Depression vulnerability: Studying components of cognitive models

Kruijt, A.W.

Author: Kruijt, Anne-Wil
Title: Depression vulnerability studying components of cognitive models
Issue Date: 2014-09-10

chapter 3

The effects of a visual search attentional bias modification paradigm on attentional bias in dysphoric individuals

Kruijt, A.-W., Putman, P., & Van der Does, A. J. W. (2013).
Journal of Behavior Therapy and Experimental Psychiatry, 44(2).
doi: 10.1016/j.jbtep.2012.11.003

Background and Objectives: Attentional Bias Modification (ABM) may constitute a new type of treatment for affective disorders. ABM refers to computerized training programs that have been developed based on laboratory findings in experimental psychology. Meta-analyses have reported moderate effect sizes in anxiety disorders. Two small studies have also claimed an effect in dysphoria. Furthermore, a series of studies in individuals with low self-esteem has shown that they benefit from a single session of an ABM variant based on a visual search task. The current study tested the working mechanism of visual search ABM in dysphoria.
Methods: Forty dysphoric individuals engaged in a single session of ABM training or control training. Attentional bias for positive and negative facial expressions was assessed pre- and posttraining. Positive and negative mood states were assessed throughout the procedure.
Results: Attentional training had no effect on attentional bias. Positive and negative mood states were not differentially affected by training condition.
Limitations: Small treatment effects may have gone undetected and there are some methodological differences with prior research.
Conclusion: We found no evidence that engaging in a single session of a visual search ABM modifies attentional biases for happy, sad or disgusted facial expressions.

Despite the availability of psychotherapies and medications for affective disorders, the search for new treatments continues. Existing treatments have limited efficacy, unwanted side effects, (Cuijpers, van Straten, Bohlmeijer, Hollon, & Andersson, 2010; Turner, Matthews, Linardatos, Tell, & Rosenthal, 2008) or are not easily available (Shapiro, Cavanagh, & Lomas, 2003). It is therefore not surprising that there is much interest in the development of computerized programs for the treatment of affective disorders. These could be relatively cheap, easily available, and more tolerable (Bar-Haim, 2010; Browning, Holmes, & Harmer, 2010).

Computerized treatments in development include the so-called Attention Bias Modification (ABM) paradigms. These training programs aim to modify individuals' automatic tendencies to direct attention towards negative visual information. Cognitive theories predict that such automatic tendencies, called attentional bias, play a role in the aetiology and maintenance of mood and anxiety disorders (Roiser, Elliott, & Sahakian, 2012; Yiend, 2010). Attentional bias is most often assessed with the so-called dot probe task. The ABM version of the dot probe task is designed to reduce attentional bias to negative information (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002), which is expected to lead to a reduction in symptoms (Bar-Haim, 2010; Browning, et al., 2010; MacLeod & Mathews, 2012). Many studies have now tested ABM for anxiety and anxiety disorders and meta-analyses found small to moderate effect sizes compared with control treatment (Hakamata et al., 2010; Hallion & Ruscio, 2011).

A few small studies have tested ABM for depression. In the first of these, 34 dysphoric students engaged in four sessions of a dot probe ABM treatment (Wells & Beevers, 2010). No effects were observed immediately following training, but depressive symptoms were reduced in the ABM group at a 2-week follow-up assessment. This is consistent with the model that ABM changes information processing, which over time translates into an effect on mood. Attrition over the course of this study was quite high, however. The follow-up assessment was based on only 18 participants, seven of whom were in the ABM condition. In an extensive case series analysis in a similar population, we did not observe any consistent effect of six variants of the dot probe ABM training on attentional bias, the hypothesized mediator of clinical response (Kruijt, Putman, & Van der Does, 2013). An ABM version of the spatial cueing task, which is closely related to the dot probe task, has also been explored (Baert, De Raedt, Schacht, & Koster, 2010). No effects of this training were found in both a dysphoric and a depressed patient sample. A post-hoc analysis on the dysphoric sample suggested that the participants with relatively mild symptoms of depression might have improved on one of several anxiety measures. For those with higher levels of depression symptoms however, the training had an adverse effect. In conclusion, the application of dot probe-based ABM treatments of depression has not yielded very encouraging results yet.

In individuals with low self-esteem, however, beneficial effects of an attentional training based on a specific type of visual search task, the “face-in-the-crowd task” (Hansen & Hansen, 1988), have repeatedly been reported (Dandeneau & Baldwin, 2004; Dandeneau & Baldwin, 2009; Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007). In this paradigm, image grids of 16 faces are shown. One of the images portrays a smiling face, the others show negative, rejecting expressions. Participants have to locate the image of the smiling face as fast as possible. In the first study, individuals who had engaged in the experimental training experienced less cognitive interference from interpersonal rejecting words (e.g. ignored, disliked) in an emotional Stroop task, compared to a control training group. This effect was confined to individuals with low self-esteem (Dandeneau & Baldwin, 2004). Subsequently, this paradigm was tested in a series of studies assessing a range of outcome measures in diverse populations (Dandeneau, et al., 2007). Following training, less attentional bias towards rejecting faces was found compared to control training. Students who had received the training reported lower levels of exam stress. In a sample of telemarketers, several beneficial effects of the training were found on outcome measures related to stress and work performance. These included higher self-reported self-esteem, lower stress-hormone levels, and higher work performance ratings. In a third paper the finding of less attentional bias towards rejecting faces following training was replicated (Dandeneau & Baldwin, 2009). In addition, participants in the training group reported higher levels of self-esteem, showed more effective emotion regulation behaviour in a stressful anagram task, and reported less feelings of rejection following a simulated social rejection situation.

This visual search ABM task may be a more suitable approach for depression than dot probe-based ABM, since attentional bias for negative information in depression may differ from anxiety-related bias. The availability of elaboration time may be crucial. In depression, attentional bias is more often found in studies that used prolonged stimulus exposure times (750 ms or longer) (Mogg & Bradley, 2005) and there is no difference in effect size between biases detected at 500 and 1000 ms (Peckham, McHugh, & Otto, 2010). In contrast with dot probe-based tasks, the visual search ABM task does not place constraints on the amount of time individuals spend elaborating on the presented stimuli before responding. Moreover, depression may not only be characterized by attentional bias towards negative information but also by a lack of bias towards positive information (Fritzsche et al., 2009; Joormann & Gotlib, 2007; Joormann, Talbot, & Gotlib, 2007). These two biases may be dissociable rather than two ends of a continuum (Shane & Peterson, 2007). The visual search ABM training involves detecting an ‘accepting’ face in an array of ‘rejecting’ faces. This training may therefore target bias towards negative information and lack of bias towards positive information simultaneously.

Given the above findings and considering that ‘feelings of worthlessness’ are a diagnostic criterion of depression (American Psychiatric Association, 2000), we aimed to assess whether visual search ABM training is a suitable approach for depression and dysphoria. The current study tested the hypothesis that a single session of the visual search training reduces attentional bias towards rejecting and sad facial expressions and increases bias towards happy facial expression in a dysphoric population. By testing this hypothesis, this study specifically aimed to establish whether the proposed mechanism of action, i.e. modification of bias, occurs. The influence of baseline depression symptom levels and mood on the efficacy of training, as well as acute effects of the training on mood was also explored.

Methods

Participants

Participants were dysphoric individuals recruited through advertisement. The Depression subscale of the Hospital Anxiety and Depression Scale (HADS-D) (Zigmond & Snaith, 1983) was used to preselect participants. The sum scores on these seven items range from 0 to 21. A mean HADS-D score of 3.4 was reported for a Dutch general population sample. In psychiatric outpatients, a mean score of 9.3 was found (Spinhoven et al., 1997). A HADS-D score between 4 and 9 was used as the main inclusion criterion. Exclusion criteria were: psychoactive drug use during the past three months and prior participation in ABM studies.

Symptom and mood state questionnaires

The Beck Depression Inventory-II (BDI-II) was used to assess depressive symptoms at baseline. The cut-off scores for mild and moderate depression are 14 and 20, respectively (Beck, Steer, & Brown, 1996). Trait anxiety was assessed with the Y-2 version of the State Trait Anxiety Inventory (STAI-T) (Spielberger, Gorsuch, & Lushene, 1970). Average scores in a student and a psychiatric outpatient sample were 37 and 52, respectively (Van der Ploeg, Defares, & Spielberger, 1980). Worry was assessed with the Penn State Worry Questionnaire (PSWQ). Average scores in a student and a GAD patient sample were 49 and 68, respectively (Meyer, Miller, Metzger, & Borkovec, 1990). The Positive and Negative Affect Schedule (PANAS) (Watson, Clark, & Tellegen, 1988) was administered four times throughout the test procedure. The PANAS consists of 20 items that have to be rated as being descriptive of how the participant feels right now. The answer options range from 'very slightly or not at all' to 'extremely. Two subscales (positive affect, PA and negative affect, NA) each consist of ten items.

Materials

Computerized version of all tests and questionnaires, were created using the E-prime 2.0 software package (Psychology Software Tools, Pittsburgh, PA). Stimulus pictures were selected from the Karolinska Directed Emotional Faces set (Lundqvist, Flykt, & Ohman, 1998) based on expression identification hit rate, intensity, and arousal ratings provided in a validation study (Goeleven, De Raedt, Leyman, & Verschuere, 2008).

Visual search ABM

Participants were instructed to locate a single happy face among 15 disgusted faces in 4*4 arrays. Participants responded by clicking with the mouse on one of the pictures, after which a blank screen was shown for 500 ms, followed by the next stimulus array. In the experimental training task happy and disgusted expressions from sixteen identities (eight male, eight female) were used. Strictly speaking it is not known whether the rejecting facial expressions used in previous studies testing this training would be classified as disgusted expressions, as these were never rated for this quality. However, at face value those images do resemble disgusting expressions. Moreover, ABM studies targeting Social Anxiety Disorder often feature disgusted facial expressions because these signal social rejection more strongly than sad or angry expressions (Amir, Weber, Beard, Bomyea, & Taylor, 2008; Klumpp & Amir, 2009; Schmidt, Richey, Buckner, & Timpano, 2009). Expression identification hit rate, intensity, and arousal ratings for the happy and disgusted expressions were matched with those for the identities used in the dot probe task. Each of the 16 stimulus identities appeared as the target identity (happy expression) at each of the 16 grid positions once, resulting in a total of 256 trials. Within each trial, the remaining 15 distractor identities (displaying a disgusted expression) were randomly allocated to the 15 remaining positions. The order of target identities and target locations was randomized. The training started with a number of practice trials. These continued until the participant answered six consecutive trials correctly with a minimum of ten practice trials. Every 32 trials a short self-paced break was given. These breaks consist of a display informing the participant that he/she can take a moment of rest and continue the task by clicking a button. Similar to Dandeneau and collegaues (Dandeneau & Baldwin, 2004; Dandeneau & Baldwin, 2009; Dandeneau, et al., 2007), grayscale images of flowers with either five (target) or seven (distractors) petals were created and used as stimuli in the control training. The control training was identical to the experimental training in all other respects. Figure 3.1 shows example stimulus grids from the experimental and the control training.

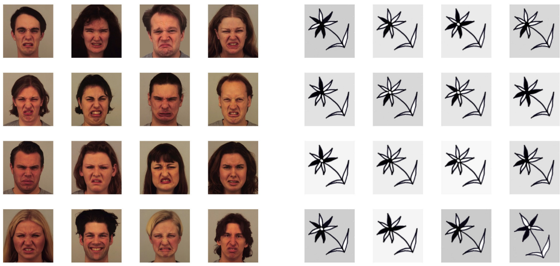

Figure 3.1. examples of stimulus grids used in the visual search training (left) and the flower control training (right).

Attentional Bias Assessment

Attentional bias was measured with a dot probe task. At the start of each trial, a fixation cross was shown in the middle of the display for 500 ms followed by the stimulus display for 750 ms. Upon offset of the stimulus display, the probe was shown on the location previously taken by either one of the stimulus pictures until a response was given after which a 350 ms blank screen preceded the next fixation cross. The probe was a 15*15 pixels black square that was shown either upright (square) or tilted 45° (diamond). Square probes were used because they are entirely identical except for being rotated 45 degrees. Moreover, this probe set does not have an implicit logical ordering, as is the case with the more often used probe sets "E versus F" and ". versus ..". Using a probe set that has no implicit logical order, reduces possible influence of handedness on motor-response mapping: "E is left, F is right" might be easier to learn for right-handed participants. The happy, sad, disgusted and neutral expressions of 16 identities (eight male, eight female) were used as stimulus pictures. The expression identification hit rate, intensity and arousal ratings for the happy and disgusted expressions were matched with the identities used in the training task. The stimulus display showed two images of facial expressions in a horizontal arrangement. Each stimulus width was 8° of visual angle. The midlines were 16° apart, leaving 8° of visual angle in between the two stimuli. The probe width was 0.4° of visual angle and the two possible probe locations were 15.6° of visual angle apart. The test started with a number of practice trials. These were neutral-neutral trials showing stimulus pictures not used in the experimental trials or the training task. Practice trials continued until the subject answered six consecutive trials correctly with a minimum of ten practice trials. Participants received no specific instructions regarding where to direct their attention but were instructed to respond to the identity of the probe as fast as possible while answering correctly. Participants responded by pressing one of the two buttons on a mouse that was fixated to the desk, centred in front of the participant. Participants operated the buttons using the index and middle fingers of their preferred mouse hand. Whether the left or the right mouse button corresponded to the square or the diamond shape of the probe, was counterbalanced across participants. Five happy-neutral, five sad-neutral, five disgusted-neutral, and five neutral-neutral trials were administered for each of the 16 stimulus identities, resulting in a total of 320 trials. Thus, one entire administration of the dot probe task consisted of 80 neutral-happy, 80 neutral-disgusted, 80 neutral-sad and 80 neutral-neutral trials. Within trials for each emotional expression, the identities of the stimulus pictures, the position of the emotional stimulus, the position of the probe (location previously taken by the emotional or by the neutral stimulus) and the identity of the probe were counterbalanced and administered in random order. Every 20 trials a short self-paced break was given. These breaks consist of a display informing the participant that he/she can take a moment of rest and continue the task by clicking a button.

Procedure

Upon arrival at the laboratory, participants read an information letter, were given the opportunity to ask questions and signed an informed consent form. Participants were not informed on the purpose of the training; they were lead to believe that the training was just one of several attention measures. The test procedure started with filling out the PANAS followed by the PSWQ, STAI-T and BDI-II. Following the questionnaires participants engaged in the baseline assessment of the dot probe task and a second task with verbal stimuli. We later discovered a flaw in the design of this second task, therefore data for this task are not reported. The order of the two tasks was randomized across participants. A five minutes break was given in between the two task administrations. The baseline assessment was concluded with a second administration of the PANAS. Training took place directly following the baseline assessment and a 5-minute break was given after 128 trials. Following the second part of the training, the PANAS was administered again, after which participants engaged in the post-assessment. In between the two post-assessment tasks participants received a short, 32 trials, retraining session followed by another five minutes break. The post-assessment was concluded by another administration of the PANAS. The duration of the entire procedure was approximately 90 minutes.

Results

Participants

Two hundred and sixty individuals filled out the screening questionnaire. Seventy-three participants, scoring between four and nine on the HADS-D (indicating mild to moderate symptoms of dysphoria), were invited to participate. Forty-eight individuals responded and were scheduled for testing. Three participants were excluded because they had recently participated in another ABM experiment. The data of five participants were discarded due to technical problems. Of the remaining 40 participants, 20 were assigned to the experimental group and 20 to the control group. Participants received either course credits or a small financial compensation for their time.

Baseline group characteristics are given in table 3.1. The mean BDI-II score for the entire group was 15, slightly above the cut-off score for a mildly depressed state (14). For STAI Y-2 and PSWQ, mean scores also fell in between average scores reported for healthy control and patient samples.

Table 3.1. *baseline questionnaire outcomes per condition.*

	Training (*n* = 20)		Control (*n* = 20)			
	M	*SD*	*M*	*SD*	*t*	*p*
BDI-II	16.7	6.8	12.5	7.3	1.896	.066
STAI Y-2	46.5	9.7	41.6	10.4	1.543	.131
PSWQ	52.8	12.2	48.6	15.1	.969	.338
PANAS						
PA (t1)	25.8	5.8	27.3	4.9	-.907	.370
NA (t1)	13.2	2.8	13.8	2.6	-.640	.526

BDI-II = Beck Depression Inventory II; STAI Y-2 = State Trait Anxiety Inventory Y-2; PSWQ = Penn State Worry Questionnaire; PANAS = Positive and Negative Affect Scale; t1 = baseline.

Preliminary analyses

Error rates per participant were explored. Twenty participants performed errorless during the training, 15 made a single error in 256 trials, five made between two and five errors. Error rates did not differ between the experimental and the control training conditions ($t(38) = .145$, $p = .878$). Changes in response times during the training task were evaluated by comparing the median response times for the first and the last 25% of the trials ($n = 2*64$) in a 2*2 repeated measures ANOVA with factors time (first 25% versus last 25% of the training trials) and condition (faces versus flowers task). Outcomes indicated that participants' response times decreased significantly over the course of the training ($F(1,38) = 49.445$, $p < .001$) and that, although response times were higher in the faces version ($F(1,38) = 13.808$, $p = .001$), the reduction in response times over the course of training did not differ between the two conditions ($F(1,38) = .000$, $p = .992$).

Practice trials and error trials (4.1 % of the experimental trials) were removed from the dot probe task data. Response times below 200 ms or above 2000 ms were also removed (0.1% of the remaining data). The then remaining data were not normally distributed (positive skew and kurtosis) and therefore the median instead of the mean reaction time was used for calculating bias index (MacLeod, et al., 2002)[1]. Bias index was calculated by subtracting the median response time for trials in which the probe appeared on the location of the emotional stimulus (congruent trials) from the median response time for trials in which the probe appeared on the location of the neutral stimulus (incongruent trials). A positive bias index indicates vigilance towards the emotional (happy, sad or disgust) stimulus whereas a negative bias index indicates avoidance of the emotional stimulus. Bias indices were calculated separately for trials of each emotional valence (e.g. happy-neutral, sad-neutral and disgust-neutral trials) for both assessments and each participant[2].

Effects of training on attentional bias

Bias indices did not differ between training and control groups at baseline although there was a trend for the control group to show less bias towards disgust, compared to the ABM group (happy: $t(38) = .505$, $p = .616$; sad: $t(38) = .765$, $p = .449$; disgust: $t(38) = 1.784$, $p = .082$). No correlations were found between the questionnaire outcomes and either of the three baseline bias indices, neither for the entire sample nor within the two condition groups.

The effects of training on the attentional bias indices were evaluated using 2*2 repeated measures ANOVAs with factors time (baseline versus post training) and condition (experimental versus control), for each of the three emotional expressions: happy, sad and disgusted. Since no previous studies reported repeated dot probe measurements with this type of training, it was not possible to perform a priori power analyses. Using the software program G*power we performed sensitivity analyses for the repeated measures ANOVA, calculating the minimum detectable effect sizes requiring a power of .80 (Faul, Erdfelder, Lang, & Buchner, 2007). The minimum detectable effect sizes could range from $f = .32$ to $f = .03$, depending on the correlation between the repeated measurements. Taking the observed correlations into account, the achieved minimum detectable effect sizes for the time by group interaction terms were $f = .21$ (happy), $f = .16$ (sad expressions) and $f = .27$ (disgust expressions).

For happy and sad bias indices, none of the main and interaction effects approached significance (all $p > .15$). For the disgusted bias index, a trend towards an interaction effect of time and treatment was found ($F(1,38) = 3.560$, $p = .067$). Following training, bias for disgusted expressions was non-significantly increased in the control group. Including BDI-II scores as a covariate in these analyses yielded similar outcomes.

1 Analyses using bias indices calculated from mean response times and log transformed mean response times yielded comparable outcomes

2 The reported comparison of bias indices is the most commonly used analysis of dot probe data. The assessment of neutral-neutral trials, however, also allows for separate exploration of effects of vigilance versus difficulty to disengage attention (Koster, Crombez, Verschuere, & De Houwer, 2004). No significant interaction effects were found in 3*2*2 repeated measures ANOVA's comparing the response times on congruent, incongruent and neutral-neutral trials assessed pre- and post training with condition as between subjects factor for each of the three emotional facial expressions.

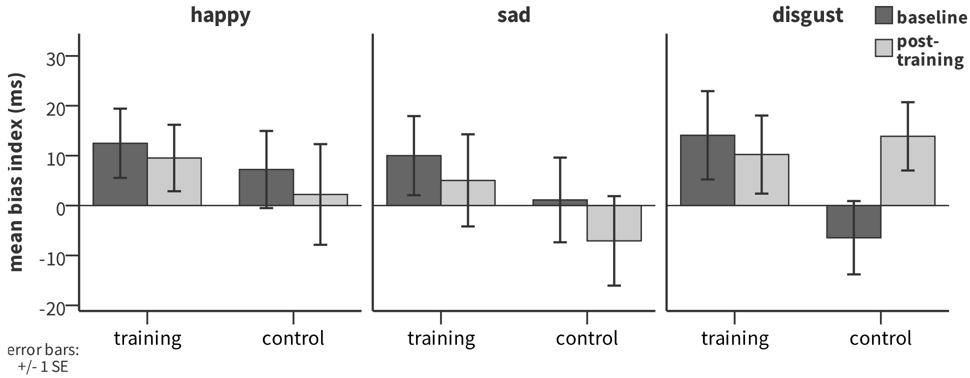

Figure 3.2. bias indices for happy, sad and disgust facial expression, at baseline and post-training for the experimental and the control training groups.

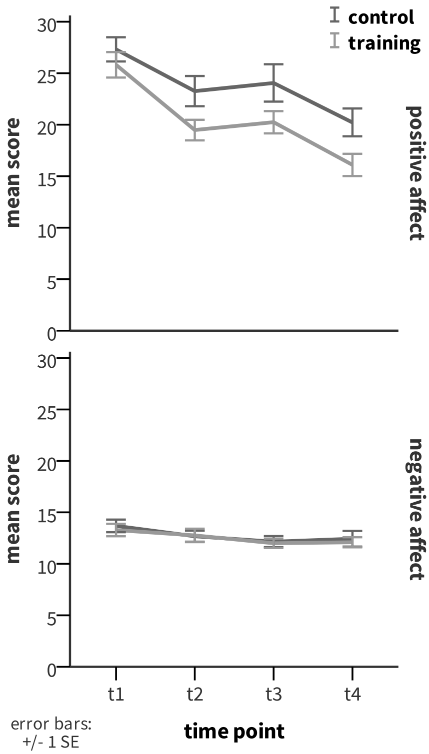

Figure 3.3. positive and negative affect (PANAS) throughout the experimental procedure. t1 = before baseline assessments, t2 = following baseline assessments - pre training, t3 = post training - before post-training assessments, t4 = following post-training assessments.

The analyses were also repeated with the scores on the PA and NA subscales of the PANAS assessed pretraining as covariates. This revealed a main effect of time ($F(1,36) = 9.126$, $p = .005$) and an interaction effect of time and negative affect ($F(1,36) = 10.846$, $p = .002$) on bias for sad facial expressions. Those participants who reported less negative affect pretraining had a larger decrease in bias for sad faces following training, whereas those who reported more negative affect showed an increase in bias for sad faces following the training. A similar trend was observed for bias for disgusted facial expressions (main effect of time: $F(1,36) = 3.233$, $p = .081$, interaction effect time by negative affect: $F(1,36) = 3.038$, $p = .090$). Entering the PANAS scores as covariates did, however, not reveal any effects of training condition. Thus, no effects of the visual search training on attentional bias for happy sad or disgust facial expressions were found (see figure 3.2).

Effects of training on self-reported mood states

Figure 3.3 shows the observed values of PA and NA at all four assessments: at baseline (t1), pretraining, following the pre-assessment tasks (t2), immediately following training (t3), and following the post-assessment tasks (t4). Visual inspection learns that positive affect decreases considerably throughout the whole procedure, especially during the pre- and post-assessment tasks. In order to statistically explore whether immediate effects of training on mood occurred, two 2*2 repeated measures ANOVAs were conducted with group (experimental vs. control) as between subjects variable, on the PANAS mood ratings assessed immediately pre- and posttraining (t2 and t3). There was a main effect of time on the negative affect scores ($F(1,38) = 5.255$, $p = .028$): following training participants reported less negative affect than before. This effect did not differ between the experimental and the control group as indicated by a non-significant interaction effect ($F(1,38) = .280$, $p = .600$). A significant main effect of condition was found on the positive affect scores ($F(1,38) = 4.752$, $p = .036$): the control group reported higher positive affect than the experimental group. This effect was however not affected by the training as indicated by a non-significant condition by time interaction effect ($F(1,38) = .055$, $p = .816$). Sensitivity analyses showed that, requiring a power of .80, effect sizes on the interaction term as small as $f = .17$ (PA) and $f = .16$ (NA) could have been detected.

Post-hoc exploration of self-esteem related BDI-II items

Since the expected effects were not found, and because Dandeneau and colleagues found some effects specifically in participants reporting low self-esteem, we conducted an explorative post hoc analysis. Three items from the BDI-II were selected which, at face value, tap constructs related to self-esteem: self-dislike (item 7), self-criticalness (item 8) and worthlessness (item 14). Spearman's rank order correlations between the scores on these three items and the change in bias index were calculated. Bias index change scores were calculated by subtracting the baseline bias index from the post-training bias index. The resulting correlation coefficients are shown in table 3.2[3]. Scores on BDI-II item 7, self-dislike, correlated with the decrease in bias index for both disgusted ($r_s(38) = -.67$, $p = .003$) and sad expressions ($r_s(38 = -.56$, $p = .010$) in the experimental but not in the control group. This suggests that the training may change bias for negative facial expressions in participants who endorse BDI-II item 7 (self-dislike).

Table 3.2. S*pearman's correlation coefficients for BDI-II items 7, 8 & 14 and bias index change scores.*

	self-dislike		self-criticalness		worthlessness	
	training	control	training	control	training	control
happy bias	-.07	-.10	.07	-.03	.05	.15
sad bias	-.56[a]	.32	-.31	-.07	-.33	-.04
disgust bias	-.64[b]	-.03	.02	.02	-.35	-.03

Change scores = bias index post training – bias index pre training.
[a] *p = .010 - 2-tailed*
[b] *p = .003 - 2-tailed*

Comparing the Fisher transformed correlation coefficients showed that the correlation between BDI-II item 7 (self-dislike) and decrease in bias index differed significantly between the experimental and the control group for both disgusted ($Z = -2.1$, $p = .036$) and sad ($Z = -2.79$, $p = .005$) facial expressions.

3 Since this is an explorative analysis, Bonferroni correction was not applied. If applied, the correlation between change in bias for disgust faces and BDI-II item 7 remains significant.

Discussion

We observed no effects of a single session of visual search ABM on attentional bias for either happy, sad or disgust facial expressions. The training also had no differential effects on positive and negative affect states. When self-reported negative and positive affect states were used as covariates in the analyses evaluating the effects of ABM on bias indices, negative affect was associated with bias towards sad facial expressions, but no effects of training were revealed. This lack of effect was unexpected given earlier reports with this type of training.

We used the same control training (the flower task) as in previous studies. Although response times were lower in the control training task than in the experimental task, response times in both conditions decreased to a similar extent over the course of the training, indicating that both groups learned equally well. The main outcome measure in this study, the dot probe task, differs on several parameters from the dot probe task with which previous studies assessed effects of this type of training. Since depression related biases may be more pronounced at longer stimulus durations (Donaldson, Lam, & Mathews, 2007; Mogg & Bradley, 2005; Shane & Peterson, 2007), we used a longer stimulus duration (750 ms versus 500 ms in previous studies). Because we assessed multiple biases, a single session of our dot probe task took as many as 320 trials. This may have affected the outcomes both through fatigue, as well as through the occurrence of learning effects. Over the course of the dot probe task, the images depicting emotional facial expressions may have become less meaningful and less attention capturing. These potential problems were addressed by offering self-paced break opportunities every 20 trials and by using stimulus pictures of 16 different identities so that each emotional expression picture occurred only five times within one assessment. Different stimulus sets were used in the assessment and training tasks to ensure that the dot probe assessed the generalization of training effects rather than effects on a specific set of stimuli.

The current study is the first to evaluate the effects of this training on attentional bias in a pre-post design. In previous studies, attentional bias in treatment and control groups was only assessed post-training (Dandeneau & Baldwin, 2009; Dandeneau, et al., 2007). This might be because the dot probe task has a low reliability in a general population sample (Schmukle, 2005; Staugaard, 2009). There are, however, no tasks or techniques available for assessing preferential spatial orienting of attention that are proven to be more reliable than the dot probe task, and it remains the most often used task for assessing and modifying attentional bias. A within-between design, like we used, is generally considered a more suitable and powerful design for evaluating treatment effects. However, our sample was considerably smaller than in previous studies assessing the effects of this training on attentional bias. Based on the sample size, the minimum detectable effect size on the time by group interaction terms could have ranged from f =.03 to f =.32. Taking the observed correlations between repeated measurements into account, minimum effect sizes of .16, .21 and, .27 could have been detected with 80% power for the effects of training on sad, happy and disgusted attentional bias. Although the exact size of the post training between groups effects on attentional bias reported in previous studies are not known, they could be smaller in size than the minimum effect sizes that we could detect on the within-between interaction effect. Thus, it is possible that smaller sized effects occurred in the current study but went undetected.

The current study focused on establishing ABM's mechanism of action, modification of attentional bias. We had no strong expectations about immediate effects on mood states or symptoms. One theory is that ABM affects attentional bias which needs time and interaction with the environment to translate into a mood effect (e.g., Wells & Beevers, 2010). However, previous studies with this type of training (Dandeneau & Baldwin, 2004; Dandeneau & Baldwin, 2009; Dandeneau, et al., 2007) did find immediate effects on self-esteem. We observed no differential effects of the training on positive or negative affect, however.

Although cognitive biases in low self-esteem may not be exactly the same as cognitive biases in dysphoria or depression, it has been theorized that all biased cognitive processing in depression occurs as a function of elaborate processing and low self-esteem (Wisco, 2009). In order to explore possible differential influences of self-esteem, we looked at the individual BDI-II items. Correlations were found between the score on item 7, self-dislike, and the attentional bias change scores for both disgust and sad faces in the experimental but not the control group. The Fisher transformed correlation coefficients differed significantly between the experimental and the control group. This suggests that the experimental training may have reduced attentional bias for sad and disgusted facial expressions in those participants endorsing statements at the higher end of a four-point scale running from "I feel the same about myself as ever" to "I dislike myself". This was a post-hoc analysis and the effect was only found for one of three items that are likely self-esteem related. Although the pattern of this effects fits with what would have been expected when a true measure of self-esteem had been assessed, this could be a chance finding.

In conclusion, although small treatment effects may have gone undetected, we found no evidence that engaging in a single session of a visual search ABM modifies attentional biases for happy, sad or disgusted facial expressions.

Acknowledgements
The authors would like to thank Britt Dijkstra and Johanna Morks for their help in collecting data for this study.