COMPARING ATTENTION-TRAINING METHODS IN ATTENTION BIAS MODIFICATION FOR DEPRESSION

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COMPARING ATTENTION-TRAINING METHODS IN ATTENTION BIAS MODIFICATION FOR DEPRESSION

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Abstract: Cognitive and information processing models of depression suggest that attention biases for dysphoric information are a causal factor in the development of depression. Attention bias modification is a procedure designed to reduce maladaptive attention biases in order to reduce emotional distress. Attention bias modification literature in the context of depression has demonstrated mixed findings, in that it is currently unclear which method of attention-training, if any, is the most effective in altering attention biases. Accordingly, in the current study, participants were randomly assigned to one of four attention-training methods or to a no-training control condition to evaluate each method's ability to reduce maladaptive attention biases and enhance adaptive attention biases. The four active training conditions were (1) spatially disengaging from dysphoric stimuli, (2) spatially engaging with positive stimuli, (3) a combination of spatial disengagement from dysphoric stimuli and engagement with positive stimuli, and (4) disengagement from the emotional content of dysphoric images. Attention to positive and dysphoric stimuli was measured pre- and post-training via eye tracking. We tested the following hypotheses: 1) each active training method would result in a significant decrease in attention to dysphoric information compared to control; 2a) the positive engagement and combined conditions would result in a significant increase in attention to positive information compared to control; and 2b) the spatial disengagement and content disengagement conditions would not result in a significant increase in attention to positive information relative to control. Change in attention to dysphoric and positive information did not differ between the control condition and any of the active training conditions, which supported hypothesis 2b but not hypotheses 1 or 2a. The lack of differences between the active training and control conditions indicates that the methods of attention-training used in the current study are not effective at altering attention for dysphoric and positive information.

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CHAPTER I

INTRODUCTION

Cognitive models of depression posit that attention biases for dysphoric emotional information contribute to the etiology and maintenance of depressive symptoms (Beck, 1976; Ingram, 1984). Empirical studies have supported cognitive theories of depression by consistently demonstrating that attention biases for dysphoric information are related to the development and course of depressive symptoms (Beevers & Carver, 2003; Wells & Beevers, 2010; Disner, Shumake, & Beevers, 2017). As attention for dysphoric information is associated with the experience of depressive symptoms and mood states, increasing numbers of studies have evaluated different methods of experimentally altering attention biases.

Attention bias modification (ABM) was first developed as a dot-probe paradigm that was designed to systematically train individuals to attend to specific valences of emotional information (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). ABM has been studied in the context of altering attention biases for threatening and dysphoric information, and while there is evidence suggesting that attention training paradigms are successful in altering attention biases (e.g., Wells and Beevers, 2010; Browning, Holmes, Charles, Cowen, & Harmer, 2012), there is inconsistent information regarding the efficacy of specific methods of attention-training in altering attention biases for different valences of emotional information. The current study aimed to directly evaluate and compare the efficacy of four different attention-training paradigms in altering attention biases for positive, dysphoric, threatening, and neutral information.

Attention Bias in Depression

Beck's cognitive model of depression (1976) proposes that engaging in negative cognitive patterns (e.g., attending to dysphoric information, having negative thoughts about the self) enhances vulnerability for depression. Information processing models of depression (e.g., Ingram, 1984) posit that individuals who experience depressed mood states are more likely to experience negatively biased cognitive processes (e.g., attention), resulting in continued experience of depressive symptoms. Taken together, these models indicate that attending to and elaborating on dysphoric information serves to facilitate the maintenance of depression.

Throughout the past few decades, attention biases for emotional information have been studied thoroughly in the context of depression. While preliminary studies suggested that depressed individuals lacked an attention bias for positive information that non-depressed individuals possess (Gotlib, McLachlan, & Katz, 1998), these findings were likely due to a relatively brief stimulus presentation duration (e.g., 250 ms). Subsequent studies that presented stimuli for longer durations (e.g., 1000 ms) have demonstrated that depressed individuals preferentially attend toward dysphoric, mood-congruent information (Mogg & Bradley, 2005; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; Kellough, Beevers, Ellis, & Wells, 2008 Peckham, McHugh, & Otto, 2010).

Moreover, there is a positive relationship between depressive symptom severity and attention bias for dysphoric information; individuals experiencing more severe depressive symptoms demonstrate more pronounced attention biases for dysphoric information compared to those experiencing mild depressive symptoms (Baert, De Raedt, & Koster, 2009). Attention biases for dysphoric information also predict a natural worsening of depressive symptoms (Disner, Shumake, & Beevers, 2017). Attention for dysphoric information increases one's vulnerability for developing depression, as attention biases for dysphoric information moderate (strengthen) the relationship between life stress and depressive symptoms (Beevers & Carver, 2003). Not only are attention biases for dysphoric information associated with the course of depression symptom severity, but they are also associated with diminished mood recovery following a sad mood induction, which suggests that attention biases for dysphoric information facilitate the maintenance of sad mood states (Clasen, Wells, Ellis, & Beevers, 2013). Collectively, these findings implicate attention biases for dysphoric information as a factor that enhances to depression vulnerability.

While the aforementioned studies established that attention biases for dysphoric information serve to enhance depression vulnerability, they cannot directly determine whether attention biases play a causal role in the experience of depression. Accordingly, it is important to evaluate work that has investigated the causal nature of the relationship between depression and attention for dysphoric information.

Attention Bias Modification in Depression

Most ABM research has been influenced by a study conducted by MacLeod, Rutherford, Campbell, Ebsworth, and Holker (2002). In this study, the authors utilized a modified dot-probe task in order to systematically train participants to attend to either negative or neutral information. Participants who were trained to attend to negative information demonstrated a more negative emotional response to a stress anagram task compared to those in the neutral training condition. The findings from this study established a causal connection between attention for emotional information and emotional experience. Based on their findings, the authors suggested that a neutral or positive attention-training condition could be used therapeutically to improve symptoms of emotional disorders, and laid the foundation for subsequent ABM studies to expand upon their findings.

Multiple meta-analyses have been conducted with the purpose of evaluating the efficacy of ABM in regard to changing depressive symptoms, anxiety symptoms, and attention to emotional information. A meta-analysis conducted by Beard, Sawyer, and Hoffman (2012) found that ABM was generally effective in improving anxiety and depressive symptom, but the effect sizes evaluating different methods of attention-training varied significantly. A meta-analysis by Mogoaşe, David, and Koster (2014) found that ABM reduced anxiety and depressive symptoms, but the average effect size for altering attention biases within depressed samples was non-significant. A third meta-analysis by Cristea, Kok, and Cuijpers (2015) revealed small effect sizes for changes in symptomology and attention. Moreover, there was a high degree of heterogeneity in effect sizes, which suggests that ABM procedures demonstrate variable degrees of efficacy regardless of the method of attention-training used or the primary outcome or sample. Collectively, these meta-analyses raise concerns regarding the efficacy of ABM in regard to attention change, which highlights the need for further studies to evaluate the mechanistic processes of ABM.

As ABM was developed as a clinical tool for reducing anxiety and depression, the primary outcome of most ABM research has been symptom change. However, evidence suggests that ABM programs that have failed to successfully modify attention subsequently failed to alter emotional distress (e.g., Baert, De Raedt, Schacht, & Koster, 2010; see Clarke, Notebaert, & MacLeod, 2014, for a review). Since change in attention is related to symptom change, it is important to evaluate which methods of ABM are reliable in altering attention for emotional information. Accordingly, examining the literature surrounding specific mechanisms of attention-training provides more detailed information about their efficacy.

One method of attention-training involves participants to spatially disengage from a dysphoric stimulus and engage with a neutral stimulus. Studies evaluating this ABM paradigm generally suggest that training individuals to attend away dysphoric information and toward neutral information is effective in reducing attention for dysphoric information (e.g., Wells and Beevers, 2010; Beevers, Clasen, Enock, & Schnyer, 2015; Yang, Ding, Dai, Peng, & Zhang, 2015). Moreover, there is evidence indicating that training individuals to attend away from negative information and toward both positive and neutral information is another effective method for reducing attention for dysphoric information (LeMoult, Joormann, Kircanski, & Gotlib, 2016; Yang, Zhang, Ding, & Xiao, 2016). While the results of one study conducted by Browning, Holmes, Charles, Cowen, & Harmer (2012) suggested that training individuals to attend toward positive information is also an effective method for reducing dysphoric attention biases, other studies have yielded conflicting findings regarding the efficacy of training attention toward positive information in reducing attention biases for dysphoric information (Baert, De Raedt, Schacht, & Koster, 2010; Arditte & Joormann, 2014; Notebaert, Clarke, Grafton, & MacLeod, 2015). Another method of attention-training involves having participants disengage from the emotional content of pictorial stimuli, and instead focus attention on non-emotional aspects of an image. Although this method of attention-training has only been evaluated in one study to date (e.g., Notebaert et al., 2015), the results of this study suggest that training individuals to disengage from emotional content is a more effective method of reducing dysphoric attention biases than standard dot-probe ABM tasks.

The findings from these studies have contributed to our understanding concerning the efficacy of various attention-training paradigms in altering attention biases and emotional vulnerability. However, these studies also vary in terms of their study design, which further contributes to the ambiguity in findings in the ABM literature. More specifically, the aforementioned studies employed different types of attention-training paradigms, utilized different numbers of trials, varied in terms of stimuli type, and yielded disparate and at times conflicting results. Given the differences in methodology between these ABM studies, it is important to identify what features are necessary and sufficient for ABM to be efficacious. Clarke, Notebaert, and MacLeod (2014) noted that the ABM paradigms that failed to change attention also failed to improve mood, which highlights the need to specifically evaluate which method(s) of attention-training are reliably effective at modifying attention.

Limitations of Prior Depression ABM Studies

In reviewing the ABM literature, we have identified some limitations of prior work that serve as barriers to understanding which mechanisms of ABM contribute to effective attention change. First, one of the most commonly used attention-training paradigms is a modified dot-probe task (e.g., Wells and Beevers, 2010; Beevers et al., 2015), but this task combines attentional engagement to non-dysphoric stimuli with attentional disengagement from dysphoric stimuli. The dot-probe task presents 2 images simultaneously, and after the offset of one image, a probe appears in the location of one of the images. In this task, participants can view both stimuli when they are presented simultaneously. This creates a potential mixture of attentional mechanisms, which makes it unclear which attentional mechanism (e.g., disengagement or engagement) is necessary or sufficient to change attention.

Second, most ABM tasks that are designed to reduce attention for dysphoric information do not actually involve disengagement from the dysphoric stimuli because the dysphoric stimulus is not presented on the screen at the same time as the probe image at the time of response (e.g., Wells and Beevers, 2010; Baert et al., 2010; Beevers et al., 2015). The dysphoric stimulus not being presented with the probe stimulus is problematic because it hinders our ability to evaluate whether training attention away from dysphoric information actually reduces attention for dysphoric information.

Third, while the majority of ABM studies have utilized spatial disengagement and engagement, it may be possible to train attention by having participants to attend to non-emotional components of emotional stimuli while maintaining their visual attention on the same stimuli. However, only one study has evaluated this method of attention-training to our knowledge (Notebaert et al., 2015). Accordingly, further studies need to evaluate this promising method of attention-training to understand if it is a reliable method of altering attention.

Fourth, ABM studies typically do not compare different methods of attention-training in the same study (e.g., Baert et al., 2010; Browning et al., 2012). Attention-training studies typically compare one active training condition to a control condition, which affords the ability to compare training and no training in regard to attention and symptom change. Without comparing multiple attention-training paradigms, we are limited in our ability to draw comparisons between different mechanisms of attention-training regarding which method is more effective for altering attention biases.

Current Study

In order to address these limitations in the attention-training literature, the current study directly compared four different attention-training paradigms to a control condition in order to evaluate their ability to alter attention biases for dysphoric, positive, neutral, and threatening information. All of the attention-training conditions are depicted below in Figure 2. To address the limitations of the dot-probe in differentiating between engagement and disengagement of attention, three conditions were employed to dismantle these processes. The *spatial disengagement* condition involved training participants to attend away from dysphoric images and toward a masked, non-emotional image (i.e., a gray square). For the spatial disengagement condition, the dysphoric stimulus remained on the screen with the probe image in order to enhance the likelihood that participants disengaged from the dysphoric stimuli. The *positive engagement* condition involved training participants to attend toward positive stimuli, but did not involve disengagement from an emotional stimulus. This isolated the process of engaging with positive information. The *combined* spatial disengagement and positive engagement condition involves training participants to attend away from dysphoric information and toward positive information.

In order to address the limitation that the majority of ABM tasks are designed to decreased attention to dysphoric information may not actually involve disengagement from dysphoric stimuli, the spatial disengagement condition presented the dysphoric stimuli and probe image simultaneously. This provided us more valid information as to the efficacy of spatially disengaging from dysphoric stimuli in altering attention biases. Additionally, the combined condition involved both disengagement and engagement, which allowed us to compared the efficacy of disengagement, engagement, and a combination of the two.

The *content disengagement* condition involved having participants disengage from the emotional content of pictures of sad faces by having participants attend to non-emotional content of images (i.e., the actor's apparent biological sex). This condition theoretically allowed participants to disengage from the dysphoric emotional content of the image, and in doing so we were able to gain more information regarding the efficacy of this method of attention-training. Finally, we directly compared four active training conditions to a control condition in order to address the limitation that no ABM studies directly compare multiple active training conditions. Comparing four active training conditions to a control condition allowed us to evaluate which mechanism of attention-training is the most effective at altering attention.

For this study, participants were randomly assigned to one of five attention-training conditions. All participants completed four training sessions, and completed an eye-tracking task at pre-training and post-training in order to evaluate change in attention. As noted above, identifying which attention-training methods effectively train attention is important to better understand which methods are most likely to change symptoms (Clarke et al., 2014). As such, the primary outcome of this study was change in attention bias for dysphoric and positive stimuli because depression is associated with attention to dysphoric stimuli and away from positive stimuli (Baert et al., 2009; Duque and Vazquez, 2015). The following hypotheses were tested:

1. Each of the active training conditions will result in significant reductions in attention to dysphoric information relative to the control condition.
2. a) Participants in the positive engagement and combined conditions will demonstrate significant increases in attention to positive information relative to the control, and b) the spatial disengagement and content disengagement conditions will not demonstrate significant increases in attention to positive information relative to the control condition.

CHAPTER II

METHODOLOGY

Participants

An a priori power analysis indicated that in order to detect a Cohen's *d* effect size of 0.8 (Beard et al., 2012) we would need to recruit a sample size of 34 participants per condition, with a grand total of 170 participants across all 5 conditions. We planned on recruiting 200 total participants to account for loss of data due to poor quality eye-tracking data, general procedural errors, and scheduling difficulties. After accounting for participants with poor quality eye-tracking data, we recruited a final sample of 209 participants. We specifically recruited males and females who were at least 18 years old; there were no additional requirements for participating in the study. After participants were recruited they were randomly assigned to one of five attention-training condition.

Materials (see Appendix B)

Questionnaires

Demographic Information. Participants provided basic demographic information, such as age, gender, income, race, ethnicity, sexual orientation, prior medical and mental health history, and education history.

Patient Health Questionnaire (PHQ-9). Depression symptoms were measured using the PHQ-9, which is a 9-item self-report measure that assesses the frequency of depressive symptoms over the past two weeks (Kroenke, Spitzer, & Williams, 2001). Scores on the PHQ-9 range from 0 to 27, with greater scores indicating greater severity of depressive symptoms. The PHQ-9 has demonstrated excellent test-retest reliability (r = .84). In the current study, the PHQ-9 demonstrated reliable internal consistency (α = .88). While we did not specifically recruit participants with elevated depressive symptoms, we included the PHQ-9 to evaluate whether any change in attention may be attributed to depressive symptoms.

Generalized Anxiety Disorder 7-item (GAD-7). Anxiety symptoms were measured using the GAD-7, which is a 7-item self-report measure that assesses for severity of anxiety symptoms (Spitzer, Kroenke, Williams, & Lowe, 2006). The GAD-7 asks respondents how often, over the past two weeks, they are bothered by specific symptoms of anxiety. Responses are recorded on a 4-point Likert scale, with lower scores indicating lower frequency of experiencing anxiety symptoms. The GAD-7 has demonstrated excellent test-retest reliability (r = .83), and in the current study the GAD-7 exhibited strong internal validity (α = .91). Anxiety symptoms were also measured for exploratory purposes, specifically to evaluate whether any variation in attention may be related to the experience of anxiety.

Attention Bias Measurement

Eye-tracking task. Participants completed an eye-tracking task at baseline (session 1) and post-test (session 4). The task involved twelve trials of a free-viewing eye-tracking procedure. Each trial contained 4 images, and each image displayed individuals or scenarios that conveyed one of four valences of emotional information: happiness, sadness, threat, or neutral (see Figure 1 for an example eye-tracking trial).

In total, 48 images were chosen, 15 images from the International Affective Picture System (IAPS) database (Lang, Bradley, & Cuthbert, 2008) and 33 images from the EmoPics database (Wessa, Kanske, Neumeister, Bode, Heissler, & Schönfelder, 2010)[1]. Both the IAPS and EmoPics databases were used in order to obtain more well-defined and homogenous image categories. The IAPS and the EmoPics databases are highly comparable as their image rating procedures were near identical; for both databases, participants were asked to rate the valence of each image using the Self-Assessment Manikin (SAM) scales, with lower valence scores representing more unpleasant images (Lang et al, 2008; Wessa et al., 2010). Due to the methodological similarities between the databases, it is sensible to create mean valence ratings for each emotional category even though images were drawn from disparate sources. For this study specifically, we selected images with valence ratings of 6.6 or higher for the positive images, 4.4 or lower for dysphoric and threatening images, and between 4.5 and 6.5 for the neutral images. Prior to conducting the study, Lucas Kelberer and Dr. Tony Wells independently identified each negative image as either “dysphoric” or “threatening”. Any images with conflicting labels were to be removed; however, agreement for the images in this study was perfect between raters. Table 1 provides the means and standard deviations for valence, arousal, RGB, and luminance scores for all of the images used, as well as summary statistics for the one-way ANOVA described below.

[1] The following EmoPics images were used: 013 023 025 027 031 032 037 040 042 043 049 074 093 099 106 115 119 133 145 147 148 149 157 159 208 211 217 219 220 221 222 224 225. The following IAPS images were used: 2457 2683 2691 2811 2900 6231 6312 6510 6520 6530 6540 6561 6562 6571 9332.

As expected, the one-way ANOVA revealed significant differences in valence ratings between the images chosen for the eye-tracking paradigm. Dysphoric and threat images did not differ significantly in valence, but the other comparisons were all significantly different. There were also expected significant differences in arousal between the different categories of images with all image types differing significantly from each other. The ANOVA also revealed significant differences across the categories of emotional stimuli for both luminance and RGB distribution. Luminance and RGB ratings were only significantly different between positive and threatening images.

During the eye-tracking task, the four valences of emotional information were counter-balanced for each trial, meaning that the location of the different valences of emotional information changed in every trial. The experimenter clicked the mouse to proceed to the image slide, but only once participants visually fixated on the cross in the center of the screen. This was done in order to standardize the participants' gaze location at the start of each trial and to prevent the starting gaze location from beginning on the location of any of the images presented in the task. During the task, participants were instructed to freely gaze at the images as if they were looking at a photo album, which is a protocol consistent with past studies that have utilized eye-tracking (e.g., Kellough et al., 2008). Each trial lasted 30 seconds, and the experimenters instructed participants to focus on the images on the slide if their gaze strayed from the slide. Throughout the eye-tracking paradigm, participants sat 60-70 cm away from the viewing monitor in order to improve the accuracy of the eye-tracking data. Each image measured approximately 11.4 cm (10° visual angle) by 9.8 cm (8.6° visual angle) on the screen.

Eye-tracking technology. Line of visual gaze was assessed using a Tobii T60 eye-tracker in conjunction with the accompanying Tobii Studio Software. The viewing screen measures 17 inches diagonally and has a display resolution of 1280x1024 pixels. The T60 has binocular infrared sensors that detect the position of the pupils and corneal reflection in both eyes as a metric of attention. Gaze location was sampled every 16.7 ms (or 60 Hz). Each image that displayed one of the valences of emotional information was identified as an area of interest (AOI) in order to directly associate attentional gaze to stimuli of a given emotional valence.

Eye-tracking outcomes. Using Tobii Studio Software, several indices of attention were calculated for each AOI. Total visit duration (TVD) was the primary index used to assess for attention bias in this study. Prior research has utilized TVD as a primary index of attention because it is related to sustained stages of information processing (Armstrong & Olatungi, 2012; Peckham et al., 2010). A visit is defined as the amount of time an individual spends attending to a given AOI throughout the duration of stimuli presentation. Visits for each AOI were summed across all trials, creating a TVD variable for each valence of emotional information. Separate TVD variables were created for baseline and post-training measurements of attention. While TVD is the most common metric used to assess for sustained attention bias in eye-tracking research, additional indices of attention were also calculated and utilized as part of exploratory analyses for this project.

Attention Bias Modification

For this study, participants completed four separate sessions of ABM training. Consistent with prior ABM research (e.g., Wells & Beevers, 2010), all four training sessions were scheduled within a 2-week period. The ABM paradigms used for this study were created in E-Prime, which is a program that is frequently used for designing behavioral experiments. Each individual training session involved 144 training trials; participants completed 576 trials in total after completing all four training sessions, which is consistent with past ABM research (e.g., MacLeod et al., 2002). Participants were randomized to one of the five attention-training conditions by the computer program in order to keep the researchers blind to condition. Prior to beginning the task, the participants were provided with instructions for their task. They were also given four test trials and were provided feedback concerning whether they completed the test trials correctly. Feedback was not provided during the rest of the trials. Halfway through the ABM task, participants were given the opportunity to take a small break.

The images utilized for the ABM tasks were selected from the Karolinska Directed Emotional Faces database[2] (KDEF; Lundqvist, Flykt, & Öhman, 1998). Across the ABM programs, 56 total images were utilized, with 24 images selected from both the sad and happy categories, and the remaining 8 images selected from the neutral category. The faces were selected for their reliability in being identified as the correct emotional expression. For the images utilized in the current study, participants correctly identified dysphoric images at an average rate of 91.43%, positive images at an average rate of 97.29%, and neutral images at an average rate of 98.57% (Calvo & Lundqvist, 2008).

[2] The following KDEF images were used: AF07SAS, AF11SAS, AF13SAS, AF19SAS, AF20SAS, AM04SAS, AM05SAS, AM06SAS, AM11SAS, AM14SAS, AM17SAS, AM18SAS, AM30SAS, BF06SAS, BF11SAS, BF13SAS, BF17SAS, BF22SAS, BF24SAS, BF28SAS, BM01SAS, BM23SAS, BM25SAS, BM34SAS, AF07HAS, AF11HAS, AF13HAS, AF19HAS, AF20HAS, AM04HAS, AM05HAS, AM06HAS, AM11HAS, AM14HAS, AM17HAS, AM18HAS, AM30HAS, BF06HAS, BF11HAS, BF13HAS, BF17HAS, BF22HAS, BF24HAS, BF28HAS, BM01HAS, BM23HAS, BM25HAS, BM34HAS, AF07NES, AF11NES, AF13NES, AF19NES, AM04NES, AM05NES, AM11NES, AM14NES

The images chosen for the ABM tasks were equally distributed between male and female actors. See Figure 2 for examples of each training condition.

Spatial Disengagement. Participants who were randomly assigned to this condition (N = 46) were instructed that they needed to identify a probe image when it appeared on the screen. The instructions stated that they should keep their right and left index fingers over the 'M' and 'N' keys, respectively, and to press the 'M' key if the image is a dollar sign ($) or to press the 'N' key if the probe image is a percent sign (%). After the offset of the central fixation cross, a dysphoric face was presented in the center of the screen. After 1000 ms, an image with no emotional valence (i.e., a gray square) appeared either to the left or the right of the centrally-presented face. After 1000 ms, the gray square disappeared and the visual probe (dollar or percent sign) appeared in the same visual field where the gray image previously appeared. For the spatial disengagement condition, participants were asked to identify the probe image as quickly as possible. The dysphoric face remained present on the screen until the participant responded to the probe, or until 1000 ms passed. This constraint was placed on participants' response times as longer response latencies could have potentially reduced the likelihood that a contingency was established between the emotional content of the dysphoric stimuli and the location of the probe image. Moreover, limiting participants' response times has been utilized in other ABM tasks (e.g., Sharpe, Johnson, & Dear, 2015; Mayer, Wilcox, Dodd, Klimaj, Dekonenko, Claus, & Pogenschutz, 2016). The 24 dysphoric stimuli used for this task were presented in a random order for each participant. Moreover, each cycle of 24 images in each training session of 144 trials was presented in a different random order.

Participants who were randomly assigned to this condition were trained to disengage from dysphoric stimuli. They visually engaged with the dysphoric stimulus because the stimulus appeared in the location of the fixation cross. Then, participants disengaged with the dysphoric stimulus, attending towards the gray square, which signaled the location of the probe with 100% accuracy.

Positive Engagement. Participants who were randomly assigned to this condition (N = 39) were provided with instructions that were identical to the instructions for the spatial disengagement condition; participants were instructed that they were supposed to identify the probe image ($ or %) that appeared throughout the task. For this condition, a centrally presented image with no emotional valence (a gray square) was shown in the center of the screen for 1000 ms. After that time, an image displaying a happy face appeared to either side of the gray square. After another 1000 ms, the happy face disappeared and the probe image appeared in the same visual field where the image of the happy face was previously located. Participants were required to identify the probe as quickly and accurately as possible. The 24 happy stimuli were presented in a different random order for each participant, and each cycle of 24 images in each training session of 144 trials was presented in a new random order. The probe stimulus remained on the screen until the participant responded, or until 1000 ms passed.

Participants who were randomly assigned to this condition were trained to specifically attend toward positive stimuli. First, they engaged with the non-emotional image because it appeared in the location of the fixation cross. Then, participants attended toward a positive image, which signaled the location of the probe with 100% accuracy.

Combined. Participants who were randomly assigned to this condition (N = 41) were provided instructions that mirrored instructions from the spatial disengagement and positive engagement condition. Initially, a centrally presented dysphoric face appeared for 1000 ms. Then, a happy face was presented on either side of the central dysphoric face and remained on screen with the dysphoric face for 1000 ms. After this time, the happy image disappeared and a probe image immediately appeared in the same visual field where the happy face was presented previously. Consistent with other conditions, participants were asked to identify the probe image as quickly and accurately as possible. The dysphoric face remained on the screen with the probe image until the participant responded or until 1000 ms passed. The 24 dysphoric images and 24 positive images were presented in a different random order for each participants, and each cycle of 24 images in each training session of 144 trials was presented in a new random order.

Participants who were randomly assigned to this condition were trained to specifically shift their attention away from dysphoric stimuli and toward positive stimuli. First, they visually engaged with the centrally-presented dysphoric stimuli because it appeared in the location of the fixation cross. Then, participants disengaged from the dysphoric image and attended toward the positive image, which signaled the location of the probe image with 100% accuracy.

Content Disengagement. Participants who were randomly assigned to this condition (N = 45) were instructed to identify the apparent biological sex of the actor displayed in the images throughout the task. More specifically, participants were told to keep their right and left index fingers over the ‘M’ and ‘N’ keys, respectively, and to press the ‘M’ key if they thought the actor was male or the ‘N’ key if they thought the actor was female. After they completed the instructions and test trials, participants began the training phase. Following the offset of the fixation cross, a dysphoric face was presented in the center of the screen. The 24 dysphoric stimuli were presented in a different random order for each participant, and each cycle of 24 images in each training session of 144 trials was presented in a new random order. For this condition, the centrally presented dysphoric images were displayed until the participant provided a response, or until 1000 ms passed.

Participants who were randomly assigned to this condition were trained to disengage from the dysphoric emotional content of the image. While participants still be visually engaged with the dysphoric image, the focus of their attention was on the physical details of the actors and not on the emotional content of the image.

Control. Participants randomized to this condition (N = 38) were provided with instructions that mirrored the instructions and structure from the positive engagement condition. Following the offset of the fixation cross, a centrally-presented gray square was shown on the screen for 1000 ms. After this time, an image displaying either a dysphoric, positive, or neutral face appeared to either side of the gray square. Like with other conditions, participants randomized to the control condition were asked to identify the probe as quickly and as accurately as possible. For this condition, dysphoric, positive, and neutral faces were displayed with equal frequency across all the trials. The image of the face remained on the screen until the participant provided a response, or until 1000 ms passed. The 8 dysphoric stimuli, 8 positive stimuli, and 8 neutral stimuli utilized throughout this task were all presented in a different random order for each participant.

Moreover, each cycle of 24 images in each training session of 144 trials was presented in a new random order.

Participants who were randomly assigned to this condition were trained to attend equally toward dysphoric, positive, and neutral images. Initially, they engaged with the image of the gray square because it appeared in the location of the fixation cross. Then, participants shifted their attention toward an image of either a dysphoric, positive, or neutral face, which signaled the location of the probe with 100% accuracy.

Procedure

All data collection and study procedures were conducted in North Murray 023 in the Behavior, Affect, and Thinking Laboratory. Participants completed four study sessions within a two-week period. After arriving to the lab for the first session, participants provided informed consent to participate in the study. Afterward, participants completed self-report measures for depressive and anxiety symptoms. Then, participants completed the eye-tracking task in order to evaluate attentional biases. After participants completed their baseline attention measurements, they completed their first attention-training task. For the second and third sessions, participants completed additional attention-training tasks. For the fourth session, participants completed the final training task, followed by the same questionnaires and eye-tracking task administered in the initial training session. After completing the study procedures for the fourth session, participants were debriefed regarding the purposes of the study.

Analytic Plan

Prior to running the analyses, a change score in total visit duration (TVD) for dysphoric stimuli was created by subtracting the pre-training TVD for dysphoric stimuli from the post-training TVD for dysphoric stimuli. We also created a change score in TVD for positive information by subtracting the pre-training TVD for positive stimuli from the post-training TVD for positive stimuli. We created two additional change variables for changes in TVD for neutral and threatening information. In order to control for multiple comparisons in the analyses for our hypotheses and for the exploratory analyses, we utilized a *p*-value of <.0125 to indicate statistical significance.

CHAPTER III

RESULTS

Two-hundred and twenty-one participants from Oklahoma State University completed all four sessions for the study. Twelve participants were removed from the sample due to poor quality in eye-tracking data (i.e., <70% valid eye-tracking data on the eye-tracking task), resulting in a final sample of 209 participants whose data were used in the analyses. Participants had a mean age of 19.00 (SD = 1.05), and 75.1% of participants identified as female. Participants were primarily Caucasian (74.2%), and 11% were Black or African American, 5.3% were Native American or Alaskan Native, 3.3% were Asian or Asian American, and 1.9% did not answer. Eight point one percent of participants identified as being Hispanic or Latino/a.

Hypotheses Results

To test hypothesis 1 – that each of the active training conditions would result in significant reductions in attention to dysphoric information relative to the control condition – four planned independent samples t-tests were conducted. The results are depicted in Figure 3.

The results of these analyses suggested that none of the active training conditions resulted in a significant decrease in attention for dysphoric information compared to the control condition; change in attention for dysphoric information was not statistically significantly different between the control condition and the spatial disengagement, $t(82) = .56$, $p = .58$, $d = .12$, positive engagement, $t(75) = .48$, $p = .63$, $d = .11$, combined, $t(77) = .47$, $p = .64$, $d = .11$, or content disengagement conditions, $t(81) = -1.61$, $p = .11$, $d = .36$. As hypothesis 1 was not supported, these findings suggest that none of the active training conditions were more effective than the control condition in reducing attention for dysphoric information.

To test hypothesis 2a – that participants in the positive engagement and combined conditions would demonstrate significant increases in attention to positive information relative to control – and hypothesis 2b – that participants in the spatial disengagement and content disengagement conditions would not demonstrate significant increases in attention to positive information relative to control – four planned independent samples t-tests were conducted. The results of these analyses are also depicted in Figure 3. The results of these analyses suggested that none of the active training conditions resulted in a significant increase in attention for positive information compared to the control condition; change in attention for positive information was not statistically significantly different between the control condition and the spatial disengagement, $t(82) = .67$, $p = .51$, $d = .15$, positive engagement, $t(75) = -.41$, $p = .68$, $d = .09$, combined, $t(77) = -.47$, $p = .64$, $d = .11$, or content disengagement conditions, $t(81) = 1.78$, $p = .08$, $d = .40$. As hypothesis 2a was not supported and hypothesis 2b was supported, these findings suggest that the active training conditions were not more effective than the control condition in increasing attention to positive information.

Exploratory Analyses

Relationships between Different Indices of Attention

We conducted a correlation analysis to evaluate the relationships between total visit duration and other indices of attention, including total fixation duration, fixation count, and first fixation duration. We focused on evaluating the relationships between these indices of attention within specific categories of emotional information (e.g., TVD for dysphoric and fixation count for dysphoric). The results of this analysis are depicted in Table 2. The relationships between total visit duration, total fixation duration, and fixation count were all significant at $p < .001$. As expected, first fixation duration, which is a metric for difficulty disengaging from stimuli, was not positively correlated with any of the indices of sustained attention.

Changes in Attention for Threat and Neutral Information

We also evaluated whether any of our active training conditions differed from the control condition in regard to changes in attention for neutral and threatening information. Four independent samples t-tests were conducted in over to evaluate for differences between the training conditions and control condition in regard to change in TVD for neutral information. Four additional independent samples t-tests were conducted in order to evaluate for differences between the training conditions and control condition in regard to change in TVD for threatening information. The results of these analyses are depicted in Figure 4. The results indicate that none of the active training conditions differed significantly from the control condition in regard to change in attention for neutral information (all *p*-values > .18) or threatening information (all *p*-values > .11).

Effects of Condition on Alternate Attention Indices

A 4 (stimulus type) x 2 (time) x 2 (condition) repeated measures ANOVA with condition as the between-subjects factor was conducted in order to evaluate whether there were differences between the conditions in changes in *fixation duration*. There was a significant main effect of time, $F = 3.95$, $p = .048$, $\eta_p^2 = .02$, which was driven by greater fixation duration at pre-training compared to post-training. There was also a significant main effect of stimulus type, $F = 30.47$, $p < .001$, $\eta_p^2 = .31$, which was driven by greater average fixation duration for positive information compared to the other valences of emotional information. The main effect of condition and the time by condition, stimulus by condition, stimulus by time, and time by stimulus by condition interactions were all non-significant ($p > .09$ for the main effect and interactions).

An additional 4 (stimulus type) x 2 (time) x 2 (condition) repeated measures ANOVA with condition as the between-subjects factor was conducted in order to evaluate whether there were differences between the conditions in changes in *fixation count*. There was a main effect of time, $F = 13.68$, $p < .001$, $\eta_p^2 = .06$, which was driven by greater number of fixation counts at pre-training compared to post-training. There was also a main effect of stimulus type, $F = 29.82$, $p < .001$, $\eta_p^2 = .31$, which was driven by significantly greater number of fixations for positive information compared to the other categories of emotional information. There was also a significant time by stimulus type interaction, $F = 3.33$, $p < .021$, $\eta_p^2 = .05$, which was driven by decreases in fixation count for dysphoric ($t = 3.44$, $p = .001$), neutral ($t = 2.26$, $p = .03$), and threatening ($t = 4.38$, $p < .001$) information from pre-training to post-training. The main effect of condition and the time by condition, stimulus by condition, and time by stimulus by condition interactions were all non-significant ($p > .40$ for all interactions).

Another 4 (stimulus type) x 2 (time) x 2 (condition) repeated measures ANOVA with condition as the between-subjects factor was conducted in order to evaluate whether there were differences between the conditions in changes in *first fixation duration*. There was a main effect of stimulus type, $F = 10.61$, $p < .001$, $\eta_p^2 = .14$, which was driven by a greater average first fixation duration for positive information compared to the other valences of emotional information. The main effect of time was marginally non-significant, $F = 3.23$, $p = .074$, $\eta_p^2 = .02$. The main effect of condition and the time by condition, stimulus type by condition, time by stimulus type, and time by stimulus type by condition interactions were all non-significant ($p > .17$ for the main effect and all interactions).

Relationship between Attention and Depression and Anxiety Symptoms

In order to evaluate whether depression symptoms were related to change in attention in all of our conditions, we conducted a 4 (stimulus type) x 2 (time) x 2 (condition) repeated measures ANOVA, with pre-training PHQ-9 scores included as a covariate. The time by depression symptom interaction was not significant, $F = .77$, $p = .38$, $\eta_p^2 = .004$, indicating that depression symptoms did not change from pre-training to post-training across all conditions. The stimulus type by depression symptom interaction was also not significant, F = 1.49, p = .22, η_p^2 = .02, indicating that depression symptoms were not related to attention for different categories of emotional information. The time by stimulus type by depression symptom interaction was not significant, F = .26, p = .85, η_p^2 = .004, indicating that depression symptom severity was not related to change in attention for any category of emotional information across all of the training conditions. Finally, the time by stimulus type by condition interaction with depressive symptoms as a covariate was also not significant, F = 1.30, p = .22, η_p^2 = .025, indicating that, when controlling for depressive symptoms, there were no significant differences in changes in total visit duration across for any category of information across all of the conditions.

Additional analyses were conducted in order to evaluate whether anxiety symptoms were related to change in attention in all of our conditions. We conducted a 4 (stimulus type) x 2 (time) x 2 (condition) repeated measures ANOVA, with pre-training GAD-7 scores included as a covariate. The time by anxiety symptom interaction was not significant, F = .895, p = .345, η_p^2 = .004, indicating that anxiety symptoms did not change from pre-training to post-training across all conditions. The stimulus type by anxiety symptom interaction was also not significant, F = 1.61, p = .190, η_p^2 = .024, indicating that anxiety symptoms were not related to attention for different categories of emotional information. The time by stimulus type by anxiety symptom interaction was not significant, F = .450, p = .718, η_p^2 = .007, indicating that anxiety symptom severity was not related to change in attention for any category of emotional information across all of the training conditions. Finally, the time by stimulus type by condition interaction with anxiety symptoms as a covariate was also not significant, F = 1.32, p = .20, η_p^2 = .026, indicating that, when controlling for anxiety symptoms, there were no significant differences in changes in total visit duration for any category of information across all conditions.

We also conducted correlational analyses across all conditions in order to evaluate for any significant relationships between change in attention for all categories of emotional information, change in depressive symptoms, and change in anxiety symptoms. Results from this analysis are displayed on Table 3. The analyses revealed that across all conditions, there were no significant relationships between changes in depression or anxiety symptoms and changes in total visit duration for any category of emotional information (all p-values > .12).

Changes from Pre- to Post-Training Compared to No Change

We conducted exploratory analyses to determine if the training conditions resulted in changes from pre- to post-training that differed significantly from zero. Despite the fact that the training conditions did not differ from the control condition, this would allow us to identify effects that may be fruitful to explore in future studies. A one-sample t-test was conducted for each of the conditions comparing values to zero. Change in attention for dysphoric, positive, threatening, and neutral information, as well as change scores for depression and anxiety symptoms were utilized as the outcome variables. Changes in attention for dysphoric and positive information are depicted in Figure 3 on page 26, changes in attention for neutral and threatening information are depicted in Figure 4 on page 29, and changes in depression and anxiety symptoms are depicted below in Figure 5.

The *spatial disengagement* condition did not result in significant changes in attention to any valence of emotional information, depression symptoms, or anxiety symptoms compared to no change (all *p*-values > .08).

The *positive engagement* condition resulted in a marginally non-significant decrease in attention for neutral information, $t(38) = -1.948$, $p = .059$, $d = -.32$, and a significant decrease in depressive symptoms, $t(38) = -2.30$, $p = .027$, $d = -.37$, compared to no change. This condition did not result in significant changes in attention to dysphoric, attention to positive, attention to threatening, or anxiety symptoms compared to no change (all *p*-values > .07).

The *combined condition* demonstrated a significant reduction in anxiety symptoms $t(40) = -2.20$, $p = .034$, $d = -.34$, compared to no change, but did not result in significant changes in attention to any valence of emotional information or depressive symptoms compared (all *p*-values > .20).

The *content disengagement* condition resulted in a significant reduction in attention for dysphoric information, $t(44) = -2.96$, $p = .005$, $d = -.44$, attention for threatening information, $t(44) = -2.81$, $p = .007$, $d = -.42$, and a significant increase in attention to positive information, $t(44) = 2.55$, $p = .014$, $d = .38$, compared to no change. The content disengagement condition did not result in significant changes in attention to neutral information, depressive symptoms, or anxiety symptoms compared to no change (all *p*-values > .14).

The *control condition* demonstrated significant reductions in anxiety symptoms, $t(37) = -2.70$, $p = .011$, $d = -.44$, compared to no change, but did not result in significant changes in attention to any valence of emotional information or depressive symptoms (all *p*-values > .53).

Gender Differences in Attention

An independent samples t-test was conducted in order evaluate whether there were any gender differences in pre-training attention, post-training attention, or changes in attention. Results of this analysis are depicted in Table 4. The results suggest that females spent significantly less time attending to threatening information than males at pre-training, $t(206) = -2.31$, $p = .02$, $d = .40$, and post-training, $t(206) = -2.42$, $p = .02$, $d = .39$. Additionally, females spent significantly less time attending to neutral information than males at pre-training, $t(206) = -2.14$, $p = .033$, $d = .33$. There were no other significant differences between genders on the remaining indices of attention.

CHAPTER IV

DISCUSSION

Summary of Findings

The current study compared four active attention-training methods to a control condition in order to evaluate which mechanisms of attention-training are effective for changing attention. Our first hypothesis, that the active training conditions would result in significant reductions in attention for dysphoric information relative to the control condition, was not supported. None of the methods of attention-training employed in this study were more effective in altering attention for dysphoric stimuli compared to engaging equally to dysphoric, neutral, and positive information. This finding stands in contrast to prior studies that have found a significant effect of ABM on attention to dysphoric information (Wells & Beevers, 2010; Beevers et al., 2015; Yang et al., 2015; LeMoult et al., 2016 Yang et al., 2016), but it is consistent with past literature that did not find dot-probe ABM tasks effective for altering attention biases for dysphoric information (Baert et al., 2010; Arditte & Joormann, 2014; Notebaert et al., 2015).

We did not find support for hypothesis 2a, that the positive engagement and combined conditions would result in increased attention to positive information compared to the control condition.

These results are in contrast to findings supporting training attention to positive information as a means of enhancing attention biases for positive information (Browning et al., 2012; LeMoult et al., 2016). However, this finding adds to literature suggesting this mechanism of attention-training is not effective at enhancing attention for positive information compared to no training (Arditte & Joormann, 2014; Notebaert et al., 2015). Further, we found support for hypothesis 2b, that the spatial disengagement and content disengagement condition would not result in increased attention to positive information compared to the control condition. Taken together, these findings imply that no method of ABM employed in the current study was effective at increasing attention to positive information.

The current study was adequately powered to detect the hypothesized effects – if the size of the effect as reported in Beard and colleagues (2012) is an accurate representation of the true effect size – so the lack of differences between active and control conditions indicates that the effect of ABM on attention change in the current study was non-existent. Recent meta-analyses suggest that ABM has questionable efficacy in regard to changing attention for dysphoric information (Mogoaşe et al., 2014; Cristea et al., 2015). The findings from the current study further highlight the questionable efficacy of ABM outlined in these meta-analyses; since none of our active training conditions differed from the control condition, the current study suggests that, regardless of the method, ABM is not an effective method of altering attention for dysphoric information. There are several potential reasons why the current study did not find a significant ABM effect and these are discussed in more detail below.

Possible Reasons for Null Findings

It is common for ABM studies to use a standard (i.e., non-training) dot-probe or other standard non-training task as a control condition (e.g., Wells and Beevers, 2010; Baert et al., 2010; LeMoult et al., 2016), and the current study followed this convention by employing a dot-probe task designed to train attention equally toward dysphoric, neutral, and positive information. By training attention equally toward multiple valences of emotional information, this type of control condition should theoretically result in no change in attention bias. While there is evidence that this type of control condition does not result in changes in attention (e.g., Wells & Beevers, 2010; Yang et al., 2015), this type of control condition may possess some unintended training effects. Prior ABM studies have found that other methodologically similar control conditions have yielded unexpected changes in attention (Boettcher, Berger, & Renneberg, 2012; Badura-Brack, Naim, Ryan, Levy, Abend, Khanna, McDermott, Pine, & Bar-Haim, 2015; Price, Kuckertz, Amir, Bar-Haim, Carlbring, & Wallace, 2017).

It has been suggested that while this type of control condition does not directly alter attention biases, it may result in enhanced attentional control (Heeren, Mogoaşe, McNally, Schmitz, & Phillippot, 2015; Heeren, De Raedt, Koster, & Phillippot, 2013). Attentional control is associated with improved emotion regulation, as enhancing attentional control improves one’s ability to disengage and shift attention away from emotionally distressing information to improve mood (Gross & Thompson, 2007; Bardeen, Tull, Dixon-Gordon, Stevens, & Gratz, 2015). Therefore, our control condition may have resulted in improved attentional control, thereby reducing our ability to detect differences in changes in attention between conditions.

Alternatively, it has been argued that a no-training condition designed to train attention equally to multiple valences of emotional information may unintentionally resulted in direct changes in attention for emotional information (Schoorl, Putman, & Does, 2012; McNally, 2018). Because this type of control condition involves training attention equally toward different categories of emotional information, the trials that involve training attention toward emotionally positive information may constitute a lower dose of ABM, which can result in adaptive changes in attention bias. Following this logic, it possible that requiring participants to attend equally to neutral, dysphoric, and positive information in the current study conferred some benefits because the task still involved attending toward positive and neutral information. However, participants in our control condition did not demonstrate any significant changes in attention compared to no change, therefore the null findings were likely not due to an over-active control condition.

Another criticism of ABM studies is that they may not have provided participants with enough training trials or a sufficient "dose" of ABM that was adequate to modify attention (Kuckertz & Amir, 2015). The attention-training conditions evaluated in the current study had a higher number of training trials than other ABM tasks that were successfully able to alter attentional biases (e.g., LeMoult et al., 2016; Beshai et al., 2014). While the amount of training trials we utilized theoretically should have been sufficient to alter attention, a meta-analysis evaluating 12 ABM studies found that number of sessions moderated the effect of attention-training on change in attention bias (Hakamata, Lissek, Bar-Haim, Britton, Fox, Leibenluft, Ernst, & Pine, 2010). Additionally, attention-training paradigms that have consisted of a greater number of training sessions have demonstrated more success in modifying attention for negative and positive information (e.g., Wells & Beevers, 2010; Beevers et al., 2015; Yang et al., 2015; Yang et al., 2016). It is possible that the "dosage" of ABM administered in the current study was not sufficient to affect attention bias, which would at least partially explain our null findings.

A methodological factor that may have also contributed to the lack of differences between the training and control conditions is the orientation of stimuli. Past meta-analyses have found that the orientation of stimuli in ABM tasks is a factor that influences the effectiveness of attention-training. Attention-training tasks utilizing a top-bottom (vertical) stimuli orientation have achieved greater effects than tasks utilizing a left-right (horizontal) orientation (Hakamata et al., 2010; Beard et al., 2012). In the current study, the stimuli were presented in a horizontal orientation across all conditions, which may have by itself been a limiting factor for our active training conditions. A study conducted by Meier and Robinson (2006) found that negative affect in general, and depressive symptoms specifically, are associated with selective attention downward. The authors suggest that altering this vertical bias in selective attention may reduce the intensity of depressive symptoms. As such, utilizing a vertical presentation could have resulted in greater training effects on attention.

In the current study, the instructions of the active training conditions did not inform participants to the contingency between probe stimuli and emotional stimuli in their respective attention-training tasks. This 'implicit' method of training is thought to produce more generalized effects of attention-training (MacLeod & Mathews, 2012), and it has been used to successfully train attention without informing participants about the target-stimulus contingency in the dot-probe tasks (e.g., Wells and Beevers, 2010; Beevers et al., 2015; LeMoult et al., 2016). However, there is evidence to suggest that providing participants with explicit instructions (i.e., providing information regarding the contingency between probe stimulus and target stimulus) enhances the effect of attention-training on altering attention biases (Krebs, Hirsch, & Mathews, 2010; Grafton, Mackintosh, Vujic, & MacLeod, 2013; Nishiguchi, Takano, & Tanno, 2015). Providing explicit instructions may require participants to control their attention in a top-down fashion in order to attend away from negative stimuli (Nishiguchi et al., 2015). Further, a top-down mechanism of attentional control is thought to require more effort, which may enhance the effect of attention-training for participants receiving explicit instructions. Given these findings regarding explicit instruction presentation, it is possible that utilizing implicit training instructions reduced the effectiveness of our attention-training paradigms.

It is also possible that we were not able to detect differences between our active training conditions and control condition because our participants did not demonstrate depressive attentional biases at baseline. Across all conditions, participants on average spent more time attending to positive stimuli than dysphoric stimuli, therefore attempting to decrease attention to dysphoric information and/or increase attention to positive information may have been difficult without any pre-existing depressive attentional patterns. Mastikhina and Dobson (2017) conducted a replication of the study conducted by Wells and Beevers (2010), and while ABM was effective at improving depressive symptoms, their training conditions did not result in a significant change in attention bias. The authors suggested that the lack of change in attention bias may be due to their participants not demonstrating any attention biases for dysphoric information, even though they endorsed elevated depressive symptoms. Moreover, Krujit and Carlbring suggested that ABM programs may not be effective in altering attention because, "pre-existing [attention] bias is a prerequisite for successful modification of bias through contingency-based [A]BM" (2018, p. 16). As our sample did not demonstrate depressive attention biases prior to training, it is possible that our training conditions were not able to alter attention in the hypothesized directions because participants already had attention biases away from dysphoric information and toward positive information.

Not only can pre-existing attentional biases affect the success of ABM programs, but the variance of attentional biases over time also contributes to the efficacy of ABM. Heeren, Phillippot, and Koster (2014) evaluated how stable and dynamic components of attention bias affect the performance of ABM tasks. The authors evaluated attention biases at two time points prior to having participants complete an ABM task. The stable attention bias component was defined as variance shared in attention bias between the two timepoints, and the dynamic attention bias component was defined as the variance specific to a given timepoint. The findings from this study suggest that the stable component predicted maintenance of attention bias toward negative information after the ABM task, while the dynamic component was predictive of improvement following the task. This suggests that attention biases that are more stable prior to attention-training are more resistant to change. While our study design does not permit us to evaluate stability of attention biases prior to training, more stable attention biases at baseline could have potentially hindered the efficacy of our ABM conditions.

Another criticism regarding the inconsistency of ABM tasks in altering depressive attention biases is that during the dot-probe task, participants may ignore the valence of the emotional stimuli presented and only focus their attention on the probe when it is presented (Notebaert et al., 2015; Ferrari, Möbius, van Opdorp, Becker, & Rinck, 2016). By not attending to the stimuli in dot-probe ABM tasks, participants would theoretically fail to establish a contingency between the probe image and emotional information, therefore reducing the efficacy of ABM tasks. It is possible that our null findings may also be partially explained by participants not paying attention to the stimuli in the task. In order to address this issue in standard dot-probe ABM tasks, a novel attention-training task that employs eye-tracking as opposed to a dot-probe paradigm has been evaluated. The trials of eye-tracking ABM tasks (ET-ABM) are controlled by participants' eye movements, in that participants must engage with specific valences of emotional information before they can proceed with subsequent trials. This type of attention-training task helps to ensure that participants visually engage with the emotional stimuli and probe stimuli, and while ET-ABM has only been evaluated in two studies to our knowledge, it has been able to reduce depressogenic attention biases in healthy and dysphoric individuals (Ferrari et al., 2016; Möbius, Ferrari, van den Bergh, Becker, & Rinck, 2018). It is important for future studies to continue to evaluate the efficacy of ET-ABM in altering depressive attentional biases, as the design of ET-ABM tasks helps to ensure that participants are attending to the stimuli in the intended manner.

The above paragraphs discuss possible reasons why the current study may have failed to detect an ABM effect. However, it should also be noted that the current study may not have detected an effect because dot-probe attention-training tasks have been argued to be generally inefficacious in altering attentional patterns in depression (Emmelkamp, 2012). As previously mentioned, multiple meta-analyses have highlighted that ABM has generally demonstrated small and variable effect sizes in regard to altering depressive-attention biases (Beard et al., 2012; Mogoaşe et al., 2014; Cristea et al., 2015). Some authors have argued that the ineffectiveness of dot-probe ABM tasks in changing depressive attention biases may be due to the fact that these tasks target automatic attentional processes. More specifically, attentional patterns in depression are related to controlled and elaborative cognitive processes, so dot-probe ABM tasks may fail to reliably alter depressive attention patterns because they target automatic rather than elaborative attention processes (Disner, Beevers, Haigh, & Beck, 2011; Teachman, Joormann, Steinman, & Gotlib, 2012; Duque & Vazquez, 2018). Since dot-probe tasks have successfully altered attention for dysphoric information in several studies (Wells & Beevers, 2010; Beevers et al., 2015; Yang et al., 2015), it has also been suggested that targeting automatic attentional processes through dot-probe tasks can still result in changes in depressive attention biases. However, there is growing evidence to suggest that failing to target and train controlled attention processes can render dot-probe ABM tasks ineffective in the context of depression. Thus, it is possible that attention-training aimed specifically at enhancing controlled attention processes rather than automatic processes may be more effective at modifying attention biases found in depression.

Alternatively, our results may reflect a genuine result indicating that ABM does not effectively alter attention bias. As noted above, there is considerable heterogeneity in results of ABM on depression biases and symptoms (Mogoaşe et al., 2014; Cristea et al., 2015). The small overall effect reported by these meta-analyses may reflect a publication bias for positive results or other research-related biases (Francis, 2012; Lindsay, 2015). Nevertheless, the current study contributes to the field by providing some boundary conditions on the efficacy of ABM for modifying depressogenic biases.

Exploratory Findings

Exploratory analyses revealed that pre-training depressive and anxiety symptoms did not affect change in attention for emotional information across all of our conditions. These findings imply that initial depression or anxiety symptom severity does not necessarily affect whether attention-training paradigms resulted in successful change in attention for any category of emotional information. These findings are in contrast to prior work suggesting that the efficacy of ABM in altering attention is dependent on symptom severity; in a study conducted by Baert and colleagues (2010), they found that participants with mild depressive symptoms experienced a change in attention after completing an attention-training paradigm, but that participants with moderate to severe depressive symptoms did not experience a change in attention or symptomology. These contrasting findings may be explained by differences in the composition of samples. In the experiments conducted by Baert and colleagues (2010), their samples were comprised of individuals with a broad range of depressive symptoms. Our sample demonstrated a relatively limited range of pre-training depression symptoms in the current study (4 participants fell into the severe category of depressive symptoms), so it may be the case that if our sample was comprised of a greater number of participants with moderate to severe depressive symptoms we may have found findings consistent with Baert and colleagues (2010). Nevertheless, this finding provides evidence that symptom severity does not affect magnitude of change in attention after completing an attention-training task.

Additionally, our results indicate that change in depressive symptoms was not significantly associated with change in attention for dysphoric information. This finding is in contrast to prior work suggesting that altering attention is a necessary mechanistic component of ABM programs in order to yield a reduction in depressive symptoms (Baert, De Raedt, Schacht, & Koster, 2010; Clarke et al., 2014). At the same time, our sample was not comprised of individuals with elevated depressive symptoms, and as stated above our sample did not demonstrate typical depressive attentional patterns. Therefore, the composition of our sample may have precluded us from being able to detect a relationship between change in attention and change in symptoms, as there was a limited range for depressive symptoms and depressive attention biases. Still, the lack of relationship between change in attention and change in symptoms in the current sample highlights the need to further understand whether altering attention serves as the mechanism for change in depressive symptoms in ABM tasks.

While there were no differences between the active training conditions and control condition in regard to change in dysphoric and positive information, the content disengagement condition resulted in significant decreases in attention for dysphoric and significant increases for positive information compared to no change. None of the other active training conditions resulted in significant changes in attention to dysphoric or positive information compared to no change. These findings should be interpreted cautiously given that the content disengagement condition did not differ significantly from the control condition; however, these results are consistent with prior work indicating that disengaging with the emotional content of emotional images may be a more effective method of altering depressive attentional patterns compared to standard dot-probe tasks (Notebaert et al., 2015). This finding highlights the need for future attention-training studies to expand to novel tasks designed to alter attention, such as ET-ABM or other attention-training methods that involve disengagement from emotional content.

Prior work evaluating attention biases suggests that some attention biases may be facilitated by gender differences. More specifically, previous studies suggest that men demonstrate decreased attention to emotional faces generally compared to women (Pfabigan, Lamplmayr-Kragl, Pintzinger, Sailer, & Tran, 2014). Moreover, past studies have found that men spend more time attending to neutral information, and women spend more time attending to socially threatening faces (i.e., disgust faces; Kraines, Kelberer, & Wells, 2017; Goos & Silverman, 2002). In the current study, gender was not related to differences in attention training, but our exploratory analyses revealed that males spent more time attending to scenes displaying threat-related situations prior to and after completing the attention training paradigms, which is consistent with other work indicating males demonstrate attentional biases toward angry faces (Rotter & Rotter, 1988). Males also spent more time attending to emotionally neutral scenes prior to completing the attention-training paradigms, which is consistent with past work (Kraines et al., 2017). The effect of gender on attention biases is a relatively understudied area of research, and the findings from the current study indicate that additional studies are required in order to better understand how gender can influence attention biases.

Limitations

Limitations of the current study include the use of an undergraduate student sample, as these findings may not translate to the general population. Moreover, our sample demonstrated low levels of psychopathology, and consequently our findings may not generalize to clinical samples. Additionally, our attention-training tasks involved images of emotional faces, but attentional biases were assessed utilizing scenes of emotional situations. This discrepancy in the type of stimuli used could partially account for the lack of changes in attention bias. At the same time, utilizing different types of stimuli to train and assess attention would require any ABM effects to generalize to different types of emotional stimuli, which would have indicated stronger effects of ABM if there were any ABM effects in the current study. Finally, eye-tracking is a more strenuous method of assessing change in attention bias compared to dot-probe tasks. Since we utilized a dot-probe task to train attention, it is possible that the training effects of our conditions did not translate to eye-tracking. However, using eye-tracking to assess changes in attention required a more robust effect of ABM on attention; since the effect of ABM was not strong enough to translate across different types of attention, this raises questions concerning the clinical utility of ABM.

Strengths

The current study also had several notable strengths. The current study was a very careful examination of different training methods that dismantle different attentional processes that may be important for attention-training. This was the first study to compare four separate methods of attention bias modification, and accordingly we were able to gain a better understanding of which methods of attention-training were or weren't sufficient to change attention. The current study utilized a large sample size compared to other attention-training studies (Wells & Beevers, 2010; Browning et al., 2012; Notebaert et al., 2015), which increases our confidence that our results were not due to chance. Moreover, we utilized eye-tracking in order to assess for attention biases. Eye-tracking is considered to be a more valid evaluation of sustained attention bias compared to other tasks that evaluate attention bias, such as the dot-probe task or emotional Stroop task (Armstrong & Olatunji, 2012).

Conclusions

The purpose of our study was to identify which mechanism of attention change is necessary to alter attention biases for dysphoric and positive information. None of the attention-training conditions in this study were more effective than a no-training condition at altering attention for dysphoric and positive information. Therefore, our findings suggest that the methods of ABM utilized in the current study are not effective means of altering attention biases for dysphoric or positive information, drawing into question the efficacy of ABM tasks in modifying attention. While our study essentially found that ABM tasks are not effective means for enhancing adaptive attention biases, there are many other parameters that have been identified as potentially important for the efficacy of ABM that should be investigated in future studies. At the same time, these findings raise important questions about the strength, or presence of, effects of ABM on depression-relevant attention processes.

REFERENCES

Arditte, K. & Joormann, J. (2014). Rumination Moderates the Effects of Cognitive Bias Modification on Attention. *Cognitive Therapy Research, 38*, 189-199. doi: 10.1007/s10608-013-9581-9

Armstrong, T., & Olatunji, B. (2012). Eye tracking of attention in the affective disorders: meta-analytic review and synthesis. *Clinical psychology review, 32*(8), 704-723. doi: 10.1016/j.cpr.2012.09.004

Badura-Brack, A., Naim, R., Ryan, T., Levy, O., Abend, R., Khanna, M., McDermott, T., Pine, D., & Bar-Haim, Y. (2015). Effect of Attention Training on Attention Bias Variability and PTSD Symptoms: Randomized Controlled Trials in Israeli and U.S. Combat Veterans. *American Journal of Psychiatry, 172*(12), 1233-1241. doi: 14121578

Baert, S., De Raedt, R., & Koster, E. (2009). Depression-related attentional bias: The influence of symptom severity and symptom specificity. *Cognition and Emotion, 24*(6), 1044-1052. doi: 10.1080/02699930903043461

Baert, S., De Raedt, R., Schacht, R., & Koster, E. (2010). Attentional bias training in depression: Therapeutic effects depend on depression severity. *Journal of Behavior Therapy and Experimental Psychiatry, 41*, 265-274. doi: 10.1016/j.jbtep.2010.02.004

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M, & van IJzendoornm, M. (2007). Threat-Related Attentional Bias in Anxious and Nonanxious Individuals: A Meta-Analytic Study. *Psychological Bulletin, 133*(1), 1-24. doi: 10.1037/0033-2909.133.1.1

Bardeen, J., Tull, M., Dixon-Gordon, K., Stevens, E., & Gratz, K. (2015). Attentional Control as a Moderator of the Relationship Between Difficulties Accessing Effective Emotion Regulation Strategies and Distress Tolerance. *Journal of Psychopathology and Behavioral Assessment, 37*(1), 79-84.

Beard, C., Sawyer, A., & Hofmann, S. (2012). Efficacy of Attention Bias Modification using Threat and Appetitive Stimuli: A Meta-Analytic Review. *Behavior Therapy, 43*, 724-740.

Beck, A. (1976). *Cognitive therapy and the emotional disorders.* New York: International Universities Press.

Beevers, C. & Carver, C. (2003). Attentional Bias and Mood Persistence as Prospective Predictors of Dysphoria. *Cognitive Therapy and Research, 27*(6), 619-637.

Beevers, C., Clasen, P., Enock, P., & Schnyer, D. (2015). Attention Bias Modification for Major Depressive Disorder: Effects on Attention Bias, Resting State Connectivity, and Symptom Change. *Journal of Abnormal Psychology, 124*(3), 463-475. doi: http://dx.doi.org/10.1037/abn0000049

Beshai, S., Prentice, J., Dobson, K., & Nicpon, K. (2014). Gender and Attention in Depression: Examining the Role of Modified Attention in Shifting Mood and Cognitions. *Cognitive Therapy Research, 38*, 621-633. doi: 10.1007/s10608-014-9631-y

Bianchi, R. & Laurent, E. (2015). Emotional information processing in depression and burnout: an eye-tracking study. *European Archives of Psychiatry and Clinical Neuroscience*, *265*, 27-34. doi: 10.1007/s00406-014-0549-x

Boettcher, J., Berger, T., & Renneberg, B. (2012). Internet-Based Attention Training for Social Anxiety: A Randomized Controlled Trial. *Cognitive Therapy Research, 36*, 522-536. doi: 10.1007/s10608-011-9374-y

Browning, M., Holmes, E., Charles, M., Cowen, P., & Harmer, C. (2012). Using Attentional Bias Modification as a Cognitive Vaccine Against Depression. *Biological Psychiatry*, *72,* 572-579. doi: http://dx.doi.org/10.1016/j.biopsych.2012.04.014

Calvo, M. & Lundqvist, D. (2008). Facial expressions of emotion (KDEF): Identification under different display-duration conditions. *Behavior Research Methods*, *40*(1), 109-115. doi: 10.3758/BRM.40.1.109

Clarke, P., Notebaert, L., & MacLeod, C. (2014). Absence of evidence or evidence of absence: reflecting on therapeutic implementations of attentional bias modification. *BMC Psychiatry, 14*(8).

Clasen, P., Wells, T., Ellis, A., & Beevers, C. (2013). Attentional Biases and the Persistence of Sad Mood in Major Depressive Disorder. *Journal of Abnormal Psychology*, *122*(1), 74-85. doi: 10.1037/a0029211

Disner, S., Beevers, C., Haigh, E., & Beck, A. (2011). Neural mechanisms of the cognitive model of depression. *Nature Reviews. Neuroscience, 12*, 467-477. doi: 10.1038/nrn3027

Disner, S., Shumake, J., & Beevers, C. (2017). Self-referential schemas and attentional bias predict severity and naturalistic course of depression symptoms. *Cognition and Emotion, 31*(4), 632-644. doi: http://dx.doi.org/10.1080/02699931.2016.1146123

Duque, A. & Vázquez, C. (2015). Double attention bias for positive and negative emotional faces in clinical depression: Evidence from an eye-tracking study. *Journal of Behavior Therapy and Experimental Psychiatry, 46,* 107-114. doi: https://doi.org/10.1016/j.jbtep.2014.09.005

Duque, A. & Vázquez. (2018). A failure to show the efficacy of a dot-probe attentional training in dysphoria: Evidence from an eye-tracking study. *Journal of Clinical Psychology*, *74*, 2145-2160. doi: 10.1002/jclp.22652

Emmelkamp, P. (2012). Attention bias modification: the Emperor's new suit? *BMC Medicine, 10*(63), 1-4. doi: 10.1186/1741-7015-10-63

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175-191.

Ferrari, G., Möbius, M., van Opdorp, A., Becker, E., & Rinck, M. (2016). Can't Look Away: An Eye-Tracking Based Attentional Disengagement Training for Depression. *Cognitive Therapy and Research, 40*, 672-686. doi: 10.1007/s10608-016-9766-0

Fitzpatrick, K. (2016). How Positive Is Their Future? Assessing the Role of Optimism and Social Support in Mental Health Symptomatology among Homeless Adults. *Stress and Health, 33*(2), 92-101. doi: 10.1002/smi.2676

Francis, G. (2012). Publication bias and the failure of replication in experimental psychology. *Psychonomic Bulletin & Review*, *19*(6), 975-991.

Goos, L. & Silverman, I. (2002). Sex related factors in the perception of threatening facial expressions. *Journal of Nonverbal Behavior, 26*(1), 27-41.

Gotlib, I., & Krasnoperova, E. (1998). Biased Information Processing as a Vulnerability Factor for Depression. *Behavior Therapy, 29*, 603-617

Gotlib, I., Krasnoperova, E., Yue, D., & Joormann, J. (2004). Attentional Biases for Negative Interpersonal Stimuli in Clinical Depression. *Journal of Abnormal Psychology, 113*(1), 127-135. doi: 10.1037/0021-843X.113.1.127

Grafton, B., Mackintosh, B., Vujic, T., & MacLeod, C. (2013). When Ignorance is Bliss: Explicit Instruction and the Efficacy of CBM-A for Anxiety. *Cognitive Therapy and Research.* doi: 10.1007/s10608-013-9579-3

Gross, J. & Thompson, R. (2007). Emotion regulation: conceptual foundations. In J.J. Gross (Ed.), *Handbook of emotion regulation.* New York: Guildford Press.

Hakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J., Fox, N., Leibenluft, E., Ernst, M., & Pine, D. (2010). Attention Bias Modification Treatment: A Meta-Analysis Toward the Establishment of Novel Treatment for Anxiety. *Biological Psychiatry, 68,* 982-990. doi: 10.1016/j.biopsych.2010.07.021

Hazen, R., Vasey, M., & Schmidt, N. (2009). Attentional retraining: A randomized clinical trial for pathological worry. *Journal of Psychiatric Research, 43,* 627-633.

Heeren, A., De Raedt, R., Koster, E., & Phillipot, P. (2013). The (neuro)cognitive mechanisms behind attention bias modification in anxiety: proposals based on theoretical accounts of attentional bias. *Frontiers in Human Neuroscience, 7*, 119.

Heeren, A., Mogoaşe, C., McNally, R., Schmitz, A., & Phillippot, P. (2015). Does attention bias modification improve attentional control? A double-blind randomized experiment with individuals with social anxiety disorder. *Journal of Anxiety Disorders, 29*, 35-42. doi: 10.1016/j.janxdis.2014.10.007

Heeren, A., Phillippot, P., & Koster, E. (2014). Impact of the temporal stability of preexistent attentional bias for threat on its alteration through attention bias modification. *Journal of Behavior Therapy and Experimental Psychiatry, 49*, 69-75. doi: 10.1016/j.jbtep.2014.10.012

Hirsch, J., Conner, K., & Duberstein, P. (2007). Optimism and Suicide Ideation Among Young Adult College Students. *Archives of Suicide Research, 11*(2), 177-185. doi: 10.1080/13811110701249988

Iacono, W., Tuason, V., & Johnson, R. (1981). Dissociation of smooth-pursuit and saccadic eye tracking in remitted schizophrenics. An ocular reaction time task that schizophrenics perform well. *Archives of General Psychiatry, 38*(9), 991-996.

Ingram, R. (1984). Toward an Information-Processing Analysis of Depression. *Cognitive Therapy and Research, 8*(5), 443-478.

Kellough, J., Beevers, C., Ellis, A., & Wells, T. (2008). Time course of selective attention in clinically depressed young adults: An eye tracking study. *Behaviour Research and Therapy, 46,* 1238-1243. doi: 10.1016/j.brat.2008.07.004

Koster, E., De Raedt, R., Goeleven, E., Franck, E., & Crombez, G. (2005). Mood-Congruent Attentional Bias in Dysphoria: Maintained Attention to and Impaired Disengagement From Negative Information. *Emotion*, *5*(4), 446-455. doi: 10.1037/1528-3542.5.4.446

Kraines, M., Kelberer, L., & Wells, T. (2017). Sex differences in attention to disgust facial expressions. *Cognition and Emotion, 31*(8), 1692-1697. doi: 10.1080/08699931.2016.1244044

Krebs, G., Hirsch, C., & Mathews, A. (2010). The effect of attention modification with explicit vs. minimal instructions on worry. *Behaviour Research and Therapy, 48,* 251-256.

Kroenke, K., Spitzer, R., & Williams, W. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine, 16*, 606-616.

Kuckertz, J. & Amir, N. (2015). Attention Bias Modification for Anxiety and Phobias: Current Status and Future Directions. *Current Psychiatry Reports, 17*(9), 1-8. doi: 10.1007/s11920-014-0545-x

Lang, P., Bradley, M., & Cuthbert, B. (2008). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8. University of Florida, Gainesville, FL.

LeMoult, J., Joormann, J., Kircanski, K., & Gotlib, I. (2016). Attentional bias training in girls at risk for depression. *The Journal of Child Psychology and Psychiatry, 57*(11), 1326-1333. doi: 10.1111/jcpp.12587

Lindsay, D. (2015). Replication in Psychological Science. *Psychological Science*, *26*(12), 1827–1832.

Lundqvist, D., Flykt, A., & Öhman, A. (1998). *The Karolinska Directed Emotional Faces – KDEF* [CD-ROM]. Department of Clinical Neuroscience, Psychology section, Karolinska Intitutet, Stockholm, Sweden.

MacLeod, C. & Mathews, A. (2012). Cognitive Bias Modification Approaches to Anxiety. *Annual Review of Clinical Psychology, 8*(1), 189-217.

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*, 107-123.

Mastikhina, L. & Dobson, K. (2017). Biased attention retraining in dysphoria: a failure to replicate. *Cognition and Emotion*, *31*(3), 625-631. doi: 10.1080/02699931.2015.1136270

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

Mayer, A., Wilcox, C., Dodd, A., Klimaj, S., Dekonenko, C., Claus, E., & Bogenschutz, M. (2016). The efficacy of attention bias modification therapy in cocaine use disorders. *The American Journal of Drug and Alcohol Abuse, 42*(4), 459-468. doi: http://dx.doi.org/10.3109/00952990.2016.1151523

McCabe, S. & Gotlib, I. (1995). Selective Attention and Clinical Depression: Performance on a Deployment-of-Attention Task. *Journal of Abnormal Psychology, 104*(1), 241-245.

McNally, R. (2018). Attentional bias for threat: Crisis or opportunity? *Clinical Psychology Review*. doi: 10.1016/j.cpr.2018.05.005

Meier, B. & Robinson, M. (2006). Does "feeling down" mean seeing down? Depressive symptoms and vertical selective attention. *Journal of Research in Personality, 40*, 451-461. doi: 10.1016/j.jrp.2005.03.001

Möbius, M., Ferrari, G., van den Bergh, R., Becker, E., & Rinck, M. (2018). Eye-Tracking Based Attention Bias Modification (ET-ABM) Facilitates Disengagement from Negative Stimuli in Dysphoric Individuals. *Cognitive Therapy and Research, 42*, 408-420. doi: 10.1007/s10608-018-9889-6

Mogoaşe, C., David, D., & Koster, E. (2014). Clinical Efficacy of Attentional Bias Modification Procedures: An Updated Meta-Analysis. *Journal of Clinical Psychology, 00*(00), 1-25. doi: 10.1002/jclp.22081

Mogg, K. & Bradley, B. (2005). Attentional Bias in Generalized Anxiety Disorder Versus Depressive Disorder. *Cognitive Therapy and Research, 29*(1), 29-45. doi: 10.1007/s10608-005-1646-y

Nishiguchi, Y., Takano, K., & Tanno, Y. (2015). Explicitly Guided Attentional Bias Modification Promotes Attention Disengagement From Negative Stimuli. *Emotion, 15*(6), 731-741. doi: 10.1037/a0039117

Notebaert, L., Clarke, P., Grafton, B., & MacLeod, C. (2015). Validation of a novel attentional bias modification task: The future may be in the cards. *Behaviour Research and Therapy, 65*, 93-100. doi: http://dx.doi.org/10.1016/j.brat.2014.12.007

Peckham, A., McHugh, R., & Otto, M. (2010). A Meta-Analysis of the Magnitude of Biased Attention in Depression. *Depression and Anxiety, 271*, 1135-1142. doi: 10.1002/da.20755

Pfabigan, D., Lamplmayr-Kragl, E., Pintzinger, N., Sailer, U., & Tran, U. (2014). Sex differences in event-related potentials and attentional biases to emotional facial stimuli. *Frontiers in Psychology, 5*, 1477. doi: 10.3389/fpsyg.2014.01477

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

Rotter, N. & Rotter, G. (1988). Sex differences in encoding and decoding of negative facial emotion. *Journal of Nonverbal Behavior, 12*, 139-148.

Schmidt, N., Richey, J., Buckner, J., & Timpano, K. (2009). Attention-training for generalized social anxiety disorder. *Journal of Abnormal Psychology, 118,* 5-14.

Schmukle, S. (2005). Unreliability of the Dot-probe Task. *European Journal of Personality, 19*, 595-605. doi: 10.1002/per.554

Schoorl, M., Putman, P., & van der Does, W. (2012). Attentional bias modification in posttraumatic stress disorder: a randomized controlled trial. *Psychotherapy and Psychosomatics, 82*(2), 99-105. doi: 10.1159/00341920

Sharpe, L., Johnson, A., & Dear, B. (2015). Attention bias modification and its impact on experimental pain outcomes: Comparison of training with words versus faces in pain. *European Journal of Pain, 19*, 1248-1257. doi: 10.1002/ejp.648

Smith, B., Dalen, J., Wiggins, K., Tooley, E., Christopher, P., & Bernard, J. (2008). The Brief Resilience Scale: Assessing the Ability to Bounce Back. *International Journal of Behavioral medicine, 15*, 194-200. doi: 10.1080/10705500802222972

Spitzer, R., Kroenke, K., Williams, J., & Löwe, B. (2006). A Brief Measure for Assessing Generalized Anxiety Disorder: The GAD-7. *Archive of Internal Medicine*, *166*, 1092-1097.

Teachman, B., Joormann, J., Steinman, S., & Gotlib, I. (2012). Automaticity in anxiety disorders and major depressive disorder. *Clinical Psychology Review, 32*, 575-603. doi: 10.1016/j.cpr.2012.06.004

Wells, A. (1999). A cognitive model of generalized anxiety disorder. *Behavioral Modification*, *23*(4), 526-555. doi: 10.1177/0145445599234002

Wells, T. & Beevers, C. (2010). Biased attention and dysphoria: Manipulating selective attention reduces subsequent depressive symptoms. *Cognition and Emotion*, *24*(4), 719-728. doi: 10.1080/02699930802652388

Wessa, M., Kanske, P., Neumeister, P., Bode, K., Heissler, J., & Schönfelder, S. (2010). EmoPics: Subjektive und psychophysiologische Evaluationen neuen Bildmaterials fur die klinisch-biopsychologische. *Forschung Zeitschrift fur Klinische Psychologie und Psychotherapie, 39*(77).

Yang, W., Ding, Z., Dai, T., Peng, F., & Zhang, J. (2015). Attention Bias Modification training in individuals with depressive symptoms: A randomized controlled trial. *Journal of Behavior Therapy and Experimental Psychiatry, 49*, 101-111. doi: http://dx.doi.org/10.1016/j.jbtep.2014.08.005

Yang, W., Zhang, J., Ding, Z., & Xiao, L. (2016). Attention Bias Modification Treatment for Adolescents With Major Depression: A Randomized Controlled Trial. *Journal of the American Academy of Child and Adolescent Psychiatry, 55*(3), 208-218.

Yu, X., Chen, J., Liu, J., Yu, X., & Zhao, K. (2015). Dispositional Optimism as a Mediator of the Effect of Rumination on Anxiety. *Social Behavior and Personality, 43*(8), 1233-1242. doi: http://dx.doi.org/10.2224/sbp.2015.43.8.1233

APPENDICES

Appendix A

REVIEW OF THE LITERATURE

Cognitive models of depression posit that attention biases for dysphoric emotional information contribute to the etiology and maintenance of depressive symptoms (Beck, 1976; Ingram, 1984). Empirical studies have supported cognitive theories of depression by consistently demonstrating that attention biases for dysphoric information are related to the development and course of depressive symptoms (Beevers & Carver, 2003; Wells & Beevers, 2010; Disner, Shumake, & Beevers, 2017). As attention for dysphoric information is associated with the experience of depressive symptoms and mood states, increasing amounts of studies have evaluated different methods of experimentally altering attention biases.

Attention bias modification (ABM) was first developed as a dot-probe paradigm that was designed to systematically train individuals to attend to specific valences of emotional information (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). ABM has been studied in the context of altering attention biases for threatening and dysphoric information, and while there is evidence suggesting that attention training paradigms are successful in altering attention biases (e.g., Wells and Beevers, 2010; Browning, Holmes, Charles, Cowen, & Harmer, 2012), there is inconsistent information regarding the efficacy of specific methods of attention-training in altering attention biases for different valences of emotional information. The proposed study aims to directly evaluate and compare the efficacy of four different attention-training paradigms in altering attention biases for positive, dysphoric, threatening, and neutral information.

Attention Bias in Depression

Cognitive models of depression focus on the role that maladaptive or dysfunctional cognitive processes play in the experience of depressive symptoms. More specifically, Beck's (1976) cognitive model of depression infers that engaging in maladaptive cognitive patterns or styles (e.g., negative thoughts about the self, attending to dysphoric information) increases the likelihood of experiencing depression. Information processing models of depression (e.g., Ingram, 1984) further suggest that individuals who experience depressive mood states are more likely to experience negatively biased cognitive processes (e.g., attention, interpretation), resulting in the continued experience of depressive symptoms. Specifically, these models postulate that consistently attending to and elaborating upon information consistent with one's depressive mood serves to facilitate the maintenance of depression.

Over the past several decades, attention biases for emotional information have been studied thoroughly in the context of depression. Early studies examining relationships between attention biases and depressive symptoms indicated that depressed individuals lacked an attentional bias for positive information that non-depressed individuals possess, suggesting that depressed individuals don't preferentially attend to dysphoric stimuli, but rather avoid attending to positive, mood-incongruent stimuli (Gotlib, McLachlan, & Katz, 1998; McCabe & Gotlib, 1995). However, these early studies used relatively brief stimulus durations (e.g., 250 ms) that evaluate quicker, more automatic attention bias. When studies presented stimuli for longer durations (e.g., 1000 ms), research has demonstrated that depressed individuals preferentially attended toward dysphoric, mood-congruent information (Mogg & Bradley, 2005; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; Peckham, McHugh, & Otto, 2010).

Moreover, there is also evidence to suggest a positive relationship between depressive symptom severity and attention bias for dysphoric information, as individuals experiencing more severe depressive symptoms demonstrate more pronounced attention biases for dysphoric information compared to those experiencing mild depressive symptoms (Baert, De Raedt, & Koster, 2009). Studies using eye-tracking rather than reaction time also demonstrated sustained attention to dysphoric stimuli (e.g., Kellough, Beevers, Ellis, & Wells, 2008; Bianchi & Laurent, 2015; Duque and Vázquez, 2015). Importantly, there is evidence suggesting that attention biases for dysphoric information are not associated with other types of psychological distress, as other anxiety-related disorders are typically associated with attention biases for fear- or threat-related stimuli (Gotlib et al., 2004; Bar-Haim et al., 2007). As attention biases for dysphoric information have consistently been demonstrated in depressed samples when the stimuli are presented with a longer presentation duration, it can be inferred that depressive symptoms are associated with more sustained, elaborative attention for dysphoric information rather than immediate orientation biases for dysphoric stimuli, and that attention biases for dysphoric stimuli are a unique feature of depression.

The findings from the aforementioned studies infer that biased attention for dysphoric information is a characteristic of depression, but do not indicate whether attention biases are related to the course or duration of depressive symptoms. Accordingly, it’s important to explore research that has evaluated whether attention biases for dysphoric information influence one’s vulnerability to depression. A study conducted by Beevers and Carver (2003) evaluated whether attention biases and persistence of negative mood could interact with life stress to predict increases in depression symptoms after a 6- to 8-week period. In this study the authors experimentally induced a sad mood state by instructing participants to visualize their best friend suffering through various stages of cancer, from diagnosis to death. Attention was measured at baseline and post-induction utilizing a dot-probe task. In the initial session participants also reported on their level of sadness throughout the dot-probe tasks. At the follow-up session, participants completed measures of life stress and depressive symptoms. The authors found that increased attention for dysphoric stimuli from baseline to post-induction interacted with higher levels of life stress to prospectively predict increased depressive symptoms. At the same time, attentional biases were only weakly associated with persistence of depressed mood, despite the fact that both factors explained unique variance in prospective depression. Still, the findings from this study specifically suggest that attention biases for dysphoric information increase one's vulnerability for developing depression, as attention for dysphoric information moderated (strengthened) the relationship between life stress and depression.

A study conducted by Clasen, Wells, Ellis, and Beevers (2013) further explored how attention biases are related to depression vulnerability by specifically evaluating whether attention biases for emotional information were associated with impaired mood recovery following a sad mood induction. The sample utilized in this study was comprised of depressed and healthy (i.e., non-depressed) individuals. Attention bias was measured utilizing an exogenous cueing task. Additionally, participants were randomly assigned to receive one of two sad mood inductions: viewing a sad film clip, or listening to sad music and thinking about a time in their life when they were sad. The order of the exogenous cuing task and mood induction was counterbalanced. Both depressed and non-depressed participants who demonstrated attention biases for dysphoric stimuli experienced greater reactivity to the sad mood induction task and increased latency in recovering from the mood induction paradigm. Moreover, attention biases were more strongly associated with impaired mood recovery in depressed participants compared to non-depressed participants. These findings directly implicate attention biases for dysphoric information in the maintenance of sad mood states, further implying that attention biases for dysphoric information serve to worsen depression vulnerability.

While the findings from the Beevers and Carver (2003) demonstrated that attention biases for dysphoric information interact with stressful life events to predict future depressive symptoms, their findings do not directly support a relationship between attention biases and naturalistic symptom change. Disner, Shumake, & Beevers (2017) conducted a study that evaluated whether attention biases could independently predict depressive symptom severity over the course of six weeks. Participants recruited for this study all endorsed elevated levels of depression prior to participating in the study. The authors took baseline measurements of mood and measured attention utilizing a combined dot-probe and eye-tracking task. The authors continued to measure mood online weekly for a period of 6 weeks after the initial baseline measurement. The authors found that baseline attention bias for negative words was a significant predictor of depression symptom course over that 6-week period. More specifically, participants who spent more time fixating on negative stimuli demonstrated worsened depressive symptoms over time while those who spent less time fixating on negative stimuli demonstrated greater symptom recovery. These findings directly support Ingrams's (1984) cognitive model of depression by suggesting that attention biases for negative information predict naturalistic symptom change, such that negative biases in attention predict a natural worsening of depressive symptoms. Additionally, these findings strengthen the evidence that attention biases for dysphoric information contribute to depression vulnerability.

The aforementioned studies are of great importance as they collectively implicate attention for dysphoric information in the course of depression; however, they are not able to determine whether attention biases play a causal role in the experience of depression. Accordingly, it is important to evaluate work that has investigated the causal nature of the relationship between depression and attention for dysphoric information.

Attention Bias Modification in Depression

Overview of Attention Bias Modification

Most attention bias modification (ABM) studies have been influenced by a seminal study conducted by MacLeod, Rutherford, Campbell, Ebsworthy, and Holker (2002). In this study, the authors systematically trained individuals to either attend away from or toward negative information. They used a modified dot-probe task where the probe appeared more often (~ 85%) in the location of either the negative (in the train negative condition) or neutral (in the train neutral condition) stimulus. This contingency was designed to implicitly train participants to attend to the particular stimulus type. After training, participants completed a stressful anagrams task and then recorded their mood state. Participants in the train negative condition demonstrated a more negative emotional response to the stressful anagram task compared to participants in the train neutral condition and this effect was replicated in a second study. The results from these studies are of particular importance as the authors were able to directly establish a causal connection between attention bias and emotional experience, as directly manipulating attention toward negative information resulted in a more negative response to stress compared to the train neutral condition. Based on their findings, the authors suggested that a neutral or positive training condition might be used therapeutically to improve symptoms of emotional disorders, and laid the foundation for subsequent ABM studies to expand attention-training research.

Since the study conducted by MacLeod and colleagues (2002), multiple meta-analyses have examined ABM for both anxiety and depression to evaluate the utility of ABM tasks in reducing symptoms and altering attention. For example, Beard, Sawyer, and Hofmann (2012) evaluated 37 attention-training studies that utilized varying methods of ABM across multiple symptom presentations, including generalized anxiety, depression, social anxiety, and substance abuse. Their findings indicate that ABM was effective in improving anxiety and depressive symptoms, but was ineffective in improving distress related to substance use disorder. Additionally, while the results in aggregate suggest that ABM is effective in altering attentional biases, the effect sizes for studies evaluating different methods of attention-training methods varied significantly. In other words, different studies that utilized similar or identical training paradigms (e.g., neutral-training vs. control) demonstrated variable effect sizes for changes in attention.

Another meta-analysis conducted by Mogoaşe, David, and Koster (2014) revealed consistent findings as there were mixed results regarding the efficacy of ABM in different outcomes. Again, the authors found that ABM was generally effective in reducing anxiety and depression symptoms. Moreover, while the overall ABM effect size for altering attention bias across all studies was significant in this meta-analysis, the average effect size for altering attention bias specifically within depressed samples was non-significant. While the authors did not conduct any analyses based on specific type of training methodology, these findings specifically suggest that ABM has varying efficacy in terms of altering attention biases in individuals experiencing depressive symptoms.

Findings from a third meta-analysis conducted by Cristea, Kok, and Cuijpers (2015) indicate further ambiguity regarding the efficacy of ABM. The authors for this meta-analysis did not take specifically take note of different kinds of attention-training tasks and instead focused on cognitive bias interventions generally. Interestingly, their analyses revealed small effect sizes for all of the ABM interventions in regard changes in symptomology and attention. Moreover, there was a high degree of heterogeneity in the effect sizes, suggesting that ABM procedures demonstrate variable degrees of efficacy regardless of the primary outcome or sample. The findings from these meta-analyses collectively raise concerns regarding the efficacy of ABM in modifying symptoms and attention, and further highlight the need for more research to evaluate and better understand the mechanistic processes of ABM.

As ABM was developed as a clinical tool for reducing anxiety and depressive symptoms, the primary outcome of ABM research has been symptom change. However, some ABM tasks have failed to successfully modify attention biases, and consequently these same tasks also failed to alter emotional vulnerability or distress (e.g., Baert, De Raedt, Schacht, & Koster, 2010; see Clarke, Notebaert, & MacLeod, 2014, for a review). As change in attention is seemingly intimately related to change in symptoms, it’s important to understand which methods of ABM are reliable in altering attention for emotional information. In order to gain a better understanding of the efficacy of specific attention-training methods in altering attention biases, it is important to evaluate findings from individual ABM studies. While the meta-analyses collectively suggest ambiguity regarding ABM's efficacy in symptom reduction and altering attention biases, individual ABM studies provide more detailed information about the efficacy of specific mechanisms of attention-training in altering attention.

Attention Bias Modification in Depression

One of the first studies to evaluate the clinical utility of ABM in the context of depression was conducted by Wells and Beevers (2010). In this study, the authors evaluated whether training attention away from dysphoric information and toward neutral information would result in subsequent reductions in depressive symptoms. Participants in this study were assigned to either training or control (e.g., no training) conditions. In both conditions, one emotionally neutral image was presented simultaneously with one dysphoric image, and the stimulus presentation was either 3000 ms (for face image pairs) or 4500 ms (for more complex images of emotional scenes). After the images disappeared, a small single or double asterisk probe image appeared in the location of one of the images and remained on the screen until participants pressed a key to identify the probe. In the training condition, the probe appeared in the location of the neutral stimulus in 85% of the trials, whereas in the control condition the probe stimulus appeared in the location of the neutral and dysphoric stimuli with equal probability. After completing the attention-training paradigms, participants in the active training condition experienced significant reductions in attention biases for dysphoric information and depressive symptoms, while participants in the control condition did not demonstrate any significant changes in either outcome. Moreover, the effect of training on depressive symptoms was mediated by attention for dysphoric information. As systematically training attention away from dysphoric information facilitated a significant decrease in depressive symptoms, the findings from this study directly implicate attention biases for dysphoric information as a causal factor in the development of depression. These findings also suggest that training individuals to attend to neutral information is effective in reducing attention biases for dysphoric information and depressive symptoms.

Given the causal role that attention biases for dysphoric information play in the experience of depression, Baert, De Raedt, Schacht, and Koster (2010) conducted two experiments wherein they investigated the clinical utility of a different ABM paradigm in a sample of dysphoric students (experiment 1) and clinically depressed in- and out-patients (experiment 2). The authors utilized a spatial cuing paradigm to train attention, wherein participants in the training condition were presented with a positive word (e.g., smart) in half of the training trials and a dysphoric word (e.g., sad) in the other half of the trials on either the left or right visual field. In 90% of the positive word trials a probe stimulus would appear in the same visual field as the positive word and participants would respond when they identified the probe (valid trial); in 90% of the dysphoric word trials the probe stimulus presented in the opposite visual field to the negative word (invalid trial). Individuals in the control condition were not systematically trained to attend to any specific valence of emotional information, as there were an equal number of invalid and valid trials for positive and negative words. Both conditions involved 2000 training trials taking place over the course of 10 days. Unexpectedly, the results from these experiments were not consistent with the results from the study conducted by Wells and Beevers (2010). The findings from both experiments indicate that simultaneously training individuals to attend away from negative stimuli and toward positive stimuli is no more effective than receiving no training in regard to altering attentional biases, regardless of depressive symptom severity. Moreover, in the training condition only mildly depressed participants experienced mild improvements in symptomology, while those with moderate to severe symptom severity actually experienced a worsening in depressive symptoms. As the attention-training paradigm not only failed to alter attention biases but in some cases worsened depressive symptoms, the findings from this study highlight the need to understand more about the mechanistic processes of ABM, as methodologically disparate yet conceptually similar methods of attention-training yielded inconsistent findings regarding how to effectively manipulate attention in an adaptive manner.

While simultaneously training attention away from negative verbal stimuli and toward positive verbal stimuli was not effective in altering attention bias or depressive symptoms in the Baert et al. (2010) study, Browning, Holmes, Charles, Cowen, and Harmer (2012) conducted a study to evaluate whether training attention toward positive stimuli alone would prove to be effective in changing attention. Participants recruited for this study were diagnosed with recurrent depression and were randomly assigned to positive-training or placebo conditions. Further, for each condition, participants were randomly assigned to view either word stimuli or pictures of faces. For the positive-training condition, the probe stimulus always appeared in the location of the previously presented positive stimuli; the probe images in the placebo condition presented equally behind positive and negative stimuli. Consistent with findings from the Baert et al. (2010) study, participants in the verbal positive-training condition did not demonstrate significant reductions in depression or changes in attention. However, participants who completed the facial positive-training condition demonstrated significant increases in attention for positive information as well as significant reductions in depressive symptoms. These findings suggest that differences in the stimuli used in attention-training tasks are important, as utilizing pictures of positive faces was more effective than utilizing positive verbal stimuli in regard to altering attention for positive information. Moreover, these findings provide further support for the causal role that attention for emotional information plays in altering emotional states as systematically enhancing more adaptive (e.g., non-dysphoric) attentional biases resulted in a subsequent reduction in depressive symptoms.

Arditte and Joormann (2014) aimed to expand on these contradicting findings by conducting a study designed to evaluate whether training individuals to attend to positive or dysphoric facial stimuli would result in changes in attention bias. The attention-training paradigms utilized by the authors were modifications of the dot-probe paradigm wherein two images of different faces would appear on the left and right visual fields. After the two faces were presented for 6000 ms, the faces disappeared and one of two probe images appeared in the spatial location where one of the two faces was previously presented, and participants were asked to identify which probe image was presented. Participants in this study were randomly assigned to either negative, positive, or control conditions. In the negative training condition, dysphoric and neutral faces were presented simultaneously and the probe image would appear in the same location as the dysphoric face for 80% of the trials. The positive training condition was identical to the negative training condition, except that the probe image would appear in the same location as the positive face for 80% of the trials. Eye-tracking was utilized pre- and post-training in order to assess for any potential changes in attention biases. In this study, neither training condition resulted in any significant change in attention compared to baseline. These findings directly contradict the findings from the studies conducted by Browning and colleagues (2012) but are consistent with the findings yielded from the study conducted by Baert and colleagues (2010) in that training individuals to attend to positive information did not result in changes in attention bias.

A study carried out by Beshai, Prentice, Dobson, and Nicpon (2014) evaluated whether training attention toward dysphoric stimuli would influence dysphoric mood states and thoughts. In this study, participants were randomly assigned to attention-training or control groups. Both groups completed attention-training tasks, wherein pairs of neutral and dysphoric verbal or pictorial stimuli appeared on a computer screen for 1000 ms, with the neutral stimulus appearing in the center of the screen and the dysphoric stimulus appearing on either side of the neutral stimulus. After this time, the paired stimuli would disappear and a probe image would appear, and participants were required to indicate where the probe stimulus appeared. For the training condition, the probe image appeared where the dysphoric stimulus originally appeared in 75% of the trials in order to create a contingency between the probe stimulus and dysphoric stimulus in order to train individuals to attend toward dysphoric stimuli; for the control condition, the probe image appeared behind the dysphoric stimulus in 50% of the trials. Despite only participating in one extended training session as opposed to multiple training sessions, participants in the training condition demonstrated significant elevations in attention for dysphoric information compared to controls. Consequently, participants in the training condition experienced significant elevations in depressed mood after completing the attention-training paradigm compared to those in the control group.

Beevers, Clasen, Enock, and Schnyer (2015) extended the work done by Wells and Beevers by utilizing a sample comprised entirely of adults who met criteria for Major Depressive Disorder. The authors utilized the same attention-training paradigm from the Wells and Beevers (2010) study, however they utilized 1568 training trials over 8 training sessions. Attention biases were measured pre- and post-training utilizing a dot-probe task that displayed positive and dysphoric stimuli. Individuals in the training condition demonstrated significantly reduced attention biases for dysphoric information.

Additionally, Yang, Ding, Dai, Peng, and Zhang (2015) conducted a randomized controlled trial to evaluate the long-term effects of an attend-neutral ABM task in individuals with depressive symptoms. The attention-training tasks in this study were methodologically similar to the tasks utilized by Wells and Beevers (2010) and Beevers and colleagues (2015); however, the presentation duration for the stimuli utilized in the attention-training tasks was altered to 2000 ms, they utilized word stimuli as opposed to faces, and the probe stimulus appeared in the location of the neutral word in 90% of the trials. Attention bias was measured utilizing a similar dot-probe tasks, and participants completed 8 sessions within a 2-week timespan. Participants in the ABM condition demonstrated significant reductions in attention bias for dysphoric information and depressive symptoms, and these reductions in depressive symptoms were maintained during the 3-month follow-up.

A study conducted by Notebaert, Clarke, Grafton, and MacLeod (2015) expanded attention-training research by comparing standard dot-probe tasks to a novel attention-training task called the person-identity-matching (PIM) task. The PIM involves simultaneously presenting participants with two “cards”, with each card displaying two faces: a happy face and an angry face. There were two separate PIM conditions in this study: the attend-happy condition, which involved having participants judge whether the identity of the actor displaying a happy face on both cards matched, or the attend-angry condition, which involved having participants discern whether the identity of the actors displaying an angry face matched. The dot-probe conditions involved presenting participants with two images of a happy face and an angry face for 500 ms, after which time the images were replaced by a probe image and participants were required to identify the specific probe image. The probe stimulus always appeared behind the happy face in the train-happy dot-probe condition, and the probe stimulus always appeared behind the angry face in the train-angry condition. Attention bias was measured utilizing a similar dot-probe task, however the probe image appeared in equal frequency between the location of the happy and angry images. The results indicated that both of the PIM tasks were more effective than their respective dot-probe paradigms in altering attentional biases for angry and happy faces. In fact, neither of the dot-probe paradigms were able to significantly alter attention toward happy or angry stimuli. These findings are of particular importance because the methodology of the PIM task is unique, in that participants do not establish a contingency with the emotional content of the stimuli like in typical dot-probe tasks, and instead focus on extraneous, non-emotionally charged content on the stimuli (i.e., the identity of the actor in the images). Currently there is insufficient evidence to definitively suggest which attention-training method is more effective in altering attention as this is the only study to our knowledge that has utilized the PIM task; however, the results from this study suggest that disengaging from the emotional content of stimuli may be another effective mechanism of altering attentional biases.

LeMoult, Joormann, Kircanski, and Gotlib (2016) conducted the first study to evaluate whether attention biases can be modified in adolescent females who had a familial risk for depression. The authors utilized a modified dot-probe task wherein pairs of faces were presented for 1500 ms; one of the faces displayed a neutral emotional expression while the other face displayed either a happy or a sad expression. After the images disappeared, a gray dot appeared in the location of one of the previously displayed images. Participants were randomly assigned to a valid training condition or a sham training condition. For the valid training condition, the gray dot appeared behind the happy expression in 100% of the happy trials (e.g., neutral and happy presented), and behind the neutral expression in 100% of the sad trials (e.g., neutral and sad); for the sham trial, the dot appeared behind the emotional expression on 50% of the happy and sad trials. Additionally, the authors included a negative mood induction paradigm after attention-training to evaluate whether their ABM task would buffer against the experience of sad mood. The results indicated that participants in the valid training condition experienced significant increases in attention for positive information and significant decreases in attention for dysphoric information. Moreover, only participants in the sham ABM condition experienced an increase in negative mood.

A similar study was conducted by Yang, Zhang, Ding, and Xiao (2016), however the authors recruited adolescents with current MDD diagnoses. Additionally, participants randomized to the active training condition completed two separate dot-probe tasks over the course of 13 weeks: a neutral ABM task and a positive ABM task. The neutral task involved presenting pairs of neutral and sad verbal stimuli for 2500 ms, after which the stimuli disappeared and a probe stimulus appeared where the neutral word was presented in 90% of the trials. The trials in this positive training task involved presenting pairs of positive and neutral stimuli, neutral and sad stimuli, and positive and sad stimuli. In this task, the probe stimulus would always appear in the location of the positive stimuli for the trials that included positive stimuli, and in the location of the neutral stimuli for the trials that included the pairing of neutral and sad stimuli. Participants in the placebo condition completed identical tasks, however the probe stimulus appeared equally often in the position of the sad, neutral, and positive stimuli. Attention biases were assessed using additional dot-probe trials, and the authors measured attention bias after participants completed each training paradigm. The results indicated that, relative to the placebo condition, participants in the active training condition experienced significant reductions in attention for negative stimuli. Moreover, the active training conditions also resulted in significant reductions in clinician-rated depressive symptoms. While these findings are limited to adolescents with depression, they provide additional evidence that training attention toward positive stimuli and away from dysphoric stimuli is effective in altering negative attentional biases and improving depressive symptomology.

Limitations of Prior Depression ABM Studies

The aforementioned ABM studies have contributed to our understanding concerning the efficacy (or lack thereof) of various attention-training paradigms in altering attention biases and emotional vulnerability. However, the studies also varied in terms of the methodology of their tasks and the findings from their studies (see Table 5).

Given these differences in study design, it is important to identify which elements are necessary and sufficient for ABM to be efficacious. Clarke and colleagues (2014) noted that ABM studies that did not change attention bias did not result in mood change. They state, "The fact that some studies have failed to successfully modify selective attention, and consequently have not modified emotional vulnerability, suggests that more work remains to be done in order to identify the conditions under which ABM is likely to be most effective in producing the target attentional change" (2014, p. 5). As such, we have identified some limitations of prior studies that present a barrier to identifying specific mechanisms that contribute to change in attention bias.

First, as described above, a modified dot-probe is the most commonly used attention-training task (e.g., Wells & Beevers, 2010; Beevers et al., 2015), but this task mixes attentional engagement with non-dysphoric stimuli with some amount of attentional disengagement from dysphoric stimuli. The dot-probe task presents two images simultaneously and, after the offset of the images, a probe appears in the location of one of the images. As noted above, in attention training, there is a contingency where the probe appears more often in one location, which implicitly trains participants to attend to that particular stimulus. However, the participants may view both stimuli as they are presented and the attentional process may involve disengagement from the non-contingent stimulus in order to engage with the contingent stimulus. Given this potential mixture of attentional processes, it is unclear which attentional mechanism is necessary or sufficient to change attention bias.

Second, most ABM tasks that are designed to decrease attention to dysphoric information do not actually involve disengagement from dysphoric stimuli because the dysphoric stimulus is not on the screen at the same time as the probe image at the time of response (e.g., Wells and Beevers, 2010; Baert et al., 2010; Beevers et al., 2015). Because the dysphoric stimulus is not presented with the probe image, this precludes the ability to draw conclusions regarding the efficacy of disengaging from dysphoric stimuli in altering attention. This is problematic as it hinders our ability to evaluate whether training attention away from dysphoric information actually reduces attention biases for dysphoric information.

Third, most attention-training studies focus specifically on spatial disengagement or engagement with specific valences of emotional stimuli. However, it may be possible to train participants to disengage from the emotional content of stimuli by focusing on other aspects of the stimuli without a spatial shift in attention. For example, the study conducted by Notebaert and colleagues (2015) involved a task that trained attention by having participants attend to non-emotional components of emotional stimuli (identity of the actors) while maintaining their visual attention on the same stimuli. In this study, this method of training attention by disengaging form the emotional content of the image was effective in altering attentional biases, however, to our knowledge this was the only study evaluating this method of attention-training. Accordingly, further studies need to evaluate this promising method of attention-training to further understand if this method is reliable in altering attention.

Fourth, a multitude of attention-training tasks have been researched, however attention-training studies typically do not compare different experimental methods in the same study (e.g., Baert et al., 2010; Browning et al., 2012). Typically, ABM studies will compare an active training condition to a control condition, which affords the ability to draw comparisons between training and no training in terms of attention and symptom change. However, as previously mentioned, a multitude of attention-training paradigms have been empirically evaluated and at this point no studies to our knowledge have directly compared multiple active attention-training paradigms. This limits our ability to draw direct comparisons between different mechanisms of attention-training in regard to which active training method is the most effective for altering attention biases.

Appendix B

TABLES

	Dysphoric	Threat	Positive	Neutral	F-Value
Valence	2.91(.56)$_a$	2.63(.41)$_a$	7.15(.25)$_b$	5.28(.55)$_c$	236.76**
Arousal	5.47(.58)$_a$	6.21(.68)$_b$	4.63(.30)$_c$	3.01(.37)$_d$	86.29**
Luminance	98.49(26.90)$_{ab}$	76.87(22.25)$_a$	118.83(22.33)$_b$	102.30(22.43)$_{ab}$	6.44**
RGB	96.20(26.55)$_{ab}$	77.16(21.85)$_a$	117.03(23.66)$_b$	99.85(23.45)$_{ab}$	5.62**

Table 1. Means (standard deviation) for valence ratings, arousal ratings, luminance values, and RGB values for the stimuli utilized in the eye-tracking program. ** = $p < .001$. In each row, values with different subscripts are statistically significantly different at $p < .05$ using Bonferroni correction.

Table 2. Zero-order correlations between attention indices.

Attention Index	1.	2.	3.	4.	5.	6.	.7	8.	9.	10.	11.	12.	13.	14.	15.	16.
1. TVD-D	-	.90**	.77**	.10	-.53**	-.44**	-.33**	.03	-.28**	-.24**	-.18**	.03	.46**	.41**	.40**	.08
2. FD-D		-	.86**	.08	-.50**	-.54**	-.44**	.03	-.24**	-.22**	-.18	-.07	.45	.52**	.49**	.07
3. FC-D			-	.003	-.46**	-.52**	-.23**	.03	-.16*	-.15*	.10	-.11	.37**	.44**	58**	.07
4. FF-D				-	-.08	-.04	-.05	.05	-.08	-.06	-.11	.10	.10	.07	.02	.16*
5. TVD-P					-	.89**	.66**	-.08	.06	.06	-.06	.03	-.65**	-.58**	-.59**	-.07
6. FD-P						-	.74**	-.09	.08	.11	-.05	.13	-.56**	-.62**	-.63**	-.05
7. FC-P							-	-.16*	.12	.14*	.32**	.09	-.49**	-.56**	-.40**	-.08
8. FF-P								-	.03	.01	-.01	-.11	-.02	-.03	-.03	.12
9. TVD-N									-	.94**	.75**	-.08	-.29**	-.25**	-.19**	.04
10. FD-N										-	.78**	-.13	-.24**	-.23**	-.17**	.003
11. FC-N											-	-.17*	-.19**	-.18*	.05	-.04
12. FF-N												-	-.02	-.09	-.11	.02
13. TVD-T													-	.93**	.85**	-.03
14. FD-T														-	.91**	-.02
15. FC-T															-	-.05
16. FF-T																-

Note. ** = p < .001; * = p < .05; TVD = total visit duration; FD = fixation duration; FC = fixation count; FF = first fixation duration; D = dysphoric information; P = positive information; N = neutral information; T = threatening information; gray areas represent the reported relationship

Table 3. Zero-order correlations between change in depression, anxiety, and attention.

Measure	1.	2.	3.	4.	5.	6.
1. PHQ-9 change	-	.40***	.02	-.11	.08	.002
2. GAD change		-	.05	-.09	-.08	.02
3. TVD-D change			-	-.42**	.07	.37**
4. TVD-P change				-	-.02	-.39**
5. TVD-N change					-	.004
6. TVD-T change						-

Note. *** = $p < .001$; ** = $p < .01$; * = $p < .05$; change = change from session 1 to session 4; PHQ-9 = Patient Health Questionnaire-9 item; GAD = Generalized Anxiety Disorder Scale-7; TVD = Total visit duration; D = dysphoric information; P = positive information; N = neutral information; T = threatening information

Table 4. Gender differences in pre-training, post-training, and change in total visit duration.

	Females	Males	
	M(*SD*)	M(*SD*)	*t*-value
Pre-TVD-D	74.49(*24.42*)	69.67(*20.95*)	1.31
Pre-TVD-P	106.05(*39.38*)	96.91(*32.24*)	1.50
Pre-TVD-N	81.37(*21.30*)	89.19(*26.42*)	-2.14*
Pre-TVD-T	68.53(*29.70*)	79.06(*22.96*)	-2.31*
Post-TVD-D	71.05(*25.73*)	66.15(*21.43*)	1.23
Post-TVD-P	111.84(*47.85*)	98.68(*37.95*)	1.79
Post-TVD-N	81.69(*23.83*)	85.24(*24.14*)	-.92
Post-TVD-T	64.19(*29.47*)	75.60(28.40)	-2.42*
TVD-D change	-3.44(*28.62*)	-3.52(*24.04*)	.02
TVD-P change	5.79(*40.76*)	1.77(*31.05*)	.65
TVD-N change	.32 (*22.95*)	-3.95(*25.69*)	1.12
TVD-T change	-4.19(*25.18*)	-3.46(*23.42*)	-.19

Note. * = $p < .05$; change = change from session 1 to session 4; TVD = total visit duration; D = dysphoric information; P = positive information; N = neutral information; T = threatening information.

Study	Stimulus Type(s)	Task Type(s)	Type(s) of Training	Sample(s)	Trials	Attention Change	Symptom Change
Wells & Beevers (2010)	Faces & scenes	Dot-probe	Attend-Neutral	Undergraduates with elevated depressive symptoms	784	Yes	Yes
Baert et al., (2010)	Verbal	Spatial Cueing	Attend-Positive	Undergraduates with moderate depressive symptoms; adults with MDD	2300	No	No
Browning et al., (2012)	Words or faces	Dot-probe	Attend-Positive	Adults with recurrent MDD	Not reported	Yes (face condition only)	Yes (face condition only)
Arditte & Joormann (2014)	Faces	Dot-probe	Attend-Positive; Attend-Negative	Healthy undergraduates	160	No	No
Beshai et al., (2014)	Words & faces	Dot-probe	Attend-Negative	Healthy undergraduates	560	Yes	Yes
Beevers et al., (2015)	Faces & scenes	Dot-probe	Attend-Neutral	Adults with MDD	1568	Yes	No
Yang et al., (2015)	Words	Dot-probe	Attend-Neutral	Adults with depressive symptoms	1728	Yes	Yes
Notebaert et al., (2015)	Faces	Dot-probe and PIM	Attend-Positive; Attend-Angry	Healthy community members	384	Yes (PIM only)	Yes (PIM only)
LeMoult et al., (2016)	Faces	Dot-probe	Attend-Positive and Attend-Neutral	Adolescents with familial risk for depression	96	Yes	Yes
Yang et al., (2016)	Words	Dot-probe	Attend-Neutral and Attend-Positive	Adolescents with MDD	2560	Yes	Yes

Table 5. ABM-depression studies summary.

Appendix C

FIGURES

Figure 1. An example trial used in the eye-tracking tasks. Top Left = neutral, Top Right = dysphoric, Bottom Left = threatening/fear, Bottom Right = happy.

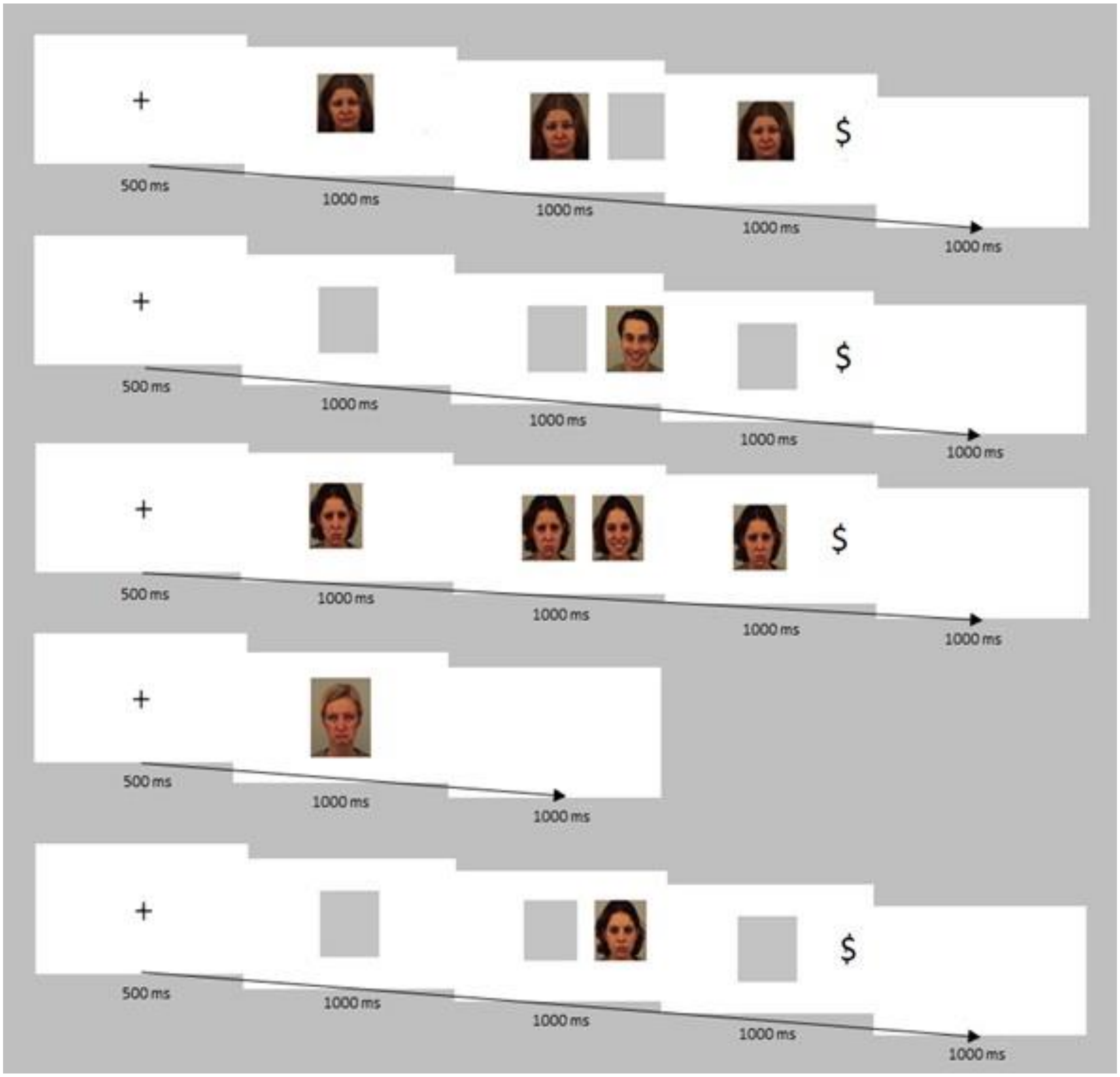

Figure 2. An example of a trial in each of the attention-training conditions. From top to bottom: spatial disengagement, positive engagement, combined, content disengagement, control. The fixation cross and probe stimulus are not to scale.

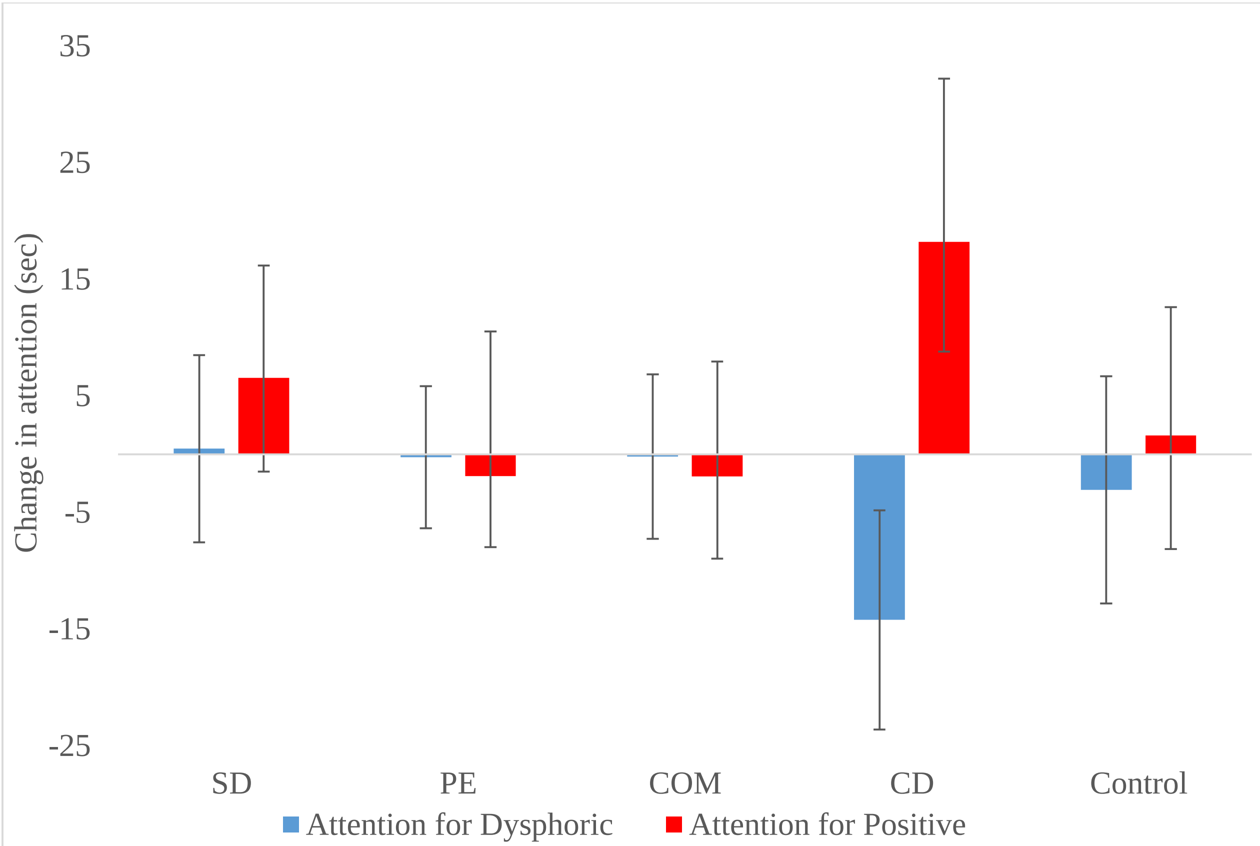

Figure 3. Depiction of change in attention from pre- to post-training for dysphoric and positive information across the training conditions. SD = spatial disengagement; PE = positive engagement; COM = combined; CD = content disengagement; error bars represent 95% confidence intervals.

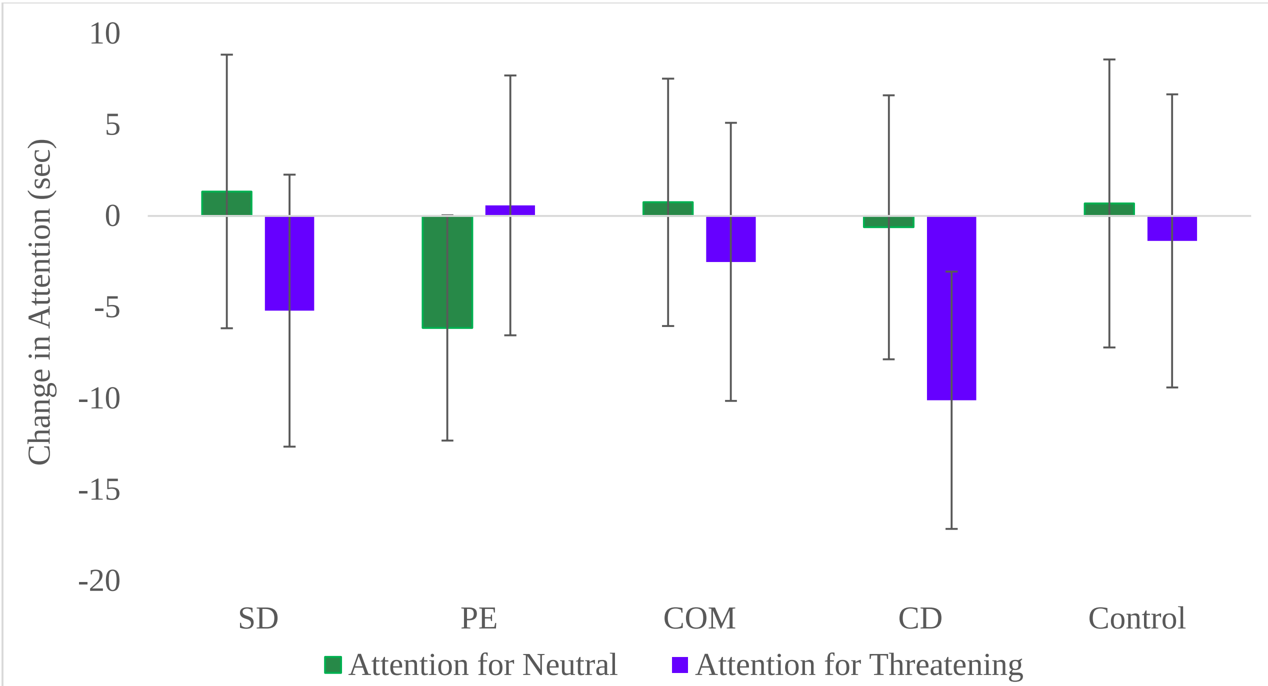

Figure 4. Depiction of change in attention from pre- to post-training for neutral and threatening information across the training conditions. SD = spatial disengagement; PE = positive engagement; COM = combined; CD = content disengagement; error bars represent 95% confidence intervals.

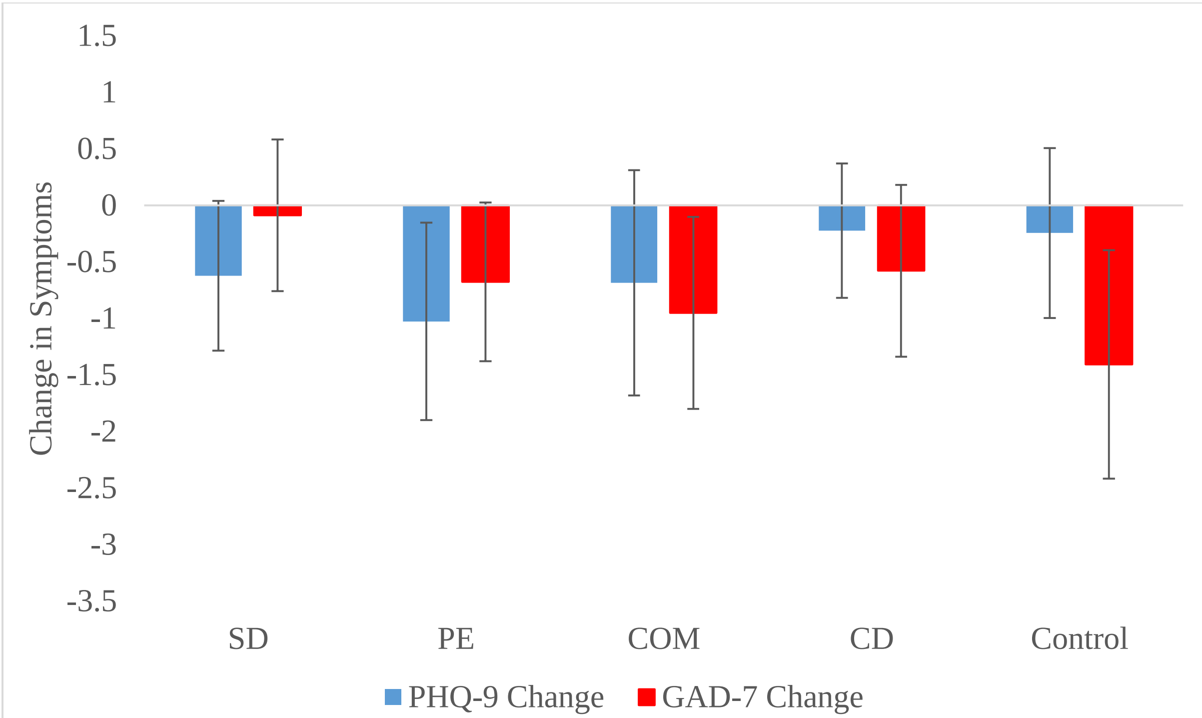

Figure 5. Depiction of change in depression and anxiety symptoms across the training conditions. SD = spatial disengagement; PE = positive engagement; COM = combined; CD = content disengagement; PHQ-9 = Patient Health Questionnaire 9-item; GAD = Generalized Anxiety Disorder Scale 7-item; error bars represent 95% confidence interval.

Appendix D

MEASURES

Demographic Information

To start with, we would like to get some background information from you.
1. What is your age? ________
2. What is your gender? ________
3. What is your current marital situation (please check one)?
_____ Married _____ Separated _____ Never married/Single
_____ Common law marriage _____ Divorced _____ Widowed

4. Do you consider yourself to be Hispanic or Latino (see definition below)? ☐Yes ☐No

Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.

5. What is your race? (please check one)

☐	American Indian or Alaska Native	A person having origins in any of the original peoples of North, Central, or South America, and who maintains tribal affiliations or community attachment.
☐	Asian	A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
☐	Black or African American	A person having origins in any of the black racial groups of Africa.
☐	Native Hawaiian or Other Pacific Islander	A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
☐	White	A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.
☐	Multiple races	
☐	None of the above	

6. What is the highest grade in school you have completed (please check one)?

_____ Less than High School (**record actual grade**)   _____ A.A. or other degree that is not a B.A. or B.S.
_____ High School   _____ 4 years of college with degree
_____ 1 year of college or technical school   _____ Postgraduate, M.D., Ph.D.
_____ 2 or more years of college but did not graduate

7. How many people do you live with (not including yourself)?

_____ Number of children   _____ Number of adults

8. During the past year, what was your total family income? $ ______________________________

9. **Do you *currently* take medication for emotional, mental, or psychological problems (e.g., depression, anxiety, ADHD, insomnia/sleep problems)**? ☐No ☐Yes

If yes, please list below (if you need additional room, please continue on the back of this page):

Date Prescribed	Medication name	Dosage	Reason for medication

10. ***In the past***, did you **take medication for emotional, mental, or psychological problems (e.g., depression, anxiety, ADHD, insomnia/sleep problems)?** ☐No ☐Yes

If yes, please list below (if you need additional room, please continue on the back of this page):

Duration	Medication name	Dosage	Reason for medication
From to			
From to			
From to			
From to			

11. Have you ever been in therapy or counseling for emotional, mental, psychological, or addiction problems? ☐No ☐Yes

If yes, please list below (if you need additional room, please continue on the back of this page):

Duration	Type of provider (PhD, MD, priest, social worker)	# of sessions	Reason for therapy
From to			
From to			
From to			

12. Have you ever been hospitalized for emotional, mental, or psychological problems (e.g., anxiety, depression, drugs)? ☐No ☐Yes

If yes, please list below (if you need additional room, please continue on the back of this page):

Duration	Length of stay	Reason for hospitalization
From to		
From to		
From to		

13. Has anyone in your family (parents, grandparents, brothers, sisters, aunts, uncles, cousins) ever had an emotional, mental, or psychological problem? ☐No ☐Yes

If yes, please list below:

Person's Relationship to you (e.g., mother, paternal aunt, etc.)	Diagnosis/Problem(s) or Symptom(s)	Treatment Received? (Y/N)	Type of Treatment

14. Do you have any of the following medical problems:

	Yes	No	Prefer not to answer
Thyroid Problems			
Seizures			
Migraine Headaches			
Diabetes/pre-diabetes			
Hypoglycemia (low blood sugar)			
Anemia			
Asthma			
Irritable Bowel Syndrome			
Fibromyalgia			
Cancer			
Heart Disease			

15. How old is your biological mother? If you are not sure, please take your best guess.

____

16. How old is your biological father? If you are not sure, please take your best guess.

____

PHQ-9

Over the last 2 weeks, how often have you been bothered by the following problems?

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself-or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed? Or the opposite—being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead or of hurting yourself in some way	0	1	2	3

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people? Circle one:

Not difficult at all   Somewhat difficult   Very difficult   Extremely difficult

GAD-7

Over the last 2 weeks, how often have you been bothered by the following problems?

	Not at all	Several days	More than half the days	Nearly every day
1. Feeling nervous, anxious or on edge	0	1	2	3
2. Not being able to stop or control worrying	0	1	2	3
3. Worrying too much about different things	0	1	2	3
4. Trouble relaxing	0	1	2	3
5. Being so restless that it is hard to sit still	0	1	2	3
6. Becoming easily annoyed or irritable	0	1	2	3
7. Feeling afraid as if something awful might happen	0	1	2	3

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people? Circle one:

Not difficult at all   Somewhat difficult   Very difficult   Extremely difficult

APPENDIX E

IRB APPROVAL

Oklahoma State University Institutional Review Board

Date:	09/10/2018
Application Number:	AS-18-80
Proposal Title:	Determining the Underlying Mechanism of Attention Bias Modification
Principal Investigator:	Luke Kelberer
Co-Investigator(s):	
Faculty Adviser:	Tony Wells
Project Coordinator:	
Research Assistant(s):	
Processed as:	Full Board

Status Recommended by Reviewer(s): Approved
Approval Date: 08/29/2018
Expiration Date: 08/28/2019

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

The final versions of any recruitment, consent and assent documents bearing the IRB approval stamp are available for download from IRBManager. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be approved by the IRB. Protocol modifications requiring approval may include changes to the title, PI, adviser, other research personnel, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any unanticipated and/or adverse events to the IRB Office promptly.
4. Notify the IRB office when your research project is complete or when you are no longer affiliated with Oklahoma State University.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB Office at 223 Scott Hall (phone: 405-744-3377, irb@okstate.edu).

Sincerely,

Hugh Crethar, Chair Institutional Review Board

VITA

Lucas James Arthur Kelberer

Candidate for the Degree of

Doctor of Philosophy

Dissertation: COMPARING ATTENTION-TRAINING METHODS IN ATTENTION BIAS MODIFICATION FOR DEPRESSION

Major Field: Clinical Psychology

Biographical:

Education: Graduated from Mounds View High School, Arden Hills, Minnesota, 2010; received Bachelor of Sciences degree in Psychology from Drake University, Des Moines, Iowa, in May, 2014; received Masters of Science in Clinical Psychology at Oklahoma State University, Stillwater, Oklahoma, in December, 2017; will complete the requirements for the Doctor of Philosophy in Clinical Psychology at Oklahoma State University, Stillwater, Oklahoma, in August 2020.

Experience: Graduate Research Assistant to Tony T. Wells, Ph.D., Behavior, Affect, and Thinking Laboratory, Department of Psychology, Oklahoma State University, August 2015 to present. Clinical practicum experience through Oklahoma State University Psychological Services Center, August 2014 to May 2019, and through Veterinary Medicine Psychological Services from August 2016 to June 2017. Instructor of Quantitative Methods, August 2014 to December 2014, Instructor of Research Methods, January 2015 to May 2015, Instructor of Introduction to Psychology, August 2018 to May 2019. Over 40 papers or posters presented at conferences. Five publications in peer-reviewed journals. Clinical residency at the Veterans Affairs Salt Lake City Health Care System.

Professional Memberships: Association for Behavioral and Cognitive Therapies (ABCT), American Psychological Association (APA), Oklahoma Psychological Association (OPA), American Psychological Society (APS).