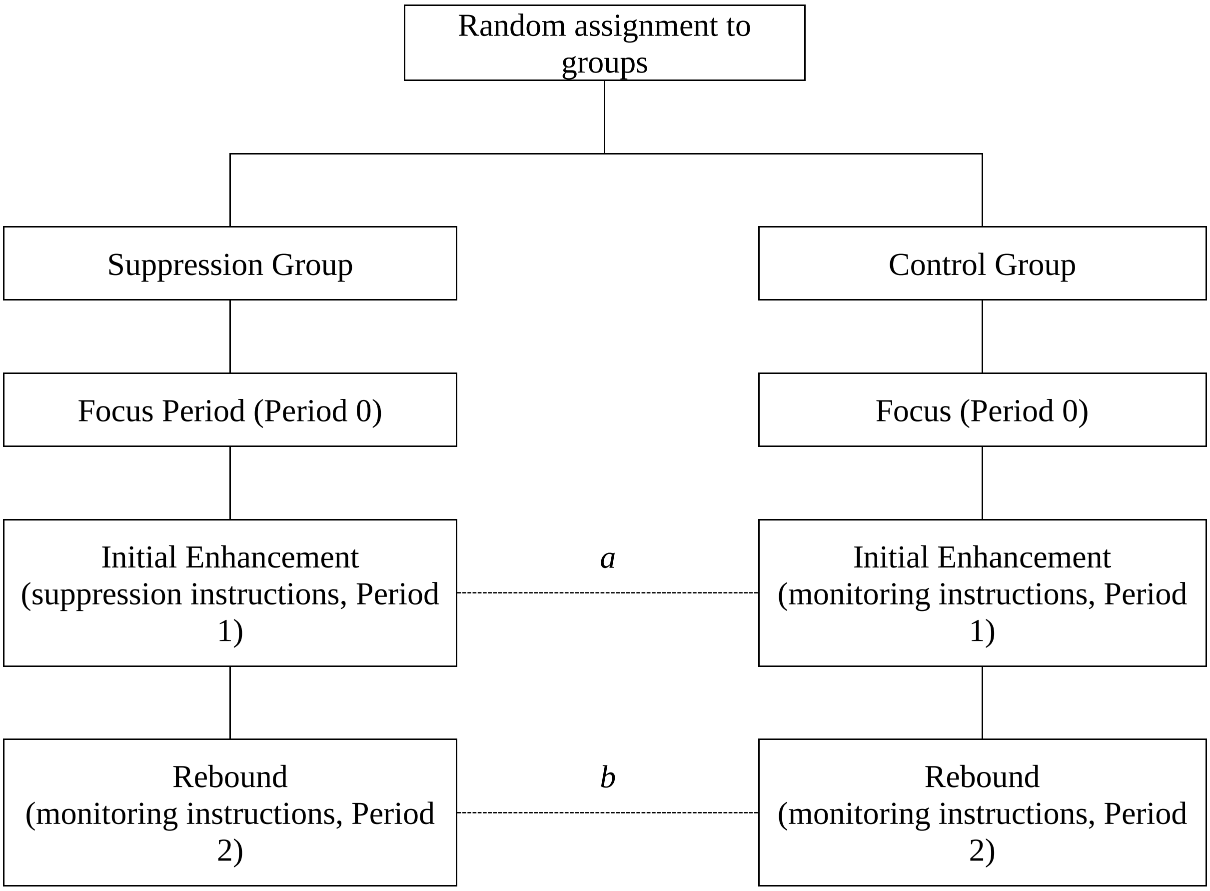
Cognitive theories of anxiety often assume that negative thoughts impair functioning, leading individuals to use cognitive strategies to avoid them (Bar-Haim et al., 2007; Beck & Clark, 1997; Cisler & Koster, 2010; Eysenck et al., 2007; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998, 2016, 2018; Williams et al., 1997). While there are multiple cognitive avoidance strategies, this chapter focuses on suppression (Lin & Wicker, 2007; Magee et al., 2019; Wang et al., 2017; Wegner, 1987). Suppression can paradoxically increase target thoughts both during and after attempts (Abramowitz, 2001; Lin & Wicker, 2007; Purdon, 2004; Magee et al., 2012; Magee et al., 2019; Wang et al., 2017; Wegner et al., 1987), a finding that will be reviewed in greater detail later. This study focuses on thought suppression because it is considered maladaptive due to ironic effects.

Ironic processing theory

Wegner (1994) developed Ironic Processing Theory to explain how attempts to exert mental control ultimately, and ironically, result in failures of mental control. When people attempt to direct their thoughts away from something, it is common for them to encounter the exact thought they are trying to avoid. Wegner et al. (1987) randomly assigned participants to either "suppress" or "monitor" all thoughts of white bears but report when they occurred. Then, all participants "monitored" and reported white-bear thoughts. Figure 1 graphically represents a thought suppression task. In Figure 1, paths *a* and *b* (indicated by dashed lines) represent the comparisons used for measuring the effect of suppression relative to monitoring instructions on the initial enhancement and rebound of target thoughts. In Wegner et al.'s study, suppressors in the first period experienced significantly more white-bear thoughts in the second thinking period compared to monitors (path *b*, Figure 1). This increase in target thoughts following active suppression has been widely replicated and is known as the *rebound* effect, (Wenzlaff & Wegner, 2000). A secondary finding was that during the first thinking period, suppression (compared to monitoring) resulted in greater frequencies of white-bear thoughts (i.e., initial enhancement period, path *a*, Figure 1; Wegner et al.). However, initial *enhancement effects* are unreliable, with some meta-analyses reporting that active suppression (compared to monitoring) results in lower thought recurrence (Abramowitz, 2001; Magee et al., 2012), and others reporting that initial enhancement effects only occur under increased cognitive load (Wang et al., 2020).

Figure 1

Thought Suppression Task with Suppression and Monitoring Instructions, with Comparisons for Initial Enhancement and Rebound Effects



According to Ironic Processing Theory, two mechanisms are responsible for suppression (Wegner, 1994). The *monitoring* process scans the contents of working memory for the target thought. It is relatively automatic and requires minimal cognitive resources. Once the thought is detected, the *operating* process generates a distractor thought and shifts attention *away* from the target. The operating process is effortful and taxes cognitive resources, which become depleted with ongoing suppression attempts, thus reducing suppression success over time. Comparatively, the monitoring process is more efficient, and remains vigilant for the target thought, regardless of depleted cognitive resources (Wegner, 1994). The explicit goal of suppression makes the monitoring system *hypervigilant*, by signalling that the target is important and must be stopped, increasing the frequency with which it is automatically re-activated. For example, if the goal is to not think about white bears, the monitoring process is hypersensitive to white bear related thoughts in working memory, which increases the likelihood of detecting them. In short, attempts to *not* think about a thought increases the likelihood that the thought will occur. In anxiety, this ironic process can lead to the belief that negative thoughts are uncontrollable.

Thought suppression, anxiety, and attention control

Anxiety can contribute to thought suppression failure through two mechanisms: depletion of cognitive resources during suppression and enhanced hypervigilance in the monitoring process (Gorlin et al., 2016). Anxiety can tax cognitive resources, reducing the efficiency with which the operating process can disengage from thoughts (Cohen et al., 2014; Eysenck et al., 2007; Eysenck & Derakshan, 201l; Hayes et al., 2008). Hypervigilance increases the salience and accessibility of targets, resulting in activation (Bar-Haim et al., 2007). From this perspective, trait-anxiety should be associated with less efficient thought suppression. Yet, while there is evidence of the ironic effects of thought suppression in general, meta-analyses have not found significant immediate enhancement or rebound effects when comparing high versus low trait anxious individuals (Magee et al., 2012). High anxious individuals sometimes report greater frequency of target thoughts during thought suppression compared to low anxious individuals (e.g., Harvey & Bryant, 1998), but other studies have found *enhanced* suppression effects (e.g., Purdon & Clark, 2000), and some have found no differences (see Magee et al., 2012; Wang et al., 2020, for a review).

A potential caveat to the unreliable differences between anxiety and controls in suppression failure is that traditional thought suppression tasks fail to capture both cognitive processes involved, namely the monitoring and operating processes (Gorlin et al., 2016; Lambert et al., 2014; Purdon, 2004). Most studies focus on thought frequency (i.e., the number of times a thought enters awareness), which reflects the monitoring process, but neglect the operating process responsible for disengaging attention from the target thought (Gorlin et al., 2016; Lambert et al., 2014). Therefore, measuring frequency alone fails to assess how suppression attempts can potentially modify the efficiency of disengagement.

Frequencies cannot capture disengagement from thoughts because they are confounded by duration (Purdon, 2004). Imagine one participant recorded a single thought but was unable to redirect their attention over a 40 second period. A second participant records 10 thoughts for a duration of 4 seconds, indicating 10 successful redirections. Finally, a third participant records 1 thought, for 4 seconds, and was successful at suppression for 36 seconds. Based on these frequencies alone, it appears that the first and third participant were equally successful at thought suppression (i.e., frequency = 1), and that the second had comparatively higher thought recurrence (frequency = 10). When considering the time taken to disengage from the thought, a different picture emerges.

This limitation can be addressed by considering the dimension of thought duration, which corresponds to the operating process and reflects the time taken to disengage from the thought (Lambert et al., 2014). Using an updated version of the white-bear paradigm, Lambert et al. found that frequency and duration were independent dimensions of suppression and displayed different patterns over time. Lambert et al. proposed that the monitoring process is like the engagement of attention as it facilitates detection of the target thought, and hence is related to frequency. On the other hand, the operating process is like disengagement or avoidance, thus determining the duration of thought recurrence. Nevertheless, while many studies have attempted to understand why target thoughts return and suppression attempts eventually fail, only a small proportion have measured real-time duration (Lambert et al., 2014; Magee et al., 2012; Wang et al., 2020). Some studies have used retrospective self-report to capture duration by asking participants to estimate how long they were thinking to-be-suppressed thoughts, but these measures are suboptimal as they rely on memory and are subject to error (Abramowitz et al., 2001). Therefore, the operating process and its contribution to thought rebound is arguably under researched.

A secondary issue with the study of the operating process is that very few studies have attempted to link the duration of thought recurrence with attention control, which is believed to underpin disengagement from thoughts. Consequently, the notion that the operating process, and its role in thought suppression failure, is dependent on cognitive resources is not well established. Nevertheless, Brewin and Beaton (2002) found evidence that attention control was linked to thought suppression failure, as the frequency of intrusions during suppression was negatively correlated working memory capacity. Further implicating the importance of cognitive resources, meta-analyses indicate that immediate enhancement effects are amplified by the presence of cognitive load (Magee et al., 2012; Wang et al., 2020). While these findings link attention control to thought suppression failure, as duration was not included in these studies, the role of attention control on *disengagement from,* rather than the *engagement with* thoughts is less clear.

Attention Control as a Moderator. The unreliable effect of anxiety on thought suppression failure may be explained by individual differences in attention control. Attention control may mitigate anxiety's impact on suppression failure as individuals with stronger attention control may be less susceptible to cognitive depletions that occur during suppression (Magee et. al., 2012; Gorlin et al., 2016). Furthermore, presuming the monitoring and operating processes are distinct cognitive mechanisms, we would expect that attention control would moderate the relationship between anxiety and disengagement from thoughts (i.e., duration), but not engagement with or detection of thoughts (i.e., frequency). This proposition aligns with the attenuating and reverse effects of attention control on the relationship between anxiety and external threats (i.e., attention bias; Derryberry & Reed, 2002; Gorlin & Teachman, 2015; Reinholdt-Dunne et al., 2009; Taylor et al., 2016).

The distinction between early and later processes may be important for understanding relationships between attention control and thought suppression, as highlighted by external threat-interference in laboratory tasks. Previous research found that attention control influences strategic, but not automatic attention biases (Taylor et al., 2016; Study 1). Assuming that frequency is driven by the relatively automatic monitoring process, and duration results from a controlled operating process, attention control should moderate the relationship between anxiety and duration, but not frequency.

One study to date has investigated anxiety, working memory capacity and both frequency and duration (Gorlin et al., 2016). While that study did not investigate the moderating effects of attention control on the relationship between anxiety and thought recurrence specifically, there was evidence that greater working memory capacity was linked to shorter thought duration in the rebound (i.e., second) thinking period, although the effect was small and the sample size was large ($N = 939$ $r = .11$, $p <.001$; Gorlin et al., 2016). Working memory capacity is a positive predictor of performance on attention control tasks (Kane et al., 2001; Shipstead et al., 2014; Unsworth et al., 2014). It has been suggested that it contributes to the goal maintenance and conflict resolution functions of attention control (Meier & Kane, 2017), which are essential processes in thought suppression (Wegner, 1994).

Internal and External Attention to Threat

Conceptualisations of attention to thoughts and to *external* threats share significant overlap, yet very few studies assess them concurrently (Price et al., 2015; Study 1), and the ones that do have not used tasks that can dissociate between automatic and strategic processes (e.g., Gorlin et al., 2016). Although Study 1 did not find that engagement or disengagement bias was linked to the use of cognitive avoidance in daily life, that may be because attention bias reflects *ability* to direct attention, whereas the self-report Cognitive Avoidance Questionnaire assesses *attempts* (e.g., "*I often do things to distract myself from my thoughts*"; Sexton & Dugas, 2008). Models of thought suppression and attention-bias both propose automatic and controlled processes can exaggerate attentional reactions to threat (Cisler & Koster, 2010; Mogg & Bradley, 2016; 2018; Wegner, 1994). Engagement bias and monitoring are automatic processes for threat detection, while disengagement bias/attentional avoidance and operating processes shift attention away from threat.

Supporting the idea that disengagement from thoughts and external stimuli both rest on attention control, neuroimaging evidence suggests the anterior cingulate cortex plays a role in thought suppression (Mitchell et al., 2007; Gillath et al., 2005, Wyland et al., 2003) and dot-probe performance (Bush et al., 2000; Etkin et al., 2011; Carlson et al., 2012; Carlson et al., 2013; Price et al. 2014; Price et al., 2016). However, no study has compared performance on the dot-probe and thought suppression tasks using methods that can dissociate different types of attention bias (i.e., engagement and disengagement) and facets of thought suppression (i.e., monitoring, and operating processes). Therefore, we sought to shed light further light on the potential relationship between these tasks by using a modified dot-probe (Rudaizky et al., 2013) and thought suppression task (Lambert et al., 2014).

Hypotheses

Conceptualising thought frequency and duration as independent facets of thought recurrence which are underpinned by different cognitive mechanisms guided predictions about immediate enhancement and rebound effects. Presuming that frequency is linked to a relatively automatic monitoring process which heightens the salience and activation of that thought (Wegner, 1994), suppression instructions, compared to monitoring instructions, should result in greater mean thought frequency in the first thinking period (Period 1; Initial enhancement) and rebound (Period 2) thinking periods. Theoretically, suppression instructions prime the monitoring process to seek out target thoughts (e.g., “keep an eye out for this thought! It is really important that I don’t think about it!”), whereas monitoring instructions do not (e.g., “the thought might be there, it might not. Just let me know if you come across it”).

In contrast, because duration is presumed to be the result of controlled processes, participants in the suppression condition were expected to have significantly longer durations in the initial enhancement and rebound thinking periods compared to those in the monitoring period, as cognitive resources become depleted due to repeated suppression attempts. Additionally, it was predicted that the difference in duration between suppression and monitoring groups would be smaller for participants with stronger baseline attention control as they are more resistant to depletions in cognitive resources.

No *a priori* predictions were made regarding the effects of anxiety on thought recurrence across the two thinking periods, given the mixed findings to date (see meta-analyses by Magee et al., 2012 and Wang et al., 2020). However, given that attention control has been shown to attenuate and even reverse the relationship between anxiety and disengagement external threat, the possibility that attention control may moderate the relationship between anxiety and thought recurrence was tested.

Regarding the relationship between attention bias on the dot-probe and thought suppression, no specific predictions were made. However, if the monitoring process in thought suppression and engagement bias are the result of automatic attentional processes, we would expect that engagement bias would be positively correlated with the frequency of thought recurrence, as they both represent hypervigilance towards threat. Similarly, if shifting attention away from thoughts and images is underpinned by the same process, disengagement bias and thought duration should be positively correlated.

Method

Participants

Study 2 hypotheses were tested using the same data collected from Study 1 and included data collected from thought suppression task, which is described below. All data was collected in one experimental session and participants completed each task once (i.e., Stroop Task, dot-probe, thought suppression task and questionnaires). The participant sample was the same as Study 1. Sample characteristics are reported in Chapter 1.

Design

This study employed a mixed-model design where participants completed a suppression task with three thinking periods. In Period 0, participants were instructed to focus on the target thought. In Period 1 (initial enhancement period) participants were randomly assigned to receive monitoring (n = 62) or suppression (n = 63) instructions in the thought suppression task. In Period 2 (rebound period) participants received monitoring instructions only. The predictor variables were trait-anxiety and Stroop Interference. The outcome variables were thought frequency and duration, engagement and disengagement bias on the dot-probe task, and self-reported cognitive avoidance. Thought duration and thought frequency were calculated based on reaction times on the thought suppression task.

Materials

Stimulus materials and equipment

Descriptions of the stimulus materials and equipment are in Study 1. Participants completed each measure in the order that they are described.

Colour –Word Stroop. The colour-word Stroop (Stroop, 1935) was used to objectively measure Stroop interference (AC). This was the same task that was described in Study 1.

Modified dot-probe. Attention biases to threat were assessed using a modified dot-probe task (Rudaizky et al., 2014), which allows separate assessments of attentional engagement and disengagement. This was the same task that was described in Study 1.

Thought Suppression Task. Suppression ability was measured using a variant of the White Bear Task. It was adapted from Lambert et al. (Wegner et al., 1987; Lambert et al., 2014). There was only one trial, with 3 thinking periods: Period 0, Period 1, Period 2, and comparisons were made as per Figure 1. Complete participant instructions are in Appendix A. Participants were provided with the thought "I hope my friend is in a car accident", following past research (Lambert et al., 2014; Magee & Teachman, 2007; Rachman et al., 1996). It was expected that participants would be motivated to suppress this thought (similarly to real life intrusive thoughts) as it is high in unpleasantness and perceived immorality (Rachman & DaSilva, 1978).

Across each phase, participants indicated the presence of the target thought by depressing the spacebar and holding it until the thought passed. In the *focussing* period (Period 0: 40 s), participants wrote the target thought and were asked to think about it. In the *initial enhancement* period (Period 1: 4 minutes), half of the participants were asked to suppress the thought (not think the thought: suppression group) and the others were free to think anything (monitoring group). All participants were asked to indicate the presence of the target thought. In the *rebound* period (Period 2: 4 minutes), all participants could think anything and indicated thought recurrence.

Across each period, the presence of the target thought was coded as 0 (absent) or 1 (present) every 0.1s. The total number of spacebar presses was summed and represented the frequency variable. Across each period, the total time that the spacebar had been depressed was measured. To obtain the mean duration of each thought occurrence, the total duration was divided by *frequency* for each time period (Lambert et al., 2014). When only the total duration of thought recurrence is considered, the task does not capture how long it takes to disengage from each individual thought. Frequency and duration were calculated for each period.

Spielberger Trait Anxiety Inventory. Trait anxiety was assessed with the 20-item trait subscale of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger et al., 1983) as in Study 1.

Cognitive Avoidance Questionnaire. The Cognitive Avoidance Questionnaire (CAQ; Gosselin et al., 2002) was the same as used on Study 1.

Procedure

The experimental procedure was the same as Study 1.

Results

Data preparation and descriptive statistics.

Stroop interference, engagement and disengagement biases were the same as Study 1. Data for four participants in the thought suppression task were lost due to computer error, providing a total sample of N = 121. Data screening showed that thought frequency and duration were positively skewed and leptokurtic for Period 1 and 2, see Table 1.

Table 1

Distribution Characteristics for the Distribution of Thought Frequency and Duration for Each Period

Variable	Skewness	SE Skewness	Skewness z-score	Kurtosis	SE Kurtosis	Kurtosis z-score
P1 Frequency	4.59	.226	20.31*	27.90	.447	62.41*
P1 Duration	10.55	.226	46.68*	112.45	.447	251.56*
P2 Frequency	2.02	.226	7.59*	5.70	.447	12.76*
P2 Duration	6.14	.226	27.15*	46.11	.447	103.15*

Note. N = 121; **p*<.001, P1 = Initial Enhancement Period; P2 = Rebound Period

Values on each measure that were greater than 3.3 standard deviations from the mean were rescaled to nearest valid value plus/minus one (Brewin & Smart, 2005; Tabachnick & Fidell, 2013). The thought suppression variables were not normally distributed; however, this was found in previous studies (e.g., Brewin & Smart, 2005). Frequency variables were normally distributed following a square root transformation (Tabachnick & Fidell, 2013), see Table 2, and were used in ANOVAs, bivariate correlations, and regressions. Transformations did not improve the normality of duration variables so the windsorized values were used in all analyses. As the data violated the assumptions of normality, moderation hypotheses were tested using PROCESS 4.0 (Hayes, 2021) with bootstrapping as this does not require data to be normally distributed (Hayes & Rockwood, 2020).

Table 2

Distribution Characteristics for the Distribution of Thought Frequency and Duration Across Each Thinking Period Using Square Root Transformations

Variable	Skewness	SE Skewness	Skewness z-score	Kurtosis	SE Kurtosis	Kurtosis z-score
Frequency P1	-0.17	.22	-0.77	-.082	.437	-0.19
Duration P1	2.30	.22	10.47*	6.71	.437	15.36*
Frequency P2	0.15	.22	0.69	-0.14	.437	-0.34
Duration P2	1.94	.22	8.82*	3.57	.437	8.16*

Note. N = 121; **p*<.001; P1 = Initial Enhancement Period;P2 = Rebound Period

Descriptive Statistics

Table 3 displays the means and standard deviations for attention control, trait anxiety, thought suppression variables, and suppression subscale (CAQ). Notably, 34 (28%) participants did not report a single occurrence of the target thought during the *focussing* period (Period 0) but reported at least one occurrence in either the *monitor vs suppression* or *monitor only* periods. The main analyses were conducted on those who reported the target thought at least once in Period 0 because we could confirm that those participants complied with the focus instructions for Period 0, and on the whole sample. Results for the whole sample are reported, as removing participants that did not report the target thought in Period 0 did not significantly alter the results.

Table 3

Descriptive statistics for Trait Anxiety, Stroop Interference, Thought frequency and Duration, CAQ Subscales, and Attention Biases

variable	M	SD	Minimum	Maximum
STAI - T	48.55	11.07	24	77
Stroop Interference	90.43	74.74	-41.94	251.03
Frequency P0	1.89	1.865	0	9
Frequency P1	6.44	5.407	0	26
Frequency P2	4.43	4.195	0	18
Duration P0 (s)	11.01	15.50	0	60.4
Duration P1 (s)	12.24	26.90	0	167.1
Duration P2 (s)	24.73	52.34	0	239.7
Suppression	15.62	5.17	5	25
Engagement	-1.39	57.90	-142.22	149.3
Disengagement	-5.10	76.24	-235.17	270.24

Note. CAQ = Cognitive Avoidance Questionnaire; STAI-T = Spielberger Trait Anxiety scores; P0 = Focus period; P1 = Initial Enhancement period; P2 = Rebound period; Frequency = total number of targets reported for each thinking period; Duration = the average duration (in seconds) of targets reported for each thinking period Suppression = suppression scores on the Cognitive Avoidance Questionnaire; Engagement = Engagement Bias on the dot probe, where positive scores indicate faster orientation to threat compared to neutral cues, and negative scores indicate faster orientation towards neutral compared to threat cues; Disengagement = disengagement bias on the dot-probe, where negative scores indicate attentional avoidance and positive scores indicate disengagement difficulties.

N = 121

Table 4 reports the inter-correlations for Stroop interference, trait anxiety, thought suppression variables, and CAQ subscales. As reported in Study 1, there was no significant relationship between trait anxiety and Stroop interference. Similarly, anxiety was not related to thought frequency or duration at any time period in the thought suppression task. No significant correlations between self-reported cognitive avoidance and the frequency or duration of target thoughts were found. This indicates that thought suppression ability is distinct from the self-reported use of cognitive avoidance outside of the laboratory.

Table 4

Inter-correlations Between Trait Anxiety, Stroop Interference, Thought Frequency and Duration, Attention Biases, and Suppression (CAQ)

variable	1	2	3	4	5	6	7	8	9	10
1. STAI - T	-									
2. Stroop Interference	-.03	-								
3. Frequency P0	-.02	.09	-							
4. Frequency P1	-.06	-.11	.23**	-						
5. Frequency P2	.05	.03	.24**	.53**	-					
6. Duration P0 (s)	-.03	.12	.36**	-.06	-.03	-				
7. Duration P1 (s)	.12	-.02	-.05	.03	-11	.30**	-			
8. Duration P2 (s)	.02	-.12	-.11	.10	.27**	-.07	.32**	-		
9. Suppression	.46**[r]	-.15	<-.01	-.12	-.08	.09	.10	-.09	-	
10. Engagement	.03	.04	-.04	-.04	-.08	-.05	.13	.03	-.10	-
11. Disengagement	.10	.04	-.09	-.07	.02	-.05	-.05	-.02	<.01	-.10

Note. P0 = focussing period; STAI-T = Spielberger Trait Anxiety scores; P0 = Focus period; P1 = Initial Enhancement period; P2 = Rebound period; Suppression = suppression subscale scores on the Cognitive Avoidance Questionnaire; Engagement = Engagement Bias on the dot probe, where positive scores indicate faster orientation to threat compared to neutral cues, and negative scores indicate faster orientation towards neutral compared to threat cues; Disengagement = disengagement bias on the dot-probe, where negative scores indicate attentional avoidance and positive scores indicate disengagement difficulties.

N = 121

Comparisons between monitoring and suppression groups

Preliminary analyses (Table 5) were conducted to determine whether the suppression and monitoring groups were equivalent on trait anxiety, Stroop interference, cognitive avoidance, and demographic variables. The monitoring group did not differ from the suppression group on any measures. The percentage of female participants in each condition did not differ significantly (Monitor = 48.5%; suppress = 51.5%), $\chi^2(1) = .698$, $p = .40$, *phi* = 0.08.

Table 5

Comparisons Between the Monitor and Suppression Groups for Age, Trait Anxiety, Stroop Interference and Suppression

	Monitor		Suppress		Inferential statistic	Effect size
Variable	*M*	*SD*	*M*	*SD*		*d*
Age	22.15	6.69	21.72	4.14	$t(123) = 0.42$, $p = .67$	0.08
STAI-T	47.35	10.36	49.77	11.70	$t(123) = 1.23$, $p = .22$	0.22
Stroop Interference	89.65	72.58	91.21	77.47	$t(123) = 0.12$, $p = .91$	0.02
Suppression	15.27	5.58	15.98	4.73	$t(123) = 0.77$, $p = .44$	0.13

Note. STAI-T = scores on the Spielberger Trait Anxiety questionnaire; Suppression = scores on the Suppression subscale of the Cognitive Avoidance Questionnaire.

N = 121

Thought Frequency and Duration over Time

Separate 2 (condition: suppression vs monitor) x 2 (time: Period 1, 2) mixed ANOVAs were performed on thought frequency and duration. For frequency (see Table 6 for descriptive statistics), there was a significant main effect of time, $F(1,119) = 16.19$, $p < .001$, $\eta^2 = .13$. Mean frequency was significantly higher in Period 1 than Period 2, $d = 0.37$. There was no main effect of condition, $F(1,119) = 0.003$, $p = .96$, $\eta^2 < .001$. The interaction between time and condition was not significant, $F(1,119) = 0.57$, $p = .452$, $\eta^2 < .001$. Overall, participants experienced a decrease in frequency in Period 2 (rebound period). The absence of an interaction demonstrated that suppression instructions did not result in an initial enhancement of thought frequency or rebound effect compared to monitoring instructions.

Table 6

Means (and Standard Deviations) of Thought Frequency (Square Root Transformed) Over Time for Monitor and Suppression Conditions

	Monitor		Suppress		Average	
Time	*M*	*SD*	*M*	*SD*	*M*	*SD*
Period 1	2.28	1.20	2.22	1.17	2.25	1.18
Period 2	1.79	1.05	1.88	1.02	1.84	1.03
Average	1.75	1.09	1.71	1.08	1.73	0.76

Note. Period 1 = Initial Enhancement (suppression vs monitoring instructions); Period 2 = Rebound (monitoring only instructions)

N = 121

For thought duration, there was a significant main effect of time, $F(1,119) = 7.28$, $p = .003$, $\eta^2 = .09$ (see Table 7 for descriptive statistics). Duration was significantly shorter in Period 1 than Period 2, $d = 0.36$. There was no main effect of condition, $F(1,119) = 2.61$, $p = .11$, $\eta^2 = .021$, and no interaction, $F(1,119) = 4.56$, $p = .03$, $\eta^2 = .038$. In Period 1, suppression instructions did not result in an initial enhancement effect, $t(119) = 0.43$, $p = .66$, $d = 0.08$. However, contrary to predictions, in Period 2 suppressors had significantly shorter durations than the monitoring group indicating a *reversed* rebound effect, $t(94.10) = 1.97$, $p = .05$, $d = 0.36$.

Table 7

Means and Standard Deviations of Thought Duration (seconds) Over Time for Monitor and Suppression Conditions

	Monitor		Suppress	
Time	*M*	*SD*	*M*	*SD*
Period 1	13.32	27.58	11.17	26.41
Period 2	34.12	63.46	15.50	36.65
Total	20.56	34.44	14.36	34.16

Note. Period 1 = Initial Enhancement period (suppression vs monitor instructions); Period 2 = Rebound period (monitor instructions only)
N = 121

Moderation Analyses for Thought Suppression Task

The hypothesised moderating effect of Stroop interference on the relationship between anxiety and thought suppression was tested via moderated regression using PROCESS 4.0 (Hayes, 2021), Model 3. Separate analyses were performed on thought frequency and thought duration for Period 1 and Period 2. In each model, instruction condition (i.e., monitor = 0 vs suppress = 1), trait anxiety (STAI-T scores) and Stroop Interference were predictors. Thought frequency or thought duration served as the dependent variables. The continuous predictors were mean centred. Reanalysis of the data using participants who reported experiencing the target thought at least once in Period 0 (i.e., the focussing period), did not yield different results, therefore the results based on the entire sample is reported.

Thought frequency

Table 8 presents the regression results for thought frequency for Period 1 and Period 2. Across both thinking periods, trait anxiety, instruction condition, attention control or their interactions did not predict frequency. Therefore, there were no initial enhancement or rebound effects found.

Average Duration

Table 9 presents the regression results for the average duration of targets for Period 1 and Period 2. Against predictions, anxiety and attention control were not significant predictors of duration. Condition was a marginally significant predictor during Period 2, indicating that suppressors tended to disengage from the target faster in the monitoring period. None of the interactions were significant.

Table 8

Hierarchical Moderated Regressions Predicting Frequencies (Square Root Transformations) from Trait Anxiety, Stroop Interference and Condition (suppress, monitor) for Each Thinking Period

Period 1						Period 2					
Predictor	*b*	*SE*	*t*	*p*	*95% CI*	Predictor	*b*	*SE*	*t*	*p*	*95% CI*
R^2 = .03, F(7,113) = 0.27, p = .93						R^2 = .02, F(5,115) = 0.36, p = .92					
Constant	2.27	0.16	14.58	<.001	[1.96, 2.58]	Constant	1.79	0.13	13.08	<.001	[1.52, 2.06]
STAI-T	-0.004	0.14	-0.29	.77	[-0.03, 0.02]	STAI-T	0.006	0.01	0.45	.65	[-0.02, 0.03]
Stroop Interference	-0.01	0.002	-0.24	.81	[-0.005, 0.0003]	Stroop Interference	0.00004	0.001	0.01	.99	[-0.004, 0.004]
Condition	-0.02	0.22	-0.08	.94	[-0.46, 0.42]	Condition	0.07	0.19	0.35	.73	[-0.32, 0.45]
STAI-T x Stroop Interference	0.0002	0.0002	1.10	.27	[-0.0002, 0.001]	STAI-T x Stroop Interference	0.0002	0.0001	1.24	.22	[-0.0001, 0.001]
STAIT x Condition	-0.0003	0.02	-0.20	.98	[-0.04, 0.04]	STAIT x Condition	-0.003	0.02	-0.15	.88	[-0.04,0.03]
Stroop Interference x Condition	-0.002	0.003	-0.53	.60	[-0.01, 0.004]	Stroop Interference x Condition	-0.0003	0.003	-0.10	.91	[-0.005, 0.005]
STAI-T x Stroop Interference x Condition	-0.0001	0.0003	-0.27	.79	[-0.001, 0.0004]	STAI-T x Stroop Interference x Condition	-0.0003	0.0002	-1.30	.20	[-0.001, 0.0002]
ΔR^2 <.001, F (1, 113) = 0.07, p = .79						ΔR^2 =.014, F (1, 113) = 1.70, p = .20					

Note. STAI-T = Trait anxiety, Period 1 = Initial Enhancement period (suppression vs monitor instructions); Period 2 = Rebound period (monitor only instructions).
N = 121
* p <.05.

Table 9

Hierarchical Moderated Regressions Predicting Average Duration per Thought (seconds) from Trait Anxiety, Stroop Interference and Condition (Suppress, Monitor) for Each Thinking Period

Period 1						Period 2					
Predictor	*b*	*SE*	*t*	*p*	*95% CI*	Predictor	*b*	*SE*	*t*	*p*	*95% CI*
R^2 = .03, F(7,113) =0.58, p = .77						R^2 = .06, F(7,113) = 1.05, p = .40					
Constant	13.31	3.54	3.84	<.001	[6.59, 20.64]	Constant	33.76	6.80	4.96	<.001	[20.28, 47.23]
STAI-T	0.23	0.34	0.69	.49	[-0.43, 0.90]	STAI-T	-0.37	0.64	-0.41	.68	[-1.54, 1.01]
Stroop Interference	-0.01	0.05	-0.25	.80	[-0.11, 0.09]	Stroop Interference	-0.12	0.09	-1.33	.19	[-0.31, 0.06]
Condition	-3.12	5.04	-0.62	.53	[-13.12, 6.88]	Condition	-18.51	9.68	-1.91	.06	[-37.69, 0.67]
STAI-T x Stroop Interference	-0.003	0.004	-0.07	.94	[-0.10, 0.01]	STAI-T x Stroop Interference	0.004	0.01	0.55	.58	[-0.01, 0.02]
STAIT x Condition	0.01	0.46	0.03	.98	[-0.90. 0.92]	STAIT x Condition	0.36	0.88	0.30	.77	[-1.48, 2.00]
Stroop Interference x Condition	-0.05	0.07	-0.71	.48	[-0.18, 0.08]	Stroop Interference x Condition	0.05	0.13	0.36	.71	[-0.21, 0.31]
STAI-T x Stroop Interference x Condition	-0.003	0.01	-0.40	.69	[-0.01, 0.01]	STAI-T x Stroop Interference x Condition	-0.01	0.01	-0.57	.57	[-0.03,0.02]
ΔR^2 = .001, F (1, 113) = 0.16, p = .69						ΔR^2 <.003, F (1, 113) = 0.30, p = .58					

Note. STAI-T = Trait anxiety, Period 1 = Initial Enhancement period (suppression vs monitor instructions); Period 2 = Rebound period (monitory only instructions).
N = 121
[*] p <.05.

Discussion

This study investigated whether attention control moderates the relationship between anxiety and thought recurrence using a suppression task that dissociated thought frequency and duration. Against predictions, attention control did not moderate the relationship between anxiety and the frequency *or* duration of thought recurrence. Furthermore, there were no significant relationships between these variables.

Our failure to find relationships between attention control and thought *frequency* is consistent with the notion that the monitoring process is relatively automatic (Wegner, 1994). These results showed that attention control was not related to whether the to-be-inhibited thought was detected in the first place. This was somewhat expected because attention control is only activated when there is conflict between responses (Bush et al., 2000). Frequency indicates the moment when suppression fails, and the thought is detected (Lambert et al., 2014). It is the detection of the conflict without any action to remedy it and therefore it is unlikely to be affected by baseline attention control or cognitive depletion that results from repeated suppression attempts.

The prediction that attention control would facilitate shorter thought *duration* was not supported. Thus, in our sample, baseline cognitive resources, or lack thereof, did not predict thought suppression failure, which contradicts Ironic Processing Theory (Wegner 1994; Wegner & Erber 1992). In contrast, others have found significant relationships using measures of working memory capacity that encompass attention control, namely Operation Span (OSPAN; Brewin & Smart, 2005; Gorlin et al., 2016; Kane & Engle, 2003). Notably, the OSPAN differs from the Stroop as the OSPAN represents how much information can be held in mind at one time, whereas the Stroop assesses conflict resolution between automatic and strategic responses. This raises the possibility that working memory capacity is a better predictor of suppression performance than attention control, however this has not been tested.

Overall, the results indicated that anxiety and attention control, nor their interaction predicted thought suppression outcomes. However, these unexpected findings may be explained by thought suppression effort, the nature of the target thought, and the relatively low level of thought recurrence compared to previous research (e.g., Lambert et al., 2014; Gorlin et al., 2016). The next section discusses these methodological considerations, as well as general methodological issues in the measurement of thought.

Effort and thought suppression

Another factor beyond capacity or ability that may contribute to thought suppression outcomes is effort. Anxiety is associated with greater self-reported suppression effort, regardless of suppression instructions, leading to higher frequencies but shorter durations during the initial enhancement period (Gorlin et al., 2016). This may reflect that anxious, compared to non-anxious, participants are more motivated to suppress negative thoughts, corresponding to greater effort, hypervigilance to the target, and faster disengagement. Additionally, the link between effort and thought recurrence during or after suppression was unaffected by baseline working memory capacity or the depletion of cognitive resources (Gorlin et al., 2016). In a similar vein, we found that anxious participants were more likely to report using cognitive avoidance outside of the laboratory (i.e., suppression and total CAQ scores, r =.43 and r = .53) but that was unrelated to performance on the thought suppression task. This raises the possibility that that *efforts* to suppress thoughts, rather than the *ability* to suppress, are a better predictor of thought recurrence. If this was the case in the current study, it may have obscured differences between suppression and monitor instructions as anxious participants may have attempted to suppress even if they were assigned monitoring instructions. A methodological limitation of the present study is that suppression effort was not assessed. To address this shortcoming and shed further light on the potential impacts of effort on thought recurrence, self-reported suppression effort was used in Study 3.

Personal relevance of thoughts

In the current study, we found that suppression instructions in the first thinking period corresponded to significantly shorter durations of the target in the second period, compared to monitor instructions. One potential explanation for the reversed rebound effect found in the present study was that the target thought was personally relevant (i.e., "I hope my friend is in a car accident"), whereas white bear thoughts used in the original suppression task (e.g., Wegner et al., 1987) were not. Personally relevant thoughts are associated with smaller and even reversed rebound effects (Abramowitz, 2001; Magee et al., 2012; Kelley & Khan, 1994; Roemer & Borkovec 1994). Kelley and Khan (1994) suggested that a reversed rebound effect for personally relevant, but not irrelevant thoughts could be explained by participants' previous experience suppressing similar thoughts. Practicing suppression in real life contexts, which would be expected for personally relevant intrusive thoughts, may lead to reversed rebound effects as participants might have developed an elaborate network of distracter thoughts (Kelley & Khan, 1994; see Wegner 1987, Wegner & Erber 1992). Tapping into this network may have facilitated disengagement from subsequent intrusions of the thoughts during the rebound thinking period in our study. However, using the same thought, Lambert et al. (2014) found classic rebound effects, where average duration increased post-suppression.

One caveat to this explanation is that the target thought in our study was *provided* to participants rather than being personally generated, and it could be argued that participants would not have had a pre-existing network of distracters to tap into. This raises a methodological consideration for future research seeking to elucidate the reversed rebound effect – are people better at suppressing idiopathic, self-referential thoughts compared novel, yet personally relevant thoughts? If people do tap into a complex network of distracters to suppress negative thoughts they commonly experience, we might not expect to find reversed rebound effects for externally generated negative thoughts used in laboratory tasks. One way to address this question would be to compare suppression outcomes for self- versus other-generated targets for personally relevant thoughts. If there are different effects for self- versus other-generated targets, it has implications for the generalisability of laboratory findings based on studies that provide targets to participants.

Levels of thought recurrence in the current study

Notably, while we failed to find relationships between anxiety and attention control on thought recurrence measures, this may be due to the relatively low levels of thought recurrence in the current study. The mean duration for each thought appeared considerably lower during the initial enhancement (Period 1: M = 12.24 s, SD = 26.90 s vs Lambert et al., M = 22 s, SD = not provided) and rebound periods (Period 2: M = 24.73 s, SD = 52.34 s vs Lambert et al., M = 17, SD = not provided) despite having identical period lengths. Frequencies also appeared to be considerably lower compared to other studies for both the initial enhancement (Period 1, 4 minutes: M = 6.44, SD = 5.41) and rebound thinking periods (Period 2, 4 minutes: M = 4.43, SD = 4.20) compared to studies that suppressed the same or similar thoughts (i.e., Gorlin et al., 2016: "*I hope my friend loses their wallet*"; Lambert et al., 2014: "*I hope my friend is in a car accident*"). In Lambert et al. (2014), the approximate frequencies were 10 and 7 in the initial enhancement and rebound thinking periods respectively. Using shorter thinking periods than ours (i.e., 1 minute vs 4 minutes), Gorlin et al. (2016), found comparable frequencies (Period 1: M = 4.17, SD = 7.24; Period 2: M = 3.59, SD = 6.45) to our sample.

This discrepancy is not likely to be explained by the instructions in our task, as the instructions were identical to those published by Lambert et al. (2014). Further, as the suppression group had more intrusions during the initial enhancement period than the monitoring group, it is unlikely that the low levels of thought recurrence were due to socially desirable responding. If participants wanted to be seen as “obeying the researcher”, suppression instructions would have resulted in fewer intrusions in Period 1.

A potential explanation for the low levels of thought recurrence in the current study is that participants were underreporting when they were thinking about the target, or that they forgot to press the spacebar. Thirty-four percent of participants did not report experiencing the thought by pressing the spacebar during the focus period. While it is possible that some participants were unable to focus on the thought when asked to do so, it is also possible that participants did not report experiencing the thought even though it was in their minds. If participants did not press the spacebar whenever the thought was activated, whether intentionally or unintentionally, that could have led to lower levels of thought recurrence and may reflect a shortcoming of event marking procedures. Although this could have occurred in other studies, data from the focus periods of those studies were not reported so it is unclear whether this is a common phenomenon (Gorlin et al., 2016; Lambert et al., 2014).

Thought recording measures

The present study used event-marking procedures, which rely on participants to catch themselves thinking about targets. The low thought recurrence in this study may be a result of participants only reporting when they had the exact thought “I hope my friend is in a car accident”, and not reporting other thoughts that may be associated with it (e.g., repercussions of friend being in the accident, feelings of sadness, or grief). Although this cannot directly account for the discrepancy between our study and others (e.g., Lambert et al., 2014; Gorlin et al., 2016), as the instructions were the same as Lambert et al., it highlights potential limitations of event marking in general.

While event marking procedures can allow frequency and duration to be captured, participants are required to determine what constitutes thinking about the thought, yet many studies do not inform participants on how thoughts should be classified (e.g., Lambert et al., 2014; Gorlin et al., 2016; Magee & Teachman, 2007). During suppression, alternative thoughts are generated to be used as distracters, however some may be more closely linked to the target than others (Magee et al., 2019; Roemer & Borkovec, 1994, Wegner, 1987; 1994). Direct statements are those that describe the situation itself, an emotional response to it, or a reference to thinking (or not thinking) about it. Indirect statements are thematically related (e.g., involves harm to someone else) or contextually related (e.g., statements of any type about friends or cars). This can be conceptualized as incomplete avoidance, whereby the individual is thinking, at least in part, of the original target thought. In sum, we cannot be certain whether our participants were able to shift their focus away from the target thought *completely* using distracter thoughts (e.g., ice-cream) or whether they were using incomplete avoidance. Without instructions on thought classification, participants may be less accurate at identifying when they are thinking about targets, leading to lower levels of recurrence.

One method that can overcome underreporting by participants is the use of a streaming procedure, where participants verbalise thoughts in real time and recurrence is coded by researchers based on transcripts (Pope & Singer, 1975). A meta-analysis of potential moderators of the relationship between suppression instructions and thought recurrence found that streaming procedures resulted in greater initial enhancement and rebound effects compared to button press, or similar event marking procedures (Abramowitz et al., 2001). This has implications for studies that measure recurrence using self-report. Specifically, it may reduce effect sizes and conceal significant relationships.

Thought suppression performance and habitual avoidance

Another question that has been raised is whether performance on thought suppression tasks is linked with the use of cognitive avoidance strategies in daily life. While anxious participants reported higher levels of cognitive avoidance outside of the laboratory, avoidance did not predict frequency or duration of targets in the suppression task. This indicates that despite engaging in cognitive avoidance strategies more frequently (according to self-report), anxious participants were no better at suppressing targets than non-anxious controls. By extension, these results suggest that performance does not necessarily improve by repeatedly and habitually supressing negative thoughts (i.e., practice does not make perfect). In line with this, repeated suppression attempts have been shown to increase or maintain intrusions (Hooper & McHugh, 2013; Trinder and Salkovskis, 1994).

From a clinical perspective, these results point to the cyclical negative effects that suppression has on anxiety. Anxious individuals are more likely to suppress thoughts, and the act of suppression can paradoxically increase the frequency and intensity of thoughts, contributing to ongoing anxiety and distress, although it is acknowledged that this is not always the case (Magee et al., 2012; Wang et al., 2020). Furthermore, suppression can interfere with cognitive functioning as this effortful process can distract focus from other tasks, resulting in decreased performance and concentration difficulties commonly noted in clinical anxiety (Hallion et al., 2018). Finally, as suppression ensures that thoughts maintain their anxiety provoking properties, it means that anxious individuals are more likely to continue this strategy, despite its negative effects.

Internal and External Attention

A secondary aim of Study 2 was to elucidate whether the association between attention processes responsible for internal and external stimuli by comparing performance across thought suppression and dot-probe tasks. While conceptually similar, engagement bias was not correlated with thought frequency. Further, disengagement bias was not associated with thought duration. That may simply reflect that the dot-probe and suppression task are very different in that the dot-probe requires orientation and disengagement from visual cues.

However, it is also possible that, even if dimensions of thought recurrence correspond with engagement and disengagement biases, that may not have been detected in this study due to the instability of attention biases to threat. As previously mentioned, mean based measures of attention bias to threat have recently been criticised for their instability in comparison to more novel measures (i.e., attention bias variability; Carlson & Fang, 2020; Iacoviello et al., 2014; Zvielli et al., 2015).

Furthermore, while we did not find evidence that engagement and disengagement biases correlate with though frequency and duration, evidence from Attention Bias Modification (ABM) tasks have shown that these constructs are related, as ABM training has been demonstrated to reduce clinical symptoms of anxiety, including negative cognitions (Amir et al., 2009; Hayes et al., 2010, Hazen et al., 2009; Schmidt et al., 2009; Waters et al., 2013). Therefore, although we did not find evidence that attention biases to external stimuli corresponded to engagement and disengagement from thoughts, it is possible that this is because of the methodological issues described above.

Conclusion and future directions

Overall, the results of the current study were unable to shed further light on the cognitive processes that underlie thought suppression, and whether attention biases correspond to facets of thought suppression. That has raised significant methodological questions regarding the measurement of thought suppression, specifically, the accuracy of self-caught event marking procedures in thought suppression tasks. As highlighted, event marking procedures require participants to decide what constitutes “thinking the thought” which is likely to be variable across participants and creates significant opportunity for error. This has considerable implications for studies that investigate the role of attention to thoughts in anxiety, because if participants are unable to accurately identify when they are thinking a particular thought, conclusions based on event marking studies will be weaker. However, no studies to date have directly compared thought recurrence outcomes across event marking and experimenter coded tasks. The final study (Study 3) therefore shifted focus towards the methodological question of whether self-caught versus other-caught measures of recurrence demonstrate convergent validity, and whether different methods produce different results when investigating the interplay between anxiety and attention control. Additionally, to shed light on the nature of distracter thoughts and participants’ sensitivity to classifying them as a thought recurrence, experimenter coded thoughts were classified as being directly or indirectly related to or unrelated to the target, or task-related.

Chapter 4: Study 3:

Anxiety, Attention Control and Distracter Thoughts in Suppression

Overview

In Study 1 and Study 2 the relationships between anxiety, attention control and thought suppression were investigated. The findings from these studies have important implications for understanding the complex interplay between these psychological processes. Neither study found significant relationships between thought suppression and attention control, or between thought recurrence and anxiety. This suggests that these relationships are multifaceted and depend on other factors, such as cognitive load, and the distinction between clinical versus subclinical anxiety (Shi et al., 2019). Study 2 also highlighted broader methodological considerations in measuring thought recurrence, thereby setting the stage of the current investigation. Specifically, Study 3 investigated various measures of thought suppression and the types of distracter thoughts that are generated during suppression.

Measurement Issues

Negative thoughts are a hallmark of anxiety (Borkovec et al., 2004; Hirsch & Mathews, 2012) and are central to anxiety-related treatments such as Cognitive Behaviour Therapy, Acceptance and Commitment Therapy, and Mindfulness-based CBT (Hayes et al., 2011; Hoffman et al., 2009; Segal et al., 2004). Laboratory studies provide controlled environments to test theoretical propositions underlying these approaches. Thoughts, despite their ubiquity, are difficult to conceptualise, operationalise and measure. Nevertheless, various thought measurement methods exist. Historically, methods like *streaming* capture participants' inner dialogues by verbalising their thoughts as they occurred (Pope, 1975). Subsequently, experimenters coded transcripts for lapses in suppression, and is known as an *other-caught* method.

Another approach, self-reported event marking, described in Study 2, entails participants pressing a button or spacebar when target thoughts occur. This is a *self-caught* method. However, ambiguity in defining "thinking the thought" in task instructions leads to variability in reporting thresholds (Fikretoglu et al. 2003; Gorlin & Teachman, 2016; Lambert et al., 2014; Magee et al., 2019; Wegner et al., 1987). This lack of clarity may lead to differing thresholds of conflict detection between participants and may result in underreporting of target thoughts, potentially weakening the associations with variables of interest, such as attention control and anxiety.

Meta-analyses (Abramowitz, 2001; Magee et al., 2012) have identified that recording methods moderate initial enhancement and rebound effects, with smaller effect sizes for event marking compared to streaming (Magee et al., 2012, supplementary material). While some studies have employed both methods concurrently (Davies & Clarke, 1998; Fikretoglu et al., 2003), few have directly compared them, as discussed below. Nevertheless, participants have self-reported that they were more likely to verbalise targets than to record them by button press, indicating participants were more compliant with streaming instructions in comparison to event marking methods (Davies & Clarke, 1998). Broadly this implies that people will respond differently using different thought sampling methods.

Convergent validity between event marking and streaming procedures, both presumed to measure thought recurrence, remains an important question. Although these methods are proposed to measure the same construct, convergent validity has not been well-established. Fikretoglu et al. (2003) correlated self-reported frequencies with the total duration of target thoughts obtained through streaming (Study 1, *rs ranged from* .37 –.71; Study 2, *rs* = .62 – .76). However, these results are difficult to interpret because frequency and total duration are confounded (i.e., long durations limit opportunities for further recurrences; Lambert et al., 2014; Purdon, 2004). Furthermore, in a study regarding suppressing food related thoughts, event-marking and streaming *frequencies* were not significantly correlated, indicating inconsistencies between self-monitored recurrence and verbalised thoughts (O'Connell et al., 2005).

While streaming and event marking are inherently different, as described below, if they are measuring the same construct there should be considerable shared variance. This has implications for research focussing on thought suppression, where meta-analyses often incorporate studies employing event marking or streaming, under the presumption that they measure the same phenomenon (e.g., Abramowitz et al., 2001; Magee et al., 2012; Wang et al., 2020). Therefore, Study 3 assessed the extent to which these measures are correlated. Further, if event marking and streaming are not correlated, it raises the question of what each method is assessing.

Regarding the differences between event marking and streaming during suppression, streaming only requires participants verbalise their thoughts while trying not to think about a target. Comparatively, event marking requires the identification of conflicts between current thoughts and the task demands (i.e., not think the target) so participants can press a button. Therefore, event marking may not solely reflect occurrence but also detection and subsequent suppression (i.e., monitoring, and operating processes).

This raises the possibility that the degree to which event marking and streaming methods correspond may depend on attention control (AC). AC, measured through the Stroop Task (Stroop, 1935), involves detecting conflict between higher order goals and automatic responses. To self-report thought recurrence, one must detect when thoughts are incongruent with suppression goals. Higher AC should facilitate more accurate conflict detection during thought suppression, potentially strengthening the relationship between event marking and streaming procedures. Given that an overarching aim of this thesis is to investigate whether attention control contributes to attentional reactions to thoughts, the proposition that it may facilitate greater convergent validity between thought suppression measures was tested.

Distracter Type

An advantage of streaming is that it captures thought content, shedding light on which thoughts serve as distracters. Distinguishing between different types of distracters, such as positive thoughts, punishing thoughts, or minor worries, can broaden our understanding of which types are associated with thought recurrence and effective replacements (Wells & Davies, 1994). The operating process is responsible for generating and selecting distracters and may be qualitatively more or less effective depending on the nature of the distracters it generates (Fikretoglu, 2003; Page et al., 2005; Reich & Mathers, 2008; Renaud & McConnell, 2002; Roemer & Borkovec, 1994; Wang et al., 2017; Wang et al., 2018; Wegner et al., 1987; Wenzlaff et al., 1988). Although many studies recommend alternative self-regulatory strategies to suppression, including mindfulness and acceptance-based approaches (Litvin, 2012), these are not necessarily suitable for everyone as they demand training, meta-cognitive awareness, and may require financial cost through therapeutic intervention (Segal et al., 2002; Wang et al., 2017). Given the widespread use of suppression and potential barriers to other approaches, it may be useful to understand whether distracter type has a differential effect on thought recurrence and rebound. That is, while suppression is still considered a maladaptive strategy, there may be ways to reduce its potential harmful effects.

There is evidence that distraction methods influence thought recurrence. Single distracters specified by experimenters (i.e., focussed distraction - "think of a red Volkswagen") resulted in less intrusions compared to when participants generated their own (i.e., unfocussed distraction – "think anything"; Luciano & Gonzalez, 2007; Lin & Wicker, 2007; Magee et al., 2019; Namji et al., 2009; Wang et al., 2017; Wegner et al., 1987).

However, less is known about whether the type of distracters used during unfocussed suppression contribute to thought recurrence. This is potentially important because it may explain why unfocussed suppression leads to initial enhancement and rebound effects. Further, as will be discussed, the types of distracters used may be linked with anxiety and attention control.

Anxiety and distracter type

Self-generated distracters can be classified as being directly or indirectly linked, or unrelated to the target (Roemer & Borkovec, 1994). Direct thoughts are those related to the situation, emotional responses, and references to thinking (or not thinking) about the thought. In the context of the thought “I hope my friend is in a car accident”, this would include thoughts about car accident, or sequalae. Indirect thoughts are thematically (e.g., referring to an instance of harm or injury to a friend) or contextually related to specifics about the situation (e.g., thoughts of another friend, or buying a new car). They are not related to the thought itself but contain similar elements that are semantically linked (e.g., friends, cars, other types of accidents). Indirect thoughts are peripherally related to the target. Finally, unrelated thoughts, also termed neutral thoughts, are not linked to the target thought (e.g., grocery lists). Based on Associative Network Theory (Anderson 1983), the most effective distracters should be semantically and affectively dissimilar to the target because they are not linked in memory (Fikretoglu et al., 2003; Wegner & Erber, 1992; Wenzlaff et al. 1988; Wenzlaff & Wegner, 2000). For example, substituting (i.e., suppressing) thoughts of cars with planes would be more likely to result in recurrence compared to elephants because cars and planes are related (i.e., modes of transport).

Mathews (1990) proposed that anxious cognition involves the early detection of threat-related thoughts and a tendency to avoid the voluntary elaboration of them (i.e., avoidance of the associative network). However, Roemer and Borkovec (1994) suggested that in anxiety, the distracters used may be ineffective as they are linked to the target in some peripheral way. Indeed, anxiety provoking targets have been associated with more indirect, compared to direct or unrelated thoughts (Roemer & Borkovec, 1994). This can be conceptualized as incomplete avoidance (Roemer & Borkovec, 1994). Indirect distracters may perpetuate anxiety by maintaining some connection to the target while evading detection. This may also explain reversed rebound effects associated with anxiety (see Magee et al., 2012), as individuals high in trait anxiety may be using indirect distracters during suppression, resulting in fewer direct thoughts (i.e., less recurrence) but still maintaining anxiety. This study tested whether anxiety predisposes individuals to employ distinct types of distracters (i.e., direct, indirect, task, unrelated, no thought). Task-related and no-thought categories were also included as it was expected participants would think about the task due to the artificialness of the experiment and that at some point participants may not think anything at all.

Effort

While AC may facilitate suppression, it is also noted that effort is a necessary precondition of successful suppression (Abramowitz, 2001; Gorlin et al., 2016; Magee et al., 2012; Wegner, 1994; Wenzlaff & Wegner, 2000). Having the capacity alone to complete an action is not sufficient to engage in the behaviour successfully, and effort is often required. For example, having the knowledge and physical capacity to clean the dishes without trying to wash them means they will remain on the sink, or putting in too little effort will result in plates speckled with food. The same could be said for thought suppression, in that while one may have the cognitive resources to do so, without intention and effort to stop thinking a thought, it is likely that the thought will continue, at least until the mind wanders to something else. Consistent with this, when participants are given suppression instructions compared to monitoring instructions, they report greater efforts to keep the thoughts from mind, resulting in lower frequencies and shorter durations (Gorlin et al., 2016).

However, in the context of anxiety a different picture emerges. In an online suppression study Gorlin et al. (2016) found self-reported effort mediated the relationship between anxiety and thought recurrence. Consistent past with theoretical and empirical evidence, they found that anxiety was associated with greater suppression effort, regardless of suppression and monitor instructions (Clark, 2004; Gorlin et al., 2016; Magee et al., 2012; Namji et al., Purdon et al., 2005; Wenzlaff & Wegner, 2000). Furthermore, higher effort was associated with faster deactivation of the target (i.e., shorter durations), but concurrently increased the likelihood that they were reactivated in the future (i.e., higher frequencies; Gorlin et al., 2016). Gorlin et al. (2016) acknowledged that the effect sizes in their study were small (*rs* ranging from .06 - .18) and considering the large sample size (N = 939), the study may have been overpowered. For effort to mediate the relationship between anxiety and recurrence the relationship must be reliable; yet the relationship between anxiety and recurrence is not consistent, and many studies have failed to find relationships between anxiety and thought suppression outcomes (see Magee et al., 2012 for review). Whether or not effort mediates the relationship between anxiety and thought recurrence has clinical relevance because it can provide perspective on whether suppression effort is associated with recurrence and consequently contributes to the maintenance of anxiety. Therefore, the present study also investigated whether anxiety corresponded to greater suppression effort and intrusions.

Summary and Hypotheses

Study 3 tested the relationship between streaming and event marking procedures and investigated the relationship between anxiety and attention control on distracter types. The potential mediating effect of effort on the relationship between anxiety and thought recurrence was also investigated. This study also reassessed whether attention control moderated the relationship between anxiety and intrusions during active suppression and subsequent monitoring to clarify findings from Study 2.

The first aim was to assess the convergent validity of subjective/self-caught (i.e., event marking) and more objective/other-caught (i.e., streaming) thought measures. Based on the presumption that streaming and event marking procedures both capture thought recurrence, it was expected that there would be a positive correlation between frequencies obtained through streaming and event marking procedures. The potential moderating effect of attention control, as measured by Stroop performance was also investigated. If conflict detection is responsible for accurately identifying when one is thinking the target, it would be expected that higher attention control (i.e., less Stroop interference) would result in a stronger relationship between event marking and streaming.

The second aim was to test the association between anxiety and types of distracter thoughts. Different types of distracter thoughts may explain reversed rebound effects that have been identified in previous studies. If anxiety is associated with incomplete avoidance of the target, it would be expected that there would be a positive correlation between anxiety and the proportion of indirect distracters generated during suppression (Roemer & Borkovec, 1994).

Self-reported efforts to suppress have been proposed to mediate the link between anxiety and thought recurrence, however the effect sizes were small, and the authors acknowledged the need for replication (Gorlin et al., 2016). Previous research suggests that effort will have opposing effects on frequency and duration (Gorlin et al., 2016). Anxiety is associated with increased suppression efforts across both suppression and monitoring periods, and that this increased effort will result in higher frequencies for event-marking and streaming procedures. Conversely, it was predicted that anxiety would be associated with increased effort, but faster disengagement from targets once they are activated (i.e., shorter average durations).

Finally, keeping in line with the focus of Study 2, we explored whether attention control moderated the relationship between trait anxiety and thought recurrence. Given the mixed findings to date on the relationships between anxiety and attention control on thought recurrence, no specific predictions were made.

Method

Participants

Fifty-eight participants (45 female; aged 17 – 46 years, *M* = 23.10, *SD* = 7.0) were recruited through the Flinders University School of Psychology, where first year psychology students may volunteer to participate in research for partial course credit, or payment of $15.00. Participants were included if they reported normal colour vision, with normal, or corrected to normal visual acuity. A priori power analyses based on a small effect size, Cohen's $f^2 = 0.15$, indicated that a sample size of $N = 119$ would be required to have sufficient power for moderation analyses with three predictors (i.e., time, anxiety, and attention control). However, due to the COVID-19 pandemic, we were unable to recruit this many participants in line with time constraints, and online data collection was not suitable for the streaming procedure.

Design

This study employed a within-subjects design, where thought suppression measures for each time period (i.e., suppression versus monitoring) were compared. The predictor variables were trait-anxiety and Stroop interference (i.e., attention control). Attention control was calculated based on reaction times on the Colour-Word Stroop. Trait-anxiety was assessed via self-report questionnaire. The outcome variables were thought frequencies and duration (obtained through event marking), and distracter type (direct, indirect, task-related, unrelated, no thought; obtained through streaming).

Materials

Stimulus materials and equipment

Apparatus. The computer tasks we conducted using the same equipment and hardware as the previous studies, however there was the addition of a voice recorder for the thought suppression task. Participants verbalised their thoughts and were recorded by a Phillips Voice Tracer DVT4110, recordings were then transcribed using voice recognition software (Dragon Naturally Speaking , Version 15, Nuance Communications).

Stream of consciousness recording. During the thought suppression task participants were asked to speak their thoughts aloud and these responses were audio recorded. Participants practiced "think out loud" using the following modified version of Pope's (1978) instructions:

> "This study is concerned with how and what people think. Past studies like this have measured thoughts by recording people's voices, but others have used button presses, so we are going to do both. For the practice, we just want you to talk aloud. We want to know what you are thinking, but we do not have technology that can tell us exactly what you are thinking, so we need you to tell us. It is really important that you just speak whatever is on your mind throughout the entire task. Please convey whatever information you can on your stream of consciousness at that moment. Your report might include, but is not limited to images, ideas, memories, feelings, fantasies, plans, sensations, observations, daydreams, objects that catch your attention, efforts to solve a problem. There are no restrictions, so

just say report whatever is going through your mind that you are aware of. You might find that your mind is blank, and even if you are not thinking anything, tell us that. Speak clearly and as loudly as you would in normal conversation (about as loud as I am talking now). The practice will go for 2 minutes. Do you have any questions? Begin."

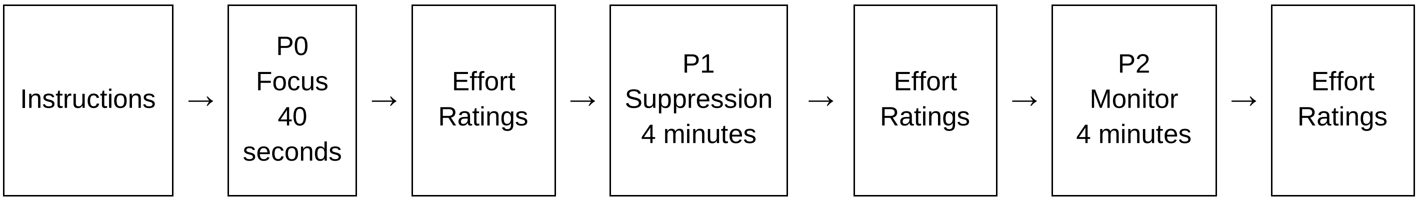
Participants practiced talking their thoughts aloud, without being recorded, for two minutes with the experimenter present. It was necessary to have the experimenter present to provide feedback to participants on whether they were speaking loud enough to be captured by the audio recorder, and that they did not stop speaking their thoughts aloud for prolonged periods. Where participants did not speak for periods of 5 seconds or more, the experimenter provided scripted feedback at the end of the two minutes: "remember that you need to continuously speak your mind aloud. This is very important because we cannot tell what you are thinking. If your mind is blank, tell us that." Where participants were speaking quietly or mumbling to the extent that the transcription software would not be able to transcribe the recording, the experimenter said: "Remember that you need to talk as loud as you would in conversation, about as loud as I am talking now." Following the practice, the experimenter set up the thought suppression task on the computer.

Thought Suppression Task. The thought suppression task was almost identical to the task described in Study 2. A visual depiction of the blocks of the task is presented in Figure 1. In Period 0, participants were asked to focus on the thought. In Period 1 all participants were given suppression instructions and in Period 2 all participants were asked to monitor the thought. Participants were asked after each thinking period to rate how hard they tried to not think about the thought (i.e., effort). Self-reported effort was measured as it has been linked with thought suppression outcomes (Gorlin et al., 2016; Koster et al., 2003).

In the initial enhancement period (Period 1: 4 minutes), all participants were asked to suppress the thought (i.e., not think the thought) and to depress the spacebar when they were thinking about the thought. In the rebound period (Period 2: 4 minutes), participants could think anything and indicated thought recurrence. While a “monitoring” condition was not included in Period 1, making our study ‘uncontrolled’, its focus was the role of anxiety and attention control during active suppression attempts, and therefore a monitoring condition was not required.

Figure 1

Visual representation of the phases of the thought suppression task



Note. P0 = period 0, focus instructions; P1 = Initial Enhancement period (suppression instructions); P2 = Rebound period (monitoring instructions). Effort ratings = self-reported effort to suppress, 100pt analogue scales.

Independent Variables

Stroop Interference. The colour-word Stroop (Stroop, 1935) measured Stroop Interference and by extension, attention control. Higher scores indicated greater Stroop interference, thus weaker attention control.

Trait anxiety. Trait anxiety was assessed with the 20-item trait subscale of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger et al., 1983) as in Study 1 and Study 2. Higher scores indicated higher trait anxiety. In the present study, the STAI-T demonstrated good internal consistency (α = .92).

Dependent Variables

Event marking frequency. Self-reported frequency was measured by counting each time participants depressed the spacebar.

Event marking duration. Self-reported duration was measured by recording the length of time that the spacebar was depressed. As a key interest in the present study was how quickly participants can shift their attention away from the target, the total duration was divided by frequency to give an average duration per target thought occurrence. Average thought duration was used in subsequent analyses.

Distracter Type. Transcripts from the streaming procedure were generated using transcription software, and each statement/sentence was coded by researchers who were blind to scores on trait anxiety and attention control. Fifty-three transcripts were generated (8.6% were lost owing to equipment malfunction). There were five categories of distracter type in total, which are outlined below and more fully described in the coding guide (see Appendix B). Each rater completed 2 hours of training with the primary researcher, and interrater reliability was assessed using Krippendorff's alpha for each thinking period for 25% of transcripts (Focus instructions, $\alpha = .87$; Suppression instructions, $\alpha = .76$; and Monitoring instructions, $\alpha = .77$).

Categories for distracter thoughts were based off previous research identifying how closely related thoughts were to the target (i.e., directly, indirectly, or unrelated to the target; Roemer and Borkovec 1994). The definitions for direct, indirect, and unrelated thoughts were adapted from Roemer and Borkovec (1994) however it was necessary to include two additional categories – *task* and *no thought.*

Direct thoughts were defined as descriptions of the situation itself, an emotional response to it or a reference to thinking (or not thinking) about it.

Indirect thoughts were defined as thoughts that do not directly refer to the target but were thematically related (e.g., involves harm to someone else, "*my mum was in a car accident*") or contextually related to the specifics of the situation (e.g., statements of any type about friends or cars).

Unrelated thoughts were defined as thoughts that did not directly refer to the target and did not contain contextual or thematic connections to the target (e.g., "*I really need to drink more water"*).

Task thoughts were defined as statements that reflected the nature of the task itself, such as how much longer the trial was, references to being recorded (e.g., "I wonder if I am speaking loud enough"), having experimenters read transcripts (e.g., "the person who reads my transcript is going to laugh at me") or following the instructions ("I can't remember if I have been pressing the spacebar when I am supposed to"). It was important to differentiate task related thoughts from direct thoughts and indirect thoughts because they capture the artificial nature of the task, and do not clearly fit within the aforementioned categories. These thoughts are distinct from direct thoughts, as they are not about the thought itself, or attempts to suppress it, which would constitute as a direct thought. Task thoughts were conceptualised as also being distinct from *indirect* thoughts as they are not related in any way to thematic or contextual aspects of the target thought (e.g., thoughts about friends, cars, or accidents).

No thought was also included for any reference to the absence of thought or not being able to identify a thought (e.g., "my mind is blank"). While other researchers (e.g., McNally & Riccardi 1996; Fikretoglu, 2003) have included periods of silence in audio-recordings as evidence that a participant has not effectively switched to a suitable distracter (i.e., direct thought), this conclusion is presumptuous because there are alternative explanations for silence. For example, participants may disengage with the task and forget to continue verbalising their thoughts, or they may simply not be thinking anything at all.

Another consideration was the definition of what constituted a thought in the current study, particularly as we aimed to compare different thought recording procedures (i.e., streaming vs event marking. While some studies have measured frequencies using the total number of statements (e.g., Roemer & Borkovec, 1994; Pope, 1978), it was unlikely that when a participant is told to indicate recurrence via button press that they would press and release the spacebar for each statement, for example:

PRESS. *I hope my friend is in a car accident.* RELEASE.

PRESS. *What a terrible thing that would be.* RELEASE.

PRESS. *If they died that would make me incredibly sad.* RELEASE.

PRESS. *Where would they crash?* RELEASE.

Instead, it was expected that participants would press and hold the spacebar down when they were having a train of direct thoughts, and release it when they used a distracter:

PRESS *I hope my friend is in a car accident. What a terrible thing that would be. If they died that would make me incredibly sad. Where would they crash?* RELEASE. *What am I going to have for dinner later?*

A train of thought was identified through shifts between distracter types (e.g., direct to unrelated thoughts; task thoughts to direct thoughts) or a significant shift in thought content or topic which is within the same distracter category (e.g., unrelated: "*This room is really ugly*" SHIFT "*I really want to get my hair cut*"). Krippendorff's alpha for identifying the number of shifts in each thinking period was calculated for 25% of transcripts (Period 0, α = .92; Period 1, α = .82; and Period 2, α = .81). For analyses comparing self-caught versus other-caught measures of thought recurrence, event-marking frequencies (i.e., spacebar presses) were compared with the number of direct trains of thought coded by experimenters.

A decision also had to be made regarding how distracter type was going to be measured in terms of whether the total frequency, or proportion of thoughts was used for analyses that investigated the relationship between anxiety and distracter types. During preliminary analyses, it was found that there was a small positive correlation between trait anxiety and the total number of thoughts during suppression, $r(51) = .28$, $p = .042$. Therefore, if trait anxiety was positively correlated with frequencies of particular distracters, it may not indicate that anxiety is associated with a specific distracter type, but instead reflect a greater number of thoughts overall. Therefore, the proportion of direct, indirect, task, unrelated and no thought was obtained for each thinking period and used in the subsequent analyses.

Self-reported effort. Following each thinking period, participants rated "*how hard did you try to not think about your friend being in a car accident"* using a visual analogue scale (0-100), with labels (0 = not at all, 20 = minimal, 40 = somewhat, 60 = moderate, 80= very, 100 = extremely).

Procedure

The experiment took place in a laboratory in the College of Education, Psychology and Social Work at Flinders University, South Australia in April 2021. Ethics approval was sought from the Social and Behavioural Research Ethics Committee. Experimental sessions took approximately 45 minutes to complete. Participants completed tasks individually during one session. Tasks were completed in the following order: colour-word Stroop, thought suppression task and concurrent streaming procedure, questionnaires (See Appendix C for procedure outline).

Results

Preliminary data screening revealed no outliers and data were acceptably distributed. Descriptive statistics and distribution characteristics are presented in Table 1.

Table 1

Descriptive Statistics for Attention Control, Anxiety and Thought Suppression by Event Marking (EM) and Streaming (S) Measures

	Min	Max	Mean	SE Mean	SD
Stroop Interference	- 23.32	259.26	78.30	10.61	80.81
STAI-T	25	70	49.69	1.37	10.42
Suppress Frequency (EM)	0	26	4.55	0.53	4.06
Suppress Duration (EM)	0	98.19	19.56	2.71	20.63
Suppress Direct (S)[a]	0	1	0.29	0.03	0.21
Monitor Frequency (EM)	0	9	2.36	0.25	1.87
Monitor Duration (EM)	0	75.69	17.25	2.15	16.33
Monitor Direct (S)[a]	0	0.80	0.21	0.03	0.19

Note. AC = attention control, STAI-T = trait anxiety; "Suppress" refers to measures taken during the first thinking period (i.e., suppression instructions); Monitoring refers to measures taken during the second thinking period (i.e., free thinking instructions). "Direct" refers to the proportion of direct statements made during each thinking period. Duration is the average duration of each thought in seconds.
N = 58, [a] N = 53.

Comparisons of thought suppression measures

As a preliminary analysis, cases where participants mentioned the target thought during the streaming procedure but did not press the spacebar (i.e., did not self-report the thought) were counted. Interestingly, in the focus period where participants were asked to think about the thought, 13.2% (n = 7) verbalised the thought but did not press the spacebar at all, and one participant (1.8%) did not have the thought based on either measure (i.e., all thoughts were task related, not direct thoughts). In the suppression period, 5.6% (n = 3) verbalised the thought but did not press the spacebar, and in the monitor period 7.5% (n = 4) verbalised the thought but did not press the spacebar. This indicated false negatives, but they occurred for different participants at each time period (i.e., it did not occur across multiple time periods for the same participants). All analyses were run including and excluding cases with false negatives; however, this only changed the pattern of results for one analysis. Therefore, analyses are reported for the whole sample, except the analyses assessing whether attention control moderated the relationship between event marking and streaming measures.

In relation to the study's primary aim to determine whether event marking and streaming procedures demonstrated convergent validity, correlations were conducted between frequencies for event marking and streaming procedures. There were two ways of calculating frequencies for streaming: a) the total number of direct statements (e.g., *I hope my friend is in a car accident* (direct). *That would be terrible* (direct). *What will I have for dinner?* (unrelated) = total of 2 direct) or b) a train of direct thoughts (e.g., *I hope my friend is in a car accident* (direct). *That would be terrible* (direct). What will *I have for dinner*? (unrelated) = total of 1 direct). The decision was made to compare the relative strength of the correlations between both streaming measures (i.e., statements vs trains of thought) and event marking frequencies because, as discussed earlier, it is not clear whether participants press the button for every individual thought/statement they have about a target, or whether button presses capture shifts from trains of direct thought to distracters. Finally, the strength of the correlations between the event marking and streaming measures were tested to see if they were significantly different from $r \geq .70$, as this is the recommended benchmark for convergent validity (Carlson & Herdman, 2007).

As expected, for both periods, there was a moderate positive correlation between event marking frequency and the number of direct statements during suppression, and the number of direct trains of thought, with no significant difference in the strength of the correlations (See Table 2 for inferential statistics and correlation coefficients). However, during suppression the correlations did not reach the cut-off of $r \geq .70$ $Z = 2.11$, $p = .03$ (statements) and $Z = 2.05$, $p = .04$ (trains). Yet under monitoring conditions, both individual statement, $Z = 0.77$, $p = .44$, and train, $Z = 0.00$, $p \geq .99$, measures met the threshold for convergent validity with event marking frequencies; $r \geq .70$. All further analyses used *trains* of thought instead of statements because participants were not instructed to press the button for each individual direct thought but rather to press and hold the spacebar while they were thinking about the target.

Table 2

Comparisons of Correlations Between Event Marking Frequencies and Streaming Measures of Recurrence During Suppression and Monitoring

	Streaming			
	Direct Statements	Direct Trains	*Z*	*p*
EMF Suppression	$.41^{**}$	$.46^{***}$	0.30	.76
EMF Monitoring	$.61^{***\dagger}$	$.70^{***\dagger}$	0.79	.43

Note. EMF = event marking frequencies; *direct statements* refers to the number of statements or sentences directly related to the target for each time period; *direct trains* is the total number of times a person was on the topic of direct thoughts.
$N = 53$
* p <.05. ** p <.01. *** p <.001. † r not significantly different from .70

Moderated regression analyses were used to determine whether attention control strengthened the relationship between self-caught and other-caught measures of thought recurrence (PROCESS 4.0, Model 1; Hayes, 2018). Separate analyses were for the suppression and monitor periods. Predictors were mean centred prior to analysis. For both thinking periods, event marking frequencies (self-caught) and attention control were predictors and the dependent variable was direct trains of thought measured through streaming (other-caught). Regression results are in Table 3 .

Unsurprisingly, in both thinking periods, event marking frequencies predicted direct thoughts. Attention control did not predict direct thoughts during suppression or monitoring. The interaction for the suppression period was not significant. Although the interaction for the monitoring period approached significance, post-hoc power analyses indicated that the study was underpowered to detect a significant effect (α = .19). If the interaction had been significant, the coefficients would indicate that the relationship between self- and other-caught measures was stronger at lower levels of Stroop Interference (i.e., higher attention control).

Table 3

Hierarchical Multiple Regressions Predicting Thought Recurrence Using the Streaming Procedure (S) from the Event Marking Procedure (EMF) and Stroop Interference for Suppression and Monitoring Periods

Dependent variable	Predictor	*b*	*SE*	*t*	*p*	*95% CI*
Suppress Direct (S)						
	R^2 = .25, F (3, 47) = 4.86, p =. 005**					
	Constant	3.62	0.300	12.26	<.001***	[3.03, 4.22]
	Stroop Interference	-0.01	0.004	1.32	.19	[- 0.003, 0.01]
	Suppress EMF	0.18	0.070	2.53	.015*	[0.38, 0.33]
	Suppress EMF x Stroop Interference	-0.001	0.001	1.36	.18	[- 0.001,0.003]
	ΔR^2 = .03, F (1, 49) = 1.84, p = .18					
Monitor Direct (S)						
	R^2 = .46, F (3, 49) = 13.75, p < .001					
	Constant	2.11	0.16	13.26	<.001***	[1.79 – 2.43]
	Stroop Interference	-0.001	0.001	1.25	.22	
	Monitor EMF	0.49	.08	5.82	<.001***	[0.32 – 0.67]
	Monitor EMF x Stroop Interference	-0.001	0.001	1.85	.06	
	ΔR^2 = .04, F (1, 49) = 3.43, p = .07					

Note. Suppress = suppression instructions, and Monitor = monitoring instructions. Direct = the proportion of direct statements captured using the streaming procedure.
N = 53.
*p <.05.

Distracter type

To assess whether there were differences in the types of thoughts that were generated, paired samples t-tests were conducted for each thinking period on the proportion of each distracter type. Descriptive statistics are in Table 4. Ironically, participants verbalised more direct thoughts during suppression than monitoring, $t(52) = 1.83$, $p = .04$, $d = 0.24$, suggesting a small immediate enhancement effect. During suppression, direct thoughts were more prevalent than indirect, $t(52) = 6.50$. $p < .001$, $d = 0.89$; task related, $t(52) = 5.68$, $p < .001$, $d = 0.78$; and no thought, $t(52) = 4.43$, $p < .001$, $d = 0.61$. No significant differences between direct and unrelated thoughts were found, $t(52) = -0.28$, $p = .39$, $d = -0.04$. Overall, 32.7% of thoughts were direct, and 34.3% of thoughts were unrelated, signalling that during suppression participants were either directly thinking the thought or using an unrelated distracter.

During monitoring, unrelated thoughts were significantly more prevalent than direct thoughts, $t(52) = -2.76$, $p = .004$, $d = -0.38$, although the difference was modest. Direct thoughts were verbalised more than task, $t(52) = 3.58$, $p = <.001$, $d = 0.49$; indirect, $t(52) = 4.18$ $p < .001$, $d = 0.57$; and no thought, $t(52) = 3.25$, $p < .001$, $d = 0.45$. This indicated that during monitoring, 43% of verbalised thoughts were unrelated to the target, whereas 26% were directly associated with the target following suppression.

Table 4

Descriptive Statistics for the Proportion of Distracter Types Generated by Thinking Period

Time period and distracter type	M	SD	Min	Max
Suppression				
Direct	0.33	0.25	0.00	1.00
Task	0.10	0.12	0.00	0.45
Indirect	0.08	0.09	0.00	0.40
Unrelated	0.34	0.20	0.00	0.92
No Thought	0.13	0.13	0.00	0.43
Monitor				
Direct	0.26	0.25	0.00	1.00
Task	0.10	0.17	0.00	1.00
Indirect	0.10	0.13	0.00	0.44
Unrelated	0.43	0.24	0.00	0.86
No Thought	0.12	0.12	0.00	0.43

Note. Suppress = suppression instructions, and Monitor = monitoring instructions. $N = 53$

The idea that some distracters are better than others for reducing direct thoughts was evaluated by correlating the proportions of direct trains of thought and other distracter types and comparing the relative strengths of significant correlations. Significant correlations are reported in Table 5, and the complete results can be found in Appendix D).

Table 5

Correlations between distracter type and the proportion of direct thoughts for the suppression and monitoring periods

	Direct thoughts	
	Suppression	Monitoring
Unrelated thoughts	$-.65^{***}$	$-.73^{***}$
No thought	$-.40^{***}$	$-.33^{***}$

Note. Suppression = suppression instructions, and Monitor = monitoring instructions. Direct thoughts = the proportion of direct thoughts. Unrelated thoughts = proportion of unrelated thoughts. No-thought = proportion of thoughts participants described as not thinking anything
$N = 53$.
$^{***}p < .001$.

Across both thinking periods, only unrelated thoughts and no-thoughts were significant negative predictors of direct thoughts. During suppression, there was no significant difference between their relative strength, $Z = 1.24$, $p = .213$. However, during monitoring, unrelated thoughts were a significantly stronger predictor of direct thoughts than no-thought, $Z = 3.41$, $p < .001$. Therefore, unrelated thoughts appeared to be the most effective distracter against recurrence for both periods, compared to other distractors, although during active suppression, “not thinking” appeared to be beneficial at reducing direct thoughts. That will be discussed later.

Anxiety, Effort and Distracter Type

Whether trait anxiety and attention control were related to the types of distracter thoughts generated during and after suppression was tested. Additionally, as self-reported effort (i.e., how hard a participant tried to keep the thought from mind) has been linked with thought recurrence (e.g., Gorlin et al., 2016), effort was included in the analyses. The dependent variables were the proportion of distracter types generated during each thinking period and represented the types of thoughts that participants generated during the suppression and monitoring periods. For conciseness, significant correlation coefficients are reported below, and complete results can be found in Appendix D.

Trait anxiety was positively correlated with self-reported effort during suppression and monitoring, $r(56) = .27$, $p = .04$; $r(56) = .39$, $p = .003$, respectively, and positively predicted task related thoughts during suppression $r(51) = .41$, $p = .002$; indicating higher anxiety was associated with a greater tendency to think about the task (e.g., being recorded, or talking aloud) and efforts to suppress the target. Anxiety was not correlated with Stroop Interference. Anxiety did not predict other distracter types (i.e., direct thoughts, unrelated, indirect, or no thoughts), indicating that anxiety was not characterised by the generation of lower quality distracters (e.g., direct, or indirect thoughts).

Suppression instructions corresponded to higher suppression effort ($M = 60.02$, $SD = 26.21$) compared to monitoring instructions ($M = 45.31$, $SD = 29.73$), $t(57) = 3.48$, $p < .001$, $d = 0.51$. The means indicated that suppression instructions corresponded with “moderate” suppression effort (i.e., 60 on the visual analogue scale), while monitor instructions indicated participants tried “somewhat” to keep the thought from mind (i.e., 40 on the visual analogue scale). Notably, effort was positively correlated with the proportion of direct thoughts in suppression, $r(51) = .59$, $p < .001$), and monitoring, $r(51) = .38$, $p = .005$. Effort was also moderately negatively correlated with the proportion of unrelated thoughts during suppression, $r(51) = -.55$, $p < .001$, which aligns with the notion that unrelated thoughts may be high quality distracters.

Effort as a Mediator of the Relationship Between Anxiety and Thought Recurrence

Mediation analyses tested the possibility that anxiety results in thought recurrence due to increased efforts to suppress (PROCESS, Model 4, with 10,000 bootstraps; Hayes, 2018).

Separate analyses were conducted for each dependent measure of thought recurrence (i.e., frequency, duration, and direct thoughts) for each period (i.e., suppression and monitoring). In all analyses, trait anxiety was the predictor variable and self-reported suppression effort was the mediator. All predictors were centred. For all measures of recurrence, a similar pattern emerged. For conciseness, only the regression results for event marking frequencies and average duration are reported (see Table 6 and Table 7 respectively). Regression results for the streaming procedure are in Appendix D.

In all models, anxiety did not have a significant direct effect on thought recurrence after controlling for effort, regardless of thinking period. In the suppression period, anxiety was not a significant predictor of effort based on event marking frequencies, b = 0.06, [-0.09, 1.23], p = .09; average duration b = 0.07, [-0.09, 1.23], p = .09; and the proportion of direct thoughts (i.e., streaming), and b = 0.33, [-0.36, 1.01], p = .33. This indicated that under suppression instructions, increases in anxiety did not correspond to increased effort. The indirect effect was not significant, indicating that effort did not mediate the relationship between anxiety and thought recurrence. However, effort had a significant positive effect on all measures of thought recurrence, indicating that increased effort corresponded to higher frequencies and proportions of the target, as well as time taken to disengage from the target.

In the monitoring period, anxiety significantly predicted effort, for event marking frequencies, b = 1.07, [0.36, 1.78], p = .004; average duration b = 1.07, [0.37, 1.78], p = .004; and direct thoughts, b = 1.11, [0.37, 1.85], p = .004. But effort was not a significant predictor for any measure of recurrence. Interestingly, there was a significant, positive, indirect effect of anxiety through effort on frequencies and direct thoughts, providing evidence for mediation. This is consistent with the notion that anxiety results in greater effort, which in turn leads to greater thought recurrence.

Table 6

Direct, Indirect and Total Effects from Mediation Analyses of the Effect of Anxiety on Event Marking (EM) Frequencies with Effort as a Mediator Across Suppression and Monitoring Periods

	Suppression			Monitoring		
Independent variables and mediator	*b*	95% CI [lower, upper]	*p*	*b*	(95% CI (lower, upper)	*p*
EM Frequencies	R^2 (1,56) = .12, *p* = .04*			R^2 (2,55) =.06, *p* = .17		
Constant	4.15	[3.41, 4.90]	<.001***	2.36	[1.88, 2.85]	<.001***
STAI-T						
Total Effect	-0.03	[-0.11, 0.04]	.36	0.02	[-.03, 0.06]	.50
Direct Effect	-0.05	[-0.13, 0.02]	.14	-0.001	[.05, 0.05]	.98
Indirect Effect	0.02	[-0.01, 0.05]		0.02	[0.002, 0.40]	
Effort						
Direct Effect	0.04	[0.007, 0.07]	.02*	0.02	[-.002, 0.03]	.08

Note. *N*=58; STAI-T = trait anxiety

* *p* <.05. ** *p* <.01. *** *p* <.001.

Table 7

Direct, Indirect and Total Effects from Mediation Analyses of the Effect of Anxiety on Event Marking (EM) Duration with Effort as a Mediator Across Suppression and Monitoring Periods

	Suppression			Monitoring		
Independent variables and mediator	*b*	95% CI [lower, upper]	*p*	*b*	(95% CI (lower, upper)	*p*
EM Average Duration	R^2 (2,55) =.15, p = .01**			R^2 (2,55) =.02, p = .58		
Constant	19.60	[14.47, 24.65]	<.001***	17.25	[12.91, 21.58]	<.001***
STAI-T						
Total Effect	0.46	[-0.10, 0.97]	.08	.15	[-0.27, 0.57]	.47
Direct Effect	0.31	[-0.20, 0.82]	.22	0.10	[-0.40, 0.54]	.70
Indirect Effect	0.16	[-0.06, 0.82]		0.06	[-0.10, 0.22]	
Effort						
Direct Effect	0.30	[0.05, 0.46]	.01*	0.10	[-.10, 0.22]	.45

Note. *N*=58; STAI-T = trait anxiety

* *p* <.05. ** *p* <.01. *** *p* <.001.

Anxiety, Attention Control, and Thought Recurrence

Finally, keeping in line with Study 2, the potential moderating effects of attention control on the relationship between anxiety and thought recurrence both during and after suppression was tested via repeated measures moderated regression using MEMORE Version 2.1, Model 3 (Montoya, 2018). The tests were based on 95% Bias Corrected total confidence intervals and 10,000 bootstrapping samples. Separate regression analyses were conducted for event marking frequencies and durations, and the proportion of direct thoughts obtained by streaming.

Results based on frequencies derived from streaming measures and event marking procedures were similar, therefore only event marking measures are reported for conciseness (see regression results in Table 8). There was decrease in target thoughts from the suppression to the monitoring, which was significant for event marking. Neither anxiety or attention control, nor the interaction between them were predictors of the difference between suppression and monitoring periods. This indicated that while there appeared to be an initial enhancement effect where suppression instructions resulted in greater recurrence, this difference was not influenced by anxiety or attention control.

Table 8

Hierarchical Multiple Regressions Predicting Event Marking Frequencies from trait anxiety, Stroop Interference and thinking period (active suppression, monitoring)

Dependent	Predictor	*b*	*SE*	*t*	*p*	*95% CI*
Suppression - Monitor	R^2 = .06, *F*(3,54) = 1.13, *p* = .34					
	Constant	2.19	0.44	4.83	<.001*	[1.28, 3.10]
	STAI-T	- 0.04	0.04	- 0.80	.43	[- 0.12, 0.05]
	Stroop Interference	- 0.01	0.01	- 1.65	.10	[- 0.02, 0.002]
	STAI-T x Stroop Interference	0.0001	0.01	- 0.24	.81	[-0.001, 0.001]
Suppression	R^2 = .03, *F*(3,54) = 0.70, *p* = .57					
	Constant	4.55	0.54	8.47	<.001*	[3.47, 5.63]
	STAI-T	- 0.02	0.05	-0.39	.70	[- 0.13, 0.09]
	Stroop Interference	- 0.01	0.01	-1.33	.19	[- 0.02, 0.01]
	STAI-T x Stroop Interference	0.0001	0.001	-0.01	.99	[-0.001, 0.001]
Monitor	R^2 = .01, *F*(3,54) = 0.20, *p* = .98					
	Constant	2.36	0.25	9.42	<.001*	[1.86, 2.87]
	STAI-T	0.015	0.03	0.59	.56	[-0.04, 0.06]
	Stroop Interference	0.001	0.003	0.13	.90	[-0.01, 0.01]
	STAI-T x Stroop Interference	0.0001	0.001	0.43	.67	[-0.001, .001]

Note. *N* = 58; STAI-T = Trait anxiety.
* *p* <.05. ** *p* <.01. *** *p* <.001.

For average duration, there was no significant difference between the suppression and monitoring periods, indicating that there was no immediate enhancement or rebound effects (see Table 9 for regression results). Further, anxiety, attention control and their interaction did not significantly contribute to the differences between thinking periods. However, in the suppression period both anxiety and the interaction between attention control and anxiety were significant predictors of the average duration of target thoughts. This provided support for the notion that attention control moderates the relationship between anxiety and how long it takes to disengage from a target. Figure 1 illustrates that at high (b = - 0.13, p = .74) and average attention control (b = 0.27, p = .33), anxiety was not a significant predictor of disengagement. However, at lower levels of attention control, anxiety was a significant positive predictor of the average duration of intrusions (b = 0.83, p = .01). The lack of effects in the monitoring period may indicate that the effects of anxiety and AC on thought recurrence only apply under active suppression conditions.

Table 9

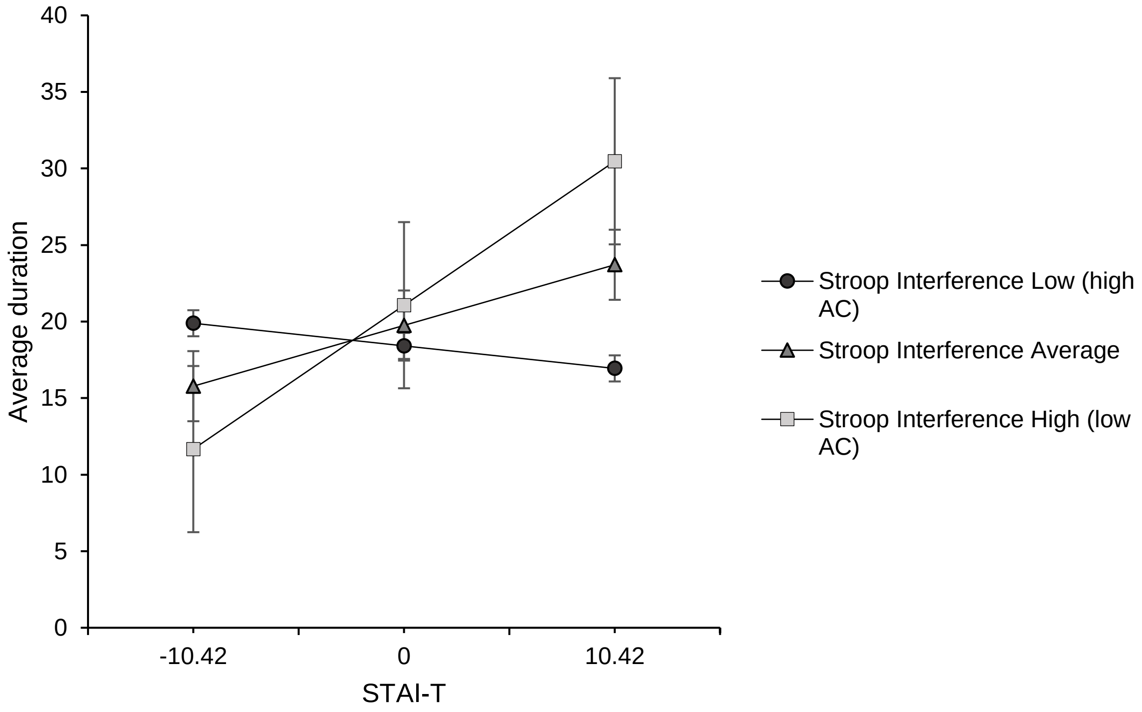
Hierarchical Multiple Regression Predicting Average Duration (Event Marking) from Trait Anxiety, Attention Control and Thinking Period (suppression, monitoring)

Dependent	Predictor	*b*	*SE*	*t*	*p*	*95% CI*
Suppression - Monitor	R^2 = .06, $F(3,54)$ = 1.06, p = .37					
	Constant	2.46	2.94	0.79	.44	[-3.44, 8.37]
	STAI-T	0.24	0.29	0.84	.40	[-0.33, 0.82]
	Stroop Interference	0.01	0.04	0.33	.74	[-0.06, 0.09]
	STAI-T x Stroop Interference	0.005	0.004	1.42	.16	[-0.002, 0.01]
Suppression	R^2 = .12, $F(3,54)$ = 2.39, p = .08					
	Constant	19.74	2.62	7.54	<.001	[14.49, 24.99]
	Stroop Interference	0.02	0.03	0.48	.64	[-0.05, 0.08]
	STAI-T	0.38	0.26	1.49	.04*	[0.01, 0.78]
	STAI-T x Stroop Interference	0.01	0.003	1.98	.03*	[0.004, 0.01]
Monitor	R^2 = .01, $F(3,54)$ = 0.24, p = .87					
	Constant	17.28	2.19	7.89	<.001	[12.89, 21.67]
	Stroop Interference	0.004	0.03	0.14	.89	[-0.05, 0.05]
	STAI-T	0.14	0.21	0.64	.53	[-0.29, 0.57]
	STAI-T x Stroop Interference	0.001	0.003	0.46	.61	[-0.004, 0.01]

Note. *N* = 58; STAI-T = Trait anxiety, AC = attention control.
* p <.05. ** p <.01. *** p <.001.

Figure 1

The Interactive Effects of Anxiety and Stroop Interference on Average Thought Duration (Seconds) During Suppression



Note. STAI-T = trait anxiety; AC = Attention Control. High, Average and Low Stroop Interference represent the 84th, 50th and 16th percentiles, respectively. Error bars represent the standard errors.

Discussion

Comparisons of thought suppression measures

A key aim of this study was to assess the convergent validity between measures of thought recurrence obtained from event marking and streaming procedures. Frequencies measured using event marking were positively correlated with direct thoughts captured during streaming, and the strength of the relationship did not differ significantly between the number of direct statements and the number of direct trains of thought. Overall, the strength of the relationship between event marking and streaming procedures was moderate to strong (r = .41 to .70). Although this does provide support that both measures must reflect, at least in part, thought recurrence, there is still a considerable amount of unshared variance. Furthermore, all but one comparison (i.e., event marking frequency and direct trains of thought in the monitoring period) failed to meet the recommended benchmark for convergent validity, $r \geq .70$ (Carlson & Herdman, 2007). While that may indicate that event marking and streaming procedures are capturing different constructs, there are multiple explanations for the disparity between measures.

One potential explanation for the differences between measures is that event marking captures *recognition* that one is thinking the target (i.e., conflict detection) whereas streaming procedures do not. Streaming simply requires participants to verbalise their thoughts, without judging their content. Of course, during the suppression period, participants were asked to "not think" about a particular thought so they must have been evaluating their thoughts, but this monitoring is comparatively covert compared to event marking where participants must press the spacebar each time they experience the thought. This raises the possibility that attention control might strengthen the relationship between event marking and streaming measures. Logically, if one is better at identifying conflict between an automatic response and top-down goals, they may be better at recognising and therefore reporting when they are thinking the thought, resulting in higher correspondence between the measures. However, follow up analyses did not find that attention control strengthened the relationship between event marking and streaming methods. Nevertheless, it may be premature to conclude that attention control does not influence the relationship between event marking and streaming.

One potential explanation as to why attention control did not moderate the relationship is that participants were given little instruction on when they should press the spacebar. In line with other studies that used event marking, participants were told to indicate when they were "thinking about the thought," without further elaboration (Gorlin et al., 2016; Lambert et al., 2014; Magee et al., 2019). In contrast, for the streaming procedure, coders were given a definition of "direct" thoughts and other distracter types, along with examples and practice transcripts. Consequently, during event marking, participants were left to their own devices to determine what constitutes thinking a thought, and this threshold may not have been consistent across participants. Some participants may have only reported when they were thinking the exact thought, while others may have pressed the spacebar when thinking about when or where the car accident would happen and corresponding emotional reactions. It is also possible that participants were purposely not pressing the spacebar to be seen as compliant with suppression instructions, or they may have simply forgotten. While this cannot be confirmed in the current study, it highlights the need for future studies to monitor and control for socially desirable responding and lapses in adherence to task instructions (e.g., forgetting).

Comprehension of the suppression task instructions was raised as a potential issue in Study 2, where 28% of participants did not report having the target thought during the focus period. However, in the previous study as event marking was the sole measure of recurrence, it could not be determined whether participants did not have the thought (i.e., did not focus on it as instructed) or whether they had the thought and did not press the spacebar (i.e., false negative). In the current study during the focus period, 12.9% (n = 7) of participants did not press the spacebar when they were asked to focus on the target, despite verbalising direct thoughts. While the percentage of these false negatives decreased during suppression (5.5%, n = 3) and monitoring (7.4%, n = 4) indicating that participants may have needed additional practice, the presence of false negatives may also indicate that self-report measures are not a reliable measure of thought recurrence.

To resolve these issues, future comparisons of event marking and streaming could compare whether additional instructions in the event marking procedure result in stronger convergent validity. This is important because most of the emerging research uses event marking. If people are not good at identifying when they are thinking a thought, conclusions based on these measures will be compromised. While it is acknowledged that the definition of direct thoughts used in streaming is arbitrary, it should provide some level of uniformity to help rule out differing operationalisations of direct thoughts as a potential explanation for the difference between measures.

A limitation of the current study is that the average duration of thoughts was not able to be calculated for the streaming procedure as only written transcripts were available to coders based on the conditions of ethics approval, and time constraints prevented calculating durations from time stamping. Consequently, the current study was unable to compare durations for event marking and streaming procedures. Average thought duration is an important dimension of thought recurrence, as it reflects how long it takes to disengage from the target (Lambert et al., 2014). Therefore, it is recommended that future comparisons of event marking and streaming allow for the calculation of duration for both methods. In streaming, this is typically done by listening to thought recordings and timing how long it takes for content to shift from direct thoughts to other distracter types (Fikretoglu et al., 2003).

Both event marking and streaming procedures have benefits and limitations. On one hand, event marking procedures can capture frequency and duration easily and can be done in laboratory and online settings (e.g., Gorlin et al., 2016; Lambert et al., 2014). However, the quality of the data depends on participants understanding on what constitutes thinking the thought, and accurate reporting. On the other hand, streaming requires more resources (experimenter coding) and equipment (voice recorders, which are susceptible to malfunctions), and may place participants under additional stress due to being recorded. However, streaming is less susceptible to underreporting by participants, whether intentional or not. Streaming also allows for a richer understanding of the types of thoughts that people use to distract themselves during and after suppression. This is a relative strength, particularly where researchers are interested thinking patterns or cognitive styles that are associated with anxiety or other disorders.

Anxiety and Distracter Type

We investigated whether trait anxiety is associated with the use of specific types of distracter thoughts. During suppression and monitoring, anxiety was not correlated with the proportion of direct thoughts. This is consistent with meta-analytic evidence that suggests that trait anxiety is not a reliable predictor of thought recurrence (Magee et al., 2012), indicating that dispositional anxiety is not associated with deficits in suppression ability. Anxiety was positively correlated with the proportion of task-related thoughts during suppression, indicating an increased focus on the task. This may not be surprising, given participants high in trait anxiety may be more likely to be worried about doing the task ‘correctly’, corresponding to a higher proportion of thoughts related to the task itself.

Notably, anxiety was not correlated with other types of distracters, including indirect, unrelated or no thought, and is therefore inconsistent with the notion that anxiety is characterised by incomplete avoidance (i.e., indirect thoughts; Roemer & Borkovec, 1994). For the entire sample, the proportion of time spent thinking about direct thoughts and unrelated thoughts was similar in the suppression period and significantly higher than the proportion of indirect, task, or no-thoughts; indicating that participants tended to use unrelated thoughts as a distraction strategy. Additionally, there was a significant negative correlation between the proportion of direct and unrelated thoughts, indicating that the most effective distracters were those that were unrelated to the target. In contrast, thinking about the task, experiencing an indirect thought that is peripherally related to the target, or not thinking anything had no relationship with the proportion of direct thoughts. Other research (e.g., Magee et al., 2019) found that unrelated thoughts are the most effective distracters during suppression, and our study extends these findings as participants had a natural tendency to generate unrelated distracters, whereas previous studies had directed participants to use specific thoughts (e.g., think about a Red Jeep). All together, these findings suggest that people naturally use unrelated thoughts as distracters, and that these thoughts are the most effective at warding off target thoughts. This is not to say that suppression using unrelated distracters is adaptive, particularly as the results indicated that suppression effort was associated with increased thought recurrence in this study. As expected, suppression instructions resulted in significantly higher efforts to suppress the target compared to monitoring instructions. Ironically though, suppression instructions resulted in significantly higher proportions of direct thoughts and frequencies of the target, than monitoring instructions, indicating potential immediate enhancement effects, which will be discussed in further detail later.

Anxiety, Effort and Thought Recurrence

We tested the proposition that anxiety is associated with increased thought suppression effort, and this in turn results in greater thought recurrence (Gorlin et al., 2016). Although we used a non-clinical sample, mean trait-anxiety was M = 49.69, SD = 10.42 which is above the optimal cut off value of 44 used to differentiate between clinically anxious and healthy adults (Ercan et al., 2015). Therefore, it appeared that our sample contained sufficient levels of trait-anxiety when comparing low (16^{th} percentile) and high (84^{th} percentile) scores on the STAI-T. Under suppression instructions, anxiety did not predict effort ; however, this may be unsurprising as all participants were instructed to *not think* the target. Nevertheless, effort was associated with higher frequencies and proportions of direct thought during the suppression period.

In contrast, during the monitoring period, effort mediated the relationship between anxiety and the frequency and proportion of direct thoughts, but not the average duration of thoughts. Although the externally imposed goal to not think the target was removed, anxious participants reported greater suppression effort. The link between anxiety and effort in the monitoring period is consistent with findings that anxiety is associated with an avoidant cognitive style (Günther et al., 2022) and can potentially explain why worrisome thoughts continue even when the explicit goal to suppress has been relinquished. If anxious people have trouble letting go of the suppression goal (i.e., continue suppression efforts), the monitoring system will continue to be hyper-vigilant towards the target, thus increasing the thoughts activation.

Comparatively, effort may not mediate the relationship between anxiety and duration because there is no explicit goal to disengage under monitoring conditions, or because attentional resources required to redirect attention from the thought have been exhausted by past suppression attempts. In this study, effort was a positive but non-significant predictor of duration. This contrasts with findings that during monitoring, anxiety was associated with higher effort and *shorter* durations (Gorlin et al., 2016).

These discrepant results could be the result of the different lengths of the suppression and monitoring periods in each study. Gorlin et al. (2016) used 1 minute thinking periods in comparison to the 4-minute thinking periods in the current study. Evidence suggests following suppression instructions, the average duration of target thoughts increases over each minute in the subsequent monitoring period (Lambert et al., 2014). Therefore, the role of effort may differ as a function of time due to the depletion of cognitive resources. Following suppression, increased effort may result in shorter durations during the first minute of the monitoring period, but as time goes on and effort depletes cognitive resources, average duration may increase. While this explanation is possible, it needs to be tested. Although the specific mechanism by which effort impacts thought recurrence requires further investigation, the finding that anxiety is associated with greater effort once suppression instructions has ceased appears to be consistent across studies (e.g., Gorlin et al., 2016).

Anxiety, Attention Control, and Thought Recurrence

Keeping in line with Study 2, the moderating role of attention control on the relationship between anxiety and thought recurrence was also investigated. During suppression, attention control weakened the relationship between anxiety and duration. This indicated that trait anxiety combined with weaker attention control led to greater difficulties disengaging from the target. The finding that attention control facilitated disengagement from the target in anxious participants is consistent with Ironic Processing Theory's assumption that the operating process, which is responsible for directing attention towards alternative thoughts once the target has been detected, is dependent on cognitive resources (Wegner 1994). Further, the finding that attention control did not influence the relationship between anxiety and the frequency or proportion of direct thoughts gives support to the idea that these processes are automatic and independent of cognitive resources (Wegner, 1994).

The results also suggested that there were immediate enhancement effects in the current study, whereby initial suppression instructions resulted in greater frequencies, but not durations of target thoughts, compared to the monitoring period. This finding is inconsistent with literature that efforts to suppress thoughts are initially successful but become less effective over time, which would indicate rebound effects (Abramowitz et al., 2001; Magee et al., 2012; Wang et al., 2020).

It has been suggested that immediate enhancement effects are only observed under cognitive load (Wang et al., 2020), which may explain the initial enhancement effects found in the current study. While participants were not intentionally placed under cognitive load, the experiment itself may have been cognitively demanding as they were required to verbalise their thoughts aloud and monitor the rate and volume of their speech to ensure that it was being captured by the recording device. This, in combination with completing the colour-word Stroop, may have placed sufficient load on the participants such that immediate enhancement effects were observed.

Summary and Future Directions

In reconciling the present study with past research and theoretical accounts it appears that both increased effort and lower attention control contribute to thought suppression difficulties. Consider a scenario where an anxious and non-anxious person may need to engage in thought suppression of irrelevant or potentially anxiety-provoking thoughts during a meeting (e.g., missing a deadline). Based on the current findings, both appear to place the same effort into suppression and tend to use unrelated thoughts as the primary distracter type. During the meeting, the anxious individual may struggle to redirect their attention away from the deadline due to increased emotional reactivity to the thought, and subsequent disruptions to top-down regulation of attention (Amir & Bernstein, 2022). However, if the anxious individual has sufficient attentional resources, this can attenuate the slowing effect that anxiety has on disengagement. Critically, after the meeting when the need to suppress deadline-related thoughts has gone, the anxious person continues their suppression efforts, but this results in more thoughts of missing the deadline. This raises questions regarding sustained suppression effort and not only why it is more likely to occur in anxiety, but how it results in rebound effects.

The simplest explanation for continued suppression effort after it is no longer required is that cognitive avoidance is a keystone of anxiety and the sustained effort is intentional. Nevertheless, it is also possible that anxiety is associated with compromised executive function(s) responsible for updating superordinate goals, making sustained effort less intentional (e.g., Attention Control Theory, Eysenck et al., 2007; Eysenck et al., 2023). Supporting this, anxiety, trait-worry, and repetitive negative thinking have been linked with poorer removal of no-longer relevant information from working memory (i.e., *updating*; Berggren & Derakshan, 2013; Gustavson & Miyake, 2016; Moran, 2016; Roberts et al., 2021; Zainal & Newman, 2018; Zetsche et al., 2018). Anxiety has also been linked with difficulties *shifting* between cognitive sets (Ansari et al., 2008; Ansari & Derakshan, 2010; Booth, 2014; Derakshan et al., 2009; Goodwin & Sher, 1992; Orem et al., 2008). Cognitive sets refer to mental frameworks, rules and criteria that can be used to respond to information. When there is a change in goals (e.g., when suppression instructions are no longer relevant) the cognitive set needs to be adjusted to accommodate these changes. However, if anxious people have difficulty updating the suppression goal and shifting cognitive sets, they may continue to monitor for the thought, thus increasing the likelihood that it would be reactivated.

Not only can sustained effort result in rebound effects by priming the monitoring system, but also by reducing the efficiency of the operating system through the depletion of cognitive resources (Gordijn et al., 2004; Wegner, 1994). While there is no direct evidence that level of effort corresponds to resource depletion, it is possible that intensive efforts to suppress could result in greater depletions. Therefore, suppression diminishes the resources needed to regulate attention towards alternative thoughts. Although suppression effort is growing as a mechanism of interest (Gorlin et al., 2016; Lambert et al., 2014; Magee et al., 2019), the potential interplay between effort, attention control and their transactive effects on suppression outcomes is arguably under researched. Elucidating the underlying reasons for sustained suppression effort, regardless of whether they are intentional or reflect executive dysfunction, may be useful for clarifying potential targets for intervention.

A second key finding was that people are not necessarily good at self-catching or identifying when they are thinking about a target, which may be due to inconsistent definitions of “thinking the thought”, purposeful under reporting, or even suboptimal conflict detection or difficulties with meta-awareness (i.e., awareness of the content of cognitions). The differences between event marking and streaming methods add to a growing body of evidence that people may not be able to accurately identify their thoughts. While this has clinical implications, which will be explored in the general discussion, it also highlights methodological concerns regarding tasks employed to capture thoughts.

While self-caught (e.g., event marking) methods have been useful in identifying general cognitive patterns such as negative thinking styles in anxiety, the evolution and refinement of thought measures is essential as event marking measures may mask true suppression due to under-reporting. Understanding why people may be inaccurate at reporting their thoughts is crucial to refining current measures and developing alternative tasks. Future studies may wish to investigate the potential effects of cognitive load on thought catching or assess whether additional instructions improve the convergent validity between event marking and streaming methods. While we did not find that increased attention control strengthened the relationship between self- and other caught methods, this may be due to the limited definition of “thinking the thought” that was provided to participants or due to challenges with power. In summary, future research may benefit from clarifying the reasons for under-reporting using self-caught methods, as this can lead to improved tasks and ultimately improve our understanding of thought processes.

Chapter 5: General Discussion

This dissertation investigated the relationships between anxiety, attention control and reactions to external threats (i.e., images) and anxiety provoking thoughts. Of particular interest was whether the ability to inhibit irrelevant information attenuated the relationship between trait anxiety and attention biases to images and thoughts (Study 1, Study 2, and Study 3). Study 2 and Study 3 investigated whether attentional reactions to threat were underpinned by similar processes by comparing attention biases for images (i.e., dot-probe task; Rudaizky et al., 2013), negative thoughts (i.e., thought suppression task, Lambert et al., 2014) and self-reported habitual avoidance strategies (Cognitive Avoidance Questionnaire, Gosselin et al., 2002; Sexton & Dugas 2009). Finally, Study 3 also provided a direct comparison of different methods of capturing thought recurrence (i.e., streaming and event marking procedures) during suppression tasks. Shedding light on the processes underlying attention biases can inform current and future treatment approaches that aim to modify these biases (i.e., Attention Bias Modification, ABM). Furthermore, findings regarding individuals' ability to identify target thoughts have implications for psychological treatment of anxiety disorders (e.g., cognitive behaviour therapy and mindfulness).

Attention Control as a Moderator of the Relationship Between Anxiety and Reactions to Threat

Attention control has been proposed to explain the mixed findings regarding attention biases in anxiety. One possibility is that attention control can attenuate or even reverse attention biases in anxiety (Derryberry & Reed, 2002; Gorlin et al., 2015; Reinholdt-Dunne et al., 2009; Taylor et al., 2016). Partial support for this proposition was found as attention control moderated the relationships between anxiety and attentional responses to threat to external (Study 1) and internal stimuli (Study 3); albeit the patten was opposite for internal versus external threat. Consistent with theoretical predictions (e.g., Attention Control Theory, Eysenck et al., 2007), at low control when trait anxiety increased, there was slowed disengagement from negative thoughts. That relationship became non-significant at higher control. Unexpectedly, in Study 1, at higher attention control, there was a positive relationship between anxiety and the time taken to shift attention away from negative images but as control decreased, the relationship became less positive. Briefly, as discussed in Study 1, disengagement may have been facilitated in low-control participants because they used compensatory strategies, resulting in better filtering of task-irrelevant information. Conversely, delayed disengagement may have occurred in high-control participants because the task demands did not reach the threshold for these compensatory strategies (Basanovic et al., 2021; Berggren & Derakshan, 2013; Bishop, 2007; 2009; Pessoa, 2010).

Despite the mixed results regarding the direction of the effects that attention control has on later stage attentional reactions, there was a consistent lack of effect of attention control on engagement with (orientation towards) threat on the dot-probe and thought suppression tasks. This is consistent with a growing body of evidence that suggests disengagement from, but not engagement with, external threat is influenced by top-down, later stages of processing (e.g., Taylor et al., 2016). So far, these results suggest that attention control impacts on disengagement from threat in the context of anxiety. This raises the question of why attention control has the greatest effect on disengagement.

One potential reason is that anxious participants are more likely to become stuck on threat in the first place. Mild threat cues are believed to impair attention control to a greater degree in anxious than non-anxious people (Eysenck et al., 2007). For example, a person who is anxious about an upcoming deadline might have difficulties suppressing thoughts about that deadline while they are in a meeting because that deadline appears threatening. In contrast, a less anxious person can stop thinking about the deadline more easily because the deadline is interpreted to be less threatening. Where there is a predisposition to focus on negative information (e.g., trait anxiety), additional cognitive resources will need to be allocated to shift to alternative thoughts. Therefore, stronger attention control may be of greater benefit in contexts where a person is more likely to become stuck, such as when the thought appears threatening.

Our results contribute to a growing body of evidence that suggests that attention control can modify later-stage attention biases in anxiety and impact how they manifest (Study 1, Study 3; Gorlin et al., 2015; Taylor et al., 2016). This has implications for attention bias modification (ABM) procedures that aim to reduce anxiety. ABM procedures typically focus on reducing hypervigilance to threat, by training attention towards neutral or positive stimuli (Beard et al., 2012; Hallion & Ruscio, 2011; Hakamata et al., 2010; Krujit et al., 2019; Mogoaşe et al., 2014; Price et al., 2016). However, meta-analyses reach differing conclusions regarding the effectiveness of ABM. Some found threat-avoidance training has no reliable anxiolytic effect (Cristea et al., 2015), others concluded effects were comparable to first line interventions (e.g., psychotherapy and selective-serotonin re-uptake inhibitors; Hakamata, 2010), and others identified modest symptom reductions (Beard et al., 2012; Hallion & Ruscio, 2011; Mogoaşe et al., 2014; Price et al., 2016). Furthermore, some studies have found that training sustained attention *toward* threat was associated with greater reductions in symptoms compared to attention control training and threat-avoidance training (Boettcher, 2013). Sustained attention to threat may attenuate anxiety through the process of habituation (Foa & Kozak, 1996). These differing results suggest that a one-size-fits-all approach to ABM may not be optimal for reducing anxiety, and as will be discussed next, could be a double-edged sword.

Theoretical and empirical evidence suggests that attention control attenuates disengagement difficulties or even reverses them, leading to attentional avoidance

(Derryberry & Reed, 2002; Gorlin et al., 2015; Reinhold-Dunne et al., 2009; Taylor et al., 2016). ABM procedures train attention away from threat by presenting probes at the location of neutral images in negative/neutral pairs. While attenuating disengagement bias through threat-avoidance training may reduce anxiety, this training has the potential to create attentional avoidance, which is proposed to maintain anxiety (Cisler et al., 2009). A meta-analysis found that interventions with high numbers of training trials did not reduce social anxiety, but those with less sessions did (Price et al., 2017). The authors suggested that excessive training of avoidance could have resulted in overcorrection of disengagement difficulties and rigidity, thus cancelling the beneficial effects of earlier trials that promoted attentional flexibility (Price et al., 2017). In effect, one bias could be traded for (or trained into) another, but both contribute to anxiety.

This raises questions about whether ABM approaches could be tailored to avoid this double-edged sword. Consistent with the view that attention control may moderate the effects of ABM, a meta-analysis found ABM was more beneficial for those with lower attention control compared to higher control (Pergamin-Hight et al., 2015), however other studies have found opposite effects (Ollendick et al., 2019. Therefore, tailoring the type of ABM (e.g., threat-avoidance versus threat-approach) based on participants pre-training bias and attention control may improve the overall anxiolytic effects of ABM.

One study tailored ABM based on pre-existing bias type, and bias-contingent ABM training reduced post-traumatic stress symptoms (Lazarov et al., 2018). Further investigation of this finding is recommended as all participants received ABM that was proposed to target their pattern of bias, and therefore whether being mismatched (i.e., disengagement difficulties targeted using threat-approach training) reduces the efficacy of ABM remains unclear. Additionally, there is emerging evidence that suggests that attention control training, where probes replace negative and neutral images equally, is also associated with reductions in anxiety (Boettcher et al., 2013) and posttraumatic stress symptoms (Badura-Brack et al., 2015; Lazarov et al., 2018). Overall, further investigation of whether improved anxiety reduction follows from tailored ABM procedures, or general attention control training is warranted as it can lead to the refinement of computer-based interventions for anxiety.

Do External and Internal Attention Biases Share Common Underpinnings?

A novel contribution of this thesis was to test the assumption that research investigating external attention (i.e., sensory-perceptual tasks such as the dot-probe) extends to internal attention processes (e.g., the selection and maintenance of attention towards thoughts). We found that attention control, measured using an external attention task, moderated the effects of anxiety on attentional responses to images (i.e., external stimuli) and thoughts (i.e., internal stimuli, Study 1 & Study 3). However, when direct comparisons were made between external and internal attention tasks (i.e., dot-probe and thought suppression tasks), attentional capture by negative thoughts and images were not related. This was the same for disengagement from negative images and thoughts.

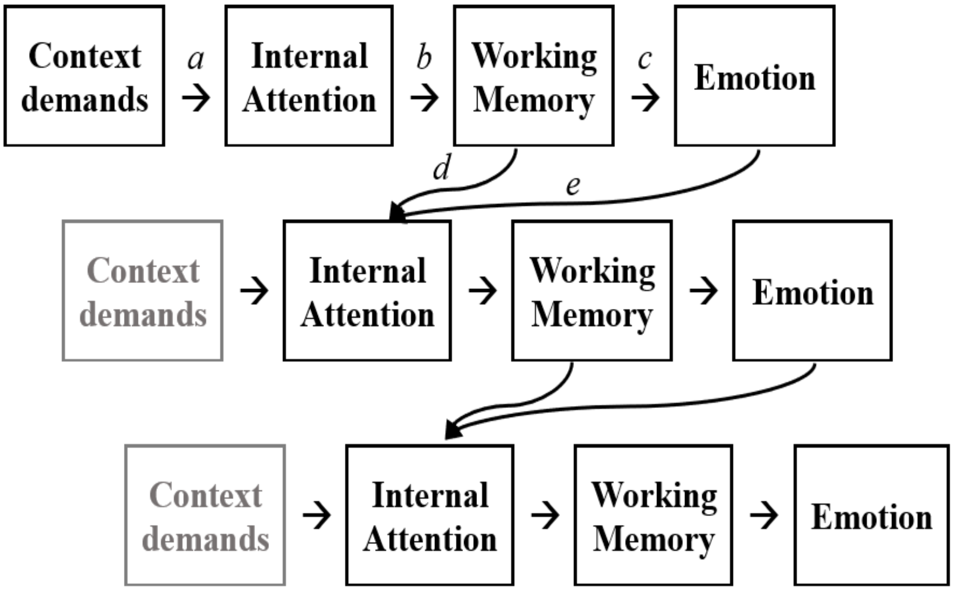
Methodologically, the dot-probe and thought suppression tasks are distinct and this may explain why they were not related. The dot-probe cues attention at multiple points during a trial (i.e., anchoring and then signalling where to shift/maintain attention; Rudaizky et al., 2013), whereas there is no such cueing in the thought suppression task apart from the overarching goal to "not think about" the target. Further, the images disappear in the dot-probe after 500ms, whereas the target thought in thought suppression remains in awareness until an alternative thought is generated. From this perspective, the dot-probe primes attentional shifts because the stimuli disappear and a probe appears quickly, whereas the thought suppression task does not (Falkinger, 2008; Kahneman, 1973).

A second consideration is the way in which engagement and disengagement bias were calculated for each task. Traditional methods of calculating attention biases on the dot-probe average across multiple trials and blocks to determine attention bias. However, there is increasing evidence that these mean-based measures of attention bias show low levels of reliability across trials and time (e.g., Price et al., 2015; Schmukle, 2003; Staugaard, 2009), and Zveilli and colleagues challenged whether attention biases are stable or dynamic (Zveilli, Berstein & Koster, 2015). Zveilli et al. developed a novel way of computing trial-by-trial attention bias, to obtain a score of attention bias variability. Attention bias variability measures fluctuations in attentional allocation towards and away from threat (Zveilli et al., 2015). It has greater reliability and appears to be more strongly associated with different measures of psychopathology than mean-based measures of attention bias (Carlson, Fang & Lin, 2020; Naim, Pine, Bliese & Bar-Haim 2019; Rodebaugh et al., 2016; Shäfer et al., 2016; Zveilli et al., 2015). Throughout this dissertation, similar mean-based measures of attention bias to thought were also calculated. With respect to frequency (engagement bias), the total number of thoughts was calculated for each 4-minute period. Duration (disengagement from thoughts) was calculated by dividing the total duration of the target thoughts, divided by the frequency provided a measure of average duration. This way of calculating internal attention biases may be subject to the same criticisms as mean-based measures of external attention bias in that they are not susceptible to fluctuations or *variability* in these biases.

Amir and Bernstein (2022) describe a dynamic computational model of internally directed attention: the Attention to Thoughts model (A2T), which suggests that there may be variability in internal attention biases. Briefly, the model characterises the dynamic interplay between four key components from moment to moment in time (see Figure 1 for a graphic representation). *Contextual demands* (i.e., situational demands for effortful attention) influence *internal attentional selection* of mental representation for preferential processing (path *a*); this subsequently activates *representations in working memory* (path *b)* which contributes to *affective* experience (path *c*). Both working memory representations and emotion are proposed to feed back into further internal attentional selection (paths *d* and *e*), by biasing internal attention in favour of content- and affect –congruent representations (Amir & Bernstein, 2022; Eich, 1995; Hollingworth & Luck, 2009; Smallwood, 2013; Williams et al., 2007). From this perspective, thought recurrence, which is believed to reflect biased attention towards a target, is the result of dynamic and temporally unfolding processes.

Figure 1

Overview of Amir and Bernstein's (2022) Attention to Thoughts (A2T Model)



Note. Adapted from Amir & Bernstein 2022. Path a reflects cognitive control (i.e., task demands biasing attention allocation towards task relevant goals; path c represents emotional reactivity to working memory representations. Paths d and e show cognitive and emotional reactivity biasing the subsequent selection of material.

The idea that internal attention relies on dynamic and interactive processes raises the possibility that traditional measures of thought recurrence that rely on averaging the duration of target thoughts or summing the total frequency over time are not sensitive to the potential variability in biased processing of internal stimuli (Amir & Bernstein, 2022). There is initial evidence of variability in biased processing of self-referential thoughts based on a simulated thought task. Ruimi et al. (2023) found that participants' disengagement bias to audio-recordings of themselves speaking negative thoughts was more varied compared to neutral thoughts. This provides tentative evidence that internal attention biases may be variable, but the thoughts were simulated and presented externally, therefore, further investigation is necessary.

Attention bias variability has been linked with trait anxiety, and it is possible that this extends to internal stimuli (Clarke et al., 2020). Developing measures that capture this moment-to-moment variability improve our understanding of the processes underlying biased attention to thoughts and shed light on potential treatment targets. It is not yet clear whether attention bias modification (ABM) programs that use external training paradigms (e.g., dot-probe) have a direct impact on biased internal processing, however there is some evidence that Cognitive Behaviour Therapy (CBT) combined with ABM led to a greater reduction on automatic thoughts compared to CBT alone, meaning that it may be advantageous as an adjunct therapy (Lin et al., 2023).

Whether or not internal and external attention rest on similar processes has implications for the treatment of anxiety. Although interventions that focus on training attention using external methods (e.g., auditory stimuli in the Attention Training Technique; Wells, 2002) are presumed to influence internal attention processes, it is also possible that these effects do not transfer to internal attention. Evidence suggests that successful transfer depends on whether the intervention evokes the same or similar cognitive processing of emotional material as the target situation (Hertel & Mathews, 2011; Hoppitt et al., 2010; Leung et al., 2022). Therefore, training attention to disengage from external stimuli may not generalise to thoughts because the cognitive processes involved are too distinct. Overall, this may explain why these methods appear to have small to modest effect sizes (e.g., Beard et al., 2012; Hallion & Ruscio, 2011; Mogoaşe et al., 2014; Price et al., 2016) while treatments that focus on challenging negative thoughts report stronger effects (e.g., cognitive behaviour therapy; Carpenter et al., 2018; Cuijpers et al., 2016; Olatunji et al., 2010; Otte, 2011). Negative thoughts are a core and debilitating symptom of anxiety, and further understanding of the processes that underly attention to them can also highlight potential ways to modify them. Although a consistent challenge for researchers is how attention to thoughts is measured.

Gotcha! Self- versus Other- caught Thoughts During Suppression.

Whether or not people are accurate at identifying and reporting their thoughts has both scientific and clinical implications. It is important to acknowledge that self-report measures may be biased by contextual and motivational factors, and these biases can occur outside of participants' awareness (Nisbett and Wilson, 1977). Problems with the validity and reliability of self-reports limit the potential for event marking measures to be useful as a tool for understanding processes underlying thought suppression. Schooler (2002) suggested that "triangulation" can quantify these inaccuracies by examining the strength of correlations with objective measures. To address this, event marking and streaming procedures were compared on a thought suppression task to investigate convergent validity (Study 3). Acceptable convergent validity between the two methods was only found when all participants were asked to monitor their thoughts. This may indicate that self-caught methods (e.g., event marking) are at risk of demand effects (i.e., underreporting of targets) during suppression and therefore this measure may have less utility when studying processes underlying thought suppression.

The lack of convergent validity may also have occurred because threshold of determining what constitutes a thought is variable between streaming and event marking methods. Streaming provides manualised definitions to trained coders and does not require moment by moment reflections or judgements. For event marking the definition of a target is comparatively vague (i.e., press the button when you think the thought), and each person's definition of thinking about the thought is likely to be different. For example, a person may only report exact thoughts of "I hope my friend is in a car accident" whereas another may also include the sequalae of such events (e.g., thinking about their eulogy). This highlights the need for the refinement of task instructions, especially for event marking methods. It is recommended that future studies manipulate task instructions (e.g., vague versus specific) to determine whether specific instructions improve convergent validity with other-caught methods such as streaming.

I Do Not Know What I Was Thinking! Meta-awareness of Thoughts in Anxiety

Whether or not individuals are able to identify and categorise their thoughts has implications for treatments for anxiety. Our findings add to a growing body of evidence that suggests people are not necessarily good at reporting their thoughts or being aware that they might be stuck on them (e.g., Nixon et al., 2021; Ruiumi et al., 2013: Takarangi et al., 2014). Successful suppression presumably rests on the ability to monitor thoughts. It has been proposed that there are two levels of conscious thought – *experiential consciousness* – thoughts that occur without reflection, and *meta-awareness* – thinking with explicit recognition of thoughts (Baird et al., 2013). During suppression, it is possible that attention lapses from the task, albeit briefly (i.e., mind-wandering; Bernstein & Zveilli, 2014; Ruimi et al., 2020; Ruimi et al., 2023; Zvielli et al. 2016), and targets are not reported when they occur due to lack of meta-awareness.

Thoughts that occur with meta-awareness are presumed to be less detrimental because once the thought is noticed, regulatory strategies can be implemented (Baird et al., 2013). There is a positive relationship between meta-awareness and therapeutic outcomes (Conte et al., 1990; Hargus et al., 2010; Piper et al., 1994), and difficulties identifying and expressing thoughts are linked with poorer outcomes (Brady et al., 2015) In contrast, experiencing thoughts without explicit awareness can result in emotional reactions that subsequently bias attention towards congruent content, resulting in “sticky” thoughts (Amir & Bernstein, 2022; Baird et al., 2013; van Vugt & Broers, 2016). While there is no current direct evidence that anxiety is characterised by reduced meta-awareness, there is peripheral support as habitual cognitive avoidance, a common feature of anxiety, is associated with decreased meta-awareness (Baird et al., 2013). Furthermore, evidence suggests that cognitive load can reduce meta-awareness and increase intrusions (Sayette et al., 2009; Smallwood & Schooler, 2006), and anxiety is proposed to have a deleterious effect on cognitive resources (Eysenck et al., 2007).

One implication of these findings is that suppression difficulties in anxiety could be related to less meta-awareness of thought content. If thoughts are associated with anxiety are not recognised, they could take root and continue without regulation. Moreover, given that attempts to control thinking can often backfire, problems in identifying unwanted thoughts, followed by ineffective control strategies (i.e., suppression) could lead to a vicious cycle that extends the amount of time devoted to these thoughts. If correct, this helps to explain why habitual suppressors are generally bad at suppressing thoughts (Baird, 2013), as well as the effectiveness of therapies that encourage the identification of thought content and effective counterstrategies (e.g., challenging, reappraisal, acceptance and commitment, or mindfulness). Furthermore, if meta-awareness is essential to Cognitive Behaviour Therapy, Acceptance and Commitment Therapy, and mindfulness, and anxiety is associated with decreased meta-awareness, improving meta-awareness should increase the utility of these interventions.

General Applications

There is widespread opinion that anxiety prevalence is increasing due to political, societal, economic, and environmental changes, as well as technological advancements (Bandelow & Michaelis, 2015; Yang et al., 2021). Whether prevalence is increasing remains a topic for debate, however our results indicate that the ability to direct attention contributes to anxiety. Technological advancements have ensured that the external world is increasingly accessible, but this may come at the cost of introspection. Previously, walking across campus may have been a time for quiet reflection but now such an opportunity is declined in favour of other priorities (e.g., listening to a podcast about productivity). Consequently, meta-awareness of anxious thoughts may be reduced, thereby limiting opportunities for regulatory strategies (e.g., cognitive reappraisal) to be implemented, thus prolonging anxious states. Therefore, consistently maintaining attention to external stimuli may increase anxiety vulnerability as opportunities to practice regulatory strategies are decreased.

Conclusion and Future Directions

Overall, we found evidence that attention control may be an important process underlying attention biases in anxiety to both internal and external stimuli. The current studies found mixed patterns of results, however, and it remains unclear whether attention control can present as a double-edged sword and reverse the pattern of disengagement difficulties to result in attentional avoidance. With the development of attention bias modification methods as stand-alone or adjunct treatments for anxiety, that is an important question. Current training procedures may inadvertently cause excessive attentional avoidance in participants with stronger attention control, and this may maintain anxiety.

Future studies may wish to manipulate whether (mis)matching participants to attention training protocols (e.g., attending towards threat, attending away from threat) based on pre-treatment bias and attention control scores influences the anxiolytic effect of ABM.

The finding that individuals may not be good at identifying their thoughts is also critical from a clinical and experimental perspective. It is recommended that emphasis is placed on refining measures or procedures that can increase thought recognition and identification both within and outside of the laboratory (i.e., meta-awareness). From a clinical perspective, this may improve the effectiveness of therapeutic interventions as clients are able to identify negative thoughts and engage in regulatory strategies (e.g., Cognitive restructuring, mindfulness, acceptance, and commitment). From a research perspective, improving participants' awareness and ability to self-report on their thoughts will be valuable in circumstances where thought content is of interest.

References

Abramowitz, J. S., Tolin, D. F., & Street, G. P. (2001). Paradoxical effects of thought suppression: a meta-analysis of controlled studies. *Clinical Psychology Review, 21*(5), 683–703. https://doi.org/10.1016/S0272-7358(00)00057-X

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

Airaksinen, E., Larsson, M & Forsell, Y. (2005). Neuropsychological functions in anxiety disorders in population-based samples: evidence of episodic memory dysfunction. *Journal of Psychiatric Research, 39*, 207 – 214. https://doi.org/10.1016/j.jpsychires.2004.06.001

Amir, I. & Bernstein, A. (2022). Dynamics of internal attention and internally-directed cognition: the Attention-to-Thoughts (A2T) model. *Psychological Inquiry, 33* (4), 239 – 260. https://doi.org/10.1080/1047840X.2022.2141000

Amir, N., Beard, C., Burns, M., & Bomyea, J. (2009). Attention modification program in individuals with generalized anxiety disorder : cognitive bias modification. *Journal of Abnormal Psychology,118*(1), 28–33. https://doi.org/10.1037/a0012589

Anderson, J. R. (1983). A spreading activation theory of memory. *Journal of Verbal Learning and Verbal Behavior*, *22*(3), 261–295. https://doi.org/10.1016/S0022-5371(83)90201-3

Ansari, T. L., & Derakshan, N. (2010). Anxiety impairs inhibitory control but not volitional action control. *Cognition & Emotion*, *24*(2), 241–254. https://doi.org/10.1080/02699930903381531

Ansari, T. L., Derakshan, N., & Richards, A. (2008). Effects of anxiety on task switching: Evidence from the mixed antisaccade task. *Cognitive, Affective, & Behavioral Neuroscience*, *8*(3), 229–238. https://doi.org/10.3758/CABN.8.3.229

Armstrong, T., Zald, D. H., & Olatunji, B. O. (2011). Attentional control in OCD and GAD: specificity and associations with core cognitive symptoms. *Behaviour Research and Therapy*, *49*, 756-762. https://doi.org/10.1016/j.brat.2011.08.003

Aso, T., Nishimura, K., Kiyonaka, T., Aoki, T., Inagawa, M., Matsuhashi, M., Tobinaga, Y., & Fukuyama, H. (2016). Dynamic interactions of the cortical networks during thought suppression. *Brain and Behavior*, *6*(8), https://doi.org/10.1002/brb3.503

Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. H. Bower (Ed.), *Psychology of learning and motivation* (Vol. 8, pp. 47–89). Academic Press. https://doi.org/10.1016/S0079-7421(08)60452-1

Baird, B., Smallwood, J., Fishman, D., Mrazek, M. D., & Schooler, J. (2013). Unnoticed intrusions: Dissociations of meta-consciousness in thought suppression. *Consciousness and Cognition*, *22,* 1003 – 1012. https://doi.org/10.1016/j.concog.2013.06.009

Balsamo, M., Romanelli, R., Innamorati, M., Ciccarese, G., Carlucci, L., & Saggino, A. (2013). The State-Trait Anxiety Inventory: Shadows and Lights on *its Construct Validity. Journal of Psychopathology and Behavioral Assessment, 35*(4), 475–486. https://doi.org/10.1007/s10862-013-9354-5

Bar-Haim, Y. (2010). Research review: attention bias modification (ABM): a novel treatment for anxiety disorders. *J Child Psychol Psychiatry, 51*, 859–870. https://doi.org/10.1111/j.1469-7610.2010.02251.x

Bar-Haim, Y., Pergamin, L., Bakermans-Kranenburg, M., & Van Ijzendoorn, M. (2007). Threat-related attentional bias in anxious and non-anxious individuals: a meta-analytic study. *Psychological Bulletin, 133*(1), 24. https://doi.org/10.1037/0033-2909.133.1.1

Barlow, D. H., Allen, L. B., & Choate, M. L. (2004). Toward a unified treatment for emotional disorders. *Behavior Therapy, 35*(2), 205–230. https://doi.org/10.1016/S0005-7894(04)80036-4

Basanovic, J., Kaiko, I., MacLeod, C. (2021). Change in attentional control predicts change in attentional bias to negative information in response to elevated state anxiety. *Cognitive Therapy and Research, 45,* 111- 122. https://doi.org/10.1007/s10608-020-10176-3

Basanovic, J., Notebaert, L., Clarke, P. J., MacLeod, C., Jawinski, P., Chen, N. T. M. (2018). Inhibitory attention control: manipulating cognitive load in an antisaccade task. *PLoS ONE 13*(10) : e0205720. https://doi.org/10.1371/journal.pone.0205720

Basten, U., Stelzel, C., & Fiebach, C. J. (2011). Trait anxiety modulates the neural efficiency of inhibitory control. *Journal of Cognitive Neuroscience*, *23,* 3132 -3145.

Basten, U., Stelzel, C., & Fiebach, C. J. (2012). Trait anxiety and the neural efficiency of manipulation in working memory. *Cognitive, affective & behavioral neuroscience*, *12*(3), 571–588. https://doi.org/10.3758/s13415-012-0100-3

Baxter, A. J., Vos, T., Scott, K.M., Ferrari, A. J., Whiteford, H. A. (2014). The global burden of anxiety disorders in 2010. *Psychological Medicine, 44,* 2363 – 2374. https://doi.org/10.1017/S0033291713003243

Beard, C., Sawyer, A. T., & Hofmann, S. G. (2012). Efficacy of attention bias modification using threat and appetitive stimuli: A meta-analytic review. *Behavior Therapy*, *43*(4), 724–740. https://doi.org/10.1016/j.beth.2012.01.002

Beck, A. T., & Clark, D. A. (1997). An information processing model of anxiety: automatic and strategic processes. *Behaviour Research Therapy, 31*(1), 49-58. https://doi.org/10.1016/S0005-7967(96)00069-1

Beck, A. T., & Emery, G. (1985). *Anxiety disorders and phobias: a cognitive perspective*. New York: Basic Books.

Berggren, N., & Derakshan, N. (2013). The neural correlates of impaired inhibitory control in anxiety. *Neuropsychologia, 49*, 1146-1153. https://doi.org/10.1016/j.neuropsychologia.2011.01.019

Berman, N. C., Wheaton, M. G., McGrath, P., & Abramowitz, J. S. (2010). Predicting anxiety: The role of experiential avoidance and anxiety sensitivity. *Journal of Anxiety Disorders, 24*(1), 109–113. https://doi.org/10.1016/j.janxdis.2009.09.005

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

Boldrini, M., Del Pace, L., Placidi, G. P. A., Keilp, J., Ellis, S. P., and Cappa, S. F. (2005). Selective cognitive deficits in obsessive-compulsive disorder compared to panic disorder with agoraphobia. *Acta Psychiatrica Scandinavica, 111*(2), 150–158. https://doi.org/10.1038/nn.2242x

Booth, R. W. (2014). Uncontrolled avoidance of threat: vigilance-avoidance, executive control, inhibition and shifting. *Cognition and Emotion*, *28*(8) 1465 – 1473. https://doi.org/10.1080/02699931.2014.882294

Booth, R. W., & Tekes, B. (2019). Individual differences in anxiety and worry, not anxiety disorders, predict weakened executive control: preliminary evidence. *International Journal of Psychology and Psychological Therapy*, *19* (3), 337-344.

Booth, R. W., Mackintosh, B., Sharma, D. (2017). Working memory regulates trait anxiety-related threat processing biases. *Emotion*, *17*(4), 616-627. https://doi.org/10.1037/emo0000264

Borkovec, T. D. & Inz, J. (1990). The nature of worry in generalized anxiety disorder: a predominance of thought activity. *Behaviour Research and Therapy*, *28*(2), 153-158. https://doi.org/10.1016/0005-7967(90)90027-G

Borkovec, T. D., Alcaine, O., & Behair, E. (2004). Avoidance theory of worry and generalized anxiety disorder. In R. Heimberg, C. L. Turk, & D. Mennin (Eds.), *Generalized anxiety disorder: Advances in research and practice* (pp. 77-108). New York: Guilford Press.

Bretherton, P. M., Eysenck, M. W., Richards, A., & Holmes, A. (2020). Target and distractor processing and the influence of load on the allocation of attention to task-irrelevant threat. *Neuropsychologia*, *145*, 106491. https://doi.org/10.1016/j.neuropsychologia.2017.09.009

Brewin, C. R., & Beaton, A. (2002). Thought suppression, intelligence, and working memory capacity. *Behaviour Research and Therapy*, *40*(8), 923–930. https://doi.org/10.1016/S0005-7967(01)00127-9

Brewin, C. R., & Smart, L. (2005). Working memory capacity and suppression of intrusive thoughts. *Journal of Behavior Therapy and Experimental Psychiatry*, *36*(1), 61–68. https://doi.org/10.1016/j.jbtep.2004.11.006

Bush, G., Luu, P., & Posner, M. I. (2000). Cognitive and emotional influences in anterior cingulate cortex. *Trends in Cognitive Sciences*, *4*(6), 215–222. https://doi.org/10.1016/S1364-6613(00)01483-2

Calvo, M. G., & Avero, P. (2012). Time course of attentional bias to emotional scenes in anxiety: gaze direction and duration, *Cognition and Emotion*, *19*(3), 433-451. https://doi.org/10.1016/S1364-6613(00)01483-2

Carlson, J. M., & Fang, L. (2020). The stability and reliability of attentional bias measures in the dot-probe task: evidence from both traditional mean bias scores and trial -level bias scores. *Motivation and Emotion*, *44*, 657-669. https://doi.org/10.1007/s11031-020-09834-6

Carlson, J. M., Beacher, F., Reinke, K. S., Habib, R., Harmon-Jones, E., Mujica-Parodi, L. R., & Hajcak, G. (2012). Nonconscious attention bias to threat is correlated with anterior cingulate cortex gray matter volume: A voxel-based morphometry result and replication. *NeuroImage*, *59*(2), 1713–1718. https://doi.org/10.1016/j.neuroimage.2011.09.040

Carlson, J. M., Cha, J., & Mujica-Parodi, L. R. (2013). Functional and structural amygdala – Anterior cingulate connectivity correlates with attentional bias to masked fearful faces. *Cortex*, *49*(9), 2595–2600. https://doi.org/10.1016/j.neuroimage.2011.09.040

Chawla, N., & Ostafin, B. (2007). Experiential avoidance as a functional dimensional approach to psychopathology: an empirical review. *Journal of Clinical Psychology*, 63(9), 871-890. https://doi.org/10.1002/jclp.20400

Chun, M. M., Golomb, J. D., & Turk-Browne, N. B.(2011). A Taxonomy of External and Internal Attention. *Annual Review of Psychology*, *62*(1), 73-101. https://doi.org/10.1146/annurev.psych.093008.100427

Cisler, J., & Koster, E. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: an integrative review. *Clinical Psychology Review*, *30*(2), 203-216. https://doi.org/10.1016/j.cpr.2009.11.003

Cisler, J., Bacon, A., & Williams, N. (2009). Phenomenological characteristics of attentional biases towards threat: a critical review. Cognitive Therapy and Research, 33(2), 221 - 234. https://doi.org/10.1007/s10608-007-9161-y

Clark, D. A. (2004). *Intrusive thoughts in clinical disorders: Theory, research, and treatment* (1st ed.). Guilford Publications.

Clark, D. A., & Beck, A. T. (2010). Cognitive theory and therapy of anxiety and depression: Convergence with neurobiological findings. *Trends in Cognitive Sciences, 14*(9), 418–424. https://doi.org/10.1007/s10608-007-9161-y

Clarke, P. J. F., MacLeod, C., & Guastella, A. J. (2013). Assessing the role of spatial engagement and disengagement of attention in anxiety-linked attentional bias: a critique of current paradigms and suggestions for future research directions. *Anxiety, Stress and Coping, 26*(1), 1-19. https://doi.org/10.1080/10615806.2011.638054

Clarke, P. J. F., Marinovic, E., Todd, J., Basanovic, J. Chen, N. T. M. & Notebaert, L. (2020). What is attention bias variability? Examining the potential roles of attention control and response time variability in its relationship with anxiety. Behaviour Research and Therapy, 135, 103751, https://doi.org/10.1016/j.brat.2020.103751

Cohen, L. J., Hollander, E., DeCaria, C. M., Stein, D. J., Simeon, D., Liebowitz, M. R., et al. (1996). Specificity of neuropsychological impairment in obsessive compulsive disorder: a comparison with social phobic and normal control subjects. *Journal of Neuropsychiatry and Clinical Neurosciences, 8*, 82–85. https://doi.org/10.1016/j.brat.2020.103751

Cohen, N., Mor, N., & Henik, A. (2014). Linking executive control and emotional response: A training procedure to reduce rumination. *Clinical Psychological Science*, *3*(1), 15-25. https://doi.org/10.1177/2167702614530114

Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience, 3*(3), 215-229. https://doi.org/10.1038/nrn755

Cowan, N. (1988). Evolving conceptions of memory storage, selective attention, and their mutual constraints within the human information processing system. *Psychological Bulletin, 104*, 163-191. https://doi.org/10.1037/0033-2909.104.2.163

Craske, M. G., & Barlow, D. H. (2007). Mastery of your anxiety and panic: therapist guide. Oxford University Press. https://doi.org/10.1037/0033-2909.104.2.163

Cristea, I., Kok, R., & Cuijpers, P. (2015). Efficacy of cognitive bias modification interventions in anxiety and depression: Meta-analysis. *The British Journal of Psychiatry*, *206*(1), 7-16. https://doi.org/10.1192/bjp.bp.114.146761

Culot, C., & Gevers, W. (2021). Happy is easy: the influence of affective states on cognitive control and metacognitive reports. *Cognition and Emotion*, *35*(6), 1195–1202. https://doi.org/10.1192/bjp.bp.114.146761

Davies, M. I., & Clark, D. M. (1998). Thought suppression produces a rebound effect with analogue post-traumatic intrusions. *Behaviour Research and Therapy*, *36*(6), 571–582. https://doi.org/10.1016/S0005-7967(98)00051-5

Dennis-Tiwary, T., Cho, H., & Myruski, S. (2023) Effects of attention bias modification for anxiety: neurophysiological indices and moderation by symptom severity. *Clinical Neurophysiology, 147*, 45-57. https://doi.org/10.1016/S0005-7967(98)00051-5

Derakshan, N., Ansari, T. L., Hansard, M., Shoker, L., Eysenck, M. W. (2009). Anxiety, inhibition, efficiency, and effectiveness. *Experimental Psychology*, *56*(1), 48 – 55. https://doi.org/10.1016/S0005-7967(98)00051-5

Derryberry, D., & Reed, M. A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology, 111*(2), 225-236. https://doi.org/10.1037//0021-843X.111.2.225

Diagnostic and statistical manual of mental disorders : DSM-5-TR (5th edition, text revision.). (2022). American Psychiatric Association Publishing.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135-168. https://doi.org/10.1146/annurev-psych-113011-143750

Dickson, K. S., Ciesla, J., & Reilly, L. C. (2012). Rumination, worry, cognitive avoidance, and behavioural avoidance: examination of temporal effects. *Behavior Therapy, 43*(2), 629-640. https://doi.org/10.1146/annurev-psych-113011-143750

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science*, *11*(9), 19 – 23. https://doi.org/10.1146/annurev-psych-113011-143750

Engle, R. W. (2010). Role of working-memory capacity in cognitive control. *Current Anthropology, 51, Supplement 1,* S17 – S26. https://doi.org/10.1111/1467-8721.00160

Ercan, I., Hafizoglu, S., & Ozkaya, G. (2015). Examining cut-off values for the state-trait anxiety inventory. *Revista Argentina de Clinica Psicologica 24 (2)* 143 – 148. https://www.revistaclinicapsicologica.com/resumen.php?idt=278

Etkin, A., Egner, T., & Kalisch, R. (2011). Emotional processing in anterior cingulate and medial prefrontal cortex. *Trends in Cognitive Sciences*, *15*(2), 85–93. https://doi.org/10.1016/j.tics.2010.11.004

Eysenck, M. W., & Derakshan, N. (2011). New perspectives in attentional control theory. Personality and Individual Differences, 50(7), 955-960. https://doi.org/10.1016/j.paid.2010.08.019

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. Emotion, 7(2), 336–353. https://doi.org/10.1037/1528-3542.7.2.336

Eysenck, M. W., Moser, J. S., Derakshan, N., Hepsomali, P., & Allen, P. (2023). A neurocognitive account of Attentional Control Theory: How does trait anxiety affect the brain's attentional networks? *Cognition and Emotion, 37(2),* 220-237, https://doi.org/10.1080/02699931.2022.2159936

Eysenck, M. W., Payne, S., & Derakshan, N. (2005). Trait anxiety, visuospatial processing, and working memory. *Cognition & Emotion, 19*, 1214–1228. https://doi.org/10.1080/02699931.2022.2159936

Fales, C. L., Barch, D. M., Burgess, G. C., Schaefer, A., Mennin, D. S., Gray, J. R., et al. (2008). Anxiety and cognitive efficiency: Differential modulation of transient and sustained neural activity during a working memory task. *Cognitive, Affective & Behavioral Neuroscience, 8*, 239–253. https://doi.org/10.3758/CABN.8.3.239

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. (2009). Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. *Behaviour Research Methods, 41 (4)*, 1149 - 1160.

Fialko, L., Bolton, D., & Perrin, S. (2012). Applicability of a cognitive model of worry to children and adolescents. Behaviour Research and Therapy, 50(5), 341–349. https://doi.org/10.1016/j.brat.2012.02.003

Fikretoglu, D. (2003). *An examination of type of distracter used in suppression efforts as a potential moderator of the relationship between thought suppression and preoccupation with previously suppressed thoughts* (Unpublished Doctoral Dissertation). https://www.proquest.com/docview/305299501?_oafollow=false&pq-origsite=primo

Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin, 99*, 20–35. https://doi.org/10.1037/0033-2909.99.1.20

Foa, E., Hembree, E., & Rothbaum, B. O. (2007). *Prolonged Exposure Therapy for PTSD: Emotional Processing of Traumatic Experiences*. Oxford University Press, Incorporated. https://doi.org/10.1093/med:psych/9780195308501.001.0001

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology General, 130*(4), 42. https://doi.org/10.1093/med:psych/9780195308501.001.0001

Garner, M., Mogg, K., & Bradley, B. (2006). Orienting and maintenance of gaze to facial expressions in social anxiety. *Journal of Abnormal Psychology*, *115*(4), 760-770. https://doi.org/10.1037/0021-843X.115.4.760

Gillath, O., Bunge, S. A., Shaver, P. R., Wendelken, C., & Mikulincer, M. (2005). Attachment-style differences in the ability to suppress negative thoughts: Exploring the neural correlates. *NeuroImage*, *28*(4), 835–847. https://doi.org/10.1016/j.neuroimage.2005.06.048

Goodwin, H., Eagleson, C., Mathews, A., Yiend, J., & Hirsch, C. (2017). Automaticity of attention bias to threat in high and low worriers. *Cognitive Therapy and Research, 41*, 479-488. https://doi.org/10.1007/s10608-016-9818-5

Goodwin, A. H., & Sher, K. J. (1992). Deficits in set-shifting ability in nonclinical compulsive checkers. *Journal of Psychopathology and Behavioral Assessment*, *14*(1), 81–92. https://doi.org/10.1007/BF00960093

Gordijn, E. H., Hindriks, I., Koomen, W., Dijksterhuis, A., & Van Knippenberg, A. (2004). Consequences of stereotype suppression and internal suppression motivation: A self-regulation approach. *Personality and Social Psychology Bulletin, 30*, 212–224. https://doi.org/10.1007/s10608-016-9818-5

Gorlin, E. I., Lambert, A. E., & Teachman, B. A. (2016). When does it hurt to try? Effort as a mediator of the links between anxiety symptoms and the frequency and duration of unwanted thought recurrence. *Personality and Individual Differences, 98*, 137–144. https://doi.org/10.1016/j.paid.2016.03.070

Gorlin, E., & Teachman, B. A. (2015). Inhibitory control as a moderator of threat-related interference biases in social anxiety. *Cognition & Emotion*, *29*(4), 723-735. https://doi.org/10.1080/02699931.2014.931275

Gosselin, P., Langlois, F., Freeston, M. H., Ladouceur, R., Dugas, M., & Pelletier, O. (2002). The Cognitive Avoidance Questionnaire (CAQ): Development and validation among adult and adolescent samples. *Journal de Therapie Comportementale et Cognitive, 12*(1), 24-37.

Gosselin, P., Langlois, F., Freeston, M. H., Ladouceur, R., Laberge, M., & Lemay, D. (2007). Cognitive variables related to worry among adolescents: Avoidance strategies and faulty beliefs about worry. *Behaviour Research and Therapy*, *45*(2), 225–233. https://doi.org/10.1016/j.brat.2006.03.001

Grattery, A. (2023). The effect of attention disengagement on anxiety and emotion maintenance: A theoretical perspective. *International Journal of Psychology and Psychological Therapy*, *23*(2), 117-147. https://www.ijpsy.com/volumen23/num2/634.html

Gray, J. A. (2010). The neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system. Oxford University Press.

Grös, D.F., Antony, M.M., Simms, L.J., & McCabe, R.E. (2007). Psychometric properties of the State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA): comparison to the State-Trait Anxiety Inventory (STAI). *Psychological assessment, 19*(*4*), 369-81. https://doi.org/10.1016/j.brat.2006.03.001

Günther, V., Jahn, S., Webelhorst, C., Bodenschatz, C. M., Bujanow, A., Mucha, S., Kersting, A., Hoffmann, K., Egloff, B., Lobsien, D., Suslow, T. Correlates with anxiety: Brain structural correlates of vigilance and cognitive avoidance. *Frontiers in Psychiatry, 13,* 869367. https://doi.org/10.3389/fpsyt.2022.869367

Gustavson, D. E., & Miyake, A. (2016). Trait worry is associated with difficulties in working memory updating. *Cognition and Emotion, 30*(7), 1289 – 1303. https://doi.org/10.1080/02699931.2015.1060194

Gustavson, D. E., du Pont, A., Whisman, M. A., & Miyake, A. (2018). Evidence for transdiagnostic repetitive negative thinking and its association with rumination, worry, and depression and anxiety symptoms: A commonality analysis. *Collabra. Psychology*, *4*(1), 1-18. https://doi.org/10.1525/collabra.128

Hadwin, J. A., & Richards, H. J. (2016). Working memory training and CBT reduces anxiety symptoms and attentional biases to threat: A preliminary study. *Frontiers in psychology*, *7*, 47. https://doi.org/10.3389/fpsyg.2016.00047

Hallion, L. S., & Ruscio, A. M. (2011). A Meta-Analysis of the Effect of Cognitive Bias Modification on Anxiety and Depression. *Psychological Bulletin*, *137*(6), 940–958. https://doi.org/10.1007/s10608-017-9832-2

Hallion, L. S., Steinman, S. A., Kusmierski, S. N. (2018). Difficulty concentrating in generalised anxiety disorder: an evaluation of incremental utility and relationship to worry. *Journal of Anxiety Disorders*, *53*, 39-45. https://doi.org/10.1007/s10608-017-9832-2

Hallion, L., Tolin, D., Goethe, J., & Diefenbach, G. (2017). Cognitive control in generalized anxiety disorder: relation of inhibition impairments to worry and anxiety severity. *Cognitive Therapy and Research*, *41*, 610-618. https://doi.org/10.1007/s10608-017-9832-2

Hakamata. (2010). Attention Bias Modification Treatment: A Meta-Analysis Toward the Establishment of Novel Treatment for Anxiety. *Biological Psychiatry.*, *68*(11), 982–990. https://doi.org/10.1016/j.biopsych.2010.07.021

Harvey, A. G., & Bryant, R. A. (1998). The effect of attempted thought suppression in acute stress disorder. *Behaviour Research and Therapy*, *36*(6), 583–590. https://doi.org/10.1016/S0005-7967(98)00052-7

Hayes, A. F. (2018). I*ntroduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach (Methodology in the Social Sciences)* (2nd ed.). New York, NY: The Guilford Press.

Hayes, S., Hirsch, C. R., & Mathews, A. (2008). Restriction of working memory capacity during worry. *Journal of Abnormal Psychology*, *117*, 712–717. https://doi.org/10.1037/a0012908

Hayes, S., Hirsch, C. R., & Mathews, A. (2010). Facilitating a benign attentional bias reduces negative thought intrusions. *Journal of Abnormal Psychology*, *119*(1), 235–240. https://doi.org/10.1037/a0012908

Hayes, S., MacLeod, C., & Hammond, G. (2009). Anxiety-linked task performance: Dissociating the influence of restricted working memory capacity and increased investment of effort. *Cognition & Emotion*, *23*, 753–781. https://doi.org/10.1080/02699930802131078

Hayes, A. F., & Rockwood, N. J. (2020). Conditional process analysis: Concepts, computation, and advances in the modelling of the contingencies of mechanisms. *American Behavioral Scientist*, *64*, 19-54. https://doi.org/10.1177/0002764219859633

Hayes, S., Strosahl, K., Wilson, K., Bissett, R., Pistorello, J., Toarmino, J., . . . McCurry, S. (2004). Measuring experiential avoidance: a preliminary test of a working model. *The Psychological Record*, *54*(4), 26. https://doi.org/10.1007/BF03395492

Hayes, S.C., Strosahl, K.D., and Wilson, K.G. (2011) Acceptance and Commitment Therapy: The Process and Practice of Mindful Change, 2nd edn, Guilford Press, New York.

Hazen, R. A., Vasey, M. W., & Schmidt, N. B. (2009). Attentional retraining: A randomized clinical trial for pathological worry. *Journal of Psychiatric Research*, *43*(6), 627–633. https://doi.org/10.1016/j.jpsychires.2008.07.004

Hepsomali, P., Hadwin, J. A., Liversedge, S. P., Degno, F., & Garner, M. (2019). The impact of cognitive load on processing efficiency and performance effectiveness in anxiety: evidence from event-related potentials and pupillary responses. *Experimental brain research*, *237*(4), 897–909. https://doi.org/10.1007/s00221-018-05466-y

Hertel, P. T., & Mathews, A. (2011). Cognitive bias modification: past perspectives, current findings, and future applications. *Perspectives on Psychological Science*, *6*(6), 521–536. https://doi.org/10.1177/1745691611421205

Hirsch, C. R., & Mathews, A. (2012). A cognitive model of pathological worry. *Behaviour Research and Therapy*, *50*(10), 636–646. https://doi.org/10.1016/j.brat.2012.06.007

Hofmann, S.G., Heering, S., Sawyer, A.T., and Asnaani, A. (2009) How to handle anxiety: The effects of reappraisal, acceptance, and suppression strategies on anxious arousal. *Behaviour Research and Therapy*, *47*, 389–394. https://doi.org/10.1016/j.brat.2009.02.010

Hooper, N. & McHugh, L. (2013). The effects of repeated thought suppression attempts on thought recurrence. *American Journal of Psychology*, *126*, 3, 315-322. https://doi.org/10.5406/amerjpsyc.126.3.0315

Hoppitt, L., Mathews, A., Yiend, J., & Mackintosh, B. (2010). Cognitive mechanisms underlying the emotional effects of bias modification: Current directions at the juncture of clinical and cognitive science. *Applied Cognitive Psychology*, *24*(3), 312–325. https://doi.org/10.1002/acp.1678

Hoshino, T., & Tanno, Y. (2016). Trait anxiety and impaired control of reflective attention in working memory. *Cognition and Emotion*, *30*(2), 369–377. https://doi.org/10.1080/02699931.2014.993597

Iacoviello, B. M., Wu, G., Abend, R., Murrough, J. W., Feder, A., Fruchter, E., et al. (2014). Attention bias variability and symptoms of posttraumatic stress disorder. *Journal of Traumatic Stress*, *27*(2), 232–239. https://doi.org/10.1080/02699931.2014.993597

Johnson, M. K., & Hirst, W. (1993). MEM: Memory subsystems as processes. In A. F. Collins, S. E. Gathercole, M. A. Conway, & P. E. Morris (Eds.), *Theories of memory* (pp. 241–286). Lawrence Erlbaum Associates, Inc. https://doi.org/10.4324/9781315782119-9

Jones, E. B., & Sharpe, L. (2017). Cognitive bias modification: A review of meta-analyses. *Journal of Affective Disorders, 223,* 175-183. https://doi.org/10.1016/j.jad.2017.07.034

Judah, M. R., DeMond, M. G., Lechner, W. V., & Mills, A. C. (2013). Working memory load moderates attentional bias in social anxiety. *Cognition and Emotion*, *27(3)*, 502-511, https://doi.org/10.1016/j.jad.2017.07.034

Kaczkurkin, A., & Foa, E. (2015). Cognitive-Behavioural Therapy for anxiety disorders: An update on the empirical evidence, *Dialogues in Clinical Neuroscience, 17(*3), 337-346. https://doi.org/10.1016/j.jad.2017.07.034

Kappenman, E. S., Geddert, R., Farrens, J. L., McDonald, J. J., & Hajcak, G. (2021). Recoiling From Threat: Anxiety Is Related to Heightened Suppression of Threat, Not Increased Attention to Threat. *Clinical Psychological Science*, *9*(3), 434-448. https://doi.org/10.1177/2167702620961074

Kane, M. J., & Engle, R. W. (2003). Working-Memory Capacity and the Control of Attention: The Contributions of Goal Neglect, Response Competition, and Task Set to

Stroop Interference. *Journal of Experimental Psychology. General*, *132*(1), 47–70. https://doi.org/10.1037/0096-3445.132.1.47

Kelley, A. E., & Kahn, J. H. (1994). Effects of suppression of personal intrusive thoughts. *Journal of Personality and Social Psychology, 66*(6), 998–1006. https://doi.org/10.1037/0022-3514.66.6.998

Koster, E., Crombez, G., Van Damme, S., Verschuere, B., & De Houwer, J. (2004). Does imminent threat capture and hold attention? *Emotion*, *4*(3), 312-317. https://doi.org/10.1037/0022-3514.66.6.998

Koster, E., Crombez, G., Van Damme, S., Verschuere, B., & De Houwer, J. (2005). Signals for threat modulate attentional capture and holding: fear-conditioning and extinction during the exogenous cueing task. *Cognition & Emotion*, *19*(5), 771-780. https://doi.org/10.1080/02699930441000418

Koster, E., Crombez, G., Verschuere, B., & De Houwer, J. (2004). Selective attention to threat in the dot probe paradigm: Differentiating vigilance and difficulty to disengage. *Behaviour Research and Therapy*, *42*, 1183–1192. https://doi.org/10.1080/02699930441000418

Koster, E., Crombez, G., Verschuere, B., Van Damme, & Wiersema, J. R. (2006). Components of attentional bias to threat in high trait anxiety: facilitated engagement, impaired disengagement and attentional avoidance. *Behaviour Research and Therapy, 44*, 1757-1771. https://doi.org/10.1080/02699930441000418

Koster, E., Verschuere, B., Crombez, G., & Van Damme, S. (2005). Time-course of attention for threatening pictures in high and low trait anxiety. *Behaviour Research and Therapy*, *43*(12), 1087. https://doi.org/10.1080/02699930441000418

Kruijit, A., Parsons, S., & Fox, E. (2019). A meta-analysis of bias at baseline in RCTs of attention bias modification: no evidence for dot-probe bias towards threat in clinical anxiety and PTSD. *Journal of Abnormal Psychology, 128 (6),* 563-573. https://doi.org/10.1037/abn0000406

Lambert, A. E., Hu, Y., lit, J. C., Beadel, J. R., & Teachman, B. A. (2014). Thought suppression across time: Change in frequency and duration of thought recurrence. *Journal of Obsessive-Compulsive and Related Disorders*, *3*(1), 21–28. https://doi.org/10.1016/j.jocrd.2013.11.004

Lau, J. Y. F., Rijsdijk, F., & Eley, T. C. (2006). I think, therefore I am: A twin study of attributional style in adolescents. *Journal of Child Psychology and Psychiatry, 47*(6), 696-703. https://doi.org/10.1111/j.1469-7610.2005.01532.x

Legrand, L. N., Gollan, J. K., & Warren, K. R. (1999). Stress and negative affect: Evidence for a reciprocal relation. Anxiety, Stress, and Coping, 12(4), 351-371.

Leung, C. J., Yiend, J., Trotta, A., Lee, T, M, C. (2022). The combined cognitive bias hypothesis in anxiety: A systematic review and meta-analysis. *Journal of anxiety disorders, 89,* 102575. https://doi.org/10.1016/j.janxdis.2022.102575

Lin, Y.-J., & Wicker, F. W. (2007). A comparison of the effects of thought suppression, distraction and concentration. Behaviour Research and Therapy, 45(12), 2924–2937. https://doi.org/10.1016/j.brat.2007.08.004

Litvin, E. B., Kovacs, M. A., Hayes, P. L., & Brandon, T. H. (2012). Responding to tobacco craving. Experimental test of acceptance versus suppression. Psychology of Addictive Behaviors, 26(4), 830–837. https://doi.org/10.1037/a0030351

Luciano, J. V., & Gonzalez, S. A. (2007). Analysis of the efficacy of different thought suppression strategies. *International Journal of Psychology and Psychological Therapy, 7,* 335-345. Retrieved from https://www.ijpsy.com/index.php

MacLeod, C. (2023). The attention bias modification approach to anxiety: origins, limitations and opportunities. *American Journal of Psychiatry, 180*(5), 328-330. https://doi.org/10.1176/appi.ajp.20230210

MacLeod, C., & Clarke, P. J. (2013). Cognitive bias modification: a new frontier in cognition and emotion research. In Handbook of cognition and emotion. United States: The Guildford Press.

MacLeod, C. & Donnellan, A. M. (1993). Individual differences in anxiety and the restriction of working memory capacity. *Person. Indivd. Diff. 15* (2), 163-173. https://doi.org/10.1016/0191-8869(93)90023-V

MacLeod, C., Grafton, B., & Notebaert, L. (2019). Anxiety-linked attentional bias: is it reliable? *Annual Review of Clinical Psychology*, *15*, 529-554. https://doi.org/10.1146/annurev-clinpsy-050718-095505

MacLeod, C., & Mathews, A. (2012). Cognitive bias modification approaches to anxiety. *Annu Rev Clin Psychol*, *8*, 189–217. https://doi.org/10.1146/annurev-clinpsy-032511-143052

Magee, J. C., & Teachman, B. A. (2007). Why did the white bear return? Obsessive–compulsive symptoms and attributions for unsuccessful thought suppression. *Behaviour Research and Therapy*, *45*(12), 2884–2898. https://doi.org/10.1016/j.brat.2007.07.014

Magee, J. C., Dreyer-Oren, S. E., Sarfan, L. D., Teachman, B. A., & Clerkin, E. M. (2019). Don’t tell me what to think: Comparing self- and other-generated distraction methods for controlling intrusive thinking. *Journal of Obsessive-Compulsive and Related Disorders*, *23*, 100368. https://doi.org/10.1016/j.jocrd.2017.12.003

Magee, J. C., Harden, K. P., & Teachman, B. A. (2012). Psychopathology and thought suppression: A quantitative review. *Clinical Psychology Review*, *32(3*), 189–201. https://doi.org/10.1016/j.cpr.2012.01.001

Mantella, R., Butters, M. A., Dew, M. A., Mulsant, B. H., Begley, A.E., Tracey, B., et al. Cognitive impairment in late-life generalized anxiety disorder. *American Journal of Geriatric Psychiatry*, *15*, 1–7. https://doi.org/10.1097/JGP.0b013e31803111f2

Martinelli, A., Grull, J., & Baum, C. (2022). Attention and interpretation cognitive bias change: a systematic review and meta-analysis of bias modification programs. *Behaviour Research and Therapy*, *157*, 104180. https://doi.org/10.1016/j.brat.2022.104180

Massoni, S. (2014). Emotion as a boost to metacognition: How worry enhances the quality of confidence. *Consciousness and Cognition*, *29*, 189–198. https://doi.org/10.1016/j.concog.2014.08.006

Mathews, A. (1990). Why worry? The cognitive function of anxiety. *Behaviour Research and Therapy*, *28* (6), 455 – 468. https://doi.org/10.1016/j.concog.2014.08.006

Mathews, A., & Mackintosh, B. (1998). A cognitive model of selective processing in anxiety. *Cognitive Therapy and Research*, *22*(6), 539-560. https://doi.org/10.1023/A:1018738019346

Mathews, A., & MacLeod, C. (2002). Induced Processing Biases Have Causal Effects on Anxiety, *Cognition and Emotion*, *16(3)*, 331-354. https://doi.org/10.1146/annurev.clinpsy.1.102803.143916

Mathews, A., & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. Annual Review of Clinical Psychology, 1, 167-195. https://doi.org/10.1146/annurev.clinpsy.1.102803.143916

McNally, R. J., & Riccardi, J. N., (1996). Suppression of negative and neutral thoughts. *Behavioural and Cognitive Psychotherapy*, *24*, 17-25. https://doi.org/10.1017/S1352465800016805

Miltner, W. H., Krieschel, S., Hecht, J., Trippe, R., & Weiss, T. (2004). Eye movements and behavioral responses to threatening and nonthreatening stimuli during visual search in phobic and nonphobic subjects. *Emotion, 4*, 17. https://doi.org/10.1037/1528-3542.4.4.323

Mitchell, D. G. V., Nakic, M., Fridberg, D., Kamel, N., Pine, D. S., & Blair, R. J. R. (2007). The impact of processing load on emotion. *NeuroImage, 34*(3), 1299–1309. https://doi.org/10.1016/j.neuroimage.2006.10.012

Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. Current Directions in Psychological Science, 21(1), 8e14. https://doi.org/10.1177/0963721411429458

Mogg, K., & Bradley, B. (1998). A cognitive-motivational analysis of anxiety. *Behaviour and Research Therapy, 36*, 40. https://doi.org/10.1016/S0005-7967(98)00063-1

Mogg, K., & Bradley, B. (2016). Anxiety and attention to threat: cognitive mechanisms and treatment with attention bias modification. *Behav Res Ther, 87*, 33. https://doi.org/10.1016/j.brat.2016.08.001

Mogg, K., & Bradley, B. (2018). Anxiety and threat-related attention: cognitive-motivational framework and treatment. *Trends in cognitive sciences, 22*, 3, 225-240. https://doi.org/10.1016/j.tics.2018.01.001

Mogg, K., Bradley, B., Miles, F., & Dixon, R. (2004). Brief report: Time course of attentional bias for threat scenes: Testing the vigilance-avoidance hypothesis. *Cognition & Emotion, 18*(5), 13. https://doi.org/10.1080/02699930341000158

Mogoaşe, C., David, D., & Koster, E. H. W. (2014). Clinical efficacy of attentional bias modification procedures: An updated meta-analysis. *Journal of Clinical Psychology*, *70*(12), 1133–1157. https://doi.org/10.1002/jclp.22081

Montoya, A. K. (2018). Moderation analysis in two-instance repeated measures designs: probing methods and multiple moderator models. *Behaviour Research Methods.* https://doi.org/10.1002/jclp.22081

Moran, T. P. (2016). Anxiety and working memory capacity: a meta-analysis and narrative review. *Psychological Bulletin, 142(8),* 831-864. https://doi.org/10.1037/bul0000051

Moser, J. S., Hajcak, G., Huppert, J. D., Foa, E. B., & Simons, R. F. (2012). Interpretation bias in social anxiety as detected by event-related brain potentials. *Emotion, 12*(6), 693-700. https://psycnet.apa.org/doi/10.1037/a0013173

Muris, P., Merckelbach, H., & Horselenberg, R. (1996). Individual differences in thought suppression. The White Bear Suppression Inventory: Factor structure, reliability, validity and correlates. *Behaviour Research and Therapy, 34*(5), 501–513. https://doi.org/10.1016/0005-7967(96)00005-8

Najmi, S., Riemann, B. C., & Wegner, D. M. (2009). Managing unwanted intrusive thoughts in obsessive compulsive disorder: Relative effectiveness of suppression, distraction, and acceptance. *Behaviour Research and Therapy, 47*, 494-503. https://doi.org/10.1016/j.brat.2009.02.015

Neophytou, K., & Panayiotou, G. (2022). Does attention bias modification reduce anxiety in soically anxious college students? An experimental study of potential moderators and considerations for implementation. *PLoS ONE, 17*(2), e0264256 https://doi.org/10.1371/journal.pone.0264256

Nixon, R. D. V., Roberts, L. N., Sun, Y-T. J., & Takarangi, M. K . T. (2021). Are individuals always aware of their trauma-related intrusive thoughts? A study of meta-awareness. *Behaviour Therapy, 52,* 874 – 882. https://doi.org/10.1016/j.beth.2020.10.009

Oberauer, K. (2019). Working memory and attention – a conceptual analysis and review. *Journal of Cognition, 2*(1), 36. https://doi.org/10.1016/j.beth.2020.10.009

O'Connell, C., Larkin, K., Mizes, J. S., & Fremouw, W. (2005). impact of caloric preloading on attempts at food and eating-related thought suppression in restrained and unrestrained eaters. *The International Journal of Eating Disorders*, *38*(1), 42–48. https://doi.org/10.1002/eat.20150

Oschner, K., & Gross, J. J. (2005): The cognitive control of emotion. *Trends Cognitive Science, 9*, 242–249. https://doi.org/10.1016/j.tics.2005.03.010

Olatunji, B. O., Moretz, M. W., & Zlomke, K. R. (2010). Linking cognitive avoidance and GAD symptoms: The mediating role of fear of emotion. *Behaviour Research and Therapy*, *48*(5), 435–441. https://doi.org/10.1016/j.brat.2009.11.014

Ollendick, T., White, S., Richey, J., Kim-Spoon, J., Ryan, S., Trubanova Wieckowski, A., Coffman, M., Elias, R., Strefe, M., Capriola-Hall, N., & Smith, M. (2019). Attention bias modification treatment for adolescents with social anxiety disorder. *Behaviour Therapy*, *50*, 126 – 139. https://doi.org/10.1016/j.beth.2018.04.002

Orem, D. M., Petrac, D. C., & Bedwell, J. S. (2008). Chronic self-perceived stress and set-shifting performance in undergraduate students. *Stress (Amsterdam, Netherlands)*, *11*(1), 73–78. https://doi.org/10.1016/j.beth.2018.04.002

Page, A.C., Locke, V., & Trio, M. (2005). An online measure of thought suppression. *Attitudes and Social Cognition*, *88*(3), 421-431. https://doi.org/10.1016/j.beth.2018.04.002

Pergamin-Hight, L., Naim, R., Bakermans-Kranenburg, M. J., van Ijzendoorn, M. H., & Bar-Ham., Y. (2015). Content specificity of attention bias to threat in anxiety disorders: a meta-analysis. *Clinical Psychology Review, 35,* 10 – 18. https://doi.org/10.1016/j.cpr.2014.10.005

Petersen, S. E., & Posner, M. I. (2012). The attention system of the human brain: 20 years after. *Annual Review of Neuroscience, 35*(1), 73-89. https://doi.org/10.1146/annurev-neuro-062111-150525

Pflugshaupt, T., Mosimann, U. P., vonWartburg, R., Schmitt, W., Nyffeler, T., & Muri, R. M. (2005). Hypervigilance-avoidancepattern in spider phobia. *Journal of Anxiety Disorders*, *19*, 12. https://doi.org/10.1146/annurev-neuro-062111-150525

Pope, K. (1978) How gender, solitude and posture influence the stream of consciousness. In K. S. Pope, & J. L. Singer (Eds.), *The stream of consciousness: scientific investigations into the flow of human experience.* Plenum Press, New York.

Pope, K. S., & Singer, J. L. (1975). Regulation of the Stream of Consciousness: Toward a Theory of Ongoing Thought. In *The Stream of Consciousness* (pp. 101–137). Springer US. https://doi.org/10.1007/978-1-4684-2571-0_3

Posner, M. I., & Boies, S. J. (1971). Components of attention. *Psychological review, 78,* 5, 391-408. https://doi.org/10.1037/h0031333

Posner, M. I., Petersen, S. E., Fox, P. T., & Raichle, M. E. (1988). Localization of cognitive operations in the human brain. *Science, 240*, 4859, 1627 - 1631. https://doi.org/10.1002/da.22634

Price, R. B., & Mohlman, J., (2007). Inhibitory control and symptom severity in late life generalized anxiety disorder. *Behaviour Research and Therapy, 45,* 2628 -2639. doi:10.1016/j.brat.2007.06.007. https://doi.org/10.1016/j.brat.2007.06.007

Price, R. B., Benoit Allen, K., Silk, J. S., Ladouceur, C. D., Ryan, N. D., Dahl, R. E., Forbes, E. E., Siegle, G. J. (2016). Vigilance in the laboratory predicts avoidance in the real world: a dimensional analysis of neural, behavioural, and ecological moementary data in anxious youth. *Developmental Cognitive Neuroscience, 19,* 128-136. https://doi.org/10.1016/j.dcn.2016.03.001

Price, R. B., Kuckertz, J. M., Amir, N., Bar-Haim, Y., Carlbring, P., Wallace, M. D. (2017). Less is more: patient-level meta-analysis reveals paradoxical dose-response effects of a computer-based social anxiety intervention for targeting attentional bias. *Depress Anxiety*, *34,* 1106 – 1115. https://doi.org/10.1002/da.22634

Price, R. B., Kuckertz, J. M., Siegle, G. J., Ladoucer, C. D., Skilk, J. S., Ryan, N. D., Dahl, R. E., Amir, N. (2016). Empirical recommendations for improving the stability of the dot-probe task in clinical research. *Psychological Assessment 27(2),* 365-376. . https://doi.org/10.1037/pas0000036

Price, R. B., Siegle, G. J., Silk, J. S., Ladouceur, C. D., McFarland, A., Dahl, R. E., & Ryan, N. D. (2014). Looking Under the Hood Of The Dot-Probe Task: An fMRI Study In Anxious Youth. *Depression and Anxiety*, *31*(3), 178–187. https://doi.org/10.1002/da.22255

Price, R. B., Wallace, M., Kuckertz, J. M., Amir, N., Graur, S., Cummings, L., Popa, P., Carlbring, P., & Bar-Haim, Y. (2016). Pooled patient-level meta-analysis of children and adults completing a computer-based anxiety intervention targeting attentional bias. *Clinical Psychology Review, 50*, 37–49. https://doi.org/10.1002/da.22255

Purdon, C. (2004). Empirical investigations of thought suppression in OCD. *Journal of Behavior Therapy and Experimental Psychiatry*, *35(*2), 121–136. https://doi.org/10.1016/j.jbtep.2004.04.004

Purdon, C., & Clark, D. A. (2000). White Bears and Other Elusive Intrusions: Assessing the Relevance of Thought Suppression for Obsessional Phenomena. *Behavior Modification, 24*(3), 425–453. https://doi.org/10.1177/0145445500243008

Purdon, C., Rowa, K., & Antony, M. M. (2005). Thought suppression and its effects on thought frequency, appraisal and mood state in individuals with obsessive-compulsive 110 disorder. Behaviour Research and Therapy, 43, 93–108. https://doi.org/10.1002/da.22255

Quigley, L., Wright, C. A., Dobson, K. S., Sears, C. R. (2017). Measuring attention control ability or beliefs? Evaluation of the factor structure and convergent validity of the Attention Control Scale. *Journal of Psychopathology and Behavioral Assessment , 39,* 742-754. https://doi.org/10.1007/s10862-017-9617-7

Rachman, S. (2004). *Anxiety*. Psychology Press.

Rachman, S., & de Silva, P. (1978). Abnormal and normal obsessions. *Behaviour Research and Therapy, 16*(4), 233–248. https://doi.org/10.1016/0005-7967(78)90022-0

Rachman, S., Shafran, R., Mitchell, D., Trant, J., & Teachman, B. (1996). How to remain neutral: An experimental analysis of neutralization. *Behaviour Research and Therapy, 34*(11), 889–898. https://doi.org/10.1016/S0005-7967(96)00051-4

Reich, D. A., & Mather, R. D. (2008). Busy perceivers and ineffective suppression goals: a critical role for distracter thoughts. *Personality and Social Psychology Bulletin, 34*(5), 706 – 718. https://doi.org/10.1016/S0005-7967(96)00051-4

Reinholdt-Dunne, M. L., Mogg, K., & Bradley, B. P. (2009). Effects of anxiety and attention control on processing pictorial and linguistic emotional information. Behaviour Research and Therapy, 47(5), 410e417. http://doi.org/10.1016/j.brat. 2009.01.012.

Reinholdt-Dunne, M. L., Mogg, K., & Bradley, B. P. (2013). Attention control: Relationships between self-report and behavioural measures, and symptoms of anxiety and depression. Cognition & Emotion, 27(3), 430-440. https://doi.org/10.1016/S0005-7967(96)00051-4

Renaud, J. M., &McConnell, A. R. (2002). Organisation of the self-concept and the suppression of self-relevant thoughts. *Journal of Experimental Social Psychology, 38,* 79-86. https://doi.org/10.1006/jesp.2001.1485

Rinck, M., Becker, E., Kellermann, J., & Roth, W. T. (2003). Selective attention in anxiety: distraction and enahncement in visual search. *Depression and Anxiety, 18*, 11. https://doi.org/10.1002/da.10105

Riskind, J. (2005). Cognitive mechanisms in Generalized Anxiety Disorder: a second generation of theoretical perspectives. *Cognitive Therapy and Research*, *29*(1), 5. https://doi.org/10.1007/s10608-005-1644-0

Roberts, H., Mostazir, M., Moberly, N. J., Watkins, E. R. Adlam, A. (2021). Working memory updating reduces state repetitive negative thinking: Proof of concept for a novel cognitive control training. *Behaviour Research and Therapy, 142,* 103871, https://doi.org/10.1007/s10608-005-1644-0

Roemer, L., & Borkovec, T. D. (1994). Effects of suppressing thoughts about emotional material. *Journal of Abnormal Psychology*, *103*(3), 467–474. https://doi.org/10.1037/0021-843X.103.3.467

Roemer, L., Salters, K., Raffa, S. D., Orsillo, S. M. (2005). Fear and avoidance of internal experiences in GAD: preliminary tests of a conceptual model. *Cognitive Therapy and Research, 29 (1),* 71-88. https://doi.org/10.1007/s10608-005-1650-2

Rudaizky, D., Basanovic, J., & MacLeod, C. (2013). Biased attentional engagement with, and disengagement from, negative information: Independent cognitive pathways to anxiety vulnerability? *Cognition and Emotion, 28*(2), 245–259. https://doi.org/10.1080/02699931.2013.815154

Ruimi, L., Amir, I., Hadash, Y., Goldstein, P., Dar, O., & Bernstein. (2023). Meta-awareness and control of internal attention: a simulated thoughts paradigm investigation. *Mindfulness, 14,* 6-18. https://doi.org/10.1007/s12671-022-02027-x

Salemink, E., Van Den Hout, M. & Kindt, M. (2007). Selective attention and threat: Quick orienting versus slow disengagment and two versions of the dot-probe task. *Behaviour Research and Therapy, 45,* 607-615. https://doi.org/10.1016/j.brat.2006.04.004

Salters-Pedneault, K., Tull, M., & Roemer, L. (2004). The role of avoidance of emotional material in the anxiety disorders. *Applied and Preventive Psychology*, *11*(2), 95-114. https://doi.org/10.1016/j.appsy.2004.09.001

Salum, G. A., Mogg, K., Bradley, B. P., Gadelha, A., Pan, P., Tamanaha, A. C., …Pine, D. S. (2013). Threat bias in attention orienting: Evidence of specificity in a large community-based study. *Psychological Medicine, 43*(04), 733-745. https://doi.org/10.1017/S0033291712001651

Sandi, C., & Richter-Levin, G. (2009). From high anxiety trait to depression: A neurocognitive hypothesis. *Trends in Neurosciences, 32*(6), 312-320. https://doi.org/10.1016/j.tins.2009.02.004

Sari, B. A., Koster, E. H., Derakshan, N. (2016). The effects of active worrying on working memory capacity. *Cognition and Emotion*, *31*(5), 995-1003. https://doi.org/10.1080/02699931.2016.1170668

Schmidt, N. B., Richey, J. A., Buckner, J. D., & Timpano, K. R. (2009). Attention training for generalized social anxiety disorder. *Journal of Abnormal Psychology, 118*(1), 5–14. https://doi.org/10.1037/a0013643

Schoorl, M., Putman, P., Van Der Werff, S., Van Der Does, A. J. W. (2014). Attentional bias and attention control in Posttraumatic Stress Disorder. *Journal of Anxiety Disorders, 28,* 203-210, https://doi.org/10.1016/j.janxdis.2013.10.001

Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2002). Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse. New York, NY: Guilford Press

Segal, Z.V., Teasdale, J.D., and Williams, J.M.J. (2004) Mindfulness-based cognitive therapy: Theoretical rationale and empirical status, in Mindfulness and Acceptance (eds S.C. Hayes, V.M. Follette, and M.M. Linehan), Guilford Press, New York, pp. 45–65.

Sexton, K. A., & Dugas, M. J. (2008). The Cognitive Avoidance Questionnaire: Validation of the English translation. Journal of Anxiety Disorders, 22(3), 355–370. https://doi.org/10.1016/j.janxdis.2007.04.005

Shi, R., Sharpe, L., & Abbott, M. (2019). A Meta-analysis of the relationship between anxiety and attentional control. *Clinical Psychology Review*, *72,* 101754. https://doi.org/10.1016/j.cpr.2019.101754

Snyder, H. R., & Munakata, Y., (2010). Becoming self-directed: abstract representations support endogenous flexibility in children. *Cognition 115*, 155 – 167, https://doi.org/10.1016/j.cognition.2010.04.007

Snyder, H. R., Hutchison, N., Nyhus, E., Curran, T., Banich, M. T., O'Reilly, R. C., & Munakata, Y. (2010). Neural inhibition enables selection during language processing. Proceedings of the National Academy of Sciences USA, 107, 16483– 16488. https://doi.org/10.1073/pnas.1002291107

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

Snyder, H. R., Miyake, A., & Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: Bridging the gap between clinical and cognitive approaches. Frontiers in Psychology, 6, 1–24. https://doi.org/10.3389/fpsyg.2015.00328

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Stefanopoulou, E., Hirsch, C. R., Hayes, S., Adlam, A., & Coker, S. (2014). Are attentional control resources reduced by worry in generalised anxiety disorder? *Journal of Abnormal Psychology, 123,* 330-335. https://doi.org/10.1037/a0036343

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*, 643–662. https://doi.org/10.1037/a0036343

Szczepanowski, R., Cichon, E., Niemiec, T., Andrzejewska, B. E., & Wojta-Kempa, M. (2021). Measurement of Unwanted Thought Suppression Strategies with the Thought Control Questionnaire in the General Polish Population: A Confirmatory Factor Analysis and Validation. Psychology Research and Behavior Management, 14, 137–148. https://doi.org/10.2147/PRBM.S286245

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Allyn & Bacon

Tabachnick, B. G., & Fidell, L. S. (2013). Using multivariate statistics (6th ed.). Pearson Education.

Takarangi, M. K. T., Strange, D., & Lindsay, D. S. (2014). Self-report may underestimate trauma intrusions. *Consciousness and Cognition, 27,* 297–305. https://doi.org/10.2147/PRBM.S286245

Taylor, C., Cross, K., & Amir, N. (2016). Attentional control moderates the relationship between social anxiety symptoms and attentional disengagement from threatening information. *Journal of Behavior Therapy and Experimental Psychiatry, 50*, 9. https://doi.org/10.1016/j.jbtep.2015.05.008

Trinder, H., & Salkovskis, P. M. (1994). Personally relevant intrusions outside the laboratory: long term suppression increases intrusion. *Behaviour Research and Therapy, 32,* 833 – 842. https://doi.org/10.1016/0005-7967(94)90163-5

Tytler, C., Yarolavsky, I., Kiss, E., Kapornai, K., Baji, I., Kovacs, M. (2022). Attention shifting individual differences moderate attention bias moderation training effects among formerly depressed persons. *Archives of Clinical Neuropsychology, 37,* 1483. https://doi.org/10.1093/arclin/acac060.287

Van Bockstaele, B., Verschuere, B., Tibboel, H., De Houwer, J., Crombez, G., & Koster, E. (2014). A review of current evidence for the causal impact of attentional bias on fear and anxiety. *Psychological Bulletin, 140*(3), 40. https://doi.org/10.1093/arclin/acac060.287

Van den Hout, M., Tenney, N., Huygens, K., Merckelbach, H., & Kindt, M. (1995). Responding to subliminal threat cues is related to trait anxiety and emotional vulnerability: a successful replication of Macleod and Hagan (1992). *Behav Res Ther*, *33*(4), 451-454. https://doi.org/10.1016/0005-7967(94)00062-O

Wang, D., Chatzisarantis, N., & Hagger, M. (2017). Mechanisms underlying effective thought suppression using focused-distraction strategies: A self-determination theory approach. *Psychology of Consciousness: Theory, Research and Practice, 4*(4), 367-380. https://doi.org/10.1037/cns0000138

Wang, D., Chatzisarantis, N., & Hagger, M. (2018). Why distractors with need-supportive content can mitigate ironic effects of thought suppression. *Motivation and Emotion, 42,* 214 – 224. https://doi.org/10.1007/s11031-017-9653-3

Wang, D., Hagger, M., & Chatzisarantis, N. L. D. (2020). Ironic Effects of Thought Suppression: A Meta-Analysis. *Perspectives on Psychological Science, 15*(3), 778–793. https://doi.org/10.1177/1745691619898795

Waters, A. M., Bradley, B. P., & Mogg, K. (2014). Biased attention to threat in paediatric anxiety disorders (generalized anxiety disorder, social phobia, specific phobia, separation anxiety disorder) as a function of 'distress' versus 'fear' diagnostic categorization. *Psychological Medicine, 44*(03), 607-616. https://doi.org/10.1177/1745691619898795

Waters, A. M., Pittaway, M., Mogg, K., Bradley, B. P., & Pine, D. S. (2013). Attention training towards positive stimuli in clinically anxious children. *Developmental Cognitive Neuroscience*, *4*, 77–84. https://doi.org/10.1177/1745691619898795

Wegner, D. M. (1994). Ironic Processes of Mental Control. *Psychological Review, 101*(1), 34–52. https://doi.org/10.1037/0033-295X.101.1.34

Wegner, D. M., & Erber, R. (1992). The Hyperaccessibility of Suppressed Thoughts. Journal of *Personality and Social Psychology*, *63*(6), 903–912. https://doi.org/10.1037/0022-3514.63.6.903

Wegner, D. M., Schneider, D. J., Carter, S. R., & White, T. L. (1987). Paradoxical Effects of Thought Suppression. *Journal of Personality and Social Psychology, 53*(1), 5–13. https://doi.org/10.1037/0022-3514.53.1.5

Wells, A. (2002). New pathways for cognitive restructuring: attention modifications (ATT and SAR). In A. Wells (Ed) *Emotional Disorders and Metacognition,* (pp. 132 – 154), John Wiley & Sons Ltd, London, United Kingdom. https://doi.org/10.1002/9780470713662.ch9

Wenzlaff, R. M., & Wegner, D. M. (2000). Thought suppression. *Annual Review of Psychology*, *51*(1), 59–91. https://doi.org/10.1002/9780470713662.ch9

Wenzlaff, R. M., Wegner, D. M., & Roper, D.W. (1988). Depression and mental control: the resurgence of unwanted negative thoughts. *Journal of Personality and Social Psychology, 55* (6), 882 – 892. https://doi.org/10.1002/9780470713662.ch9

Williams, J., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive psychology and emtional disorders* (2 ed.). Chichester: Wiley.

Wittchen, H. U., Jacobi, F., Rehm, J., Gustavsson, A., Svensson, M., Jönsson, B., ... & Steinhausen, H. C. (2011). The size and burden of mental disorders and other disorders of the brain in Europe 2010. *European Neuropsychopharmacology, 21(9),* 655-679. https://doi.org/10.1016/j.euroneuro.2011.07.018

Wyland, C. L., Kelley, W. M., Macrae, C. N., Gordon, H. L., & Heatherton, T. F. (2003). Neural correlates of thought suppression. *Neuropsychologia, 41*(14), 1863–1867. https://doi.org/10.1016/j.neuropsychologia.2003.08.001

Yapan, S., Türkçapar, M. H., & Boysan, M. (2022). Rumination, automatic thoughts, dysfunctional attitudes, and thought suppression as transdiagnostic factors in depression and anxiety. *Current Psychology*, *41*(9), 5896–5912. https://doi.org/10.1007/s12144-020-01086-4

Yiend, J., Mathews, A., Burns, T., Dutton, K., Fernandez-Martin, A., Georgiou, G. A., et al. (2015). Mechanisms of selective attention in generalized anxiety disorder. *Clinical Psychological Science*, *3*(5), 758-771. https://doi.org/10.1177/2167702614545216

Zainal, N. H., & Newman, M. G. (2018). Executive function and other cognitive deficits are distal risk factors of generalized anxiety disorder 9 years later. *Psychological Medicine*, *48*(12), 2045–2053. https://doi.org/10.1177/2167702614545216

Zetsche, U., Bürkner, P. C., Schulze, L. (2018). Shedding light on the association between repetitive negative thinking and deficits in cognitive control – a meta-analysis. *Clinical Psychology Review*, *63*, 56-65. https://doi.org/10.1016/j.cpr.2018.06.001

Zvielli, A., Amir, I., Goldstein, P., & Bernstein, A. (2015a). Targeting biased emotional attention to threat as a dynamic process in time: Attention feedback awareness and control training (A-FACT). Clinical Psychological Science, 4(2), 287–298. https://doi.org/10.1177/2167702615588048

Zvielli, A., Bernstein, A., & Koster, E. H. W. (2015). Temporal dynamics of attentional bias. *Clinical Psychological Science, 3*(5), 772–788. https://doi.org/10.1177/2167702614551572

APPENDIX A

Experimental Procedures for Study 1 and Study 2

- ❑ Prior to each experimental session, ensure that there is a participant number on each of the desks.
- ❑ Up to three participants can attend the session at one time. Ensure that all scheduled participants are present prior to starting the session.
- ❑ When all scheduled participants are present, the session can begin. Sessions must start on time, and late participants have the opportunity to reschedule if they choose, but they cannot start after the other participants in that session.
- ❑ Go over the participant information sheet and consent form with the participants
- ❑ Provide participants with a brief overview of the study:
- ❑ Participants complete the colour-word Stroop task:
- ❑ Participants complete the dot-probe task:
- ❑ Participants complete the thought suppression task;

  The instructions on the thought suppression task were as follows (adapted from Lambert et al., 2014) the text in italics represents the instructions provided on the screen:

"*This task assesses responses to an unpleasant thought. You will be presented with a thought about a motor vehicle accident. Please notify the experimenter if you do not wish to participate in this task. Press the spacebar to continue*".

<u>Period 0: focussing period</u>
"*Using the pen and paper on the desk, please write down: "I hope my friend is in a car accident". Turn over the piece of paper. Once completed, press the spacebar once."*

[pressed spacebar]

blank screen 2000ms

"*We would like you to focus on the thought "my friend is in a car accident". Press and hold the Space Bar with your dominant index (pointer finger for the entire time you are thinking the thought. Release the spacebar when you are not thinking the thought. The task will start when the screen is grey.*
Press the spacebar to Start".

[pressed spacebar]

*** "*Ready*?" 1000ms" → "*GO*" 500ms" → blank 40 seconds ***

[completes Focus period]

Period 1: Initial Enhancement (participants either monitor OR suppress)

Monitoring Instructions: "*For this period, think about whatever you would like – it could be the thought you thought about before, or it could be anything else. If you do think about the thought, press and hold the spacebar until the thought has passed. It is important that you press and hold the spacebar until the thought has passed because this is very important information for us. The task will start when the screen is grey. Press the spacebar to start*."

Suppression Instructions: "*For this period, try to not think about the thought you just focussed on. If you do think about the thought, press and hold the spacebar until the thought has passed. It is important that you press and hold the spacebar until the thought has passed because this is very important information for us, but try your best not to think about that thought. The task will start when the screen is grey. Press the spacebar to start."*

[pressed spacebar]

*** "Ready?" 1000ms" → "GO" 500ms" → blank 4 minutes ***

[completes initial enhancement period]

Period 2: Rebound Period (monitoring instructions only)
"For this period, think about whatever you would like – it could be the thought you thought about before, or it could be anything else. If you do think about the thought, press and hold the spacebar until the thought has passed. It is important that you press and hold the spacebar until the thought has passed because this is very important information for us. The task will start when the screen is grey. Press the spacebar to start."

*** "Ready?" 1000ms → "GO" 500ms → blank 4 minutes ***

[completes rebound period]

"Thank you for completing the thought task. Please indicate to the researcher that you are ready for the next phase of the experiment"

- ❑ Participants complete the State-Trait Anxiety Inventory (ref); Cognitive Avoidance Questionnaire; and Demographics information via online survey (Qualtrics)
- ❑ Provide the participant with a verbal debrief of the study

APPENDIX B

Coding Manual for Study 3

When you are given the transcripts for coding, they will be broken down into sentences and a timestamp will appear above each sentence. Lines made up of asterisks "*******" indicate the end of that thinking period.

Example
Speaker 1: I, um, I dread the day that that does happen. *Speaker 1:* I don't want that to happen to me or my friends. *Speaker 1:* I don't want my friends to get hurt. *Speaker 1:* I don't want my friends to die. *Speaker 1:* I want I know that it's almost unavoidable, um, sometimes for it to happen at some point. *Speaker 1:* *******

For each thinking period, count the total number of statements made. In the example above, there are 5 statements. Then, and you will need to code each sentence and highlight each sentence in the corresponding code colour Direct, Task, Indirect, Unrelated, no thought. **The definitions for each statement type, and examples, are later in this guide.** Then, count the number of each statement type and complete the table for each thinking period.

Example 2
Speaker 1: The ones closer to me, um, have more branches. *Speaker 1:* They have less leaves. *Speaker 1:* **Um, the sky.** *Speaker 1:* **I'm thinking about the statement again because I've realized in trying to distract myself,** *Speaker 1:* **I'm looking at the trees on the wall,** *Speaker 1:* **um, thinking about statement again** *Speaker 1:* **and I'm thinking about how eight is my favourite number,** *Speaker 1:* um, because it's really like round and symmetrical and nice and it's an even.

Speaker 1: **<u>No, um, I'm looking at the hand sanitizer on the table and thinking about why is hand sanitizer on the table if no one used, it um.</u>** *Speaker 1:* **<u>Now my mind is blank.</u>**

Example 2

Total Statements 10	Direct	Task	Indirect	Unrelated	No thought
Number	2	0	0	7	1
Proportion	0.2	0	0	0.7	0.1

Once each statement has been coded, we need to code the number of "shifts" which are changes in train of thought. **Further information on coding shifts is on p.6. When a shift occurs, <u>bold and underline the first sentence of the shift.</u>** In the example, there are 7 shifts. Once shifts have been coded, record them in the relevant table for each thinking period.
Example 2

Total Shifts 7	Direct → Direct	Task → Task	Indirect → Indirect	Unrelated → Unrelated	No thought → No thought
Number	0	0	0	**2**	0
proportion	0	0	0	**0.29**	0
	Direct → Task	**Task → direct**	**Indirect → direct**	**Unrelated → direct**	**No thought → direct**
Number	0	0	0	**2**	0
proportion	0	0	0	**0.29**	0
	Direct → Indirect	**Task → indirect**	**Indirect → task**	**Unrelated → task**	**No thought → Task**
Number	0	0	0	0	0
proportion	0	0	0	0	0
	Direct → Unrelated	**Task → unrelated**	**Indirect → unrelated**	**Unrelated → indirect**	**No thought → indirect**
Number	**2**	0	0	0	0
proportion	**0.29**	0	0	0	0
	Direct → No thought	**Task → No thought**	**Indirect → No thought**	**Unrelated → No thought**	**No thought → Unrelated**
Number	0	0	0	**1**	0
proportion	0	0	0	**0.14**	0

Coding Statements

We need to code each sentence/statement as being directly related to the target, task-related, indirectly related to the target or unrelated to the target.
Based on Roemer & Borkovec (1994):

- Direct statements are descriptions of the situation itself, a description of an emotional response to the situation, or a reference to thinking (or trying not to think about the situation)
- Task related statements are when a person is talking about the task itself, including whether they are doing it correctly (e.g., I hope I am pressing the spacebar when I am supposed to), trying to identify the aims of the study, comments on the talking out loud procedure (e.g., it is so weird talking my thoughts out loud), comments on the task or that they are being recorded (e.g., my transcript will be messed up); it is NOT about a reference to thinking about the thought when they are not supposed to (e.g., I'm not supposed to be thinking about my friend being in an accident – this is classified as a direct statement[see above]). It does not include descriptions of the task set up (e.g., the screen is grey, this microphone looks old) – these are classified as unrelated.
- Indirect statements are when the person does not directly refer to the target situation, but the statement is thematically related (e.g., referring to some other type of accident or illness/harm happening to a friend) or contextually related to the specifics of the situation (e.g., statements of any type about friends, or cars).
- Unrelated statements are statements that are not about the target situation, task or indirectly related statements. They include thoughts about what the participant can see, hear, smell, taste and feel; thinking about what they want to eat later, assignments that are due, pondering why the sky is blue, song lyrics, and when their mind is blank. It includes descriptions on comments on the environment (e.g., colour of the screen, microphone They will not contain themes relating to accidents, cars or friends.

- No thought are statements where the participant states "I am not thinking anything", "my mind is blank", "I don't know what to think about".

When we are coding each sentence/statement we need to take into account that a train of thought can be made up of multiple sentences/statements, and that the meaning of the statement may be determined by previous or subsequent sentences. While the sentences alone may appear to be either direct, task, indirect or related, we need to code that train of thought as one category. Make sure that when you are coding individual statements, you are considering the context (i.e., train of thought/sentence before it). For example:

✓And, um, I'm thinking about what I'm having for dinner right now.

✓I'm thinking about my dance class.

✓But also, like now I'm thinking back to, um, if I did get into a car accident, would it be like a serious one or would it just be like in the in this car park?

✓Because there's different types of car accidents.

✓If it's just like then getting a little bump in the Flinders Car Park, boom, that's all right.

✓But if we get into a serious accident where they would, like, collide into like a truck or something, then that's really serious.

✓And it makes me really sad to think about the possibility of that, um, because there's lots of people who drive really recklessly and, um, especially like in the, um, intersections and stuff like that.

× So, yeah. And now it's winter. There's lots more of rain and stuff like that.

× So the roads are a lot more dangerous than before.

The final two statements on their own can be classified as unrelated (discussion about weather) and indirect (discussion of road conditions), but, we would mark them as **direct** because based on the previous sentences which were directly linked to the car accident scenario and increased likelihood due to weather conditions.

And it makes me really sad to think about the possibility of that, um, because there's lots of people who drive really recklessly and, um, especially like in the, um, intersections and stuff like that.

✓ So, yeah. And now it's winter. There's lots more of rain and stuff like that.

✓ So the roads are a lot more dangerous than before.

However, if the final two sentences went like this:

✓And it makes me really sad to think about the possibility of that, um, because there's lots of people who drive really recklessly and, um, especially like in the, um, intersections and stuff like that.

? So, yeah. And now it's winter. There's lots more of rain and stuff like that.

? I hope that my hair doesn't get wet today

Both statements would be coded as unrelated because the first is unrelated on its own (i.e., about the weather), and the second sentence has no link to the thought of car accidents. We would note that there was a change from direct to unrelated thoughts. See section on "Shifts" for further details.

✓And it makes me really sad to think about the possibility of that, um, because there's lots of people who drive really recklessly and, um, especially like in the, um, intersections and stuff like that.

✓ So, yeah. And now it's winter. There's lots more of rain and stuff like that.

✓ I hope that my hair doesn't get wet today.

Direct statements
• the thought of my friend being in an accident is on my mind • I am thinking about my friend being in a car accident • Back to my friend in a car accident • That would be really bad (if sentence prior is related) • I would be very sad if they were in an accident • My friend was in an accident recently • I'm thinking about it again • Every time my mind goes blank, I think about it again • I'm trying really hard to not think about it, but it keeps coming back • Shit, I'm thinking about it again • There it is again! *(use following sentence for clarification)* • I wouldn't hope that happens to them • That's an awful thought to have • I hope that my friend is okay • Now I am worried that they will get in a car accident • I wonder what they are trying to find • Where would they get in an accident • What road would it be on? • Would it be a big crash, or a little bingle? • Who would pay for it? • My friend drives dangerously • It's easy to get into a car accident • What happens if they are reversing, and they hit someone • We'd have to make sure that everyone was okay • (Name) lives in the country and I worry she will be in an accident • My friend just bought a new car
Task related
• I wonder how long this is going to take • Surely this is almost done • I keep forgetting to press the space bar • I'm still not sure if I am doing the right • I hope that I am speaking loud enough

• It's really hard to think my thoughts out loud – *task related because it comments on the task* • When do I press the star(t) button? • I hope I don't screw this up • I am talking so much shit – this is *task related* because it reflects that the person is being recorded and is talking their thoughts out loud • My transcript is going to be hilarious • The experimenter is very nice • They are going to think I am crazy –*task related* because the participant is acknowledging that we will view their transcripts • This is the most interesting study that I have done – *task related* because the participant is expressing that they are completing a task/study • This is really boring – *task related because they are referring to the task/experiment*
Indirect statements
• I was in an accident recently • I saw a car accident on the way to work • My brother/sister/mother/father was in an accident • I really want a new car • Cars are expensive • I haven't got my p's yet • When I can drive, I will have so much freedom • I hope traffic isn't too bad today • I am going to dinner with (name) tonight • I am having a fight with my friend right now • I don't really have friends • Someone hit my car in the carpark yesterday • I haven't seen my friends in a while • We usually go through the city and there are lots of cars • I don't like driving at night because I'm scared I'll get in an accident • My friend has the cutest dog • My friend is Chinese and is an international student • My friends and I really wanted to go camping • I had planned to go to Melbourne with my friends, but we can't now because it's lockdown
Unrelated statements
• I hope there isn't another covid outbreak • I'm tired • I need my nails redone • I can't decide what I want for breakfast/lunch/dinner • I'm hungry • What am I going to do on the weekend? • I feel like spending some money

• I have no money • This room is really creepy • I can hear the air conditioner • It's good that there is hand sanitizer • I worked out too much yesterday • I have so many assignments due and I am freaking out about that • This building was hard to find • Why is there a sink in this room? • This carpet is disgusting • This is my last credit and then I'm done with research participation • I am looking forward to the end of semester break • I have an exam and I haven't studied for it • Why can I hear water? • I have to catch three buses to get home
No thought
• I am not thinking anything • My mind is blank • I don't know what I am thinking

Coding Shifts

We also need to code the number of shifts between types of thoughts. We are doing this because it is unlikely that people will press the spacebar for every thought they have, but rather they will identify when they are shifting to or from the direct thought.
According to Pope (1978, p. 266), a shift occurs when there are substantial changes in the focus, content, tone, organisation, or direction of thought.
Once a shift has been identified, bold and underline the last sentence of the previous thought:

✓And it makes me really sad to think about the possibility of that, um, because there's lots of people who **drive really recklessly and, um, especially like in the, um, intersections and stuff like that**.

✓ So, yeah. And now it's winter. There's lots more of rain and stuff like that.

✓ So the roads are a lot more dangerous than before.

Shifts will occur between each type of thought: direct, task, indirect and unrelated; However they can also occur within themselves. You still need to identify shifts that occur within each thought type.
Direct statements with shifts:

Shifts for direct statements may be transitions between the specifics of the situation (e.g., where or how it would happen), to emotional responses (e.g., sadness), other ramifications (e.g., financial difficulties), friends driving ability, previous situations involving near misses or accidents (with friends only), descriptions of the accident, statements that they are trying to not think about it, saying that they are thinking about it, statements that they cannot control the thought (e.g., I can't stop thinking about it).

✓I wonder where it would happen.

✓Would it be on their way home from work? *This is a shift because it changes from specifics of the situation to emotional reactions to the event*

✓I would be so sad if my friend got in a car accident

✓It would be devastating, their parents would be so upset *emotional reaction to specifics of situation*

✓But maybe it would just be a little bingle

✓Like, reversing into a pole or something

✓So then they wouldn't be hurt, it would just be a little damage to the car

Indirect statements with shifts

Shifts in indirect statements will be transitions between topics that are related to the thought (e.g., cars; accidents; friends – without being a friend in a car accident, which is a direct thought). In trains of thoughts that flow from one topic to another (see example below), while the topics may be similar (e.g., friends) you need to note a shift if there is a change in themes or content. For example, one might go from discussing how excited to see their friends, to how they don't feel like they have many friends. This constitutes as an emotional change and should therefore be counted as a shift.

✓ My friend is a Chinese international student

✓I am excited because we are going to get dinner tonight – *focus changed from dinner to driving*

✓I wonder if we take her car or my car tonight

✓I hope we take hers because my car doesn't have much petrol in it at the moment

✓Plus my friend has a new car and it is much nicer than mine – *change from cars/friends to relationships*

✓I invited some other friends to join us tonight, but they didn't respond

✓Sometimes I feel like I'm not as close with my friends anymore

✓Ever since Corona hit it's been harder to keep in contact with them

Task related shifts

Shifts in task related statements will be transitions between topics that are related to the task itself (e.g., potential hypotheses, the fact they are being recorded, comments about performance)

- ✓ The experimenter is really nice
- ✓ They had a good vibe
- ✓ **I hope this goes well for them** – *focus shifts from experimenter to the experiment*
- ✓ This study is so interesting
- ✓ Its definitely the most interesting one I have participated in by far
- ✓ **I just hope that I am doing it correctly** - *focus shifts from "interest" to performance*
- ✓ What if I'm not talking loud enough and they can't transcribe my thoughts
- ✓ **Ugh, now I'm thinking about being recorded** – focus shifts from "performance" to being recorded
- ✓ My voice is going to sound terrible
- ✓ The recorder looks ancient.

Unrelated shifts

Unrelated shifts will be transitions from topic to topic and have no affiliation with friends or car accidents, or worries about friends being sick (i.e., anything in direct, or indirect statements).

✓I have so much uni work to do.

✓I'll be really happy when the semester is over

✓**I am not sure whether I am going to pass my exam** – *change topic*

✓I am looking forward to getting dinner with my parents tonight

✓I wonder what we are going to have

✓**I would really like to have Thai, but Dad will probably want pizza** – *change from food to relationship*

✓I haven't seen my parents in a little bit

✓I needed some space

✓they have been nagging me a lot and so I just stopped seeing them

APPENDIX C

Experimental Procedure for Study 3

- ❑ Prior to each experimental session, ensure that there is a participant number on the desk.
- ❑ Verbally introduce participants to the study and prompt them to read the information sheet and consent forms.

"*Thank you for coming in today. As you know, today's session should last around 45 minutes. We will invite you to complete some computer tasks and fill out some questionnaires. Have you had a chance to read the information sheets? If not, that is okay, they are on the screen. Please read these and complete the consent form. Once you have done this, let me know so we can begin.*"

- ❑ Participant completes colour-word Stroop
- ❑ Set up the thought suppression task and verbally introduce the task:

The next task that I am going to set up will be focussing on your thoughts. There are instructions on the screen, but we will need to practice the task when it prompts you.

- ❑ Give the "think aloud" instructions below (Pope, 1978), and practice for 2 minutes.

Past studies like this have measured thoughts by recording people's voices, but others have used button presses, so we are going to both. For the practice, we just want you to talk out loud.

We want to know what you are thinking, but we don't have technology that can tell us exactly what you are thinking, so we need you to tell us. It is important that you just speak whatever is on your mind throughout the entire task. Please convey whatever information you can on your stream of consciousness at that moment. Your report might include, but is not limited to images, ideas, memories, feelings, fantasies, plans, sensations, observations, daydreams, objects that catch your attention, efforts to solve *a problem. There are no restrictions, so just say report whatever is going through your mind that you are aware of. You might find that your mind is blank, and even if you aren't thinking anything, tell us that. Speak clearly and as loudly as you would in normal conversation (about as loud as I am talking now). The practice will go for 2 minutes. Do you have any questions? Begin"*

- ❑ Provide the participant with feedback based on their practice:
  - *You did well at speaking your mind out loud. I could tell that you were just letting your mind flow from topic to topic. You also let us know when your mind was blank, which was good.*
  - *Good job. Remember that you need to talk as loud as you would in conversation. About as loud as I am talking now.*
  - *Good work, just remember that you need to continuously speak your mind out loud. This is very important because we can't tell what you are thinking. If your mind is blank, tell us that.*
  - *Good work. One thing I noticed is that when you were talking, you said "I am thinking about xyz" a fair bit. When we are thinking, we tend not to say, "I am thinking about what I am having for dinner", but rather "I can't decide whether I want to get Indian food or have soup".*
- ❑ After the practice, the experimenter will leave the room. Prior to exiting give the following instructions:

  Remember, there are two things we would like you to do throughout the task. 1) is to speak out loud and 2) is to press and hold the spacebar when you are thinking about the thought. If your mind wanders away from the thought. Release the spacebar.

  There will be three thinking periods in this task. The first is 40 seconds, and the next two are four minutes. After each thinking period, you will get new instructions on what to do with the thought, so please pay attention to that.

  Also, after each thought period, the screen will tell you to say STOP. This just lets us know when the thinking period is over in the transcript. Please do not press the red *button on the recorder, as this will stop the recording and we will lose data. You do not need to talk out loud unless the screen is grey.*

- ❑ Experimenter exits room.
- ❑ Participant completes thought suppression task:

The instructions on the thought suppression task were as follows (adapted from Lambert et al., 2014) the text in italics represents the instructions provided on the screen:

"*This task assesses responses to an unpleasant thought. You will be presented with a thought about a motor vehicle accident. Please notify the experimenter if you do not wish to participate in this task. Press the spacebar to continue*".

<u>Period 0: focussing period</u>
"*Using the pen and paper on the desk, please write down: "I hope my friend is in a car accident". Turn over the piece of paper. Once completed, press the spacebar once."*

[pressed spacebar]

blank screen 2000ms

"*We would like you to focus on the thought "my friend is in a car accident". Press and hold the Space Bar with your dominant index (pointer finger for the entire time you are thinking the thought. Release the spacebar when you are not thinking the thought. Continuously speak your mind throughout the task. If you are not thinking anything, say that. The task will start when the screen is grey.*
Press the spacebar to Start".

[pressed spacebar]

*** "*Ready*?" 1000ms" → "*GO*" 500ms" → blank 40 seconds ***

[completes Focus period]

<u>Period 1: Initial Enhancement (participants either monitor OR suppress)</u>

Suppression Instructions: "*For this period, try to not think about the thought you just focussed on. If you do think about the thought, press and hold the spacebar until the thought has passed. It is important that you press and hold the spacebar until the thought has passed because this is very important information for us but try your best not to think about that thought. Continuously speak your mind throughout the task. If you are not thinking anything, say that. The task will start when the screen is grey. Press the spacebar to start."*

[pressed spacebar]

*** “Ready?” 1000ms” → “GO” 500ms” → blank 4 minutes ***

[completes initial enhancement period]

Effort Visual Analogue Scale ratings: *“how hard did you try to not think about the car accident thought?”*

[makes rating on scale 0-100]

Period 2: Rebound Period (monitoring instructions only)
“For this period, think about whatever you would like – it could be the thought you thought about before, or it could be anything else. If you do think about the thought, press and hold the spacebar until the thought has passed. It is important that you press and hold the spacebar until the thought has passed because this is very important information for us. Continuously speak your mind throughout the task. If you are not thinking anything, say that. The task will start when the screen is grey. Press the spacebar to start.”

*** “Ready?” 1000ms → “GO” 500ms → blank 4 minutes ***

[completes rebound period]

Effort Visual Analogue Scale ratings: *“how hard did you try to not think about the car accident thought?”*

[makes rating on scale 0-100]

“*Thank you for completing the thought task. Please knock on the door so the experimenter can return to the room.”*

- ❑ Participant completes questionnaires: State-Trait Anxiety Inventory (STAI-T), cognitive avoidance questionnaire, and demographic information
- ❑ Provide verbal debriefing to participants

APPENDIX D

Supplementary Results for Study 3

Correlations Between Anxiety, Attention Control and the Proportion of Each Distracter Type (Direct, Task-Related, Indirect, Unrelated and No Thought) for the Suppression Period

	Anxiety	Attention Control	Direct	Task	Indirect	Unrelated	No thought
Anxiety	-						
Attention Control	-.03	-					
Direct thoughts [a]	.02	.22	-				
Task-related thoughts [a]	.48**	.06	-.07	-			
Indirect thoughts [a]	-.21	.16	-.14	-.32*			
Unrelated thoughts [a]	-.21	-.32*	-.70**	-.26	-.24	-	
No thought	.13	-.06	-.14	.01	-.31*	-.13	-

N = 58; [a] *N* = 53

* p <.05. ** p <.01. *** p <.001.

Correlations Between Anxiety, Attention Control and the Proportion of Each Distracter Type (Direct, Task-Related, Indirect, Unrelated And No Thought) for the Monitoring Period

	Anxiety	Attention Control	Direct	Task	Indirect	Unrelated	No thought
Anxiety	-						
Attention Control	-.03	-					
Direct thoughts [a]	.21	.18	-				
Task-related thoughts [a]	.13	-.05	.10	-			
Indirect thoughts [a]	-.03	-.11	-.01	-.16			
Unrelated thoughts [a]	-.08	-.14	-.63**	-.42**	-.43**	-	
No thought	-.27	-.15	-.10	.02	-.15	-.26	-

N = 58; [a] *N* = 53

* p <.05. ** p <.01. *** p <.001.

Correlations Between Anxiety, Attention Control, Effort During Suppression (S) and Monitoring (M) Periods

	Anxiety	Attention control	Effort (S)	Effort (M)
Anxiety	-			
Attention control	-.03	-		
Effort (S)	.23	.07	-	
Effort (M)	.38**	.05	.46**	-

Note. N = 53

* p <.05. ** p <.01. *** p <.001.

Direct, Indirect and Total Effects from Mediation Analyses of the Effect of Anxiety on Direct Thoughts (Streaming procedure) with Effort as a mediator across suppression and monitoring periods

	Suppression			Monitoring		
	b	95% CI [lower, upper]	*p*	*b*	95% CI [lower, upper]	*p*
Direct Thoughts	R^2 (2,50) =.25, p < .001***			R^2 (2,50) =.13, p = .03*		
Constant	0.32	[0.26, 0.38]	<.001***	0.26	[0.19, 0.32]	<.001***
STAI-T						
Total Effect	-0.003	[-0.01, 0.003]	.27	-0.002	[-0.01, 0.01]	.66
Direct Effect	-0.01	[-0.01, 0.001]	.08	-0.01	[-0.01, 0.002]	.14
Indirect Effect	0.002	[-0.002, 0.01]		0.004	[0.001, 0.01]	
Effort						
Direct Effect	0.005	[0.002, 0.01]	<.001***	0.003	[0.001, 0.01]	.01*

Note. *N*=53; STAI-T = Trait anxiety.

* *p* <.05. ** *p* <.01. *** *p* <.001.