Negative effects of an alternating-bias training aimed at attentional flexibility: a single session study

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ABSTRACT
Attentional Bias Modification (ABM) usually aims to induce automatic biases directed toward or away from certain stimulus categories. An alternative approach, termed Attention Control Training (ACT), uses a similar paradigm but aims to train the ability to exert top-down control over attention and downregulate bottom-up interference. The current study tested a novel Alternating Bias training aimed at training attention control rather than a bias. The training involved switching contingencies, so that the optimal attentional set alternated per block. Assessment and training tasks used neutral and angry faces as emotional stimuli. Results indicated that, rather than improving attention control, the Alternating Bias condition led to increased sensitivity to emotional stimuli, as measured via self-reported emotional reactivity and an Emotional Speeded Choice task. This was interpreted as an effect of enhanced salience: in the Alternating Bias condition, as with usual active ABM conditions, the emotional content of cues is task-relevant and this may increase its salience. This salience side-effect may be relevant to ABM methods. While ACT remains a potentially important avenue for research and treatment, the current results provide a warning that undesirable side effects may occur. Future methods may be able to selectively train flexibility without inducing an increase in salience.

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1. Introduction
Attentional biases are automatic effects on attention, which can be measured using implicit measures (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009; Fazio & Olson, 2003; Field & Cox, 2008; Gladwin & Figner, 2014; Moors & De Houwer, 2006). For instance, threatening stimuli may draw spatial attention to their location (Cooper & Langton, 2006; Koster, Crombez, Verschuere, & De Houwer, 2004; Zvielli, Bernstein, & Koster, 2014) or induce a prioritization in cognitive processing (Notebaert et al., 2009; van Honk et al., 2001). Such biases are not only associated with mental health problems such as anxiety (Cisler & Koster, 2010; Dalgleish et al., 2010), post-traumatic stress disorder (Ashley, Honzel, Larsen, Justus, & Swick, 2013; © 2016 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

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Cisler et al., 2011), and addiction (Mogg, Field, & Bradley, 2005; Noël et al., 2006; Townshend & Duka, 2001), but they also appear to play a causal role in such disorders. This has been studied using a class of interventions termed Attentional Bias Modification (ABM; more generally, Cognitive Bias Modification, CBM, covers techniques to change any kind of automatic process), in which modified implicit measure tasks are used in attempts to change attentional biases. In ABM, participants perform a task in which they are induced to shift attention to or from a chosen class of stimuli, for example, by manipulating the probability of the location of a probe stimulus relative to emotional cues. ABM may have beneficial clinical effects as a complementary treatment method (Cox, Fadardi, Intriligator, & Klinger, 2014; Fadardi & Cox, 2009; Field & Cox, 2008; Schoenmakers et al., 2010), although the evidence of its efficacy, and the importance of considering mediating and moderating factors (Gladwin, Wiers, & Wiers, 2017; Kuckertz et al., 2014), is debated (Clarke, Notebaert, & MacLeod, 2014; Cristea, Kok, & Cuijpers, 2015; Emmelkamp, 2012; Gladwin, Wiers, & Wiers, 2016).

Often, in a spatial ABM using a dot-probe task to manipulate attention, a control group is used in which the relationship between cues and probes in the control group is uninformative. However, this may entail a manipulation in itself: Participants are perhaps being trained to ignore the task-irrelevant emotional stimuli, precisely because they are now random and irrelevant whereas they may be highly salient in the participants’ experience. This is an essential difference from the usual ABM viewpoint, in which the direction of attention has tended to be considered the important feature. That is, in ABM, the aim is to train attention in a consistent direction: either towards a salient stimulus category, or away from it. However, considering a more general, non-directional training of top-down influence versus emotional influence provides a different way to view attentional training. This alternative view of training attention has been termed Attention Control Training (ACT) in recent studies (Badura-Brack et al., 2015; Khanna et al., 2015). The rationale is based on improving top-down, goal-directed influences on attention (Minamoto, Osaka, & Osaka, 2010; Pessoa, Kastner, & Ungerleider, 2002; Rueda, Posner, & Rothbart, 2005; Shiffrin & Schneider, 1977; Unsworth & Engle, 2007), rather than ABM’s aim of inducing a new automatic tendency to shift spatial attention in a certain direction. Such a general ability or tendency to ignore or inhibit distractors may allow flexible downregulation of emotional distraction. Thus, beyond raising the methodological question whether perhaps weak effects in ABM studies might be due to the use of random control groups that are too effective, rather than truly “null” sham training, it is of clinical and theoretical interest whether the top-down control of attention, rather than its automatic biasing, can be trained. Such non-directional ACT has been used to train general attentional control in the context of threatening stimuli (Badura-Brack et al., 2015; Khanna et al., 2015) and addiction-related stimuli (Fadardi & Cox, 2009). In one study in combat veterans with post-traumatic stress disorder (Badura-Brack et al., 2015), results showed that ACT reduced attentional bias variability relative to ABM. Attentional bias variability is a relatively recent measure shown to be related to anxiety (Naim et al., 2015; Zvielli et al., 2014), post-traumatic stress disorder (Iacoviello et al., 2014) and risky drinking behavior (Gladwin, 2016). This variability measure was found to mediate reduction in symptoms. In another study of combat-related post-
traumatic stress, ACT was found to more strongly reduce interference on an emotional Stroop task than ABM. An Alcohol Attention-Control Training Program, in which participants are trained to focus on task-related stimulus features and ignore alcoholic distractors, has been found to reduce attentional bias towards alcohol and alcohol consumption (Fadardi & Cox, 2009). A limitation of this study was a lack of control group, although it was argued that results could be compared against the expected lack of change based on existing data on waiting-list control groups.

Thus, although ACT is similar to ABM in terms of the basis task used for training, the rationale and targeted processes may be more closely related to training variants such as response inhibition training (Houben & Jansen, 2011; Houben, Nederkoorn, Wiers, & Jansen, 2011; Manuel, Grivel, Bernasconi, Murray, & Spierer, 2010) or other methods aimed at generally enhancing the influence of top-down attentional control or executive functions over bottom-up stimulus-driven or emotional interference (Diamond & Lee, 2011; Fadardi & Cox, 2009; Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005; Wass, Scerif, & Johnson, 2012).

To the aim of exploring whether more effective forms of ACT can be found, the current study used two attentional training variants, both based on a dot-probe task with angry and neutral face cues. In the Alternating group, participants had to shift their attentional bias to versus from threatening stimuli on a block-by-block basis: In some blocks, probes appeared at the angry faces’ location, while in others probes appeared at the neutral faces’ location. This was hypothesized to train goal-directed shifts in attention: Participants were expected to learn to flexibly direct their attention based on task goals and hence downregulate task-irrelevant emotional effects on attention. In the Random group, the usual control condition was used in which there was no consistent relationship between threatening cues and probes. Note that, essentially, while in both conditions the overall contingency between threat-neutral cues and probe location was 50%, in the Alternating condition cues were informative of probe location (once the current block’s contingency had been learned), while in the Random condition cues were uninformative of probe location. The Alternating group was hypothesized to more effectively train the ability to control attention based on task demands, and downregulate irrelevant emotional distractors, as the alternating but exploitable contingencies would reinforce such control more than in the Random group. The primary tests concerned effects on an Emotional Speeded Choice task. In this task, neutral and angry faces were presented as distractors during a simple speeded choice task, which were expected to induce impulsive responding. In particular, angry faces were expected to evoke defensive, threat-related responses known to involve changes in action readiness (Gladwin, Hashemi, van Ast, & Roelofs, 2016; Montoya, Van Honk, Bos, & Terburg, 2015; Schutter, Hofman, & Van Honk, 2008) and impulsivity (Hartikainen, Siiskonen, & Ogawa, 2012; Nieuwenhuys, Savelbergh, & Oudejans, 2012). Such distractor effects were predicted to be downregulated in the Alternating condition. Effects were also explored on self-reported emotional reactivity to face stimuli and on state anxiety. Changes in emotional reactivity were hypothesized to occur due to the expected downregulation of the impact of emotional stimuli. Further, it was important to consider possible negative effects of training: if a method increases anxiety or negative emotional reactivity, this would play a role in considering whether or how to use it in patient groups.
2. Method

2.1. Participants
Healthy students were recruited and received study credits for completing the study, which was performed online. Participants gave informed consent and the study was approved by the local ethics review board. Fifty-two participants completed the experiment (19% males; mean age 21, SD = 2.4).

2.2. Questionnaires

2.2.1. STAI-state
The State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was used to measure state anxiety. This scale comprises 20 statements to be rated on a 4-point Likert scale (1 = not at all, 4 = very much). Half of the items concern positive feelings, and responses on these items were scored as negative. Higher sum-scores thus represent higher state anxiety levels.

2.2.2. Facial affective cue reactivity on emotions (FACE)
For this measure, participants were instructed to view a picture of an angry face and a picture of a neutral face. Subsequently, for each face separately, a screen containing the face followed by instructions and a series of questions was presented. The order of faces (angry – neutral or neutral – angry) was randomized. The instructions were: “How does this face make you feel when you look at it? Indicate the degree to which the face evokes the feelings in you.” The feelings were: Unpleasant, Excited, Intimidated, Aggressive, Out of Control, and Ashamed. Answers could range from 1 to 7, with option 1 being labeled as “Not at all,” option 4 as “Somewhat,” and option 7 as “Extremely.”

2.3. Tasks

2.3.1. Emotional Speeded Choice task
The task consisted of 8 blocks of 25 trials. Trials began with a white fixation cross, onscreen for 400, 500, or 600 ms (with equal probabilities). A cue was then presented: a neutral face, an angry face, or a change in the size and color of the fixation cross (each with 1/3 probability). The changed fixation cross was doubled in size and turned a flesh-like color (RGB: 223, 166, and 117). Facial stimuli were drawn from a set of 11 neutral and 11 angry faces from the Bochum Emotional Stimulus Set (BESST) (Thoma, Soria Bauser, & Suchan, 2013). After a cue-stimulus interval (CSI) of 200, 600, or 1200 ms (each duration equally likely), an up-arrow (the characters /\) or down-arrow (the characters \/) stimulus was presented requiring a up- or down-button (via the I or J key) response, to be given with the right hand. Participants had 2000 ms to respond. Following each response, feedback text (in Dutch) was presented for 500 ms: a green “Correct,” a red “Incorrect” or a red “Too late.”

2.3.2. Attention manipulation
The attention manipulation consisted of 20 blocks of 30 trials of a dot-probe task. Trials began with a white fixation cross, onscreen for 400, 500, or 600 ms (with equal
probabilities). On every trial a neutral and an angry face were presented as cues, one above and one below a fixation cross, for 200, 600, or 1200 ms. The facial stimuli were selected from the same subset of 11 faces from the BESST (Thoma et al., 2013) as in the Emotional Speeded Choice task. Following the cue period, a probe stimulus appeared at one of the locations (above or below fixation) at random. Probes were left- or right-arrows (\ or //), requiring a left- versus right-hand button press response. On the other location, a distractor stimulus was presented (\ or //), to the aim of making it more difficult to recognize the probe without shifting attention to its location. In the control version of the manipulation task, the location of the probe stimulus was random and had no relationship to the locations of the angry and neutral faces presented as cue. In the training version of the manipulation task, on each block of the training version the location of the probe had an 80% probability of appearing at either the angry or neutral face’s location. This contingency was consistent within each block but alternated between blocks. Thus, optimal task performance required shifting the bias per block.

Participants were informed that they would be performing an experiment involving a training manipulation, but were given no further explanation on the training. The manipulation task was also used in a brief post-manipulation assessment task. This was used to test whether the training version of the manipulation would improve overall performance in the context of the same spatial contingencies. This assessment consisted of two blocks of the training version, one with the probe-on-threat contingency and one with the probe-on-neutral contingency. The block order was randomized over subjects.

2.4. Procedure

Participants first filled in the pre-manipulation questionnaires (STAI and FACE) and performed the pre-manipulation Emotional Speeded Choice task. This was followed by one of the attention manipulation tasks, for which participants were assigned at random to the control or alternating condition. Post-manipulation, the Emotional Speeded Choice task was performed again, the questionnaires (STAI and FACE) were repeated, and the assessment blocks of the manipulation task were performed. Finally, participants were asked whether they noticed any contingency between cues and stimuli during the training or during the Biased Attentional Bias task.

2.5. Statistical analyses

Mixed design repeated measures Analysis of Variances and Analysis of Covariances with Greenhouse–Geisser correction were used to test effects of the attention manipulation, in which participants’ manipulation condition (Control versus Alternating group) was the between-subject factor. For the psychological tasks, median reaction times and mean accuracy were tested. Median reaction times were used in order to reduce sensitivity to outliers and avoid the need to specify arbitrary criteria for rejecting trials. Tests were performed separately for the various assessment measures: STAI, FACE scores, Emotional Speeded Choice effects, and the Biased Attentional Bias task. The post-manipulation scores were used as dependent variables, and for all tests for which pre-manipulation scores were available, these were used as a covariate. The STAI test had no within-subject factors. For the FACE questionnaire, separate tests were performed for the different responses, with facial
Table 1. Descriptives of questionnaires and task performance.

|                | A. STAI |                |                |                |                |                |                |                |                |
|----------------|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                | T1      | T2             |                |                |                |                |                |                |                |
| Random group   | −19 (8) | −18 (6.3)      |                |                |                |                |                |                |                |
| Alternating group | −15 (7.1) | −12 (8.7) |                |                |                |                |                |                |                |

| B. Emotional Speeded Choice Task | No Face | Neutral | Angry | | | | | | |
| T1: Pre-manipulation. | 200 ms | 600 ms | 1200 ms | 200 ms | 600 ms | 1200 ms | 200 ms | 600 ms | 1200 ms |
| Random group RT | 505 (40) | 521 (69) | 510 (58) | 478 (41) | 488 (52) | 478 (58) | 492 (55) | 485 (48) | 494 (48) |
| Random group Acc | 0.98 (0.047) | 0.97 (0.075) | 0.99 (0.032) | 0.96 (0.051) | 0.95 (0.045) | 0.96 (0.05) | 0.96 (0.049) | 0.95 (0.041) | 0.98 (0.033) |
| Alternating group RT | 513 (59) | 482 (54) | 492 (52) | 479 (60) | 479 (56) | 484 (57) | 485 (51) | 485 (45) | 488 (57) |
| Alternating group Acc | 0.98 (0.044) | 0.98 (0.049) | 0.96 (0.068) | 0.96 (0.055) | 0.97 (0.052) | 0.95 (0.061) | 0.96 (0.044) | 0.96 (0.044) | 0.96 (0.052) |
| T2: Post-manipulation. | | | | | | | | | |
| Random group RT | 515 (48) | 500 (63) | 494 (47) | 470 (51) | 486 (63) | 484 (60) | 482 (43) | 487 (52) | 484 (59) |
| Random group Acc | 0.96 (0.07) | 0.97 (0.047) | 0.96 (0.068) | 0.93 (0.063) | 0.96 (0.057) | 0.95 (0.05) | 0.93 (0.061) | 0.94 (0.053) | 0.95 (0.055) |
| Alternating group RT | 482 (58) | 476 (54) | 475 (45) | 451 (42) | 466 (46) | 451 (47) | 459 (42) | 467 (44) | 464 (44) |
| Alternating group Acc | 0.95 (0.088) | 0.91 (0.12) | 0.94 (0.073) | 0.93 (0.082) | 0.92 (0.086) | 0.92 (0.11) | 0.91 (0.11) | 0.92 (0.08) | 0.93 (0.088) |

| C. Spatial cueing assessment | First half of block | | Second half of block | | | | | | |
| Random group RT | 528 (61) | 527 (52) | | | | | | |
| Random group Acc | 0.97 (0.036) | 0.99 (0.032) | | | | | | |
| Alternating group RT | 512 (71) | 514 (66) | | | | | | |
| Alternating group Acc | 0.95 (0.055) | 0.95 (0.089) | | | | | | |

| D. Spatial cueing training, Random group | Probe on neutral | | Probe on threat | | | | | | |
| Probe on neutral | 200 ms | 600 ms | 1200 ms | | | | | | |
| RT | 534 (54) | 549 (53) | 548 (55) | | | | | | |
| Acc | 0.95 (0.067) | 0.95 (0.068) | 0.95 (0.089) | | | | | | |
| Probe on threat | 200 ms | 600 ms | 1200 ms | | | | | | |
| RT | 539 (55) | 547 (53) | 548 (57) | | | | | | |
| Acc | 0.96 (0.092) | 0.96 (0.092) | 0.95 (0.074) | | | | | | |
E. Spatial cueing training, Alternating group

|                  | Contingency to neutral | Contingency to threat |
|------------------|-------------------------|-----------------------|
|                  | Probe on neutral        | Probe on threat       | Probe on neutral        | Probe on threat       |
|                  | 200 ms  | 600 ms  | 1200 ms | 200 ms  | 600 ms  | 1200 ms | 200 ms  | 600 ms  | 1200 ms |
| RT               | 533 (61) | 543 (54) | 536 (60) | 544 (91) | 548 (71) | 548 (72) | 538 (66) | 548 (89) | 553 (77) |
|                  | 531 (57) | 541 (58) | 531 (57) | 533 (68) | 541 (58) | 531 (57) | 533 (68) | 541 (58) | 531 (57) |
| Acc              | 0.94 (0.097) | 0.95 (0.083) | 0.95 (0.086) | 0.94 (0.11) | 0.95 (0.12) | 0.94 (0.093) | 0.95 (0.099) | 0.95 (0.075) | 0.95 (0.11) |
|                  | 0.95 (0.093) | 0.95 (0.086) | 0.95 (0.093) | 0.95 (0.11) | 0.95 (0.075) | 0.95 (0.11) | 0.95 (0.093) | 0.95 (0.086) | 0.95 (0.11) |

Notes: (A–E) Show scores, mean reaction times (ms) and mean accuracy (proportion correct) with standard deviations between brackets. (A) Shows the pre- and post-manipulation STAI scores. (B) Shows performance data for the Emotional Speeded Choice Task, pre- (T1) and post-manipulation (T2), for the three cue types (No Face, Neutral face, and Angry face) and three CSIs (200, 600, and 1200 ms). Note that for No Face cues, the fixation cross conspicuously changed size and color, so that the prediction of the time of the upcoming stimulus was the same as for the facial cues. (C) Shows performance data for the post-manipulation assessment session, which consisted of two blocks of the Alternating version of the attention manipulation task. Data are shown for the first versus second half of blocks. (D, E) Show performance data for the Random and Alternating groups during training. These data are based on the second half of each block. For the Random group, trials were distinguished based on probe location: Either on the neutral face (probe on neutral) or on the angry face (probe on threat), and CSI (200, 600, or 1200 ms). For the Alternating group, an additional factor was the block type: per block, probes were more likely to appear at the location of the neutral face (contingency to neutral) or the angry face (contingency to threat).
expression (neutral or angry) as within-subject factor. For the Emotional Speeded Choice task, cue (no face, neutral, and angry face) and CSI (200, 600 or 1200 ms) were used as within-subject factors. For the assessment version of the manipulation task, only congruent trials (on which the probe appeared at the probable location for the block’s contingency) were analyzed and time-in-block (first versus second half of the block: Trials 1 through 13 versus trials 14 through 25, respectively) was used as the within-subjects factor.

Performance during the manipulation was tested for the control and training groups separately. In the control group, within-subject factors were probe location (probe-on-neutral and probe-on-threat) and CSI (200, 600, or 1200 ms). In the training group, within-subject factors were block type (on-neutral contingency and on-threat contingency), probe location (probe-on-neutral and probe-on-threat), and CSI (200, 600, or 1200 ms). Note that congruent trials consist of probe-on-threat trials in to-threat contingency blocks and probe-on-neutral trials in to-neutral contingency blocks; and incongruent trials consist of probe-on-neutral trials in to-threat contingency blocks and probe-on-threat trials in to-neutral contingency blocks. An effect of congruence would thus be tested

![Figure 1. FACE scores.](image)

Note: The figure shows the pre-manipulation and post-manipulation responses to the neutral and angry face. Subplots (a–f) show the responses for the different emotional responses; for example, does the face make you feel unpleasant. Labels represent group, Random versus Alternating Bias; expression of the presented face, neutral versus angry; and time point pre-training (pre) versus post-training (post).
by the interaction between block type and probe location. In these analyses, only trials in the second half of each block were used to allow for participants having to detect the alternating contingencies over blocks.

3. Results

Descriptive statistics are shown in Table 1 and Figure 1 for the FACE questionnaire. The ANCOVA for the post-manipulation STAI showed no group difference \(F(1, 49) = 2.46, p = .12\). On the FACE questionnaire, post-manipulation Unpleasant-responsive showed an interaction between facial expression and training \(F(1, 48) = 5.061, p = .029\). Participants in the Alternating group rated angry faces as more unpleasant and neutral faces as less unpleasant. There was a main effect of training on Excited- \(F(1, 48) = 6.16, p = .017\), Aggressive- \(F(1, 48) = 7.071, p = .011\), and Out of control-responses \(F(1, 48) = 12.27, p = .001\). Participants in the Alternating group reported stronger responses on these emotions. No effects were found for Intimidated- and Ashamed-responses.

For the Emotional Speeded Choice task, a descriptive pre-manipulation test with factors cue type and CSI showed an effect of cue type on RT \(F(1.46, 74.41) = 14.71, p\)
The No-Face cue was slower than the Neutral face cue, which was slower than the angry face cue, \( t \)-tests for all pairwise differences being significant \( (p < .004) \). Pairwise comparisons showed that the No-Face cue had higher accuracy than both neutral and angry face cues \( (p < .005) \).

Tests of training effects in the Emotional Speeded Choice task showed no significant results on RT. On accuracy, there was a main effect of training \( (F(1, 41) = 5.25, p = .027) \). This was due to lower accuracy in the Alternating group \( (0.92 \text{ versus } 0.96) \). There was a further interaction between training condition and CSI \( (F(1.95, 78.86) = 4.075, p = .022) \). Post hoc tests per training condition did not show significant effects of CSI in either group separately, but visual inspection of plots showed that the difference between training groups was more pronounced at the longer CSIs \( (600 \text{ and } 1200 \text{ ms}) \) than the shortest CSI \( (200 \text{ ms}) \).

The assessment version of the manipulation task showed no significant effects on RT or accuracy. A trend was found for a main effect on accuracy \( (F(1, 50) = 3.7, p = .057) \), the Alternating group showing lower accuracy than the control group \( (0.95 \text{ versus } 0.98) \).

During training, no effects of probe location or CSI were found in the control group. In the Alternating group, an interaction effect on RT was found of block type (to-threat versus to-neutral contingency) by probe location (probe on threat and probe on...
neutral) \( F(1, 29) = 9.27, p = .005 \). This interaction reflected congruent trials (e.g. probe-on-threat in to-threat contingency blocks) having faster RTs than incongruent trials (e.g. probe-on-threat in to-neutral contingency blocks) as expected, showing that subjects were sensitive to the alternating cue-probe contingencies. No effects on accuracy were found.

Despite the congruence effect found during training, only one subject in the Alternating condition reported being aware of any contingency between cues and probes; there was also a single subject who reported being aware of such a contingency in the control condition.

4. Discussion

The current study aimed to explore the possibility of training attentional control, rather than attentional bias, using an Alternating Bias manipulation. The direction in which attention was manipulated alternated over blocks, so that the direction of attention had to be flexibly adjusted. Essentially, while over the whole task the cue-probe contingencies were 50% in both the Alternating Bias and the control group, cues were informative in Alternating Bias group (because per block, there was a contingency in one or the other direction) but not in the control group (in which the cue was always non-predictive of probe location). The question is whether the Alternating Bias training would lead to the desired increase in attentional control.

The results clearly reject this hypothesis. What appears to have occurred was an increase in salience due to the Alternating Bias training, relative to the control group. Although congruence effects showed that attentional bias was successfully manipulated to and from threat during the Alternating Bias training phase, this did not lead to any advantages on assessment measures. To the contrary, participants in the Alternating Bias group showed more self-reported emotional reactivity to facial stimuli and lower overall accuracy on an Emotional Speeded Choice task. One question is whether the increased self-reported reactivity scores could reflect a change in discrimination between expressions, rather than emotional reactivity to equally well-perceived expressions; the current results cannot exclude this possibility, although the expressions appeared visually easily distinguishable and at pre-test clear differences between reactivity to angry and neutral faces were found \( p < .001 \) for the Unpleasant, Intimidated, Aggressive, and Out of Control responses). It should also be noted that it appears that the difference at post-test arose due to a decrease in reactivity in the control group, while reactivity remained high in the Alternating Bias group. On the Emotional Speeded Choice task, the decreased overall accuracy, as opposed to an interaction with cue type, suggests an effect on contextual/tonic effects of distracting stimuli rather than acute/phasic effects of the most recent cue. However, we acknowledge that the general effect is more difficult to interpret than an effect specific to an experimentally manipulated task factor. Nevertheless, taken together, the results indicate that the current form of Alternating Bias training is not suitable for ACT, with no benefits and possible negative effects.

This result may have some implications for ABM. In the usual “active” training condition a consistent bias is trained, and therefore emotional content is salient as in the current Alternating condition. This may lead to undesirable effects in some cases: although the bias may be shifted in a desirable direction, the participant or patient is still learning to attend to emotional content. This could occur concurrently with effects due to the directed shift in
bias, potentially leading to complex and noisy results. Further, the current results support the idea that the random, cue-irrelevant kind of training that tends to be considered the “control” condition may in fact train – at least relative to a possibly salience-enhancing condition – the inhibition of emotional effects. In previous studies, ACT in the context of post-traumatic stress disorder has been found to reduce measures reflecting abnormal automatic attentional responses to emotional stimuli, in terms of attentional bias variability (Badura-Brack et al., 2015) and of emotional Stroop effects (Khanna et al., 2015). ACT in the context of alcohol dependence similarly reduced biases due to automatic responses to the emotionally salient alcoholic stimuli (Fadardi & Cox, 2009). The advantage of the control group in the current study appears to be in the same line. The self-report measures indicate a reduction in emotional reactivity in the control versus Alternative Bias group. Further, it seems unlikely that the current training conditions affected the very basic cognitive processes needed to map arrows to responses, suggesting that the better accuracy in the Emotional Speeded Choice task following the control-condition training was due to a reduced influence of the emotional distractors.

As noted in the Introduction, rather than following the rationale of ABM, ACT is more similar to training aimed at executive functions (Diamond & Lee, 2011; Fadardi & Cox, 2009; Houben & Jansen, 2011; Rueda, Rothbart, et al., 2005), although specifically involving emotional regulation rather than general cognitive capabilities (Bergman-Nutley & Klingberg, 2014; Klingberg, 2010). Note that a different kind of training also termed “ACT” has been used that involves mindfulness training and cognitive therapy (Teasdale, Segal, & Williams, 1995), rather than an adapted dot-probe task; however, there do seem to be possible similarities in the goals of emotion regulation. One possible reason that flexible, task-directed attentional shifting did not seem to provide the hypothesized effects in the current study is that the shifts only occurred between blocks, as suggested by a reviewer. If shifts had occurred more frequently, this could have more likely produced the expected effects on attentional control. This would appear to be an important direction for future studies to explore.

A limitation of the current study is that it was performed in a small student sample. The role of salience may well be different in various clinical groups. Conceivably, enhanced salience for certain emotional stimuli may even be beneficial, for instance in psychopathy, where reduced sensitivity to others’ emotions may play a negative role and its enhancement may improve behavior (Hubble, Bowen, Moore, & van Goozen, 2015; Schönenberg et al., 2014). Further, only neutral and angry facial stimuli were used. It remains to be seen whether other types of stimuli, such as fear, positive emotion, or addiction-related stimuli, show the same pattern of sensitization. Further, there was no true-null control group to determine whether the benefits of the Random group were only relative to the Alternating group, or also reflected an absolute improvement over no manipulation. The lack of a pre-training measure of attention bias is a limitation of the current design: Knowledge of whether participants actually had a pre-existing bias would help interpret results and allow tests of whether individual differences might moderate training effects. For instance, subjects with weak attentional biases in the first place might not be expected to profit from training. Finally, only a single session of training was used. It remains a question whether more sessions might show increases in attentional control and decreases in salience effects, or whether the apparent salience effect found in the current study would persist or become stronger.
Nevertheless, the current results provide information on the effect of using an alternating-contingency version of ACT, the possible influence of (perhaps accidentally) training salience in ABM methods, and the use of the FACE questionnaire as a simple method to acquire information on cue reactivity. An interesting direction for future laboratory studies would be to use psychophysiology to measure effects on neural responses to cues, in addition to the online self-report or implicit measures used in the current study. This could help specify in more detail which neural and computational processes are being affected by the training contingencies, such as effects on conflict resolution (Egner & Hirsch, 2005; Reeck & Egner, 2011).

In summary, effects were tested of an ACT variant that alternated between periods of directing attention towards threat and periods of directing attention away from threat. In comparison with a no-contingency control group, the alternating method appeared to cause an increase in sensitivity to the emotional stimuli. While this result may be interesting in itself, it also suggests that ABM may need to take a “salience side-effect” into account, which may affect comparisons between normal ABM and a random control group. For further development of ACT, methods may be found in which top-down attention can be trained without undesirable effects on salience.

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