Attention Bias in Test Anxiety: The Impact of a Test-threat Congruent Situation, Presentation Time, and Approach-avoidance Temperament

David W. Putwain[1], Wendy Symes[2], Elaine Coxon[1], and Diahann Gallard[1]

[1]School of Education, Liverpool John Moores University, Liverpool, UK.

[2] Department of Education and Social Justice, University of Birmingham, Birmingham, UK.

Professor David W. Putwain, School of Education, Liverpool John Moores University, IM Marsh Campus, Mossley Hill Rd, Liverpool, L17 6DB. Phone: +44 (0)151 231 5270. Email: D.W.Putwain@ljmu.ac.uk.

Abstract

Previous studies have shown that test anxiety is related to attention bias. It is not clear, however, whether a congruent test-threat manipulation is required to elicit this bias or whether the bias is a result of automatic or conscious processes. In the present study we used a mood induction procedure to examine attention bias in test anxious persons using a dot-probe task and incorporated approach-avoidance temperament as a possible moderator. Results showed that the mood induction procedure was not effective in manipulating state anxiety. In the absence of an effective test-threat manipulation, high test anxious persons showed attention bias towards supraliminal threat stimuli. Attention bias was only shown to subliminal threat stimuli in high test anxious persons with a strong approach temperament. This suggests that the mechanism for attention bias to threat stimuli in high test anxious persons is a result of both automatic and conscious processes.

Keywords: Test anxiety, attention bias, approach-avoidance temperament,

Introduction

Attention bias refers to greater allocation of information processing resources to one type of stimuli relative to another (Macleod & Mathews, 1988; McLeod, Mathews, & Tata, 1986). Many studies have shown that persons with clinical or high trait anxiety show a bias towards threat stimuli, relative to neutral stimuli, and relative to individuals with low anxiety (e.g., Abend et al., 2017; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg & van IJzendoorn, 2007; Cisler & Koster, 2010). There is a small body of evidence to show that an attention bias may also be present in individuals with high test anxiety (Dong, De Beuckelaer, Yu, & Zhou, 2017; Jastrowski, Mano, Gibler, & Beckmann, 2018; Putwain, Langdale, Woods, & Nicholson, 2012; Vasey, El-Hag, & Daleiden, 1996; Zhang, Dong, & Zhou, 2018). Within this nascent body of work, however, it is not clear whether a congruent test-threat condition is required to produce the attention bias, whether attention bias to test-threat stimuli is a result of automatic or conscious processes, and whether, in test anxious persons, attention bias is towards or away from threat. The present study used a dot-probe task to assess attention bias under test-threat (writing about one's last examination) and test-neutral (writing about one's journey to college) conditions. To differentiate between automatic or conscious processes we used subliminal (indicative of automatic processing) and supraliminal (indicative of conscious processing) presentation of stimuli. Finally, approach-avoidance temperament was included as a moderator to examine the possibility that attention bias may be amplified in individuals with a stronger avoidance temperament.

Test Anxiety

Test anxiety is a situational-specific form of trait anxiety referring to enduring differences in the tendency to appraise evaluative situations as threatening (Spielberger & Vagg, 1995; Szafranski, Barrera & Norton, 2012). Persons with high test anxiety will typically experience negative self-related worry cognitions (e.g., 'If I fail this exam, my

whole life will be a failure') and elevated autonomic activity (e.g., increased heart-rate) in situations where one's performance will be evaluated, such as academic tests and examinations (Zeidner, 2007, 2014). According to Attentional Control theory (Derakshan & Eysenck, 2011; Eysenck, Derakshan, Santos, & Calvo, 2007) worrisome cognitions interfere with working memory processes (e.g., updating and shifting) and hence could be detrimental to examination performance. Meta-analyses have confirmed a negative relationship between the cognitive (worry) aspect of test anxiety and educational achievement (e.g., Chappell et al., 2005; von der Embse, Jester, Roy, & Post, 2018). Furthermore, working memory capacity is adversely impacted by worry (Putwain, Shah & Lewis, 2014) and has been shown to mediate relations between worry and test performance (Owens, Stevenson, & Hadwin, 2012; Owens, Stevenson, Norgate, & Hadwin, 2008). The focus of attentional resources in test anxious persons on worrisome cognitions at the expense of the task at hand suggests the likely role of an influential cognitive mechanism (also see Keogh & French, 2001; Schutz, Davis, & Schwanenflugel, 2002).

In England, where this study was conducted, compulsory standardised National Curriculum Tests (NCTs) are taken by students aged 11 years in their final year of primary school. Compulsory secondary school exit examinations (General Certificate of Secondary Education: GCSE exams) are taken by students aged 16 years (see Shackleton, 2014). In addition, Certificate of Secondary Education: Advanced Level examinations (A Level) are taken by those students, aged 18 years, following an academic route at the end of upper secondary education. GCSE and A Level results are used partly by individual students, to meet requirements for future employment, education, and training, and partly for accountability purposes to judge school and teacher effectiveness. NCTs are used solely for accountability purposes. Schools are heavily incentivised to maximise student test and examination performance through the use of sanctions (which include school closure and

replacement of school management) and ranking schools in a particular locality by student performance (referred to colloquially, using a sporting analogy, as school 'league tables') (see Perryman, Ball, Maguire, & Braun, 2011; Roberts & Abreu, 2016). These are not concerns unique to England; a recent survey reported that student performance data was used in teacher evaluations widely across the twenty-three countries studied (OECD, 2013).

In England, however, there has been increasing concern from teachers, parents, charities, and psychologists that the pressures resulting from the accountability by high-stakes testing policies on children and young people have become dangerously high. There is serious concern about their contribution to poor wellbeing (Cowburn & Blow, 2017), and exacerbation of poor mental health (Rodway et al., 2016). There is an increasing urgency to understand the causes and conditions that give rise to high levels of test anxiety and to develop and evaluate evidence-based interventions and treatments for test anxiety. One relatively under-studied cause of test anxiety is bias in information processing such as attention bias; the focus of the present study. This is a fruitful line of research, partly as interventions designed to reverse such biases (attentional bias modification) have shown promising results (e.g., Hayes, Hirsch & Mathews, 2010; See, MacLeod & Bridle, 2009) and partly as they are relatively straightforward to implement. Before such interventions are developed for test anxiety, however, it is first necessary to build the evidence base that test anxiety may be underpinned by information processing biases.

Attention Bias

A robust finding in the literature is that highly anxious persons show an information-processing bias towards the processing of threat stimuli over neutral stimuli (e.g., Abend et al., 2017; Bar-Haim et al., 2007; Cisler & Koster, 2010). Such a bias may manifest as the allocation of attention resources to differing or competing sources of stimuli. For instance, when experimentally presented with two stimuli simultaneously, such as one threat word (e.g.

cancer) and one neutral word (e.g. chair), highly anxious persons respond more quickly to a probe spatially replacing the threat word (compared with a probe replacing the neutral word) than non-anxious persons (these types of tasks are referred to in the literature as 'dot-probe' tasks). This phenomenon of attention bias has been demonstrated in over 172 studies revealing an average effect size of $d =.45$ (Bar-Haim et al., 2007). Furthermore, a similar magnitude of attention bias is reliably detected in a variety of clinical anxiety disorders and also in non-clinical persons reporting elevated trait vulnerability to anxiety (Bar-Haim et al., 2007).

Attention bias, therefore, represents a core component of elevated anxiety (Cisler & Koster, 2010). Experimental tasks, using modified dot-probe tasks, where probes always follow the location of a threat word, have provided reliable evidence that attention bias can play a causal role in anxiety and worry vulnerability (Mathews & MacLeod, 2002; MacLeod, Rutherford, Campbell, Ebsworthy & Holker, 2002). Furthermore, attention bias modification studies where the probe replaces the prior location of the neutral word have shown that it is possible to reduce anxiety by reducing attention bias to threat stimuli (e.g., Hayes, Hirsch & Mathews, 2010; See, MacLeod, & Bridle, 2009) providing further evidence for the causal role of attention bias.

Attention Bias and Test Anxiety

In comparison to the general anxiety literature few studies have specifically examined attention bias in test anxiety. As we noted earlier, test anxiety is conceptualised as a situation-specific form of trait anxiety (Spielberger & Vagg, 1995). Whereas a person high in (general) trait anxiety might be expected to respond to a variety of threat situations with elevated state anxiety, persons high in test anxiety would only respond with elevated state anxiety to performance-evaluative situations. Nonetheless, we would expect the same attention processing mechanisms that underpin trait anxiety to underpin test anxiety. The worries

experienced by highly test anxious persons and the interfering nature of these cognitions on information processing (e.g., Keogh & French, 2001; Schutz et al., 2002) is indicative of vigilance towards, and/ or disengagement from, threat stimuli. Furthermore, attention bias to threat has also been shown in mathematics anxiety (Rubinsten, Eidlin, Wohl, & Akibli, 2015) providing evidence that attention bias can be shown in a situation-specific trait; like test anxiety, mathematics anxiety is a situation-specific trait anxiety.

Vasey et al. (1996) used a dot-probe task to assess attention bias to emotionally threatening words comprised of social (including evaluative threat) and physical threats in middle school students aged 11-14 years. Results showed that high test anxious students showed a bias towards threat stimuli. Putwain et al., (2011) used a dot-probe task to measure attention bias in undergraduates to test-threat word stimuli (relative to neutral stimuli) in test-threat and test-neutral conditions. Attention bias was shown to test-threat stimuli under the corresponding test-threat condition, but not under the test-neutral condition. Also using a dot-probe task, Jastrowski et al., (2018) and Zhang et al. (2018) found that undergraduate students showed an attention bias to pictorial and verbal stimuli, respectively.

Zhang et al. (2018) also found brain activity consistent with a shift of attention to the processing of threat stimuli when participants were presented with threat stimuli, although this was not sustained over the course of the 288 trials. Dong et al. (2017) used a novel eye-tracking approach to study how undergraduates orientate to test-threat pictorial stimuli. Over the course of 48 pairs of stimuli (threat and neutral pictures presented for 3s), high test anxious persons initially attended to the threat stimuli before attending away from threat stimuli as the trials progressed. Relatedly, attention bias to general academic threat stimuli was shown in a dot-probe task by high school-anxious students aged 12-15 years that was magnified when students felt rejected (Scrimin, Moscardino, Altoè & Mason, 2017). These findings provide evidence that high test anxious persons show an attention bias. The findings

of Dong et al. (2018) question whether attention bias in test anxiety is towards or away from threat.

Attention bias to threat stimuli could occur within anxious individuals during early (automatic) and/ or late (strategic) stages of information processing. For instance, attention bias to threat for high anxious persons is shown when stimulus presentations are subliminal (e.g., 100ms presentation times or 50ms presentation time, followed by a 450ms mask made up of a nonsense word) which implies an early or automatic stage of information processing that is effortless, unintentional, and free of conscious control (Mogg, Bradley, & Williams, 1995; Mogg, Bradley, De Bono, & Painter, 1997). Highly anxious persons can also show attention bias towards, and sometimes away from, threat when stimulus presentations are supraliminal (e.g., 500ms presentation times) which implies late or strategic stage of information processing that is effortful, intentional, and conscious (Cooper & Langton, 2006; Dalgleish et al., 2003) either alone or in conjunction with automatic processes (see Williams, Watts, MacLeod, & Mathews, 1988).

In the general anxiety literature there are theories that account for attention bias in early and late-stage information processing. In the test anxiety literature, the only theory to account for biased information processing is the self-referent executive processing model (Zeidner & Matthews, 2005). This model proposes vigilance for threat (an automatic process) as a contributory factor to the maintenance of test anxiety. Somewhat paradoxically, of the studies conducted on test anxiety to date, none have examined the automated stage of processing. Accordingly, in the present study we include varying stimuli presentation times in a dot-probe task to differentiate the stage of processing; subliminal presentation to ascertain whether attention bias is automatic and supraliminal to establish whether attention bias is at least in part strategic. There is also inconsistency in the literature over whether a congruent test threat situation is required to elicit attention bias. Some studies have shown that attention

bias to threat stimuli is only shown when state anxiety is increased from baseline (e.g., Fox,

Russo, Bowles, & Dutton, 2001; Putwain et al., 2012) whereas other studies have shown that

elevated state anxiety is not required for highly trait anxious persons to show an attention bias

to threat stimuli (e.g., Abend et al., 2017; Vasey et al., 1996). A mood induction procedure,

based on the autobiographical emotional memory task (e.g., Allen, Schaefer & Falcon, 2014;

Schaefer & Philippot, 2005), was used in the present study as a means to establish whether a

congruent threat situation was required to elicit attention bias in high test anxious persons.

Specifically, we asked participants to either write about their journey to college (test-neutral)

or their last examination (test-threat).

This mood induction procedure was chosen in part for theoretical, and in part for

practical reasons. Since test anxiety is known to negatively impact on working memory

performance (e.g., Owens et al., 2008, 2012; Putwain et al., 2014) it is possible that high

levels of test anxiety could also interfere with performance on the dot-probe task. It would

therefore be beneficial to induce test anxiety using a less cognitively demanding task than an

IQ-type test used in previous research (e.g., Putwain et al., 2011). From a practical

perspective, we intended to use group testing of participants and host all instructions,

materials and data collection online. The presentation and instructions for the mood induction

were straightforward to present in this fashion and link anonymously with dot-probe and

questionnaire data. Although several test providers offer online versions of IQ and ability

type tests, this would require switching from our research webpage to the test provider

webpage and participants providing identifying details to link responses.

Approach-avoidance Temperament

As we noted above, evidence from Dong et al., (2018) questions whether high test

anxiety involves attention bias away from threat. One basic individual difference variable that

might impact on anxious persons' processing of threat stimuli is approach-avoidance

temperament. Approach temperament is defined as sensitivity towards real or imagined positive stimuli, such as reward, and avoidance temperament as sensitivity towards real or imagined negative stimuli, such as threat (Elliot & Thrash, 2010). Approach-avoidance temperament integrates trait (e.g., neuroticism and extroversion), affective dispositions (positive and negative emotionality), and motivational (e.g., behavioural activation and inhibition), approaches to personality within a unified framework (Elliot & Thrash, 2002). Elliot and Thrash (2010) propose that approach temperament focuses attention on positive, and avoidance temperament on negative, stimuli increasing the amount of positive or negative information being processed and subsequently influencing one's affective state (also see Briki, 2018; Elliot & Sheldon, 1997).

It is likely that, to some degree, test anxiety and a tendency towards avoidance temperament would co-occur (e.g., Elliot & McGregor, 2001; Putwain & Symes, 2012). Test anxiety, however, is a multi-causal phenomenon (Zeidner & Matthews, 2005); an individual could still become highly test anxious due to poor competence beliefs, poor coping strategies, metacognitive beliefs that exacerbate worry, self-handicapping, and emotion regulation strategies, independently of their avoidance temperament. It is likely that highly test anxious persons who differ in their approach-avoidance temperament would also differ in their attention bias (see Spielberg, Heller, Silton, Stewart, Miller, 2011). Specifically, the attention bias towards threat in highly test anxious persons with a strong avoidance temperament (i.e., those with a tendency to focus on and process negative stimuli) would be greater than highly test anxious persons with a weaker avoidance temperament or a stronger approach temperament (i.e., those with a tendency to focus on and process positive stimuli). In short, approach-avoidance temperament might moderate the relation between test anxiety and attention bias.

Aim of the Present Study

The aim of the present study was threefold. First, it was to examine whether a congruent test-threat condition is required to demonstrate an attention bias towards threat using a mood induction procedure. Second, it was to establish whether attention bias to threat in high test anxious persons occurred during automatic or strategic stages of information processing using subliminal and supraliminal presentation of stimuli. Third, it was to examine whether approach-avoidance temperament moderated the relation between test anxiety and attention bias. Attention bias represents a core cognitive mechanism underpinning anxiety (Abend et al., 2017; Bar-Haim et al., 2007; Cisler & Koster, 2010) and worrisome cognitions have been shown to be the component of test anxiety most strongly related to information processing interference (e.g., Keogh & French, 2001; Schutz, & Schwanenflugel, 2002; von der Embse et al. 2018). Following previous studies (e.g., Putwain et al., 2011), we chose to focus solely on the cognitive (worry) component of test anxiety.

The following three hypotheses were tested:

H1: High test anxious persons will show an attention bias to test-threat stimuli relative to test-neutral stimuli. This bias will be stronger under a congruent threat condition.

H2: Attention bias to threat in high test anxious persons will be observable at both early (sub-threshold) and late stages of processing.

H3: Attention bias to threat in high test anxious persons will be stronger for those with an avoidance temperament.

Method

Design

The study used a mixed design with two between-participants IVs and one within-participants IV. The two between-participants IVs were test-threat vs. test-neutral conditions and high vs. low exam-related test anxiety. The test-threat vs. test-neutral condition was manipulated by randomly allocating participants to a writing task where they were asked to

describe either their last examination (test-threat) or journey to college (test-neutral). Test anxiety was quasi-manipulated into low and high groups using a median split. The within-participants IV was a measurement of state anxiety taken before and after the writing task.

Participants

There were 186 participants (male = 44, female = 142), drawn from three English 6th Form Colleges, who were all in their first year of studying for a General Certificate of Education: Advanced Level in Psychology along with two other subjects. 6th Form is a tier of upper secondary education (ages 16-19 years) where students typically study university entrance qualifications in academic subjects or vocational equivalents. The mean age of participants was 16.4 years (SD = .57) and the ethnic heritage was as follows: Asian = 27, Black = 17, White = 124, other = 14, and mixed heritage = 4.

Measures

Test Anxiety. Test anxiety was measured using the 6-item worry scale from the *Revised Test Anxiety Scale* (Hagtvet & Benson, 1997). Participants responded to items (e.g., 'During exams I find myself thinking about the consequences of failing') on a four-point scale (1 = almost never, 4 = always). Items were adapted from the original to refer to 'exams' rather than 'tests' in keeping with the parlance of the English educational system. This measure has shown construct validity, predictive validity, and internal consistency in previous studies (e.g., Putwain & Aveyard, 2018; Putwain & Symes, 2011). In the present study the internal consistency was good (Cronbach's α = .74).

State anxiety. State anxiety was measured using the 6-item short adaption of the state anxiety scale from the State-trait Anxiety Inventory (STAI: Marteau & Bekker, 1992). Participants responded to items (e.g., 'I feel calm') on a four-point scale (1 = not at all, 4 = very much). This measure has been widely used in a range of clinical, health, and experimental settings where it has shown good construct validity, predictive validity, and

internal consistency (e.g., Bayrampour, McDonald, Fung, & Tough, 2014; Tluczek,

Henriques, & Brown, 2009). The internal consistency was good (Cronbach's α pre-writing

task = .78, post-writing task = .77).

Attention bias. Attention bias was measured using a dot-probe task that included 24

word pairs, each of which was presented four times: twice subliminally and twice

supraliminally. Each word pair consisted of a test-threat word (e.g., failure) and a test-neutral

word (e.g., television), matched by number of syllables, with one word presented above the

other (see appendix for list of threat and neutral words). In the subliminal condition, the word

pair was shown for 100ms and in the supraliminal condition each word pair was shown for

500ms. 40 test-threat words were initially identified from previous studies (Putwain et al.,

2011; Vasey et al., 1996) and then rated by four experts on a five-point scale in terms of how

threatening someone with test anxiety would find them, resulting in 24 threat-relevant words

selected for inclusion in the dot-probe task. Prior to the presentation of each word pair, a

fixation cue (+++) appeared in the centre of the screen for 500ms, before being replaced by

the word pair.

After 100ms (subliminal trials) or 500ms (supraliminal trials), the word pair was

removed and the probe (an arrow pointing left or right) appeared in the space where one of

the words had been. Participants were instructed to press the A key on their keyboard if the

arrow was pointing left (<), and the L key if it was pointing right (>). Participant reaction

times and accuracy were recorded. Once the participants had pressed either the A or L key,

the probe would disappear, and that would end one trial. The fixation cue would then appear

again for 500ms, before the next word pair was presented and so on, with participants

completing 96 trials in total. The fixation cue, word pairs and probe were all presented in

black in Arial, font size 12, on a white screen. The trials were presented in the same order for

all participants. For half of the word pairs, the test-threat word was on the top, and the probe

replaced the test-threat word in half of the trials, and the test-neutral word for the other half.

In addition, on half of the trials the probe pointed left, and on the other half it pointed right.

Participants completed three practice trials before the main trials began.

Approach-avoidance Temperament. Approach-avoidance temperament was

measured by the twelve-item questionnaire developed by Elliot and Thrash (2010). This scale

contains six items intended to measure avoidance (e.g., 'I react strongly to bad experiences')

and six items intended to measure approach (e.g., 'Thinking about the things I want really

energises me'). Participants responded to items on a five-point scale (1 = Strongly disagree, 3

= neither, 5 = strongly agree). The construct validity and internal consistency have been

reported in numerous studies (e.g., Elliot & Thrash, 2010; Gocłowska, Aldhobaiban, Elliot,

Murayama, Kobeisy, Abdelaziz, 2017). A higher order factor structure was used in the

present study in order to model a single score for approach-avoidance temperament.

Approach and avoidance were represented as first order factors and approach-avoidance

temperament as the second order factor. The scores of avoidance items were reversed, such

that a higher score on the second order factor for approach-avoidance temperament

corresponds to a greater approach temperament and a lower score to a greater avoidance

temperament. The internal consistency of the combined scale was good (Cronbach's α = .78).

Procedure

Data were collected at three different sites, one for each of the three participating 6th

Form Colleges. At each 6th Form College, participants were tested in groups ranging from 7

to 25 in a quiet classroom fitted with multiple PCs. Each participant was seated at their own

PC approximately one metre either side of the next participant to avoid visual distraction. All

instructions, tasks, and measures, were hosted on a website. A brief introduction to the study

was provided by the researcher and, if consent was provided, participants were randomly

allocated a URL that linked to either the test-threat or test-neutral condition. First,

participants completed the six-item state anxiety measure before being prompted to write

about their last examination (test-threat condition) or journey to college (test-neutral

condition) and completing the six-item state anxiety measure again. There was a lower limit

of 200 characters including spaces (no upper limit) for the writing task and participants were

prompted to continue writing if they attempted to move to the next webpage before

completing 200 characters.

Participants were then prompted to undertake the dot-probe task and finally to

complete the measures for test anxiety and approach-avoidance temperament and

demographic information. Instructions for the test-threat and test-neutral writing tasks, and

the dot-probe task are replicated in the appendix. The test-related worry measure was

completed after the writing and dot-probe tasks to avoid priming highly test-anxious

participants and potentially confounding the writing tasks. Ethical permission was provided

from the institutional ethics committee at which the first, third and fourth authors were based

(Reference: 16/TPL/006). Gatekeeper consent was provided by the Principal of the

participating colleges and individual consent provided by participants by clicking on an

'agree to participate' button on the instruction page of the project website.

Results

Manipulation Check

A manipulation check was conducted using a 2x2x2 mixed ANOVA with one within-

participants factor (before vs. after the writing task) and two between- participants factors

(threat vs. neutral condition; high vs. low worry) and state anxiety as the dependent variable.

There was a main effect for worry, $F(1,182) = 7.29$, $p = .008$, $\eta_p^2 = .04$, whereby state anxiety

was higher for participants who were high in worry ($M = 11.37$, $SE = .31$) compared with

those who were low in worry ($M = 10.19$, $SE = .32$). All other main effects and interactions

were not statistically significant ($ps > .05$). Descriptive statistics are presented in Table 1. A

possible reason for the failure of the test-threat condition to induce state anxiety is that whilst there were a number of references to feeling anxious before ($n = 92$) and during ($n = 49$) their last exam, the majority of participants ended their accounts with details of the positive emotions ($n = 70$) such as relief ($n = 30$) and happiness ($n = 13$). It is possible that this positively influenced their perceptions of state anxiety. Fewer students reported feeling anxious after they had finished their exam ($n = 33$).

[Table 1 about here]

Attention bias

During a data screening procedure, individual responses < 20ms and >2000 ms were removed, incorrect responses were removed, and 17 participants who had fewer than 80% valid trials ($n = 17$) were removed (i.e. any participant with more than 20% of trials incorrect or outside of the indicated time window was removed from all the analyses). An attention bias index was calculated by subtracting the reaction time to test-neutral stimuli from the reaction time to threat-threat stimuli; a positive score would indicate a bias away from threat (i.e., towards the prior location of the neutral word) and a negative score would indicate a bias towards threat (i.e., towards the prior location of the threat word). Descriptive statistics are reported in Table 1 (standardised factor loadings are reported from the measurement model described below).

[Table 2 here]

Data were analysed in a latent interaction structural equation model using the Latent Moderated Structural Equations (LMS) approach (Klein & Moosbrugger, 2000). First, a measurement model was built to assess the measurement properties of the latent constructs and to estimate latent bivariate correlations. The measurement model included six latent indicators for Worry and a higher order latent factor for Approach-avoidance temperament built from two lower order factors of avoidance and approach (six indicators each). Attention

bias index (for subliminal and supraliminal attention bias), gender (0 = male, 1 = female) and age were included as manifest variables. Indicators for Worry, Approach-avoidance temperament, and attention bias index scores were z-transformed prior to analysis. Model fit was assessed using the Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Comparative Fit Index (CFI), and the Tucker–Lewis index (TLI). A good fitting model is indicated by RMSEA and SRMR indices of <.08 and <.06, respectively, and CFI and TLI indices of >.95 (Marsh, Hau, & Grayson 2005). The measurement model, and all subsequent analyses were estimated using maximum likelihood using the M*plus* v.8 software (Muthén & Muthén, 2017).

[Table 3 about here]

By these criteria, the measurement model showed a good fit to the data: $\chi^2(175) = 182.71$ $p <.001$, RMSEA = .042, SRMR = .039, CFI = .964, and TLI = .955. Latent bivariate correlations are reported in Table 3. The latent interaction structural equation modelling followed the two-stage approach of Maslowsky, Jager, and Hemken (2015). First, a model of the latent constructs that did not contain the interaction term between worry and approach-avoidance, was built to assess model fit (Model 1). Second, a model including the interaction term (Model 2) was tested and the relative advantage over Model 1 assessed by means of the Akaike Information Criterion (AIC), sample-size adjusted Bayesian information criterion (aBIC), the log likelihood ratio test, and the change in the proportion of variance (ΔR^2), explained in attention bias.

[Tables 4 and 5 about here]

Model 1 regressed subliminal and supraliminal attention bias on Worry, Approach-avoidance temperament, gender and age, and showed a good fit to the data: $\chi^2(161) = 195.45$, $p =.002$, RMSEA = .042, SRMR = .039, CFI = .964, and TLI = .955. The fit of Model was not significantly different, $\chi^2(14) = 12.74$, $p >.05$, from that of the measurement model.

Model 2, including the latent interaction term, showed a reduction in AIC (Δ = 3.54) and

aBIC (Δ = 3.51), indicative of a better fitting model (Hix-Small, Duncan, Duncan, & Okut,

2004). Furthermore, the log-likelihood ratio test suggested a statistically significant

improvement for Model 2 over Model 1 (D = 18.97, p <.001) and a greater proportion of

variance was explained for subliminal attention bias (subliminal: ΔR^2= .052, supraliminal:

ΔR^2= .006). Standardised (βs) and unstandardised regression coefficients (Bs) are reported in

Tables 4 and 5.

For subliminal attention bias, a statistically significant interaction term was reported

between Worry and Approach-avoidance temperament (β = -.22, p = .03), which was probed

with simple slopes at ±1SD (please note that the M*plus* software only provides estimates for

unstandardised regression coefficients for simple slopes). A positive trend was shown

between Worry and subliminal attention bias at low (-1SD) Approach-avoidance (B = .47, p

= .26), which became negative at mean Approach-avoidance (B = -.20, p = .39). At high

(+1SD) Approach-avoidance the negative trend became stronger and statistically significant

(B = -.87, p = .03). Simple slopes are graphed in Figure 1. At high (+1SD) Worry, those with

a greater approach tendency (i.e., +1SD Approach-avoidance) showed subliminal attention

bias *towards* threat whereas those with a greater avoidance tendency (i.e. -1SD Approach-

avoidance) showed subliminal attention bias *away* from threat. For supraliminal stimuli,

Worry was associated with greater attention bias towards threat (β = -.19, p = .01) but did not

interact with Approach-avoidance.

[Figure 1 here]

Discussion

The aim of the study was threefold. First, to examine whether attention bias to test-

threat stimuli in highly test anxious persons was only shown in a congruent test-threat

condition. Second, to examine whether attention bias to threat in high test anxious persons

occurred during automatic or strategic stages of information processing. Third, to examine whether Approach-avoidance temperament moderated relations between test anxiety and attention bias. Results showed that the mood induction procedure was not effective in manipulating state anxiety. Approach-avoidance temperament moderated relations between Worry and subliminal, but not supraliminal attention bias. Unexpectedly, high test anxious persons with a greater approach temperament showed a stronger subliminal attention bias towards threat. In contrast, high test anxious persons with a greater avoidance temperament showed a stronger subliminal attention bias away from threat. High test anxious persons showed a supraliminal attention bias towards threat irrespective of their approach-avoidance temperament.

The first aim of our study was to resolve a point of inconsistency arising from the nascent body of studies conducted thus far into test anxiety; namely whether attention bias is only present in a congruent test-threat condition. The results of our study cannot speak conclusively to this aim as the mood induction procedure was not effective in increasing state anxiety for high test anxious persons. As a result the study was deprived of a congruent test-threat condition. Essentially, irrespective of which condition participants were allocated to, they were both low threat in respect of tests or examinations. This, perhaps, is not such a surprising finding. Studies have shown that writing about one's worries before a test can reduce anxiety (e.g., Donnelly & Murray, 1991; Graf, Gaudiano, & Geller, 2008) and boost the performance of highly math and test anxious students (e.g., Park, Ramirez,& Beilock, 2014; Ramirez & Beilock, 2011). Although our writing tasks did not occur directly before a test (notwithstanding the possibility that some participants might have viewed the dot-probe activity in test-like terms) it is possible that writing about a pressured examination in the past had a similar effect to prevent the development of state anxiety.

Nonetheless, we felt it was important to report these findings. This was partly inspired by the file drawer controversy (e.g., Franco, Malhotra, Simonovits, 2014) and we felt somewhat obliged to report this statistically non-significant finding where perhaps previously we would have been less inclined to do so. This was also partly for the benefit of research colleagues who may also be searching for effective ways of artificially creating test-threat congruent situations for laboratory research. In respect of the latter point, we would advise that the mood induction procedure employed for this study was not effective for creating the evaluative threat required for a test anxious congruent threat condition in samples of students from upper secondary education (aged 16-19 years). As we highlighted above, it is possible that writing about an examination from the past may help to reduce worries. It is notable in this respect that participants tended to finish their recollections with mainly positive deactivating emotions such as relief (see Pekrun, 2018; Weiner, 2010) rather than anxiety. A somewhat tentative conclusion would be that attention bias towards supraliminal threat can be shown without a corresponding test-threat condition. In this respect our findings are in line with some previous studies examining attention bias in test anxiety (e.g., Zhang et al., 2018; Vasey et al., 1996) and general trait anxiety (e.g., Abend et al., 2017; Mogg & Bradley, 1999; Mogg, Bradley, De Bono, & Painter, 1997).

The second aim of the study was to establish whether the mechanism underpinning attention bias in test anxiety was automatic or strategic. An attention bias shown to the subliminal presentation would imply a fast, early, automatic process (e.g., vigilance) whereas an attention bias shown to the supraliminal presentation would imply late, strategic processes (e.g., difficulty disengaging from threat) were involved (although this does not completely rule out the presence of automatic processes). The results of our study showed an attention bias to threat in high test anxious persons was present for the supraliminal presentation of test-threat stimuli but not for the subliminal presentation of test-threat stimuli. This offers

partial support for *H2* and is in line with previous studies showing that persons high in

(general) trait anxiety show attention bias to supraliminal (e.g., 500ms presentation times)

threat stimuli (e.g., Cooper & Langton, 2006; Dalgleish et al., 2003; Williams, Watts,

MacLeod, & Mathews, 1988).

The third aim of the study was to establish whether attention bias towards threat

stimuli in high test anxious persons was moderated by approach-avoidance temperament;

weaker for those with an approach tendency and greater for those with an avoidance

tendency. Results did not support *H3*. Rather than showing a stronger attention bias *towards*

threat, persons high in cognitive test anxiety with an avoidance temperament showed a

stronger attention bias *away* from subliminal threat stimuli. This was an unexpected finding

as persons high in avoidance temperament should show an orientation to, and a greater

processing of, negative information. A possible explanation may lie in the tendency for

persons to down-regulate negative emotion by moving attention away from threat stimuli

when anxiety becomes overwhelming.

For instance, studies have shown that clinically anxious and high trait anxious persons

show an attention bias away from threat when using longer stimulus presentations of 1250ms

(e.g., Koster, Verschuere, Crombez, & Van Damme, 2005; Pflugshaupt, Mosimann,

vonWartburg, Schmitt, Nyffeler, & Muri, 2005). It is possible that a similar mechanism is at

work in the present study; highly test anxious persons with a strong avoidance temperament

move attention away from subliminal threat to evade an excess of anxiety. Those highly test

anxious persons with a lower avoidance, or stronger approach, temperament do not

experience an excess of anxiety and do not need to move attention away from thereat stimuli

to down regulate negative emotions.

Our research findings are noteworthy in a number of ways. Firstly, they add to the

growing body of evidence that suggests that threat-relevant manipulation may not always be

required for attention bias to be found (e.g. Abend et al., 2017; Vasey et al., 1996), especially when threat is presented supraliminal. This has important implications for researchers in the field, as this means attention bias can be measured in students with test anxiety, without necessarily needing complicated or time-consuming mood induction procedures. Secondly, the fact that students with test anxiety appeared to display attention bias even when they were not state anxious, indicates that attention bias is likely to be a stable characteristic of test anxiety, as with other anxieties (Bar-Haim et al. 2007). Thirdly, the novel incorporation of approach-avoidance temperament, with its moderating effect on the relationship between worry and attention bias, suggests that this is a characteristic that other researchers may wish to include when examining attention bias in other anxious populations. Indeed, it is recognised that attention bias in anxious individuals can be characterised as a bias away from threat, as well as a bias towards threat (Cisler & Koster, 2010), and approach-avoidance temperament measure may help illuminate the mechanisms operating behind these different types of attention bias.

Limitations and Directions for Future Research

The main limitation of our study was, as noted above, that the mood induction procedure was not effective. We believe that this was possibly a result of writing about a previous examination and recalling deactivating emotions such as relief. Future studies should set out to test *H1* as it is still not clear whether an attention bias to threat is larger under a test-threat congruent condition and whether automatic processes (e.g., vigilance for threat) theorised by Zeinder and Mathews (2005) in addition to, or instead of, the conscious processes are elicited under test-threat conditions. One option, if using the same mood induction procedure, would be to ask participants to recall how they felt before taking their last exam (i.e., so not to recall deactivating emotions) or write about an upcoming examination. However, since not all participants may actually have experienced an

examination, such an approach may not be effective. An alternative, highlighted above, would be to adopt the ego-threat instruction used by Putwain et al. (2011) for use with adolescent participants. This approach, however, uses IQ-type cognitive ability tests and so may not be practical for group testing. Whichever approach is used, we recommend that future studies incorporate post-experimental focus groups with participants to elicit feedback about their utility of the mood induction procedure as well as other aspects of the study.

The second limitation to highlight is whether the dot-probe task itself is the best method by which to measure attention bias in test anxiety. As we note earlier, performance on the dot-probe task may be compromised by the cognitive-interfering nature of test anxiety. Building on Dong et al. (2017) who used an eye-tracking approach to measure attention bias, future studies should consider alternate ways to measure attention bias. Possibilities that have been used with trait anxiety and clinical anxiety include the simplification of the dot-probe task by removing two separate competing stimuli for attention in the attention cueing paradigm design (Fox, Russo, Bowles & Duton, 2001). Here a participant is required to respond to a probe presented to one side of a computer screen (as in the dot-probe task), however in this task, the probe is preceded by only a single stimulus cue designed to elicit positive, neutral or negative emotions. This allows for a single cue to attention without interference from a secondary cue. Fox et al. (2001) established greater attention disengagement difficulties with students with self-reported high state anxiety using this task.

A further paradigm which has been suggested is the use of visual search (Hansen & Hansen 1988). Unlike the dot probe and spatial cueing tasks, where the stimulus of interest for the research is secondary to the participants' task of responding to a probe, the visual search task requires participants to actively attend and respond to the content of the words. Participants are given a target word (i.e. test) and then see a display of words which may or may not contain this target. The participants' task is to indicate if the target is present.

Attention bias is measured by the speed to find the target; participants who have high anxiety will find threat words faster (Treisman et al, 1980). We recommend that different methods of measuring attention bias should be used comparatively within a single study to establish their relative merits.

Educational Implications

The tendency of highly test anxious persons to direct greater allocation to threat stimuli may leave fewer cognitive resources available for goal directed behaviours such as preparing and taking an examination (see Derakshan & Eysenck, 2011; Eysenck et al., 2007). As a result working memory functions, including updating, shifting, and inhibition may all be compromised, causing interference with learning and examination performance (e.g., Owens et al., 2008). Interventions are required not only to reduce the distressing experience of test anxiety itself, but also the negative educational consequences of test anxiety. Interventions designed to reduce test anxiety typically employ combinations of behavioural (e.g., muscle relaxation) and cognitive (e.g., cognitive restructuring) approaches with study-skills training. Meta-analyses have shown these approaches are effective in reducing test anxiety (Ergene, 2003; von der Embse et al., 2018). Fewer studies have investigated the dual effects of intervention on both test anxiety and educational achievement (Keogh, Bond, & Flaxman, 2006;Vagg & Spielberger, 1995) and equivocal findings reported thus far; test anxiety can be reduced with no concurrent change in achievement and vice versa.

Findings from the attention bias literature suggest that one way to reduce test anxiety would be to train students to attend to neutral or positive stimuli rather than threat stimuli. These training approaches, typically referred to as cognitive bias modification (CBM), modify dot-probe presentations such that threat stimuli are paired with neutral or positive stimuli and the probe always replaces the neutral or positive stimuli. CBM has been shown to be effective in reducing clinical anxiety (Amir, Beard, Burns & Bomyea, 2009; Hayes et al.,

2010) and responses to natural stressors in high trait anxious persons (See et al., 2009). CBM has also been successfully used in an educational context to reduce interfering thoughts and examination stress (Dandeneau & Baldwin, 2009; Dandeneau, Baldwin & Pruessner, 2007). We are only aware of one study to date to examine a CBM intervention for test anxiety, showing CBM to be equally effective as a cognitive behavioural therapy over a two-year period (de Hullu, Sportel, Nauta, de Jong, 2017). These highly promising findings suggest considerable potential for CBM as an effective intervention for test anxiety. Furthermore, by strengthening attention control, CBM may be more likely to negate the interfering effects on learning and examination performance, resulting from comprised working memory function, than other approaches to intervention.

Conclusion

Limited by the ineffective mood induction procedure our study was not able to examine attention bias in a test-threat congruent situation. However, it does partly answer the question of whether a test-threat congruent situation is required. It would seem that it does not, for supraliminal stimuli (that imply conscious processes), since attention bias towards threat was shown by high test anxious persons in the absence of an effective threat manipulation. For subliminal stimuli (that imply automatic processes) an attention bias towards threat in the absence of an effective threat manipulation was only shown, somewhat paradoxically, for those participants with a strong approach tendency. It would be useful for future research to establish if this attention bias is larger under a test-threat condition. One of the challenges is to establish an effective method for artificially manipulating the level of test-threat to mimic that of a real-life examination.

References

Abend, R., de Voogd, L., Salemink, E., Wiers, R.W., Pérez-Edga, K.,...Bar-Haim, Y. (2018)
Association between attention bias to threat and anxiety symptoms in children and
adolescents. *Depression and Anxiety, 35*(3), 229–238.doi: 0.1002/da.22706

Allen R.J., Schaefer A., Falcon T. (2014). Recollecting positive and negative
autobiographical memories disrupts working memory. *Acta Psychologica 151*, 237-
243.doi: 10.1016/j.actpsy.2014.07.003

Amir, N., Beard, C., Burns, M., & Bomyea, J. (2009) Attention modification programme in
individuals with generalized anxiety disorder. *Journal of Abnormal Psychology, 118*,
28-33. doi: 10.1037/a0012589

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M.
H. (2007). Threat-related attention bias in anxious and non-anxious individuals: A
meta-analytic study. *Psychological Bulletin, 133*(1), 1-24. doi: 10.1037/0033-
2909.133.1.1

Bayrampour, H., McDonald, S., Fung, T., & Tough, S. (2014). Reliability and validity of
three shortened versions of the State Anxiety Inventory scale during the perinatal
period. *Journal of Psychosomatic Obstetrics and Gynecology, 35*(3), 101-107.doi:
0.3109/0167482X.2014.950218

Bradley, B. P., Mogg, K., Falla, S. J., & Hamilton, L. R. (1998). Attention bias for
threatening facial expressions in anxiety: Manipulation of stimulus duration. *Cognition
and Emotion,12*(6). 737-753.doi: 10.1080/026999398379411

Briki, W. (2018). Trait self-control: Why people with a higher approach (avoidance)
temperament can experience higher (lower) subjective wellbeing. *Personality and
Individual Differences, 120*, 112-117.doi: 10.1016/j.paid.2017.08.039

Burns, R. B. (2008). Cluster analysis. In R. A. Burns, & R. B. Burns (Eds.), *Business
Research Methods and Statistics Using SPSS* (pp. 552–567). Los Angeles: Sage.

Chappell, M. S., Blanding, Z. B., Silverstein, M. E., Takahashi, M., Newman, B., Gubi, A., & McCann, N. (2005). Test anxiety and academic performance in undergraduate and graduate students. *Journal of Educational Psychology*, *97*(2), 268-274.doi: 10.1037/0022-0663.97.2.268

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

Cooper, R.M., & Langton, S.R. (2006). Attention bias to angry faces using the dot probe task? It depends when you look for it. *Behavior Research and Therapy, 44(9),* 1321–1329

Dalgleish, T., Taghavi, R., Neshat-Doost, H., Moradi, A., Canterbury, R., & Yule, W. (2003). Patterns of processing bias for emotional information across clinical disorders: A comparison of attention, memory, and prospective cognition in children and adolescents with depression, generalized anxiety, and posttraumatic stress disorder. *Journal of Clinical Child Psychology, 32*(1). 10-21.doi: 10.1207/S15374424JCCP3201_02

Dandeneau, S.D., & Baldwin, M.W., & Pruessner, J.C. (2007). Cutting off stress and the pass: Reducing vigilance and responsiveness to social threat by manipulating attention. *Journal of Personality and Social Psychology, 93*, 651-666. doi: 1 0.1037/0022-3514.93.4.651

Dandeneau, S.D., & Baldwin, M.W. (2009) The buffering effects of rejection-inhibition attentional on training on social and performance threat among adult students. *Contemporary Educational Psychology, 34*, 42-50. doi: 10.1016/j.cedpsych.2008.05.004

Derakshan, N., & Eysenck, M.W. (2001). Effects of focus of attention on physiological, behavioural, and reported state anxiety in repressors, low-anxious, high-anxious, and defensive high-anxious individuals. *Anxiety, Stress, and Coping, 14*, 285-299.doi: 10.1080/10615800108248358

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

Donnelly, D. A., & Murray, E. J. (1991). Cognitive and emotional changes in written essays and therapy interviews. *Journal of Social and Clinical Psychology, 10*, 334–350. doi:10.1521/jscp.1991.10.3.334

de Hullu, E., Sportel, B.E., Nauta, M.H., de Jong, P. J. (2017). Cognitive bias modification and CBT as early interventions for adolescent social and test anxiety: Two-year follow-up of a randomized controlled trial. *Journal of Behavior Therapy and Experimental Psychiatry, 55*, 81-89.doi: 10.1016/j.jbtep.2016.11.011

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 50*(7), 336-353.doi: 10.1037/1528-3542.7.2.336

Dong, Y., De Beuckelaer, A., Yu, L., & Zhou. R. (2017). Eye-movement evidence of the time-course of attention bias for threatening pictures in test-anxious students. *Cognition and Emotion, 31*(4), 781-790.doi: 10.1080/02699931.2016.1152953

Elliot, A. J., &. McGregor, H.A.(2001). A 2 × 2 achievement goal framework. *Journal of Personality and Social Psychology*, *80*(3), 501–519. doi:10.1037//0022-3514.80.3.501

Elliot, A. J., & Sheldon, K. M. (1997). Avoidance achievement motivation: A personal goals analysis. *Journal of Personality and Social Psychology, 73*(1), 171–185.doi: 10.1037/0022-3514.73.1.171

Elliot, A.J., & Thrash, T.M. (2010). Approach and avoidance as basic dimensions of
personality. *Journal of Personality, 78*(3), 865-906.doi: 10.1111/j.1467-
6494.2010.00636.x

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

Ergene, T. (2003). Effective interventions for test anxiety reduction. *School Psychology*
International, 24, 313–328. doi: 10.1177/01430343030243004

Franco, A., Malhotra, N., Simonovits, G. (2014). Publication bias in the social sciences:
Unlocking the file drawer. *Science, 345*, 1502-1505.doi: 10.1126/science.1255484

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001) Bias in interpretation of ambiguous
sentences related to threat in anxiety. *Journal of Experimental Psychology: General,*
130, 681-700. doi: 10.1037/0096-3445.130.4.681

Gocłowska, M. A., Aldhobaiban, N., Elliot, A., J., Murayama, K., Kobeisy, A., & Abdelaziz,
A. (2017). Temperament and self-based correlates of cooperative, competitive and
individualistic learning preferences. *International Journal of Psychology, 52*(3), 180-
188.doi.org/10.1002/ijop.12206

Graf, M. C., Gaudiano, B. A., & Geller, P. A. (2008). Written emotional disclosure: A
controlled study of benefits of expressive writing home-work in outpatient
psychotherapy. *Psychotherapy Research, 18*, 389–399.
doi:10.1080/10503300701691664

Hagtvet, K. A., & Benson, J. (1997). The motive to avoid failure and test anxiety responses:
Empirical support for integration of two research traditions. *Anxiety, Stress and Coping*
10(1), 35–37. doi: 10.1080/10615809708249294

Hansen, C. H., & Hansen, R. D. (1988). Finding the face in the crowd: an anger superiority

  effect. *Journal of Personality and Social psychology*, *54*(6), 917-924.doi:

  10.1037/0022-3514.54.6.917

Hayes, S., Hirsch, C.R., & Mathews, A. (2010) Facilitating a benign attention bias reduces

  negative thought intrusions. *Journal of Abnormal Psychology, 119*(1), 235-240.doi:

  10.1037/a0018264

Hix-Small, H., Duncan, T. E., Duncan, S. C., & Okut, H. (2004). A multivariate associative

  finite growth mixture modeling approach examining adolescent alcohol and marijuana

  use. *Journal of Psychopathology and Behavioral Assessment*, *26*, 255-270.doi:

  10.1023/B:JOBA.0000045341.56296.fa

Jastrowski, K.E., Mano, R.C., Gibler, Q.R., Beckmann, M.E. (2018). Attentional bias toward

  school-related academic and social threat among test-anxious undergraduate students.

  Learning and Individual Differences, 64, 138-146.doi: 10.1016/j.lindif.2018.05.003

Keogh, E., & French, C. C. (2001). Test anxiety, evaluative stress and susceptibility to

  distraction from threat. *European Journal of Personality, 15*(2), 123−141.doi:

  10.1002/per.400.

Keogh, E., Bond, F. W., & Flaxman, P. E. (2006). Improving academic performance and

  mental health through a stress management intervention: Outcomes and mediators of

  change. *Behaviour Research and Therapy, 44*, 339–357. doi:10.1016/j.brat.2005.03.002

Klein, A., & Moosbrugger, H. (2000). Maximum likelihood estimation of latent interaction

  effects with the LMS method. *Psychometrika, 65*, 457-474. doi:10.1007/BF02296338

Koster, E. H. W., 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*, 1087−1098. doi: 10.1016/j.brat.2004.08.004

Marteau, T.M., & Bekker, H. (1992). The development of a six-item short-form of the state

    scale of the Spielberger State—Trait Anxiety Inventory (STAI). *British Journal of*

    Clinical Psychology, 31(3), 301-306.doi: 10.1111/j.2044-8260.1992.tb00997.x

MacLeod, C., & Mathews, A. (1988). Anxiety and the allocation of attention to threat. *The*

    Quarterly Journal of Experimental Psychology Section A,40(4), 653-670. doi:

    10.1080/14640748808402292

MacLeod, C., Mathews, A., & Tata, P. (1986). Attention bias in emotional disorders. *Journal*

    of Abnormal Psychology, *95*(1), 15-20.doi: 10.1037/0021-843X.95.1.15

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002) Selective

    attention and emotional vulnerability: Assessing the causal basis of their association

    through the experimental manipulation of attention bias. *Journal of Abnormal*

    Psychology, 111(1), 107-123. doi: 10.1037//0021-843X.111.1.107

Marsh, H. W., Hau, K-T., & Grayson, D. (2005). Goodness of fit evaluation in structural

    equation modeling. In A. Maydeu-Olivares & J. McArdle (Eds.) *Contemporary*

    psychometrics. A festschrift for Roderick P. McDonald (pp. 275–340). Mahwah, NJ:

    Erlbaum.

Maslowsky, J., Jager, J., & Hemken, D. (2015). Estimating and interpreting latent variable

    interactions: A tutorial for applying the latent moderated structural equations method.

    International journal of Behavioral Development, *39*, 87-96.doi:

    10.1177/0165025414552301

Mathews, A., & MacLeod, C. (2002) Induced processing biases have causal effects on

    anxiety. *Cognition and Emotion, 16*, 331-354. doi: 10.1080/02699930143000518

Mogg, K., & Bradley, B. P. (1999). Some methodological issues in assessing attention biases

    for threatening faces in anxiety: A replication study using a modified version of the

probe detection task. *Behaviour Research and Therapy*, *37*(6), 595-604.doi:
10.1016/S0005-7967(98)00158-2

Mogg, K., Bradley, B. P., & Williams, R. (1995). Attention bias in anxiety and depression:
The role of awareness. *British Journal of Clinical Psychology*, *34*(1), 17-36. Doi:
10.1111/j.2044-8260.1995.tb01434.x

Mogg, K., Bradley, B. P., De Bono, J., & Painter, M. (1997). Time course of attention bias
for threat information in non-clinical anxiety. *Behaviour Research and Therapy*, *35*(4),
297-303.doi: 10.1016/S0005-7967(96)00109-X

Muthén, L. K., & Muthén, B. O. (2017). M*plus user's guide* (8th ed.). Los Angeles, CA:
Muthén & Muthén.

OECD (2013). *Teachers for the 21st Century: Using Evaluation to Improve Teaching*. Paris:
OECD Publishing.

Owens, M., Stevenson, J., & Hadwin, J. A. (2012). Anxiety and depression in academic
performance: An exploration of the mediating factors of worry and working memory.
School Psychology International, 33(4), 433-449. doi: 10.1177/0143034311427433

Owens, M., Stevenson, J., Norgate, R., & Hadwin, J. A. (2008). Processing efficiency theory
in children: Working memory as a mediator between trait anxiety and academic
performance. *Anxiety, Stress, & Coping*, *21*(4), 417-430.doi:
10.1080/10615800701847823

Park, D., Ramirez, G., & Beilock, S. L. (2014). The role of expressive writing in math
anxiety. *Journal of Experimental Psychology: Applied, 20*, 103–111.doi:
10.1037/xap0000013

Pekrun, R. (2018). Achievement emotions. In A.J. Elliot, C.S. Dweck, & D.S. Yeager (Eds.)
Handbook of Competence and Motivation: Theory and Application (Second Edition)
(pp. 251-272). New York: Guildford Press.

Perryman, J., Ball, S., Maguire, M., & Braun, A. (2011). Life in the pressure cooker–School

league tables and English and mathematics teachers' responses to accountability in a

results-driven era. *British Journal of Educational Studies*, *59*(2), 179-195.doi:

10.1080/00071005.2011.578568

Pflugshaupt, T., Mosimann, U. P., vonWartburg, R., Schmitt, W., Nyffeler, T., & Muri, R. M.

(2005). Hypervigilance-avoidance pattern in spider phobia. *Journal of Anxiety*

Disorders, 19, 105−116. doi: 10.1016/j.janxdis.2003.12.002

Putwain, D.W., & Aveyard, B. (2018). Is perceived control a critical factor in understanding

the negative relationship between cognitive test anxiety and examination performance?

School Psychology Quarterly 33(1), 65-74. doi: 10.1037/spq0000183

Putwain, D.W., Shah, J. & Lewis, R. (2014). Performance-evaluation threat does not always

adversely affect verbal working memory in high test anxious persons. *Journal of*

Cognitive Education and Psychology, 13(1), 120-136.doi: 10.1891/1945-8959.13.1.120

Putwain, D.W., & Symes, W. (2011) Teachers' use of fear appeals in the Mathematics

classroom: worrying or motivating students? *British Journal of Educational Psychology*

81(3)*, 456-474.doi: 10.1348/2044-8279.002005

Putwain, D.W., & Symes, W. (2012) Are low competence beliefs always associated with

high test anxiety? The mediating role of achievement goals. *British Journal of*

Educational Psychology,82(2), 207-224. doi: 10.1111/j.2044-8279.2011.02021.x

Ramirez, G., & Beilock, S. L. (2011). Writing about testing worries boosts exam performance

in the classroom. *Science, 331*, 211–213.doi: 10.1126/science.1199427

Rinck, M., Becker, E. S., Kellermann, J., & Roth, W. T. (2003). Selective attention in

anxiety: Distraction and enhancement in visual search. *Depression and Anxiety, 18*(1),

18-28.doi:10.1002/da.10105

Roberts, N. & Abreu, L. (2016). *School inspections in England: Ofsted (Briefing Paper*

07091). London: House of Commons Library. Retrieved from:

http://researchbriefings.files.parliament.uk/documents/SN07091/SN07091.pdf

Rodway, C., Tham, S. G., Ibrahim, S., Turnbull, P., Windfuhr, K., Shaw, J., ... Appleby, L.

(2016). Suicide in children and young people in England: A consecutive case series.

The Lancet Psychiatry, 3, 699-700.doi: 10.1016/S2215-0366(16)30094-3

Rubinsten, O., Eidlin, H., Wohl, H., & Akibli, O. (2015). Attentional bias in math anxiety.

Frontiers in Psychology, 6, 1539–1539. http://doi.org/10.3389/fpsyg.2015.01539

Schutz, P. A., Davis, H. A., & Schwanenflugel, P. J. (2002). Organisation of concepts

relevant to examinations and their regulation during test taking. *Journal of*

Experimental Education, 70(4), 316−342. doi:10.1080/00220970209599511.

Scrimin, S., Moscardino, U., Altoè, G., & Mason, L. (2017). Attention bias for academic

stressors and classroom climate predict adolescents' grades and socioemotional

functioning. *Journal of Research on Adolescence, 28*(1), 245-258.doi:

10.1111/jora.12329

See, J., MacLeod, C., & Bridle, R. (2009). The reduction of anxiety vulnerability through the

modification of attention bias: A real-world study with a home-based cognitive

modification procedure. *Journal of Abnormal Psychology, 118*(1), 65-75. doi:

10.1037/a0014377

Schaefer, A., & Philippot, P. (2005). Selective effects of emotion on the phenomenal

characteristics of autobiographical memories. *Memory, 13*(2), 148-160.doi:

10.1080/09658210344000648

See, J., MacLeod, C., & Bridle, R. (2009) The reduction of anxiety vulnerability through the

modification of attentional bias: a real-world study with a home-based cognitive

modification procedure. *Journal of Abnormal Psychology, 118*, 65-75. doi:

10.1037/a0014377

Shackleton, R.J. (2014). The history of qualifications and the role of competition. In H.G.

Sahlgren (Ed.), *Tests worth teaching to: Incentivising quality in qualifications and*

accountability (pp. 6-27). London: The Centre for Market Reform of Education

Spielberg, J.M., Heller, W., Silton, R.L., Stewart, J.L., & Miller, G.A. (2011). Approach and

avoidance profiles distinguish dimensions of anxiety and depression. *Cognitive*

Therapy and Research, 35(4), 359–371.doi: 10.1007/s10608-011-9364-0

Szafranski, D.D., Barrera, T.L., & Norton, P.J. (2012). Test anxiety inventory: 30 years later.

Anxiety, Stress and Coping, 25(6), 667-677.doi: 10.1080/10615806.2012.663490

Tluczek, A., Henriques, J.B., & Brown, R.L. (2009). Support for the reliability and validity of

a six-item state anxiety scale derived from the state-trait anxiety inventory. *Journal of*

Nursing Measurement, 17(1), 19–28.doi: 10.1891/1061-3749.17.1.19

Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive*

Psychology, *12*(1), 97-136.doi: 10.1016/0010-0285(80)90005-5

Vagg, P. R., & Spielberger, C. D. (1995). Treatment of test anxiety: Application of the

transactional process model. In C. D. Spielberger & P. R. Vagg (Eds.), Test anxiety:

Theory, assessment, and treatment (pp. 195–215). Washington, DC: Taylor & Francis.

Vasey, M.W., el-Hag, N. & Daleiden, E.L. (1996). Anxiety and the processing of emotionally

threatening stimuli: Distinctive patterns of selective attention among high-and low-test-

anxious children. *Child Development, 67*(3), 1173-1185.doi: 10.1111/j.1467-

8624.1996.tb01789.x

von der Embse, N.P., Jester, D., Roy, D., & Post, J. (2018). Test anxiety effects, predictors,

and correlates: A 30-year meta-analytic review. *Journal of Affective Disorders, 227*,

483-493.doi: 10.1016/j.jad.2017.11.048

Weiner, B. (2010). The development of an attribution-based theory of motivation: A history

of ideas. *Educational Psychologist*, *45*(1), 28-36.doi: 10.1080/00461520903433596

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1988). *Cognitive psychology*

and emotional disorders. Oxford, England: John Wiley & Sons.

Zhang, X., Dong, Y., & Zhou, R. (2018). Examination stress results in attention bias and

altered neural reactivity in test-anxious individuals. *Neural Plasticity, 3281040*, 1-7.

doi: 10.1155/2018/3281040

Zeidner, M. (2007). Test anxiety in educational contexts: Concepts, findings and future

directions. In P. A. Schutz & R. Pekrun (Eds.), *Emotion in Education* (pp. 165-184).

Burlington, MA: Elsevier.

Zeidner, M. (2014). Anxiety in education. In R. Pekrun and L. Linnenbrink-Garcia (Eds.).

International handbook of emotions in education (pp. 265-288). New York, NY:

Routledge.

Zeidner, M., & Matthews, G. (2005). Evaluation anxiety. In A. J. Elliot & C. S. Dweck

(Eds.), *Handbook of competence and motivation* (pp. 141–163). London: Guilford

Press.

Table 1

Pre- and Post-writing Task State Anxiety for Test-threat and Test-neutral Conditions in High and Low Exam Worry Participants.

	n	Pre-writing Task		Post-writing Task	
		M	*SD*	*M*	*SD*
Test-threat Condition	97	10.96	3.25	11.02	3.18
Low Exam Worry	44	10.61	2.82	10.39	2.62
High Exam worry	53	11.24	3.58	11.55	3.52
Test-neutral Condition	98	10.73	3.17	10.48	3.10
Low Exam Worry	47	9.96	2.86	9.80	3.09
High Exam worry	42	11.52	3.29	11.18	2.98

Table 2

Descriptive Statistics for Worry, Approach-avoidance, Gender, Age, and Attention Bias.

	Range	Mean	SD	Skewness	Kurtosis	Factor Loadings
Worry	6-24	14.90	3.78	.03	-0.51	.49 - .69
Approach-avoidance	20-60	37.43	6.99	-.06	0.11	.52 - .80
Subliminal Attention Bias	20 – 2000ms	-0.01	0.03	-.09	1.59	—
Supraliminal Attention Bias	20 – 2000ms	-0.01	0.04	-.16	1.61	—

Table 3

Latent Bivariate Correlations for Worry, Approach-avoidance, Gender, Age, and Attention Bias.

	1.	2.	3.	4.	5.	6.
1. Worry	—	-.49**	.12	-.05	-.12	-.13
2. Approach-avoidance		—	-.20*	.05	.11	-.06
3. Gender			—	.06	-.08	-.03
4. Age				—	-.01	.07
5. Subliminal Attention Bias					—	-.01
6. Supraliminal Attention Bias						—

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

Table 4

Standardised (β) and Unstandardsied (B) Regression Coefficients from Model 1 (no Interaction Term) and Model 2 (with Interaction Term) for Subliminal Stimuli.

	Model 1				Model 2			
	B	*SE*	β	*SE*	*B*	*SE*	β	*SE*
Gender	-.13	.17	-.06	.07	-.15	.17	-.07	.07
Age	-.01	.13	-.01	.07	-.06	.13	-.02	.07
Worry	-.16	.23	-.08	.11	-.20	.24	-.08	.12
Approach-avoidance	.10	.20	.07	.12	.06	.22	.07	.13
Worry × Approach-avoidance	—	—	—	—	-.67*	.33	-.22*	.09

Table 5

Standardised (β) and Unstandardsied (B) Regression Coefficients from Model 1 (no Interaction Term) and Model 2 (with Interaction Term) for Supraliminal Stimuli.

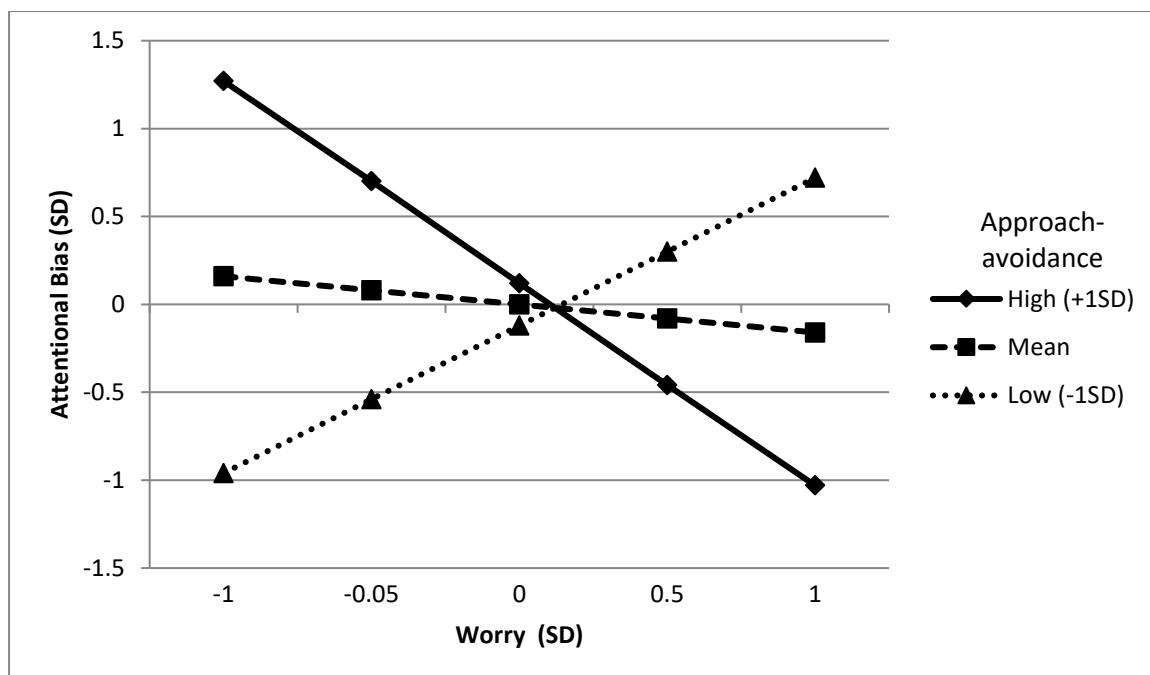|	Model 1				Model 2			
	B	*SE*	β	SE	*B*	*SE*	β	*SE*
Gender	-.10	.17	-.04	.07	-.10	.17	-.04	.07
Age	.12	.13	.07	.07	.10	.13	.06	.07
Worry	-.46*	.21	-.23*	.11	-.47*	.22	-.19*	.09
Approach-avoidance	-.32	.27	-.20	.14	-.37	.20	-.14	.08
Worry × Approach-avoidance	—	—	—		-.22	.34	-.06	.09

* $p < .05$.

Figure 1. The model implied interaction between worry and approach-avoidance on subliminal attention bias probed at (±1 SD).

Appendix

Instructions for the Test-threat Condition

Please write about the last exam that you took. You should include information about the exam itself, such as what subject it was for, how long it lasted, the types of questions asked (e.g. multiple choice or essay questions) and how important you felt that exam was for you personally. You should also write about how you felt before, during and after the exam. For example, what emotions did you experience, and why"

Instructions for the Test-neutral Condition

Please write about your typical journey to college. You should include basic information about your journey such as which form of transport you take (e.g. car, bus, walk etc.), how long it takes, how much it costs (if anything) and who you travel with. You should also write about the route you take, for example any interesting buildings that you pass on your way, or why you go the way that you do."

Instructions for the Dot-probe Task

You will now take part in an attention task. You will see three crosses on the screen (+++), followed by two words, one on top of the other. The words will disappear and an arrow will replace one of them. The arrow will point left (<) or right (>). If the arrow points left press the A key. If the arrow points right press the L key. We are recording how quickly and accurately you press the correct key. Please pay attention and try to be as accurate as you can. You will now do 3 practice trials.

Threat Word Stimuli used in the Dot-probe Task

Examination, evaluated, incompetent, underachieve, incapable, overloaded, disappoint, rejection, unable, disastrous, failure, pressure, assessed, mistake, grading, disgrace, loser, fail, stress, test, wrong, shame, score, and timed.

Neutral Word Stimuli used in the Dot-probe Task

Electricity, personality, supermarket, helicopter, television, animation, elephant, agreement, broadcaster, radio, picture, cupboard, carpet, forest, toaster, rabbit, music, tree, grass, cup, oil, cloud, hair, and washed.