Investigating Attentional Bias in Health Anxiety using a Dot-Probe Task following a 10-Day Mindfulness Intervention in Undergraduates.

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ABSTRACT

The current study investigated the effects of a 10-day mobile-based mindfulness meditation intervention on attentional bias (AB) in health anxiety in undergraduates, compared to a control group. 31 participants completed the Short Health Anxiety Inventory (SHAI) and the Mindfulness Attention Awareness Scale (MAAS) and a visual word dot-probe task. The dot-probe task explored stages of attentional processing using two types of stimuli; health-threat and neutral. Participants with high health anxiety (HHA) completed a 10-day mindfulness intervention, whereas participants with low health anxiety (LHA) completed 10-day TED talk tasks. Results demonstrate a significant difference, in that the HHA group had quicker response times to health-threat stimuli compared to neutral stimuli on the dot-probe, prior to intervention. There was a significant reduction in SHAI scores and AB towards health-threat on the dot-probe from pre- to post-intervention in the HHA group. Interestingly, no significant increase in MAAS scores from pre- to post-intervention in the HHA group were found. It was concluded that a longer mindfulness intervention may be needed to significantly increase self-report mindfulness scores. Based on these findings, future research into AB in health anxiety and mindfulness intervention may benefit from further investigating potential benefits and limitations of brief mobile-based mindfulness applications (MBMA's)

KEY WORDS:	ATTENTIONAL BIAS	HEALTH ANXIETY	DOT-PROBE	MINDFULNESS INTERVENTION	MOBILE-BASED MINDFULNESS APPLICATION (MBMA)

Introduction

Health Anxiety

Health anxiety refers to a preoccupation with inaccurate health-related beliefs, stimulated through misinterpretations of signs and symptoms of benign, or minor bodily sensations (Long and Elpern, 2017). Although it is common to experience mild forms of health anxiety, severe cases known as hypochondriasis is a diagnostic category in the Statistical Manual of Mental Disorders 5th Edition (DSM-IV: APA, 2013) and the WHO's International Classification of Diseases 10th Edition (ICD-10: WHO, 1992). It occurs in approximately 5% of the general population (Creed and Barsky, 2004), thus, amongst the most prevalent of mental disorders listed in the DSM-IV. Due to its high prevalence and associated negative effects, it is important to establish underlying causes of health anxiety.

Similar to cognitive models of anxiety disorders (e.g. Salkovskis, 1985; Eysenck, 1992), current cognitive-behavioural models of hypochondria (Salkovskis and Warwick, 1986, 2001; Warwick and Salkovskis, 1990; Abramowitz, et. al., 2002) propose a debilitating self-sustained cycle of pathological health anxiety. It is suggested that individuals with health anxiety demonstrate ruminations, which as a cognitive style is conceptualised in the Response Styles Theory as a 'tendency to repetitively focus on symptoms of distress and possible causes' (Nolen-Hoeksema, 2008, p.4). Although this theory largely refers to symptoms of depression, research demonstrates health anxiety has a strong association with rumination (Marcus, Hugher and Arnau, 2008; Wolfradt, et. al., 2014).

Another theory used to explain health anxiety is Attentional Control Theory (Eysenck, et. al., 2007), which developed as an extension of the processing efficiency theory (Eysenck and Calvo, 1992), which itself is an extension of theoretical views by Eysenck (1979). The theory suggests anxiety increases the extent to which processing is influenced by stimulus-driven attentional system whilst impairs efficient functioning towards a goal-directed attentional system (Eysenck, et. al., 2007). One study found patients with hypochondria displayed elevated cognitive biases such as an attentional vigilance to bodily symptoms, central to various anxiety disorders (Deacon and Abramowitz, 2008). The attentional system of individuals with anxiety is typically sensitive to and biased in favour of threat-related stimuli within an environment (Bar-Haim, et. al., 2007).

Biases in processing threat-related stimuli play a prominent role in the aetiology and maintenance of anxiety disorders (Beck, 1976; Williams, et. al., 1988; Mathews, 1990; Eysenck, 1992; Mathews & MacLeod, 2002), including health anxiety (Kaur, Butow and Thewes, 2011; Jasper and Witthöft, 2011; Kim and Lee, 2014; Kim, Kim & Lee, 2014). Attempts to identify the time course for hypervigilance towards a threat has

been developed by examining selective attentional bias (AB) towards threat-related stimuli (Egloff & Hock, 2001, 2003; Bar-Haim et al., 2007; Kalanthroff, 2015).

Attentional Bias

Various methods have been utilised to measure AB in health-related anxiety such as the emotional Stroop task (Stroop, 1935) and the visual dot-probe (MacLeod, et. al., 1986). The Stroop task infers an AB when an individual's performance on the primary task is impaired in the presence of health-threat stimuli, as demonstrated in previous research (e.g. Karademas, 2008). However, varying Stroop interference results across studies may be due to heightened arousal in the presence of salient stimuli that inhibits information processing (Marchetti, et. al., 2006). In addition, the procedural parameters used in the Stroop task do not dissociate the details in processing selective attention (e.g. attentional engagement/impaired disengagement) (Yiend, 2010).

The dot-probe task is a direct measure of visuo-spatial attentional allocation (MacLeod, et. al., 1986). It is used in the field of health anxiety, a health-threat stimulus and a neutral stimulus are presented simultaneously on a screen and participants are instructed to respond to the probe that replaces one of the stimuli. Koster, et. al., (2004) states that response times will be faster when the probe appears in the spatial location of which the participant's attention is already allocated. Thus, it is assumed individuals with high health anxiety will have quicker reaction times (RTs) to dot-probe replacing health-threat stimuli (e.g. threat-congruent trials) compared to dot-probe replacing neutral stimulus (e.g. threat-incongruent trials), hence demonstrating an AB in health anxiety (Kim and Lee, 2014).

Research in this field demonstrate individuals with heightened health anxiety have greater interference effects towards illness-related stimuli on modified Stroop tasks (Lecci and Cohen, 2002, 2007; Witthöft, Rist and Bailer, 2008; Karademas, *et. al*., 2008; Christopoulou, Dimostheni and Pavlu, 2008). In addition, Lee, et. al. (2013) found AB in health anxiety in a non-clinical undergraduate sample using a visual dot-probe task. This study showed behavioural and somatic aspects of health anxiety were significantly associated with AB towards personally relevant threat words whilst controlling for negative affect and anxiety sensitivity. Thus, findings from this research lends credit to cognitive theories of attentional bias in health anxiety (e.g. Eysenck, et. al., 1992). Though, definitive research is yet to be carried out that implicates whether the cognitive-emotional factors of AB in health-threat processing are modifiable through interventions found to reduce symptoms in health anxiety.

Intervention

There is an extensive body of research assessing AB in anxiety disorders using

cognitive behavioural interventions. Evidence supports the hypothesis that Cognitive Behavioural Therapy (CBT) reduces biases for threat in anxiety-related disorders (Mogg and Bradley, 1998). Though, research to support the use of CBT for individuals with health anxiety is limited and studies have experienced low enrolment rates and high rates of attrition (Greeven, et. al., 2007; Lovas and Barsky, 2010). Although individuals suffering with health anxiety prefer psychological treatment, compared to drug treatment (Walker, et. al., 1999), existing CBT treatments may not be warranted. Another promising approach proposed to reduce bias towards threat stimuli involves mindfulness meditation training (Vago and Nakamura, 2011).

Over the past three decades, interest in mental training involving the cultivation of trait and state mindfulness has successfully adapted in the contexts of clinical psychology in the Western world (Kang and Whittingham, 2010). This growing interest in mindfulness is very recent when compared to 2,500-year tradition of scholarship about, and practice of, mindfulness interventions in Buddhist traditions (Analayo, 2003). The development of mindfulness through meditation derived from Buddhist contemplative traditions is generally defined as “paying attention in a particular way: on purpose, in the present moment, and non-judgmentally” (Kabat-Zinn, 1994 p.4). Mindfulness meditation incorporates aspects such as breath-focused attention and relaxation, yoga, attention toward sensual modality, body-scans and attention to sensory experience and attention to moment-to-moment experiences (Goldin and Gross, 2012).

Mindfulness-based interventions have been increasingly integrated into a range of institutional settings, including clinical treatment (Dimidjian and Segal, 2015), schools (Sibinga, et. al., 2016), workplace (Good, et. al., 2016), prisons (Samuelson, et. al., 2007) and so on. The scientific community has often assumed that the 8-week mindfulness-based stress reduction (MBSR) program, developed by Kabat-Zinn, is perhaps the most well-known mindfulness intervention in scientific literature (Kabat-Zinn, 1982). However, extensive randomised controlled trials (RCT’s) of mindfulness interventions have developed over the past two decades (Creswell, 2017), in which some suggest brief mindfulness interventions are effective (Yang, et. al., 2018).

In a society in which technology is consistently expanding into healthcare (Weinstein, et. al., 2014), it is not surprising that a potentially useful mindfulness intervention has developed through mobile phone applications, known as Mobile-Based Mindfulness Applications (MBMAs). Technology in healthcare demonstrates clear benefits such as wider access, convenience and reduced time and costs (Pospos, et. al., 2018). Thus, it may be useful to address the effectiveness of these MBMAs in improving psychological well-being.

A review of mindfulness-based applications found ‘Headspace’ to be the highest-scoring mindfulness application in accordance with the Mobile Application Rating

Scale (MARS), which measures apps based on classification, application quality and satisfaction on a 5-point scale (Mani, et. al., 2015). The subscales of MARS included visual aesthetics, engagement, functionality or information quality, which although provides no evidence on the efficacy of the application in developing mindfulness, it proposes individuals engaged better with the application.

In one study, medical students used the Headspace application for 10-20 minutes a day for 30 days and experienced decreased perceived stress and improved well-being (Yang, et. al., 2018). Additionally, Howells, et. al. (2016) found the application Headspace reduced depressive symptoms and enhanced elements of wellbeing. Moreover, research using mindfulness in undergraduates have reported benefits regarding participants' stress, mood, anxiety and mindfulness levels (Driscoll, et. al., 2016). This suggests mindfulness is a promising intervention modality for young individuals and highlights potential benefits of MBMAs.

Though mindfulness is effective for improving psychological well-being, finding an intervention which is suitable for all individuals is challenging (Geraghty, et. al., 2013). Furthermore, although studies have reported positive effects of MBSR and other mindfulness intervention, it is unclear whether these outcomes are attributed to altered levels of mindfulness as many of these studies lack a control condition (e.g. Nyklíček and Kujipers, 2008). Fjorback et. al. (2011) conducted a meta-analysis reviewing MBSR of 72 studies and though they found improved mental health and reduced depressive relapse, many of these studies lacked an active control condition. In addition, many studies lack a baseline measure of mindfulness to address whether the mindfulness intervention has increased levels of mindfulness (e.g. Krusche, et. al., 2013).

In addition, Kabat-Zinn (1990) suggests mindfulness is an extensive learning process of growth, cultivated through time. The process only happens successfully by taking time to experience and accept difficult emotions, instead of avoiding them (Analayo, 2003). Therefore, it is difficult to suggest that a brief mindfulness intervention will have long-term benefits for individuals with health anxiety, and in turn, there is a lack of longitudinal research to support these potential benefits.

Despite this, research has shown mindfulness to be beneficial for various mental disorders (Strub and Tarquinio, 2012; King, et. al., 2013) with similar findings in clinical and non-clinal health anxiety (McManus et. al., 2011; McManus et. al., 2012; Blashill et. al., 2015, Luberto, et. al., 2017). Moreover, research has found mindfulness interventions have reduced AB in alcohol dependencies, (Garland et. al., 2010, 2011, 2012; Ostafin, et. al., 2013; Karyadi, et. al., 2014) and individuals with chronic pain, (e.g. fibromyalgia) (Vago and Nakamura, 2011; Sharpe, et. al., 2012). Though, no research has been conducted to assess the influence of mindfulness intervention on AB in health anxiety.

Current study

A sample of undergraduates completed the Short Health Anxiety Inventory (SHAI; Salkovskis, et. al., 2002) to address initial health anxiety. To assess whether individuals with health anxiety demonstrate an AB towards health-threat stimuli, the study used the dot-probe task as it is suggested to be a direct measure of visuo-spatial attentional allocation (MacLeod, et. al., 1986). To explore stages of attentional processing two types of stimuli were used; health-threat and neutral. Individuals scoring high in health anxiety on these two measures (SHAI and dot-probe) will be encouraged to take part in a brief mindfulness intervention.

Mindfulness research has been based primarily on the MBSR 8-week intensive programme, though this is suggested to be impractical for undergraduates (Jain, et. al., 2007). Research into the minimum duration required for effective mindfulness intervention is unclear (Zeidan, et. al., 2010). Therefore, the current study will assess the value of ten minute daily ten-day practice, through a MBMA as a shorter, more accessible intervention, using the highest-level rating application Headspace (Mani, et. al., 2015). Furthermore, as many studies have lacked an active control condition (Fjorback, 2011) this study will compare results to a control group taking part in TED talks for ten-minute daily ten-day tasks. In addition, as previous research lacks a baseline measure of mindfulness, participants will complete the Mindfulness Attention Awareness Scale (MAAS; Brown and Ryan, 2003) pre- and post-intervention.

We hypothesise: **H1:** Participants in the high health anxiety group will show a greater AB towards health-threat stimuli compared to neutral stimuli before the mindfulness intervention. **H2:** Participants in the high health anxiety group will show a greater AB towards health-threat stimuli, compared to the low health anxiety group. **H3:** Participants in the high health anxiety group will demonstrate a reduction in AB towards health-threat stimuli from pre- to post-intervention. **H4:** Participants in the high health anxiety group will show an increase in mindfulness scores from pre- to post-intervention, compared to the control group. **H5:** Participants in the high health anxiety group will show a decrease in health anxiety scores from pre- to post-intervention, compared to the control group.

Method

Design

The current study utilises an experimental design, results were analysed using 2 x 2 mixed factorial ANOVAs. The study has three independent variables (IV); IV 1: Word type (within subjects–health-threat and neutral); IV 2: Group (between-subjects–mindfulness and control); IV 3: Time (within subjects–pre-and post-intervention).

In the first ANOVA, the within-subjects IV was Probe Position (congruent-incongruent), the between-subjects IV was Anxiety Group (high-low health anxiety) and the DV was mean RTs to dot-probe (milliseconds). In the second ANOVA, the within-subjects IV was Time (pre-post-intervention), the between-subjects IV was Anxiety Group (high-low health anxiety) and the DV was mean AB score (milliseconds). In the third ANOVA, the within subjects IV was Time (pre-post-intervention), the between subjects IV was Anxiety Group (high-low health anxiety) and the DV was total mindfulness scores. In the fourth ANOVA, the within subjects IV was Time (pre-post-intervention), the between subjects IV was Anxiety Group (high-low health anxiety) and the DV was total health anxiety scores. If significant effects were found, Bonferroni-corrected post hoc t-tests were conducted. Effect sizes were also calculated (Rowley, 2015).

Participants

A total of 37 undergraduate students (9 male; 28 female) studying at Manchester Metropolitan University (MMU) were included in the study with a mean age of 21.83 years. Participants were either recruited through the MMU Psychology Research Participation Pool or approached during university opening times in the MMU Brooks Building. Inclusion criteria were male and female undergraduates, exclusion criteria involved individuals that had never used the mobile phone application 'Headspace'. Participants were then grouped using a median split of health anxiety scores on the SHAI (0-20=control group; 21+=mindfulness group). 6 participants dropped out of the study, therefore N = 31, 17 undergraduates were placed in the high health anxiety group (5 males; 12 females) and 14 undergraduates were placed in the low health anxiety group (3 males; 11 females).

Measures and Materials

Health Anxiety

The Short Health Anxiety Inventory (SHAI; Salkovskis, et. al., 2002) was used to measure self-report health anxiety. It consists of 18-items, each with four statements (scored 0-3) in which the participant must select the one their beliefs or thoughts associate with best. The statements assess negative associations with health anxiety; worries about health, feared consequences of illness and awareness of bodily sensations, in which high scores associates with high health anxiety. For example, *I do not worry about my health* (0); *I occasionally worry about my health* (1); *I spend much of my time worrying about my health* (2); *I spend most of my time worrying about my health* (3). The SHAI has demonstrated adequate internal consistency and test-retest reliability (Salkovskis et. al., 2002; Abramowitz et. al., 2007). Internal consistency of the SHAI in the present sample was (α = .820) pre-intervention and (α = .661) post-intervention. Additionally, it has demonstrated good reliability and validity in clinical and nonclinical samples (Alberts, et. al., 2013).

Mindfulness

The Mindfulness Attention Awareness Scale (MAAS: Brown and Ryan, 2003) consists of a 15-item Likert scale (scored 1-6; 1=almost always, 2=very frequently, 3=somewhat frequently 4=somewhat infrequently, 5=very infrequently, 6=almost never). It is designed to measure dispositional mindfulness, explained as a receptive awareness of and attention to the present moment, shown to predict a variety of self-regulation and well-being constructs. For example, *I could be experiencing some*

emotion and not be conscious of it until sometime later. High scores on this questionnaire resemble high trait mindfulness. The scale is suggested to demonstrate strong psychometric properties (Jermann, et. al., 2009). Internal consistency of the MAAS in the present sample was (α = .863) pre-intervention and (α = .853) post-intervention. Furthermore, it has been validated for use with students (Brown and Ryan, 2003).

Attentional Bias

The visual word dot-probe task was initially developed by MacLeod, Mathews and Tata (1986); a widely used computer-based paradigm used to determine AB towards a specific stimulus. In the current study, the main stimuli used were 20 health-threat words (e.g. sickness) and 20 neutral words (e.g. broadcast) taken from a study by Roberts et. al. (2010). The words were matched on total frequency and length based on the Leech et. al. (2001) frequency list, to create 20-word pairs. Each trial began with a central fixation point "+" presented in the screen centre for 500ms. Following this, the fixation cross disappears, and one-word pair (one neutral and one health-threat related) is presented with a 6cm gap, one above and one below where the centre point had been. The stimulus duration i.e. the time word pair remained on screen, was 500ms. Once the word pair disappeared, a white dot appeared in the space left by either the word above, or the word below the centre point. Once the participant indicates whether the dot-probe was located on the upper part of the screen by pressing the <UP> cursor, or the lower part of the screen by pressing the <DOWN> cursor on the keyboard, the next trial will begin. The dot-probe appeared equally often in the upper and lower area of the monitor, but randomly altered between trials. 4 practice trials were presented, before proceeding onto the 80 test trials, in which RTs i.e. time taken (milliseconds) to response to white dot-probe, were recorded.

Mindfulness Intervention

The mobile phone application 'Headspace', available on Apple and Android devices, was used in the intervention for the high health anxiety group and consists of 10-minute audio guided meditations, with the occasional animated video. The guided meditations involved techniques such as body scanning, guided breathing and improving focus. These techniques aim to cultivate awareness, compassion and to improve understanding of both mind and the world. Participants were encouraged to use the application at any time of the day, for 10 consecutive days. Permission to use the Headspace application was granted (Appendix 13). A review of mindfulness-based applications found Headspace to be the highest-scoring in accordance with the Mobile Application Rating Scale (MARS), which measures applications based on classification, application quality and satisfaction on a 5-point scale (Mani, et. al., 2015).

Control Group Intervention

The mobile phone application 'TED talks', available on Apple and Android, was used in the intervention in the low health anxiety group and consists of 10-minute videos regarding a range of political and social debates. Though, none of the TED talks involved the topic of relaxation or meditation as this could influence the validity of the results. Participants were encouraged to watch 10 specific episodes (Appendix 8) at any time of the day, for 10 consecutive days.

Procedure

Stage 1: Pre-Intervention

Participants were tested individually in an environmentally controlled room, after being seated they were provided with computer-generated instructions (Appendix 6) that informed them of the visual word dot-probe task. Instructions emphasised that a series of visual displays consisting of two words would appear, followed by a single dot. Participants are asked to indicate whether the dot-probe was located on the upper part of the screen by pressing the <UP> cursor, or the lower part of the screen by pressing the <DOWN> cursor on the keyboard. Participants were then asked to consent to the study and to formulate a unique anonymous code in order to be able to withdraw from the study. A practice trial of 4 trials followed and questions regarding the procedural requirements were answered before proceeding to the 80 test-trials. Once completed, participants were asked to complete a computerised health anxiety questionnaire (SHAI; Salkovskis et. Al., 2002), followed by a computerised mindfulness questionnaire (MAAS; Brown and Ryan, 2010) via the online secure software Qualtrics.

Stage 2: Intervention

Participants scoring high on health anxiety and thus in the mindfulness intervention were asked via email to download the mobile phone application 'Headspace'. They were asked to complete the 'Basics' section of the Headspace application which consists of 10-minute daily tasks involving relaxation and breathing exercises. Participants in the control group were asked to download the mobile phone application 'TED talks' and were asked to watch 10 specific episodes, approximately 10-minutes in length. After the ten days were completed, participants emailed the researcher and arranged a meeting to complete Stage 3.

Stage 3: Post-intervention

Participants in the control group were asked 10 questions specific to the TED talk episodes they were encouraged to watch in Stage 2. Participants in the mindfulness intervention were asked to provide evidence of their intervention by indicating to the researcher their Headspace application history. Following this, participants were asked to complete the visual word dot-probe task and the two computerised questionnaires. Once completed, participants were debriefed, in which the full research title, aims and purpose of the study were explained by the researcher, and participants were given the opportunity to ask questions. Participants in the control group were provided with clear information as to why we needed two groups to complete the study and were given access to the mindfulness application if they so wished to use it. In addition, participants were provided with counselling and support services, however, in the hope they would not be needed.

Ethical Considerations

This research was conducted in accordance with the British Psychological Society Code of Ethics and Conduct (BPS, 2009). In addition, the research has been carried out in accordance with MMU departmental ethical guidelines, with which the ethics form was completed and discussed with a supervisor (Appendix 1). Participants were

provided with an information sheet (Appendix 3), gave informed consent to take part in the study (Appendix 4) and were given the right to withdraw up until the point in which data analysis was conducted, of which they were given a date. Confidentiality could not be given as the findings may eventually be published, however, participant information and data were protected, and participant data remained anonymous.

As the study was described as an experiment investigating 'attentional bias and psychological wellbeing' (Appendix 3) and the questionnaires were labelled with their abbreviations (MAAS; SHAI), deception was involved. To address this issue, participants were given a full debrief (Appendix 5) that informed them of the topic area and the full research aims were provided alongside contact details for counselling and support teams. In addition, participants in the control group were informed of why two groups were needed to carry out the study and were given access to the mindfulness application, if they so wish to use it.

Results

Preparation of data

All raw data from the two conditions were entered into IBM SPSS Statistics 24.0; all the output data for SPSS is displayed in the Appendices (Appendix 11). Data was screened for normality and met assumptions for parametric tests (i.e. ANOVA) once extreme outliers were removed. Two participants' data were removed due to extreme outliers in dot-probe RTs which were greater than 2 *SD*s from the mean, therefore *N* = 29. Regarding dot-probe RTs, the error rate for both congruent and incongruent times were less than 2%, therefore no data was removed, which falls in line with other dot-probe research (e.g. Mogg, et. al., 1997).

Total scores for responses to the MAAS and the SHAI at pre-intervention and post-intervention were calculated. To check internal consistency reliability, Cronbach's alpha (α) coefficients were generated for each scale at each assessment time. The majority of the measures had an α coefficient significantly above .70 (Nunally, 1978). Whilst the SHAI at post-intervention had a coefficient of .661 as shown in Table 1, this is still accepted as representing a satisfactory reliability level (Loewenthal, 2004).

Table 1

Internal Consistency and Confidence Intervals for Mindfulness and Health Anxiety Measures at Each Assessment Time for (N = 31)

Measure	Number of items	Cronbach's alpha (α)	95%Confidence Interval for α	
			Lower	Upper

Pre-MAAS	15	.863**	.761	.921
Post-MAAS	15	.853**	.721	.907
Pre-SHAI	18	.820*	.733	.912
Post-SHAI	18	.661***	.435	.811

Note: *F* test with true value =.7, * $p < .05$. ** $p < .01$. *** $p < .001$ SHAI = Short Health Anxiety Inventory, MAAS = Mindfulness Attention Awareness Scale

Hypothesis 1 and 2

A 2 x 2 mixed factorial ANOVA was conducted with the within-subjects IV of Probe Position (congruent -incongruent) and the between-subjects IV of Anxiety Group (high-low health anxiety), the DV was mean RTs to dot-probe (milliseconds). Means and standard deviations for all conditions are displayed in Table 2.

Table 2

Mean Reaction Times (ms), Standard Deviations and Confidence Intervals for Probe Position of both Anxiety Groups

Anxiety Group	Probe Position	Mean RTs(ms)	95% CI	
		M(SD)	*LL*	*UL*
High Anxiety	Pre-Congruent	.403(.075)	.37	.44
	Pre-Incongruent	.496(.068)	.47	.53
Low Anxiety	Pre-Congruent	.410(.040)	.38	.45
	Pre-Incongruent	.445(.050)	.41	.48

Note. CI = confidence interval; *LL* = lower limit, *UL* = upper limit

There was a significant main effect of probe position (congruent-incongruent) on RTs to the dot-probe, $F(1,27) = 44.09$, $p < .001$, $\eta^2_p = .620$. Furthermore, there was a significant interaction between probe position (congruent-incongruent) on RTs to the dot-probe and anxiety group (high-low health anxiety) $F(1,27) = 9.00$, $p = .006$, $\eta^2_p = .250$.

Post Hoc Tests

To interpret the significant interaction, four post hoc t-tests were conducted with a Bonferroni corrected alpha of .0125 (.05/4).

Independent t-test

Two independent t-tests were conducted, to assess where the significance lay between groups. There was no significant difference found in mean RTs to congruent dot-probe position between anxiety group (high-low health anxiety) $t(23.63) = .34$, $p = .741$, d[1] = -0.13 95% CI [-0.84, 0.59], with a large effect size. Additionally, there was no significant difference in mean RTs to incongruent dot-probe position between anxiety group (high-low health anxiety) $t(27) = .2.25$, $p = .028$, $d = 0.84$ 95% CI [0.08, 1.60], with a large effect size.

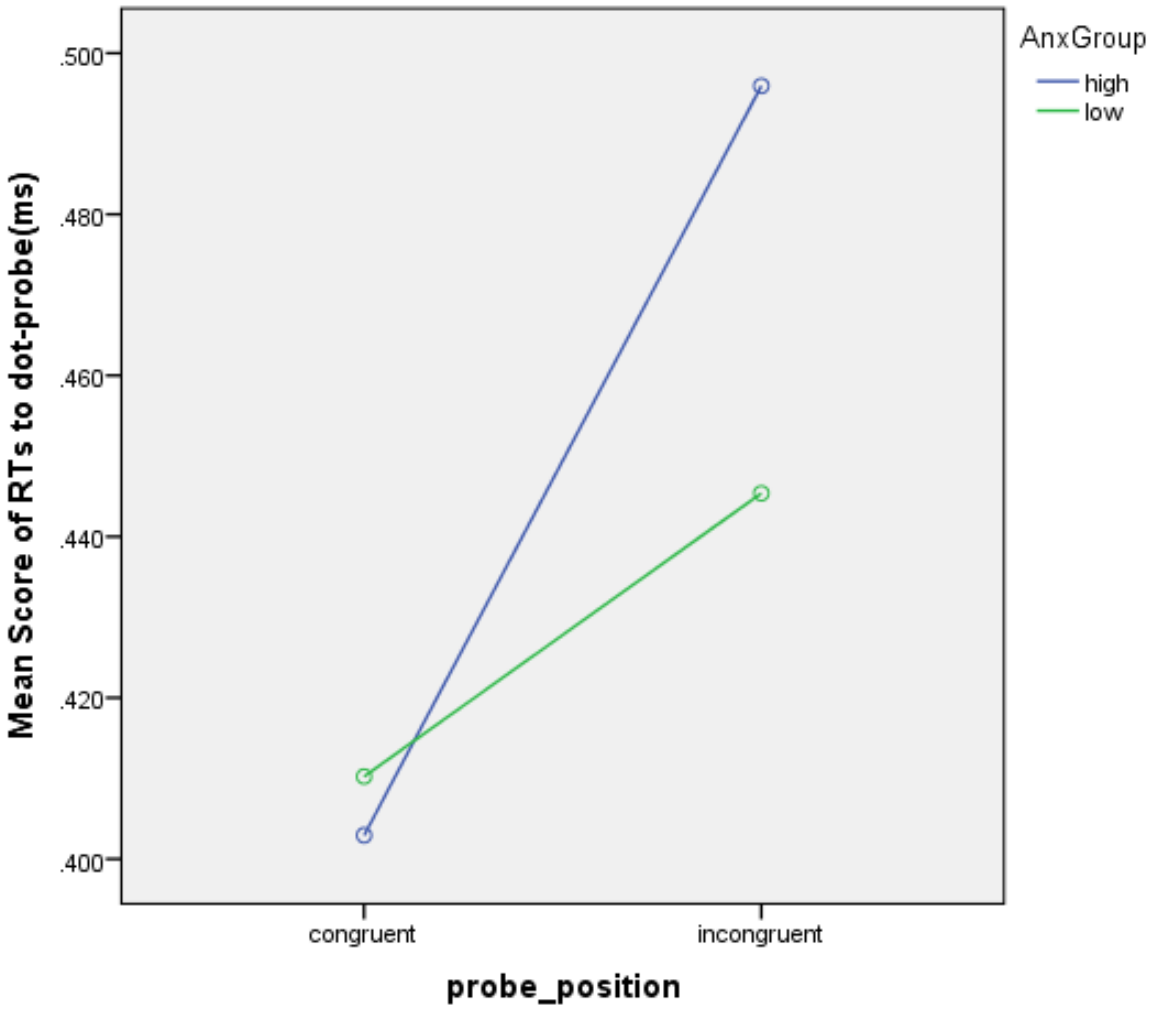

Figure 1. Means plot demonstrating significant interaction between anxiety group and time (pre-post intervention) for dot probe RTs.

Paired t-test

[1] Effect sizes were calculated using CLiCals (Rowley, 2015) and interpreted using Cohens (Cohen, 1988) conventions where .02 = small; .05 = medium; .08 = large effect size.

Two paired sample t-tests were conducted, to assess where the significance lay within the two groups (high-low health anxiety). The high health anxiety (HHA) group were significantly quicker to respond to the congruent probe position (M = 0.402, SD = 0.075) in comparison to incongruent probe position (M = 0.495, SD = 0.068), $t(15) = 6.57$, $p < .001$, d = -1.26 95% CI [-1.80, -0.71], with a large effect size. No significant difference was found between congruent and incongruent RTs for the low health anxiety group (LHA), $t(12) = 2.83$, $p = .015$, d = -0.75 95% CI [-1.34, -0.15], with a large effect size.

Hypothesis 3

An attentional bias score was calculated by subtracting the mean congruent dot-probe RT from mean incongruent dot-probe RT. Positive scores indicate AB, a value of zero indicates no AB and negative values indicate avoidance from health-threat, this is in line with previous dot-probe research (e.g. Mogg, et. al., 1997).

A 2 x 2 mixed factorial ANOVA was conducted with the within-subjects IV of Time (pre-post-intervention) and the between-subjects IV of Anxiety Group (high-low health anxiety), the DV was mean AB score (milliseconds). Means and standard deviations for all conditions are displayed in Table 3.

Table 3

Mean RTs, Standard Deviations and Confidence Intervals for Mean Attentional Bias Scores for both Anxiety Groups at Pre- and Post-Intervention

Anxiety Group	AB Score	Mean RTs (ms)	95% CI	
		M(SD)	*LL*	*UL*
High Anxiety	Pre-AB score	.093(.056)	.07	.12
	Post-AB score	.009(.032)	-.01	.02
Low Anxiety	Pre-AB score	.035(.045)	.01	.07
	Post-AB score	.009(.027)	-.01	.03

Note. CI = confidence interval; *LL* = lower limit, *UL* = upper limit

There was a significant main effect of time (pre-post-intervention) of AB scores (milliseconds) $F(1,27) = 27.36$, $p < .001$, $\eta^2_p = .503$. There was a significant interaction of time (pre-post-intervention) of AB scores with anxiety group (high-low health anxiety) $F(1,27) = 7.43$, $p = .011$, $\eta^2_p = .216$.

Post Hoc Tests

To interpret the significant interaction, two post hoc t-tests were conducted with a Bonferroni corrected alpha of .025 (.05/2).

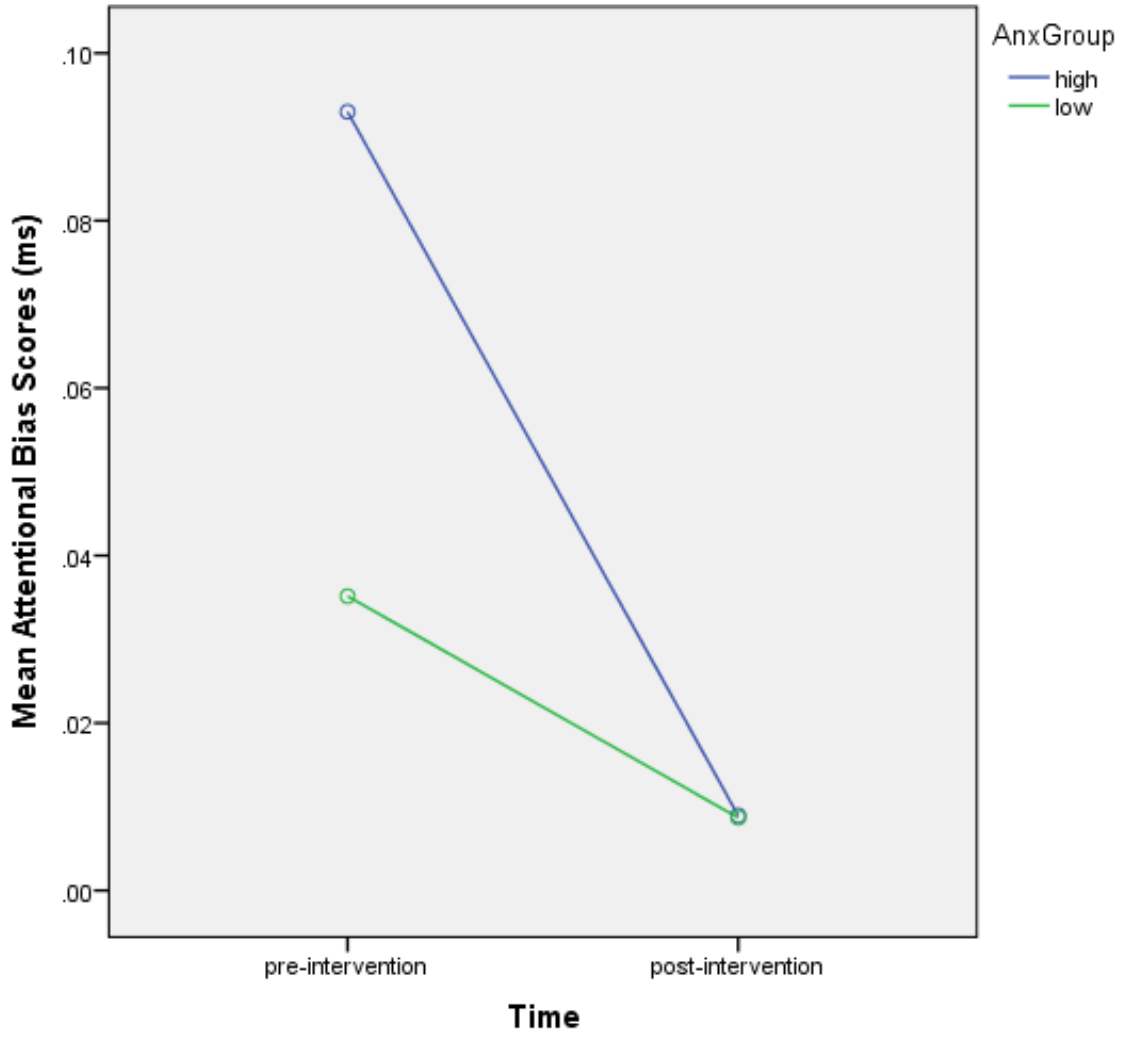

Figure 2. Means plot demonstrating significant interaction between anxiety group and time (pre-post-intervention) for dot probe RTs.

Paired t-test

Two paired sample t-tests were conducted, to assess where the significance lay between groups (high-low-health anxiety). The HHA group had a significantly smaller AB at post-intervention, (M = 0.009, SD = 0.032) compared to pre-intervention (M = 0.093, SD = 0.056), $t(15) = 5.22$, $p < .001$, d = 1.76 95% CI [0.91, 2.61], with a large effect size. No significant difference was found in AB scores for LHA group from pre- to post-intervention $t(12) = 2.13$, $p = .055$, d = 0.67 95% CI [-0.02, 1.36], with a large effect size.

Hypothesis 4

A 2 x 2 mixed factorial ANOVA was conducted with the within subjects IV of Time (pre-post-intervention) and the between subjects IV of Anxiety Group (high-low health anxiety), DV was total mindfulness scores. Means and standard deviations for all conditions are displayed in table 4.

Table 4

Mean RTs, Standard Deviations and Confidence Intervals for Mindfulness Scores of both Anxiety Groups at Pre- and Post-Intervention

Anxiety Group	MAAS Test Scores		95% CI	
		M (SD)	*LL*	*UL*
High Anxiety	Pre-MAAS	43.50(6.89)	39.20	47.80
	Post-MAAS	44.94(8.23)	40.76	49.11
Low Anxiety	Pre-MAAS	45.23(9.94)	40.46	50.00
	Post-MAAS	47.31(8.02)	42.68	51.94

Note. CI = confidence interval; *LL* = lower limit, *UL* = upper limit

There was no significant main effect found of time (pre-post-intervention) of mindfulness test scores $F(1,27) = 1.19$, $p = .284$, $\eta^2_p = .042$. There was no significant interaction of time (pre-post-intervention) of mindfulness scores with anxiety group (high-low health anxiety) $F(1,27) = .04$, $p = .844$, $\eta^2_p = .001$.

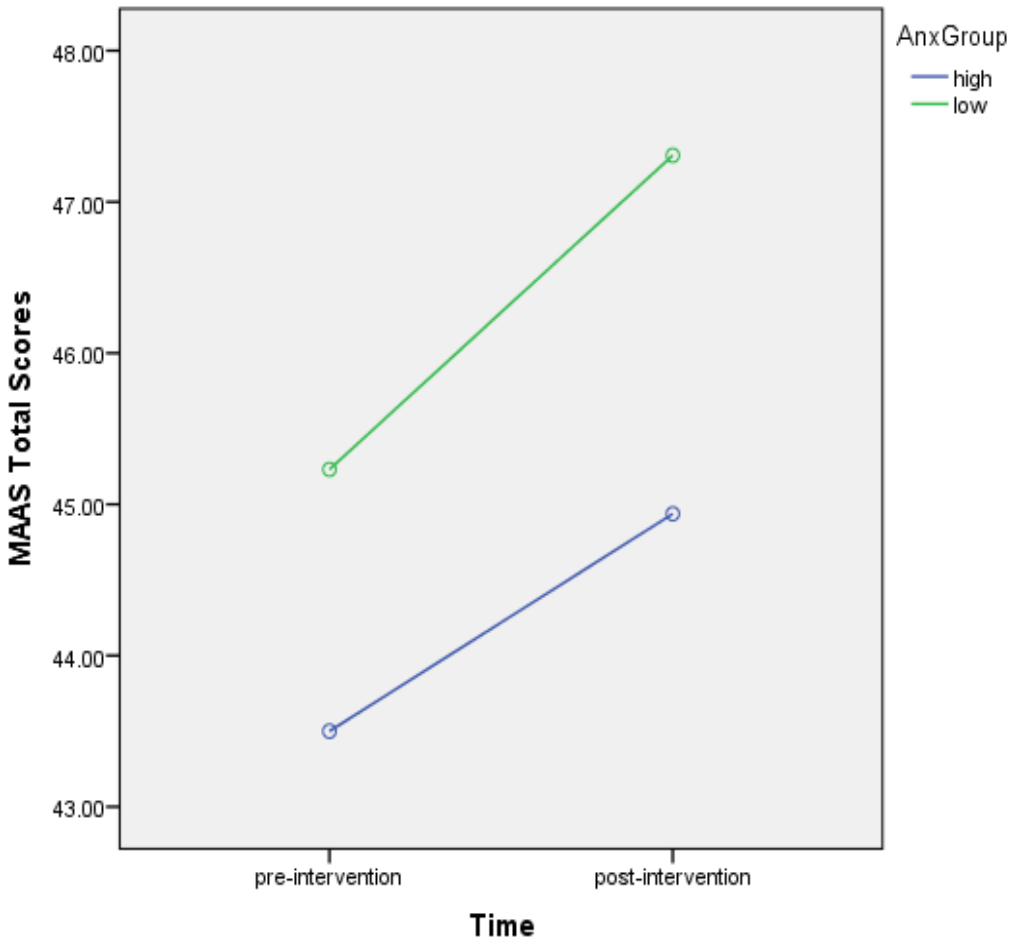

Figure 3. Means plot demonstrating no significant interaction between anxiety group and time (pre-post-intervention) for mindfulness scores.

Hypothesis 5

A 2 x 2 mixed factorial ANOVA was conducted with the within subjects IV of Time (pre-post-intervention) and the between subjects IV of Anxiety Group (high-low health anxiety), DV was total health anxiety scores. Means and Standard Deviations for all conditions are displayed in table 3.

Table 3

Mean RTs, Standard Deviations and Confidence Intervals for Total Health Anxiety Scores of both Anxiety Groups at Pre-and Post-Intervention

Anxiety Group	SHAI Test Scores		95% CI	
		M (SD)	*LL*	*UL*
High Anxiety	Pre-SHAI	25.19(3.75)	23.12	27.25
	Post-SHAI	19.81(3.08)	18.15	21.48
Low Anxiety	Pre-SHAI	16.54(4.35)	14.25	18.83
	Post-SHAI	16.38(3.43)	14.54	18.23

Note. CI = confidence interval; *LL* = lower limit, *UL* = upper limit

There was a significant main effect found of time (pre-post-intervention) of health anxiety scores $F(1, 27) = 22.13$, $p = < .001$, $\eta^2_p = .450$. There was a significant interaction found of time (pre-post-intervention) of health anxiety scores with anxiety group (high-low health anxiety) $F(1,27) = 19.74$, $p = < .001$, $\eta^2_p = .422$.

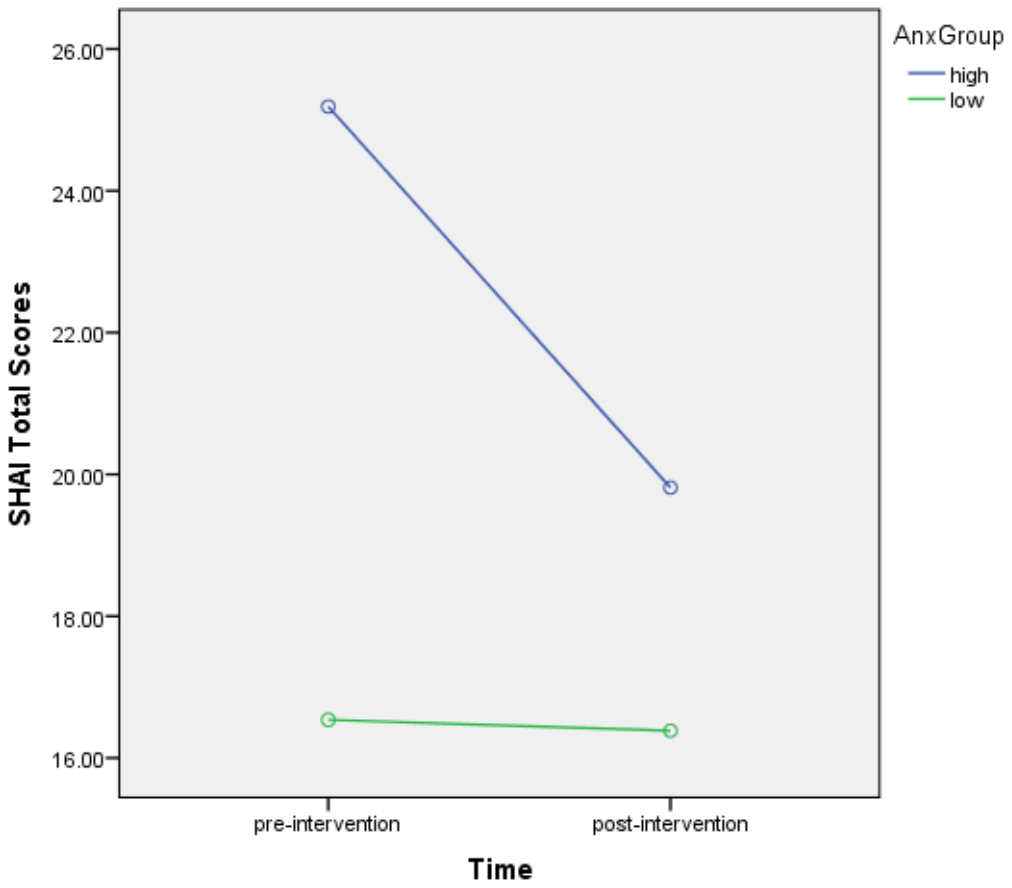

Figure 4. Means plot demonstrating significant interaction between anxiety group and time (pre-post-intervention) regarding health anxiety scores.

Paired T-Test

To interpret the significant interaction, two post hoc t-tests were conducted with a Bonferroni corrected alpha of .025 (.05/2). Two paired samples t-tests were conducted, to assess where the significance lay between groups (high-low health anxiety). The HHA group demonstrated significantly lower health anxiety scores from pre-intervention (M = 25.19, SD = 3.75) to post-intervention (M = 19.81, SD = 3.08), $t(15) = 8.02$, $p < .001$, d = 1.51 95% CI [0.91, 2.12], with a large effect size. No significant difference was found in health anxiety scores from pre- to post-intervention in the LHA group $t(12) = .15$, $p = .882$, d = 0.04 95% CI [-0.47, 0.54], with a medium effect size.

Summary

The results clearly indicate that an interaction exists between health anxiety levels as demonstrated by the SHAI and performance on the dot-probe task, with HHA individuals reacting significantly quicker to the dot-probe in a congruent position compared to an incongruent position. However, no significant difference was found in RTs to dot-probe between the HHA and LHA groups. There was a significant reduction in AB scores from pre- to post-intervention in the HHA group, whereas no significant difference was found in AB scores from pre- to post-intervention in LHA group. Interestingly, no significant difference was found in mindfulness scores from pre- to post-intervention in both HHA and LHA groups. Though, there was a significant difference in health anxiety scores, in that the HHA group had significantly reduced total SHAI scores from pre- to post- intervention. Whereas, no significant difference was found in health anxiety scores in the LHA group from pre- to post-intervention.

Discussion

Hypothesis 1 and 2

The first objective of the present study was to compare AB in health anxiety in undergraduates, given differences in self-report health anxiety scores. In light of aforementioned studies, the results lend credit, as individuals with high health anxiety demonstrated an AB towards health-threat stimuli (Kaur, Butow and Thewes, 2011; Jasper and Witthöft, 2011; Kim and Lee, 2014; Kim, Kim & Lee, 2014). Furthermore, these findings are supported by theories of cognitive biases in health anxiety (Salkovskis and Warwick, 1986, 2001; Warwick and Salkovskis, 1990; Abramowitz, et. al., 2002; Eysenck, et. al., 2007). In particular, Attentional Control Theory (Eysenck, et. al., 2007) is supported, in that those with high health anxiety increased the extent to which they were influenced by the stimulus-driven attentional system, in essence, had quicker RTs to dot-probe replacing health-threat stimuli (e.g. threat-congruent).

Hypothesis 3

The second objective of the present study was to compare AB scores of high health anxious individuals from pre- to post-intervention. In which, the results demonstrate a reduction in AB towards health-threat stimuli from pre- to post-intervention. As this particular topic is largely unexplored it is difficult to compare these findings to previous research. Though, research found reductions in AB in individuals with alcohol dependencies (Garland et. al., 2010, 2011, 2012; Ostafin, et. al., 2013; Karyadi, et. al., 2014) and individuals with chronic pain (i.e. fibromyalgia) (Vago and Nakamura, 2011; Sharpe, et. al., 2012) following a mindfulness intervention.

Hypothesis 4 and 5

In addition, the present study compared self-report health anxiety scores pre- to post-intervention and found a reduction in scores in the high health anxiety group, thus falls in line with hypothesis 5. Although there was a significant reduction in health anxiety scores and a significant reduction in AB scores in the high health anxiety group from pre- to post-intervention, it cannot be inferred that this is due to the mindfulness intervention. This is because there was no significant increase found in self-report mindfulness scores following intervention in the high health anxiety group. Thus, the findings are inconsistent with hypothesis 4 that suggests individuals will demonstrate an increase in mindfulness scores following the mindfulness intervention.

Although the findings are non-significant, we can note a positive trend in self-report mindfulness scores following the mindfulness intervention. Potentially, a longer mindfulness intervention may have led to increased mindfulness scores on the MAAS; previous research utilised at least 30 days of the application Headspace to experience significant benefits (Zoogman et. al., 2015; Yang, et. al., 2018). One limitation of the current study is that the MAAS measured trait mindfulness, it may be that by using a brief intervention with a small sample size of $N = 29$ the MAAS may not have picked up subtle changes in trait mindfulness. As mentioned previously, Kabat-Zinn (1990) suggests mindfulness meditation is cultivated over time, with extensive experience, thus, a 10-day mindfulness intervention was not sufficient to increase mindfulness scores on the MAAS. Future research may benefit from longitudinal research which implicates the associated long-term benefits of brief mindfulness intervention and MBMA.

Another explanation for the findings in the current study is that the 10-minute daily tasks led to reduced ruminations of health anxiety which lead to reduced AB in health anxiety and reduced health anxiety scores on the SHAI. Previous research found a strong association between ruminations and health anxiety (Marcus, Hugher and Arnau, 2008; Wolfradt, et. al., 2014). This may explain why mindfulness scores did not increase on the MAAS from pre- to post- intervention in the mindfulness condition as the reduction in health anxiety was possibly due to reduced ruminations, rather than improved mindfulness.

Jain, et. al., (2007) conducted a RCT with 83 undergraduates and found that

individuals demonstrated a significant reduction in distractive and ruminative thoughts and behaviours following a mindfulness intervention, compared to a control group. From this, we can conclude that brief mindfulness meditation may be specific in its ability to reduce ruminations, and this ability may offer a mechanism by which led to the reduction in health anxiety found in the current study. Though, Jain, et. al. (2007) did not investigate attentional bias, thus, future research into AB in health anxiety would benefit from using a measure for ruminations to understand its role in AB in health anxiety.

Future research

While a collective number of mobile-based mindfulness applications are developing, the current evidence base is limited to one RCT which examines the efficacy of Headspace (Howells, et. al., 2016). Though, this research focuses on mindfulness in reducing depressive symptoms. Future research is needed to ascertain the efficacy of MBMAs in improving mindfulness, whilst comparing them with one another. Furthermore, it is unclear whether a brief MBMA intervention has any lasting long-term benefits, thus longitudinal studies are likely useful for future research.

A brief mindfulness meditation intervention may provide a coping mechanism, though it takes time and experience for skills in mindfulness meditation to develop (Kabat-Zinn, 1990). Thus, future research will benefit from looking at an extended mindfulness intervention in reducing AB in health anxiety in a range of populations. Furthermore, research into the possible benefits of mindfulness in a range of anxiety disorders will be useful. In addition, future research should confirm the role of ruminations in brief mindfulness mediation reducing health anxiety. It remains unclear whether potential reduced ruminations are consistent for populations with health anxiety, as well as examining potential mediating effects of decreased ruminations in other anxiety disorders.

Moreover, given the findings from the current study may have limited generalisability due to the sample size and limited demographics, future research may benefit from investigating AB in health anxiety following a mindfulness intervention using a larger sample size in a range of populations. Cohen (1988) suggests results gained from a larger sample can be more confidently generalised to a population, a minimum of 33 participants are required in each sample to identify a medium to large treatment effect. In the current study, once participants were removed due to extreme outliers, $N = 29$, thus, future research may benefit from including larger sample sizes to adequately assess the effects of mindfulness on AB in health anxiety.

Conclusion

In conclusion, the present study has provided evidence to suggest that individuals with high health anxiety will demonstrate an attentional bias towards health-threat stimuli when compared to neutral stimuli. Furthermore, the attentional bias

decreased from pre- to post-intervention, though this cannot be specified to effects of the mindfulness intervention as no significant increase in mindfulness was found. Despite its limitations, the current study is unique in that no other studies have investigated AB in health anxiety following a mindfulness intervention, thus more research should be carried out in order to gain a better understanding.

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