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The Effect of Attention Bias Modification on Emotion Regulation

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by

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Abstract

Background: Emotion regulation is a cognitive process that is related to negative attention biases due to the relation of negative attention biases resulting in impaired emotion regulation, otherwise known as emotional dysregulation. Negative attention biases are characterized as an individual's tendency to preferentially attend to negative information and display an inability to disengage their attention from negative emotional stimuli. An attentional training task called attention bias modification (ABM) can help overcome negative attention biases. Neuroimaging studies have shown that attention and emotion regulation processes display similar neural activation patterns in regions of the frontolimbic area.

Purpose: Due to the neural and behavioral similarities, I sought to determine if emotion regulation is underpinned by the mechanisms of emotion-related attention selection.

Methodology: Participants were randomly assigned to an experimental condition (n=30) which performed a traditional ABM task prior to emotion regulation trials or a control condition in which participants performed a dot probe task (n=30). All participants were also given an emotion regulation task.

Results: I found that there was a significant effect of instruction ($p<.05$). General emotional affect was significantly less in the intervention group for the instruction of 'look' in the emotion regulation task.

Conclusions: While ABM did not increase the ability for participants to explicitly regulate their emotions, it did increase participant's ability to implicitly regulate their negative emotions.

Keywords: Attention Biases, Emotion Regulation, Attention Bias Modification

The Effect of Attention Bias Modification on Emotional Regulation

Cognitive processes can be distinct and still connected through their behavioral and neurological expression. Interested in how to observe these connections I, in this current project, investigated the possible link between emotion regulation and negative attention biases. To do this, I explored the effects of an intervention traditionally used to combat negative attention biases and shown to reduce heightened activation in the amygdala to see if it also had an effect on the behavioral expression of implicit and explicit regulation of negative emotion, which is also characterized by increased activation in the amygdala (Britton et al., 2015, Goldin et al., 2009).

To observe the possible connection between these cognitive processes of emotion and attention, I sought to explore the effects of an intervention proven to reduce negative attention biases, called attention bias modification, on measures of implicit and explicit emotion regulation (Heeren et al., 2014). Both of these processes can interfere with normal social functioning and the importance of this investigation comes from the movement some clinicians are pursuing to use attention bias modification as an additional treatment option for anxiety disorders (Goldin, Ball, Werner, Heimberg, & Gross, 2009, Clarke, Notebaert, & MacLeod, 2014). Therefore, it is important to parse out different effects that attention bias modification has, not only on negative attention biases, but also on other related cognitive processes like negative emotional affect and negative emotion regulation.

The following literature review is organized to define emotion regulation and attention biases to further explore how they are related and how I can take advantage of their possible link. To do this, within each of these topics I will explore both behavioral and neurological evidence that is relevant to the hypotheses of these experiments.

Emotion Reactivity, Regulation, and Dysregulation

Emotion is a complex cognitive process, that is both universal and individual. The emotional response of an individual emerges not only from the personal relevance of an event or stimulus, but also the preprogrammed emotional responses that are unique to that person (Gross, 2014). One cognitive process under the umbrella of emotion, is emotion regulation which is defined as both the control an individual has over their emotions as well as their ability to practice autonomy over their emotional construction (Gross, 2014). In this experiment I am trying to investigate the link between attention and emotion through an intervention (ABM) that has only thus far been used for deficits in attention. Emotion and attention share many behavioral and neural expressive similarities and it is important to note that popular theories of emotion also include aspects of attention.

In healthy populations, emotions are more readily attended to than those who suffer from emotional processing deficits, (i.e. individuals with anxiety or depressive disorders) (Mennin, Heimburg, Turk, & Fresco, 2005). This efficient processing of emotions contributes to a pattern of positive functioning in healthy individuals. Researchers Mennin, Heimburg, Turk, and Fresco (2005) created a model of emotional dysregulation that characterizes emotion dysregulation to be a longer and more intense negative emotional experience due to the inability to efficiently process negative affective stimuli.

Measuring Emotion Regulation

There are several ways to measure how well an individual is able to implicitly and explicitly regulate their emotions. In this experiment, I focused on measures of implicit ability to regulate negative emotions and an individual's ability to explicitly reappraise their emotions. Measures of implicit emotion regulation are collected through a look task in which participants are presented with neutral or negative image and instructed to attempt no mental manipulation, and then asked to rate the intensity of their positive and negative emotions (Greening, Osuch, Williamson, & Mitchell, 2013). Implicit regulation of negative emotion is collected by the self-reported emotional ratings in response to neutral images.

Reappraisal, or explicit regulation of emotion, involves an individual actively engaging their cognitive abilities to reevaluate emotionally negative evoking stimuli. Measures of explicit regulation or reappraisal are also collected through self-reported measures, but in the reappraisal task, participants are explicitly instructed to actively manipulate the image in their mind to make it less negative (Greening et al., 2013). Research has shown that an ability to successfully explicitly reappraise emotions is a sign of healthy emotional well-being (Cisler et al., 2010).

Neural Patterns of Emotion Regulation and Emotion Dysregulation

Neuroimaging studies have explored the neural patterns of activation of both emotion regulation and emotion dysregulation. When an individual has emotional processing deficits imaging studies have shown that the amygdala plays a critical role in this process and when it is impaired. Specifically, emotion dysregulation is characterized by temporal delays in the amygdala and other areas in the PFC (Goldin et al., 2009). Attention bias modification works to redirect attention of a participant. This mechanism of redirecting attention may be successful in improving implicit and explicit regulation of emotion due to findings in one experiment in which researchers found that in a population of healthy individuals, there was an increased trend of neural activation in areas associated with attention and cognitive control in response to negative stimuli. However, individuals with Social Anxiety Disorder displayed more prominent activation in areas implicated in emotion processing areas of the brain when presented with the same negative stimuli (Goldin et al., 2009). This finding reveals a neural pattern of processing negative emotional stimuli that might be affected by the current implicit attention intervention.

Attention Biases

Attention biases are irregular tendencies to fixate on a particular type of stimuli or belief. In this experiment, I am particularly focused on negative attention biases, in which the stimuli or beliefs that individuals attend to more frequently are negative. Negative attention biases are found most commonly in individuals with an anxiety disorder, and thus it is believed that this bias contributed to a cycle of enhanced emotional reactivity and impaired social functioning (Goldin, Ball, Werner, Heimberg, & Gross, 2009).

How to Observe and Combat Negative Attention Biases

Attention biases are atypical tendencies in which a person focuses more intently, frequently, or for longer time periods, on a specific type of stimuli (Macleod & Grafton, 2016). These negative biases are observed when individuals habitually, automatically, and more quickly attend to locations in which negative stimuli appear more frequently (Grafton & Macleod, 2014). One way in which attention biases are observed is through a reaction times. An attention bias is observed when there are significant differences in the reaction times between two types of stimuli.

The Dot-Probe Task

To observe this abnormal behavior, there are several cognitive tasks that may be used, but the most widely tested is the dot-probe task. In the following paragraph I will explain this task in detail to create a clear frame of reference for the rest of this literature review. The dot probe task is a behavioral measure used to detect and quantify the presence of attention biases (Macleod & Grafton, 2016). This is achieved by measuring participant reaction times in response to positive, neutral, or negative stimuli. The original dot probe task consists of three phases. The first phase is presented as a screen with a fixation cross in the middle to direct participant attention. Following the presentation of the fixation cross either word or face pairs (that are either positive, neutral, or negative) appear on the screen. Stimuli are presented in distinct hemifields. Finally, a probe (normally a dot) appears in one of these distinct hemifields. Participants are instructed to respond to this probe as quickly as possible by indicating either the type of the probe or the side of the screen that it appeared in with preassigned response keys.

Negative attention biases are observed when probes following negative stimuli are attended to more quickly than those following neutral stimuli (Mogg & Bradley, 2015). Negative attention biases are indicative of an individual's inability to disengage from a negative stimulus. Neural evidence of this behavioral phenomenon will be discussed below, but to briefly explain, negative stimuli capture the attention of some individuals and because their attention is more intently captured by these stimuli, their visual/mental attention is already focused on the area in which the negative stimuli was presented and this results in faster probe responses (Mogg & Bradley, 2015).

Negative Attention Biases as an Implicit Cognitive Process

Negative attention biases are an implicit attention process. An experiment by Bradley et al., (1999) used a dot probe task to observe and characterize the components of negative attention biases by investigating a trend in short versus longer dot-probe tasks. Participants that initially showed a higher presence of negative attention biases in the first part of the experiment (the 1st-64th trials) showed an inverse trend in the second half of the experiment (65th-124th trials). This inverse relationship of reaction times being faster to negative stimuli in the first part of the experiment, and then reversing to reveal faster reaction for positive stimuli in the last part reveal a pattern of implicit attention processes. The initial reaction times reflect implicit, automatic processes of attention, while former reaction times reflect deliberate explicit compensation for earlier biases on negative attention biases. The researchers in this experiment specifically believe that the explicit process of attenuating to positive faces in the second half of the experiment is a form of mental compensation.

Attention biases are characterized by immediate, implicit processes, and Bradley's findings support that theory. The importance of this distinction is that the intervention that I am using works to *implicitly* redirect attention and its proven efficacy, in addition to the similarities in emotion and attention processes leads me to have faith in my hypothesis that an intervention for combating negative attention biases will also combat emotion dysregulation or general negative emotional affect.

Attention Bias Modification: The Manipulated Dot-Probe Task

The intervention known as Attention Bias Modification (ABM) is a modified dot probe task designed to combat attentional bias (Macleod, et al., 2016). The ABM functions as an implicit intervention that redirects a participant's attention away from negative stimuli. In the dot-probe task, a probe is placed behind both types of stimuli an equal number of times. However, with ABM, the probe is placed behind the neutral stimuli 90-95% of the time. In a study conducted by Heeren et al., (2014) the efficacy of reducing negative attention biases using a single session of ABM was explored in both healthy individuals and those with anxiety. Measurements of attention biases, using a traditional dot-probe task were taken at several timepoints; two weeks before the intervention, directly preceding, and directly proceeding. The researchers found that ABM had a significant effect on reducing negative attention biases (see Table 1).

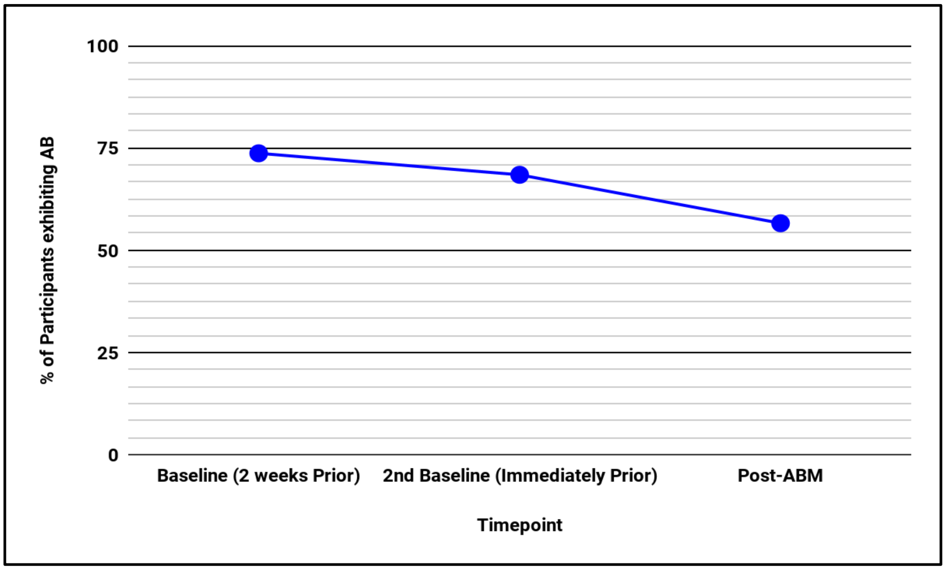


Table 1. Results for the Measure of the Efficacy of Attention Bias Modification on Negative Attention Biases. Heeren et al., 2014.

Neuroimaging Evidence for the Efficacy of ABM

Neuroimaging studies have found similar results to the Heeren study in which the heightened activation found in the amygdala that is associated with attention biases, is reduced after a single session of ABM (Britton et al., 2015; Cisler, Olatunji, Feldner, & Forsyth, 2010). Findings from fMRI studies have found that the presence of attention biases is characterized by heightened activity in areas of the prefrontal cortex (PFC) and the limbic system, compared to those without the bias (Carlson et al., 2012; Etkin et al., 2004). The Britton et al., (2015) measures attention biases using fMRI and reaction times in groups of non-clinical but high-trait anxious individuals. Like the Heeren study, baselines measuring attention biases were gathered with two baselines before the study and one immediately following. This study found that participants who had increased activation in their frontolimbic system, indicating the presence of negative attention biases, had a significant decrease in their frontolimbic activation following ABM compared to the placebo group that did not receive ABM.

Neural Patterns of Attention Biases

Functional magnetic resonance imaging (fMRI) studies have recorded that neural activation patterns involved in negative attention biases and have deduced that this phenomenon is characterized by frontolimbic activation. Specifically, the ventrolateral PFC and the dorsolateral PFC along with the amygdala in the limbic system are engaged heavily in the cognitive process of attention biases. This is because the ventrolateral PFC and dorsolateral PFC and amygdala create a chain of detecting, recognizing, and deciding if a response is appropriate to a threatening stimulus (Shechner & Bar-Haim, 2016). The amygdala has been observed as being increasingly active for a longer time in response to threatening stimuli in individuals with observed negative attention biases (Shechner & Bar-Haim, 2016). The amygdala is believed to play a role in analyzing the salience of emotionally relevant cues and increasing the probability of a response, (i.e. what I call the spam filter of emotional and attentional responses). Within the prefrontal cortex (PFC), the ventrolateral PFC and dorsolateral PFC work in tandem with the amygdala to detect threat cues and promote action when a threat cue is detected. There is a time delay between these brain regions processing threat cues which results in increased activation observed by an fMRI. This disruption in processing threatening information is what results in the behaviorally observable increased attention allocated to negative stimuli (Shechner & Bar-Haim, 2016).

Connecting the Emotion-related Attentional Biases and Emotion Regulation

Negative attention biases and emotion dysregulation have several overlapping areas of neural activation and behavioral expression. They both have similar activation patterns in the

PFC and the amygdala. Observing the correlations between these processes led me to question how ABM might affect implicit and explicit regulation. In this experiment, I intended to explore how ABM will affect implicit and explicit regulation of negative emotion in healthy individuals. The experiments mentioned above give supporting evidence that ABM can reduce automatic attention to threat cues. I believed that reducing negative attention biases will also facilitate more efficient processes of emotion regulation.

The hypothesis of this experiment originates from evidence that suggests that emotion regulation and attention biases are behaviorally and neurologically similar in their expression. Specifically, these similarities lead to two hypotheses: 1) that attention bias modification will improve implicit regulation of negative emotion and 2) that attention bias modification will improve explicit regulation of negative emotions.

Methods

Participants

Participants were undergraduate student volunteers from Louisiana State University. Participants were recruited and compensated with research participation credit which counted for class credit for various psychology courses through the LSU SONA Participation System.

Apparatus

Demographics and the State-Trait Anxiety Inventory (STAI), a self-report anxiety survey, were given to all participants. The STAI consists of two sets of 20 statements that ask the participant to rate how much they identify with that statement at that moment over the last two weeks. The score range for the STAI is 20-80 (M=34.47, SD=10.02). The internal consistency of the STAI is high with a Cronbach's alpha ratings ranging from 0.83-0.92 in a sample of college undergraduates (Spielberger, Gorsuch, & Lushene 1970).

Dot-Probe Task

A traditional dot-probe task was used to measure reaction times following negative or neutral stimuli, and like in previously mentioned experiments, was used in this study to detect the presence and magnitude of negative attention biases. An example of the dot probe task is pictured in Figure 1.

This task was designed in E-Prime 2.0 software using emotional face pairs from several databases including the Radbound faces database, the Nimstim faces database, and the STOIC faces database. All faces were edited to be grayscale and with the hair and edges of the faces cropped out with a circular frame. An equal number of female and male face pairs were used. Facial pairs were neutral and negative, with anger being the negative emotion expressed.

This dot probe task consisted of 96 total trials that were divided into 48 trials consisting of pairs of neutral/neutral and the other 48 trials consisting of negative/neutral pairs. Thus, throughout the trial participants responded to probes following neutral pairs 72 times and responded to probes following negative stimuli 24 times. Each trial takes 3500 ms to complete for a total of almost 5.6 minutes for the task to complete. The location of the negative and neutral stimuli and the probe were counterbalanced throughout the experiment.

Attention Bias Modification Task

The ABM intervention in this experiment consisted of a modified dot-probe task that was also programmed through E-Prime. Consistent with prior research, the ABM functioned by placing the probe in the location following the neutral stimuli 90% of the time. There were the same number trials in the ABM, as there were in the dot probe, with the same balance of 24 negative images and 72 neutral images. Much like the dot probe task, in the ABM the location of the negative and neutral stimuli was counterbalanced throughout the experiment, but not the probe position, as that was programmed specifically to follow the neutral stimuli 90% of the time.

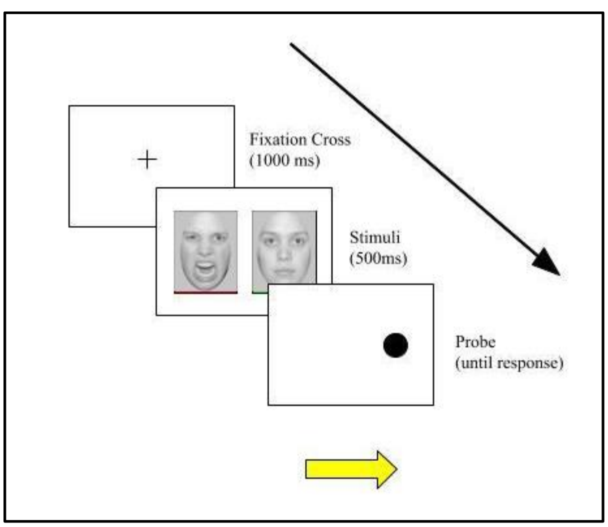


Figure 1. An example of the process of the Attention Bias Measure Task.

Emotion Regulation Task

The Emotion Regulation Task was used to measure the level to which certain emotion inducing stimuli affected participants, as well as how well they were able to self-regulate through reappraisal. This task was also programmed using E-Prime and used negative images (arousal M=5.75, SD=0.76, valence M=2.21, SD=0.39) and neutral images (arousal M=3.73, SD=0.74, valence M=3.73, SD=0.74) from the IAPS database. A T-Test was completed on the six sets of negative emotional image sets to assure no significant difference in arousal and valence scores (see Table #). Each set of images composed of 5 images that were counterbalanced across participants.

	Set A-B	Set A-C	Set A-D	Set A-E	Set A-F
ttests valence	0.29	0.61	0.70	0.39	0.37
ttests arousal	0.77	0.72	0.93	0.32	0.87
		Set B-C	Set B-D	Set B-E	Set B-F
ttests valence		0.74	0.37	0.71	0.99
ttests arousal		0.95	0.72	0.71	0.99
			Set C-D	Set C-E	Set C-F
ttests valence			0.66	0.93	0.77
ttests arousal			0.70	0.83	0.66
				Set D-E	Set D-F
ttests valence				0.84	0.28
ttests arousal				0.40	0.88
					Set E-F
ttests valence					0.71
ttests arousal					0.43

Table 2. Valence and Arousal T-Tests for Negative IAPS Image Sets

The Emotion Regulation Task was comprised of three conditions that can be parsed to form two unique assessments of emotional processing. The three conditions were look neutral, look negative, and reappraise negative. The first assessment addressed implicit emotion regulation measured with a ‘look task’ comprised of the look neutral and look negative conditions which each consisted of an equal number of negative and neutral images (10 images, 5 of each) (see fig. 2) The second assessment addressed explicit emotion regulation measured with a ‘reappraisal task’ comprised completely of negative images (20 total images) (see fig. 3). Six sets of five negative images and two sets of five neutral images were counterbalanced between participants. The emotion regulation task, consisting of the implicit and explicit regulation assessment consisted of 30 total trials from two conditions; 20 reappraisal trials and 10 look negative trials. Two likert scales proceeded each trial, in which the participants were asked to rate the intensity of their positive and negative emotions in response to the immediately preceding image. Participants reported their emotional intensity on a scale from 1-9; 1 being not intense at all, 9 being very intense. The organization of asking for negative and positive emotional intensity rating will be counterbalanced throughout the tasks. Implicit measures of emotion are derived from reportings from the look task and explicit measures of emotion are derived from the reappraisal task.

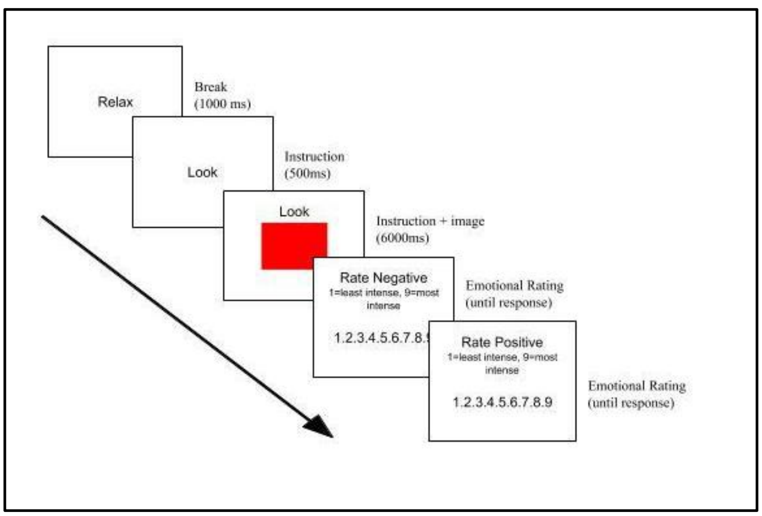


Figure 2. Example of the Emotional Look Task

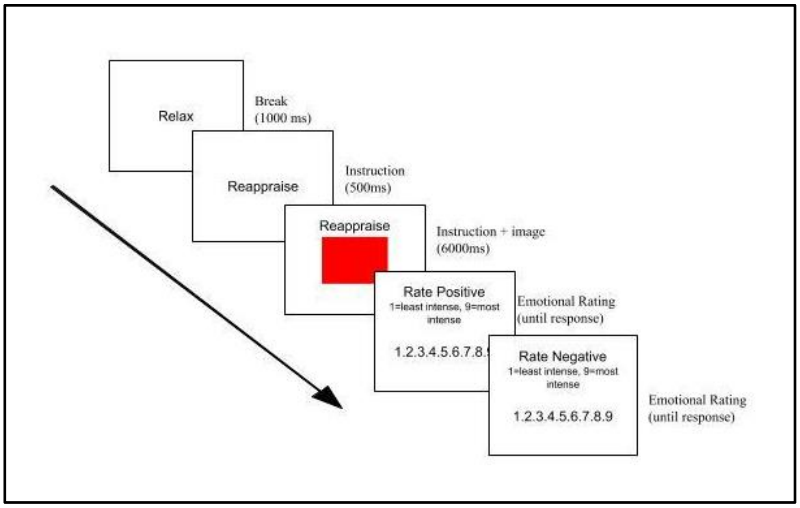


Figure 3. Example of the Emotion Regulation Reappraisal Task

Procedure

The experiment was a single visit, standard lab study that took place on LSU's campus. This is a single blind study, in which participants were unaware of which condition they were assigned to. Participants were placed at a monitor and after signing a consent form and were instructed to complete a demographics questionnaire and the STAI on the computer. After completing the STAI and demographics form on google drive, I conducted a short trial of each task to get participants comfortable with the instructions. To begin the experiment, all participants completed a dot probe task to establish baselines for negative attention biases. Next, half of the participants were randomly assigned to complete the ABM intervention, while half of the participants in the control condition completed the original dot probe task again. Instructions for both tasks were the same. Participants were asked to keep their focus on the screen throughout the task. Participants were instructed to indicate the location of the probe by using left and right the arrow keys on a standard keyboard. After completing the dot probe task or the ABM, participants completed the emotional regulation task. Participants were given an example of how to reappraise a negative scene before the first block of emotion regulation trials began.

Participants were explicitly instructed that some tasks would ask them to reappraise, where others would not. Following the first set of ABM/dot-probe and emotion regulation tasks a second set of these tasks were administered (see fig 4). After completing all the tasks, participants were debriefed and thanked for their participation.

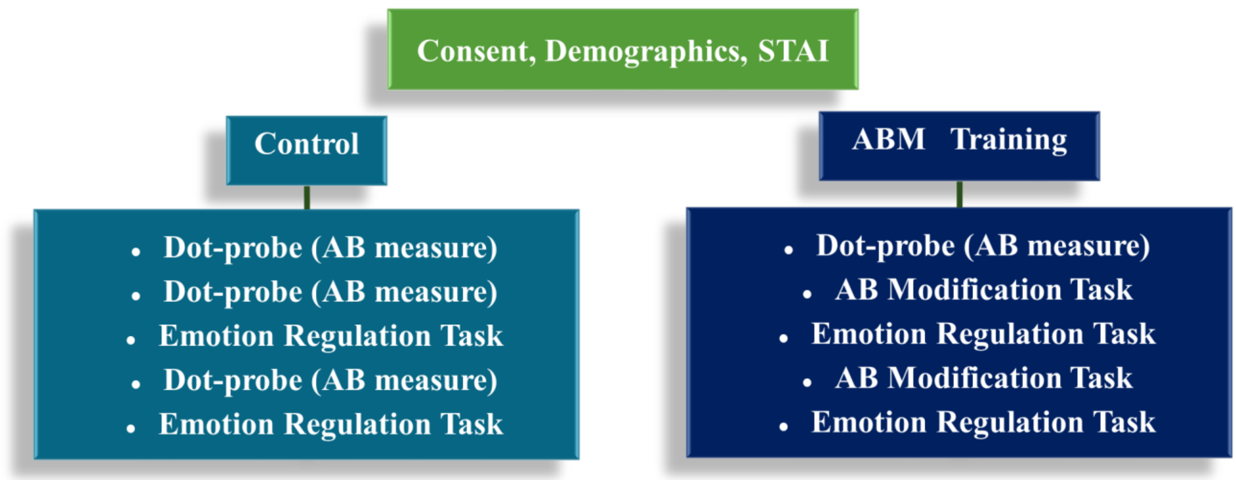


Figure 4. Organization of Experimental Design

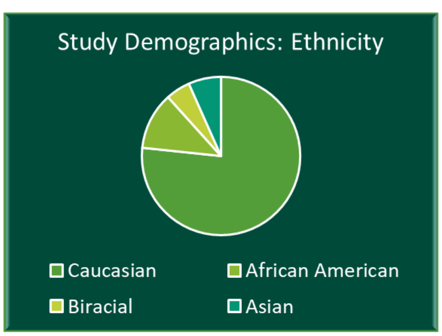
Predicted Results

My first hypothesis revolves around implicit emotion regulation in which I predict that the intervention will have an effect of lowering self-reported negative emotional intensity ratings within the intervention group. Specifically, in the analysis of the look negative and look neutral conditions, I predicted to see a main effect of image type, with negative ratings being higher in the look negative category compared to the look neutral. I also predicted an interaction between image type and group, indicating that negative ratings would be lower in the look negative condition for the intervention group compared to the control group compared to the group differences in look neutral. I also predicted that there would be no main effect of group, due to no predicted difference between groups in the look neutral condition.

My second hypothesis states that attention bias modification will improve explicit regulation of emotion. For this hypothesis I predict a main effect of instruction, with look negative having higher overall negative ratings than reappraise negative, revealing that there is a distinction between the explicit and implicit measures of regulation. I also predicted a main effect of group in which general negative affect, between the control and intervention groups, would be lower in the intervention group. I also predicted an interaction of group and instruction, in which I believed that the difference in emotional ratings would have a more severe difference in the reappraise negative condition than that of the look negative condition, indicating that explicit emotion regulation had a more significant effect of training.

Results

Participants in this study were mostly women and Caucasian (see fig. 5). State and trait levels of anxiety were collected with the STAI and a t-test was performed to show no significant difference groups within state anxiety levels t(1, 56)=2.003, p=0.28, n.s.) and trait anxiety levels t(1, 56)=2.003, p=0.58, n.s.).



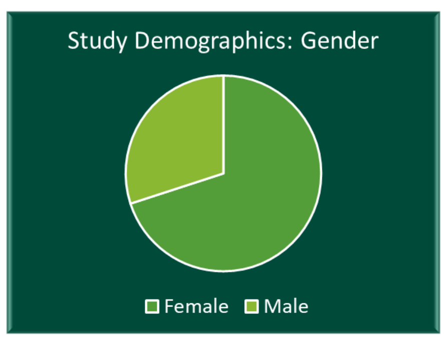


Figure 5. Demographics of Participants.

In this experiment I gathered self-reported emotional affect scores from both implicit/look and explicit/reappraisal tasks. There were two conditions in this experiment; the control group (n=30) that completed a standard dot probe task throughout the experiment, and an intervention group (n=30) that received two single sessions of ABM training throughout the experiment. There was no significant difference found between groups or conditions of neutral/neutral t(1, 57)=2.002, p=0.24, n.s., neutral/negative respond neutral t(1, 57)=1.98, p=0.12, n.s., and neutral/negative respond negative t(1, 57)=1.98, p=0.37, n.s., in the baseline dot probe tasks (see fig 6).

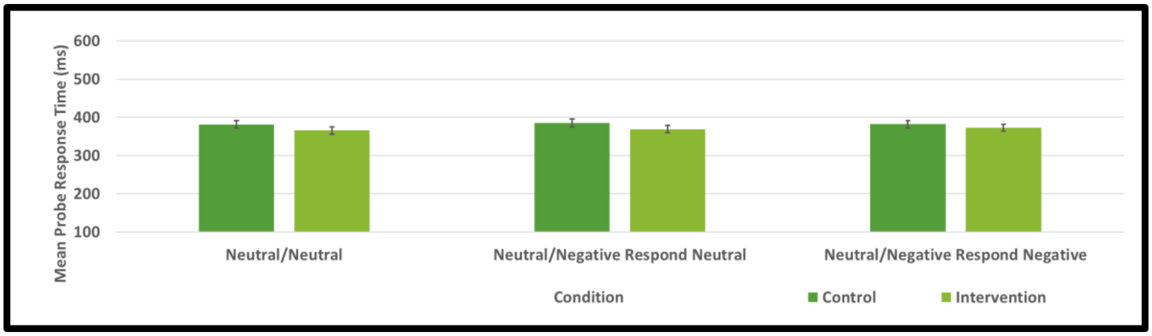


Figure 6. Mean reaction time in baseline dot probe task between groups.

In this experiment I was interested to see if an implicit attention training task that was designed to reduce negative attention biases, could reduce negative emotional affect and increase the ability to reappraise negative emotions in participants. The means of self-reported emotional intensity ratings are listed below (see Table 3).

Instruction	Image Type	Rating Type	Control	Intervention
Look	Negative	Negative	7.42	6.72
Look	Neutral	Negative	2.23	1.95
Reappraise	Negative	Negative	6.56	6.40
Look	Negative	Positive	2.56	2.91
Look	Neutral	Positive	6.72	6.51
Reappraise	Negative	Positive	3.43	3.30

Table 3. Means of Self-Reports of Emotional Intensity

Addressing my first hypothesis, I ran a 2x2 mixed design ANOVA looking at Instruction within the look task (look neutral, look negative) x and group (control, intervention). In this analysis, I found a main effect of group, F(1, 58)= 5.019, p=.029, gen.eta.^{2}= 0.048 (Figure 4). This finding supports my hypothesis that attention bias modification does influence implicit regulation of negative emotion. In this ANOVA, there was also a significant main effect of

Instruction $F(1, 58)=735.46$, $p<0.001$, gen.eta.^{2}= 0.84, however, this was expected due to the nature of negative and neutral images, and this finding is not relevant to the hypothesis of this experiment. No interaction was found between group and instruction $F(1, 58)=1.34$, $p=0.25$, n.s., gen.eta.^{2}=0.0095.

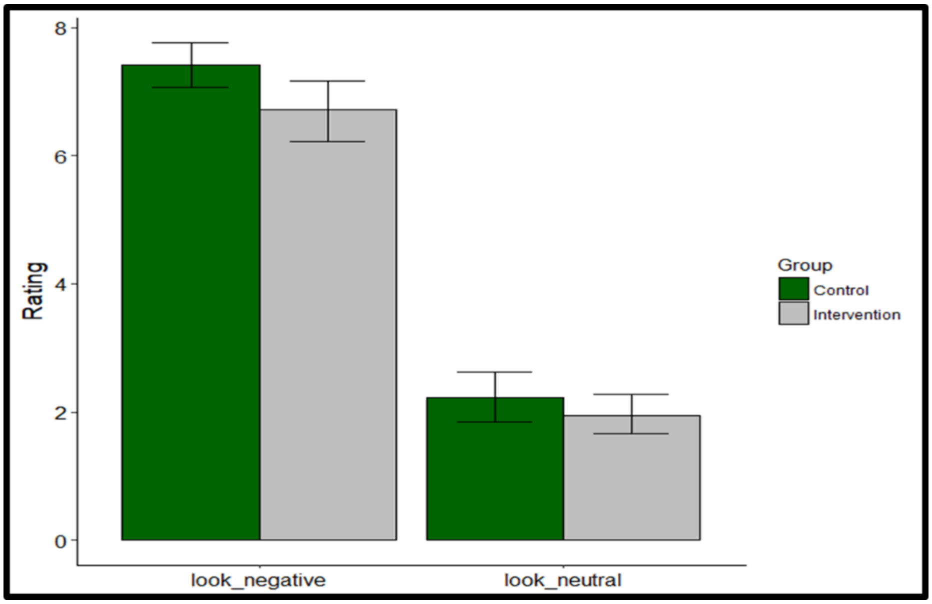


Figure 4. Mean reportings of implicit regulation of negative emotions within instruction type look (look negative and look neutral) and group (control and intervention).

To address my second hypothesis, I ran another 2x2 mixed design ANOVA, this time looking at explicit emotional regulation by looking at Instruction type (look negative, reappraise negative) x group (control, intervention). In this ANOVA, there was a main effect of instruction $F(1, 58)=10.003$, $p=0.002$, gen.eta.^{2}= 0.055 but, not group $F(1, 58)=2.694$, $p=.106$, n.s., gen. eta^2=0.029 (Figure 5). There was also no interaction found between instruction and group $F(1, 58)=2.141$, $p=.148$, gen.eta.^{2}= .0122. It was expected that there should be a difference between instruction, due to the nature of reappraise tasks reportings should always be lower than general affect. Because there is no main effect of group, this hypothesis of attention bias modification improving explicit emotion regulation is not supported.

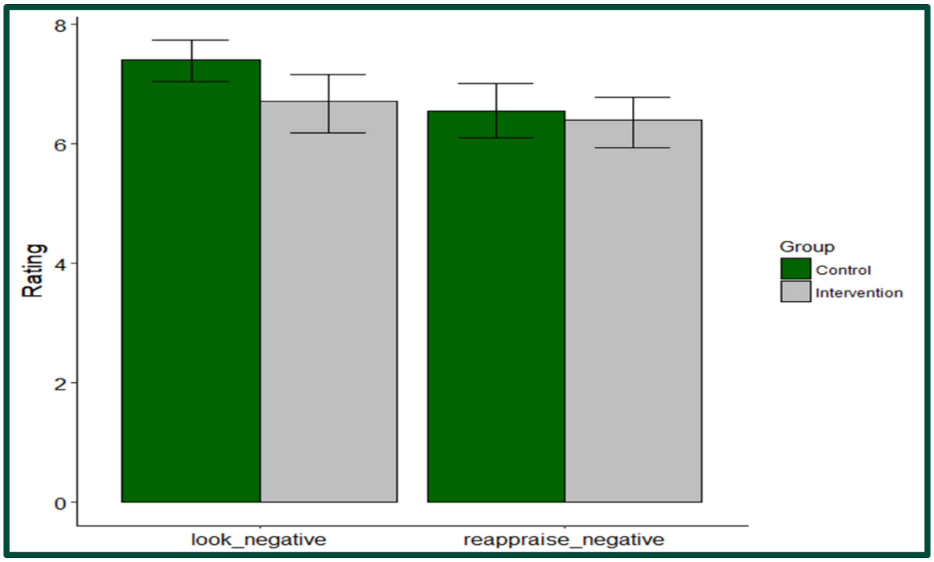


Figure 5. Mean reportings of emotional affect by instruction type (look negative and reappraise negative) and group (control and intervention).

I also ran a 3x2 mixed design ANOVA between instruction (look negative rate negative, reappraise negative rate negative, and look neutral rate negative) and group (control and intervention). There was no main effect of group $F(1,58)=3.509$, $p=0.066$, n.s., gen. $eta^2=0.0266$, however there was a main effect of instruction $F(2, 116)=399.074$, $p<.001$, gen. $eta^2=.79$, and there was no interaction found between group and instruction $F(2, 116)=1.107$, $p=0.33$, gen. $eta^2=.015$ (Figure 6). Overall emotional ratings did not differ between the intervention and control conditions.

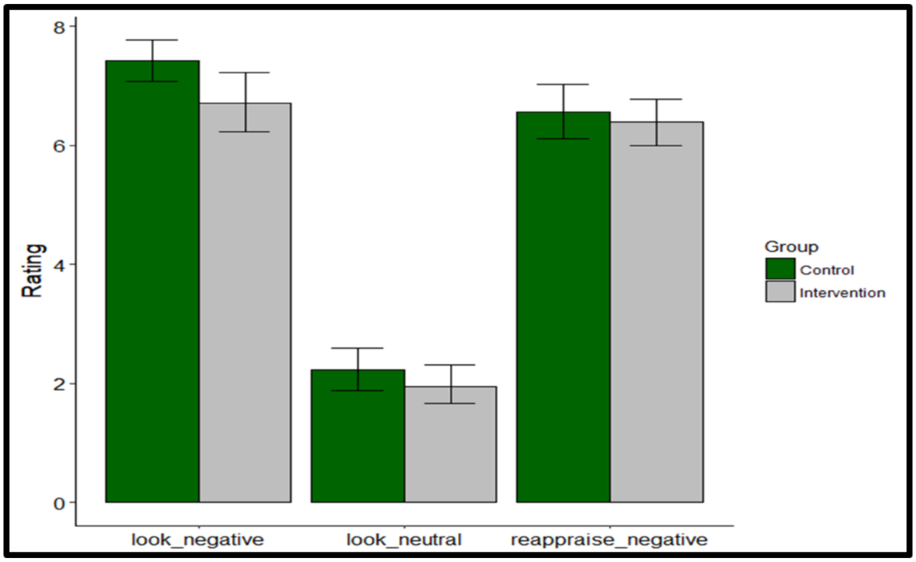


Figure 6. Mean reportings of emotional affect by Instruction (look negative rate negative, reappraise negative rate negative, and look neutral rate negative) and group (control and intervention).

Discussion

This experiment was based on previous literature that revealed that processes of emotion regulation and attention biases have several overlapping areas of neural activation and behavioral expression. They both have similar activation patterns in the PFC and the amygdala. Observing the correlations between these processes led me to question how ABM might affect implicit and explicit regulation of negative emotions. My experiment has produced supporting evidence that ABM can increase implicit regulation of implicit emotions. I believed that reducing negative attention biases would facilitate a more efficient processes of explicit emotion regulation, however this hypothesis was not supported. These findings might not be what I expected, but in retrospect, the finding that an implicit intervention has an effect on implicit emotion regulation seems plausible and was found possible in this experiment.

In the group analysis of all conditions there was a trending p value, that begs further investigation into this experiment. Therefore, additional participants will be gathered to further explore the effects of attention bias modification on explicit emotion regulation. Additional further investigation will include pursuing a larger sample size. I also want to include more detailed analyses of attention biases that were collected by the additional dot probe tasks and attention bias modification tasks. Specifically, I would like to analyze if individuals with higher negative attention biases have a more severe effect of the intervention, which is in line with previous research that indicates that that individuals with higher levels of attention biases, will show a more significant effect of an intervention (Bradley, et al., 1999; Heeren et al., 2015).

Limitations of this experiment include the sample population that consisted of a limited demographic of college students. Another limitation of this experiment is external measures of anxiety and emotion that could be gained in future experiments through fMRI or physiological apparatus. Observing the activation patterns through fMRI, might give additional insight into how emotional processes and attention processes are related through a neuroimaging lens.

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