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Impact of the temporal stability of preexistent attentional bias for threat on its alteration through attention bias modification

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ABSTRACT

Background: Attention bias modification (ABM) aims to reduce attentional bias for threat (AB), thereby diminishing anxiety symptoms. However, recent meta-analyses indicated mixed effects. Recent works suggest that the presence of AB prior to ABM can be considered as a critical moderating factor that may account for these mixed results.
Methods: We assessed AB among highly trait-anxious individuals ($n = 77$) using both a face-version and a word-version of the dot-probe task at multiple time points: two weeks before ABM (t_1), just prior to ABM (t_2), and after ABM (t_3). All participants were submitted to an ABM procedure including facial expressions. Analyses focused on 2 components of AB prior to ABM: a stable component, representing variance shared between the two baseline points (t_1 and t_2), and a dynamic component, representing variance that is specific to that point (t_1 or t_2).
Results: The stable component of AB at baseline predicted the intensity of AB after ABM (t_3) while the dynamic component did not. The dynamic component of AB at baseline positively predicts performance improvement during ABM procedure, while the stable component negatively predicted it.
Limitations: The findings depicted above only appear with the face-version of the dot-probe task.
Conclusions: The present results highlight the contribution of both the stable individual differences and dynamic components of preexistent AB. They also show the importance of moving the conceptualization of AB beyond the group-based analysis by integrating the notion and the assessment of within-person variability.

1. Introduction

The ability to rapidly orient attention towards threat in the environment is crucial for survival. However, this essentially adaptive process is oftentimes exaggerated in anxious individuals. Evidence has accumulated that anxious individuals, regardless of the type of anxiety disorders, are prone to exhibit an attentional bias (AB) for threatening stimuli, such as threatening facial expressions (for a meta-analysis, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). Over the last fifteen years, researchers have started to investigate the causal nature of these biases in the *maintenance* of anxiety disorders, by directly manipulating AB. A growing body of research has accumulated on a new therapeutic intervention, called attention bias modification (ABM). ABM builds upon cognitive theories of psychopathology that implicate AB in the maintenance, and perhaps the etiology, of anxiety disorders (for a recent review, see Van Bockstaele et al., 2014). The clinical purpose of ABM is to reduce excessive AB, thereby diminishing anxiety symptoms (MacLeod & Mathews, 2012).

The most common ABM procedure is a modification of visual dot-probe task (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002) based on the classic work of MacLeod, Mathews, and Tata (1986). In the original dot-probe task (MacLeod et al., 1986), participants view two stimuli (e.g., a threatening word/photograph and a neutral word/photograph) presented in two distinct locations (left/right or up/down) of a computer screen for a brief duration (usually 500 ms). Immediately thereafter, a probe appears at the location previously occupied by one of the two stimuli. Participants have to indicate the location of the probe (right/left or up/down) or to discriminate the nature of the probe (e.g., "E" or "F") as quickly and accurately as possible. An AB is

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demonstrated when participants respond faster to the probe when it replaces a threatening stimulus than when it replaces a nonthreatening stimulus, indicating that their attention was directed to the location occupied by the threatening stimulus. In ABM, researchers typically modify the original task such as the probe nearly always (e.g., 95% of the trials) replaces the neutral or positive stimulus, thereby redirecting subjects' attention to non-threatening cues. This work has led to several randomized controlled trials among anxious individuals reporting that, relative to control training (i.e., a sham training), this procedure reduces AB, thereby diminishing anxiety symptoms (for meta-analyses, see Hakamata et al., 2010; Mogoase et al., in press). By most standards, these results raised promising clinical avenues for ABM as it entails a very simple protocol, little contact with a mental health professional, and a potential for easy dissemination (e.g., Amir, Taylor, & Donohue, 2011; Clarke, Notebaert, & MacLeod, 2014; Heeren, Maurage, & Philippot, 2013).

However, despite these promising initial results, recent evidence suggests that the picture may be more complicated than initially thought as several studies with inconsistent findings have been published recently. More specifically, some studies have shown that ABM and the control condition did not significantly differ at post-training, neither for AB, nor for anxiety symptoms (e.g., Julian, Beard, Schmidt, Powers, & Smits, 2012; McNally, Enock, Tsai, & Tousian, 2013). These failures to replicate have led some to raise doubt about the clinical potential of ABM (Emmelkamp, 2012). However, it has inspired others to examine whether there are variables that moderate the malleability of AB (e.g., MacLeod, Koster, & Fox, 2009). Indeed, recent research suggests that several important moderating factors may account for these inconsistent findings. Given the rational of ABM, the presence of an AB before ABM has been considered as a critical one. Accordingly, Amir et al. (2011) reported that the initial level of AB significantly moderated the relationship between assigned training condition (ABM versus sham training) and improvement in anxiety symptoms. In the same vein, Kuckertz et al. (2014) reported that higher preexistent AB predicted greater symptom reduction for participants who completed ABM, but not for those who were in the sham group. More recently, Mogoase et al. (in press) demonstrated that, in the overall dataset of their meta-analysis, preexistent AB was significantly related to the change in AB from baseline to post-training and that this change correlated significantly with the change in symptoms.

The results of these studies clearly implicate preexistent AB as a critical variable in moderating ABM efficacy. Nevertheless, it is important to consider such findings within the context of the broader AB literature. Indeed, most of the cognitive models of AB have argued that such a bias is guided by both situational (e.g., state anxiety, threat-value of the stimulus, environmental factors) and stable (e.g., trait-anxiety, genes) components of the individuals (e.g., Bar-Haim et al., 2007; Eysenck, Derakshan, Santos, & Calvo, 2007; Heeren, De Raedt, Koster, & Philippot, 2013; Mogg & Bradley, 1998). For instance, while some studies suggest that context-dependent variables such as being under conditions of threat (e.g., an upcoming speech-task following the AB assessment) impact on AB (e.g., Garner, Mogg, & Bradley, 2006; Mansell, Ehlers, Clark, & Chen, 2002; Sposari & Rapee, 2007), other reported that stable individual component such as allelic variation in the promoter region of the serotonin transporter gene also modulate the sensitivity to acquire AB (e.g., Fox, Zougkou, Ridgewell, & Garner, 2011). In the same vein, Clarke and his collaborators also reported that the ease to modify AB predicts change in stable individual component such as trait-anxiety (Clarke, MacLeod, & Shirazee, 2008) and the tendency to respond to positive experiential conditions, such as group therapy (Clarke, Nigel, & Guastella, 2012). As a consequence, it seem unfortunate to only use a single time-point to examine the moderating influence of preexistent AB on ABM since such a design does not allow to properly disentangle stable from situational components of AB.

Beyond AB studies, such a distinction between stable and dynamic components is becoming widely used in the broader literature about the dynamic nature of emotional processes where the shifting nature of contextual demand across time demands flexibility (Aldao, 2013; Bonnano & Burton, 2013; Carver & Connor-Smith, 2010; Fleeson, 2004; Hoeksma, Oosterlaan, & Schipper, 2004). More specifically, it has been considered that the assessment of emotional processes at a single time-point mirrors both stable personal factors and dynamic responses to the current situational context (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004; Hoeksma et al., 2004; Srivastava, Tamir, McGonigal, John, & Gross, 2009).

Despite the previous indications that preexistent AB may interact with ABM efficacy, up to now no study has been focused on the influence of dynamic fluctuation of AB magnitude on ABM. This knowledge is critical as previous findings indicate that AB is not only guided by stable individual differences but can also change dynamically in function of situational influences and demands. To overcome these limitations, the present study relied on the use of a panel design, which contains measures of the same variables from units observed repeatedly overtime (Finkel, 1995). The most important feature of panel data is that change is explicitly incorporated into the design so that individual-level changes in a set of variables are directly measured (Finkel, 1995). We focused on the assessment of the magnitude of AB in highly trait-anxious individuals at two time-points prior to ABM: two weeks before ABM (t_1), just prior to ABM (t_2). This enables us to distinguish between two components of preexistent AB: a stable component, representing variance shared between the two baseline points (t_1 and t_2), and a dynamic component, representing variance that is specific to that point (t_1 or t_2).

All participants were submitted to a face-version of a single-session ABM procedure. AB was assessed using both a face-version and a word-version of the dot-probe task. This allowed us to examine the specificity of training effects since we only used faces in the training. Our main question addresses how stable and dynamic components of AB prior to ABM relate to AB after ABM (t_3) and on performance improvement during ABM. Provided that this study is the first of its kind, several hypotheses can be formulated. One possibility is that individuals with higher level of AB dynamics exhibit more performance improvement during the ABM and have a more malleable AB in response to ABM. Alternatively, ABM may have more beneficial effects in individuals with a higher level of AB stability.

2. Method

2.1. Participants

Participants were 77 individuals (58% female) with elevated trait-anxiety scores, with a mean age of 26.85 ($SD = 11.54$, $Min = 18$, $Max = 60$). They were drawn from a pool of the Université Catholique de Louvain community (students and employees) based on their score on the trait-version of the State and Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Those who scored among the 30% of the highest scores (among a database of 607 participants) were invited to participate in the current study. Of those who were contacted, 80 accepted to participate. Additional inclusion criteria were that the participant: (a) was not currently following a psychotherapeutic treatment, (b) had no current psychotropic medications, (c) and had normal or corrected-to-normal vision. Of the 80 who were scheduled, 3 participants did not come to the second session (see below). Data were obtained from the remaining 77 participants. Their characteristics appear in Table 1.

2.2. Measures

2.2.1. Questionnaires

Complementarily to the screening measurements, validated self-completion questionnaires were used to assess depression (Beck Depression Inventory 2nd Edition, Beck: BDI; Beck, Steer, & Brown, 1996) and state anxiety using the State version of the STAI (STAI-State; Spielberger et al., 1983). In order to control for individual's current level of anxiety at each session, the STAI-State was administered at each time-point. In the present experiment, the validated French versions of these scales were used (BDI-II, Beck et al., 1996; STAI-State and -Trait, Bruchon-Schweitzer & Paulhan, 1993).

2.2.2. Measure of AB

Since the standard ABM procedure relies on a modified version of the dot-probe discrimination task (see below), we used the dot-probe detection task (MacLeod et al., 1986) to prevent against potential practice effect when assessing AB throughout the experiment. Two similar versions of the same task were administered at each assessment time point: a word-version and a face version. Each version was administered disjointedly in a different block. For both versions, each trial began with a central fixation cross which appeared on the screen for 500 ms. Immediately following the disappearance of the cross, a pair of faces or words (as a function of the version) appeared on the screen for 500 ms. One face/word appeared to the top of the center of the screen, whereas the other face/word appeared to the bottom of the center of the screen. Immediately following their disappearance, a small probe (i.e., "X") replaced one of the faces. The probe remained on the screen until the participant indicated the location (top versus bottom) of the probe by pressing a corresponding button. The inter-trial interval was 1500 ms. There were an equal number of trials in each condition as a function of stimuli location (top or bottom) and probe location (top or bottom).

For the face-version of the dot-probe task, stimuli consisted of 24 face angry–neutral pairs (12 male, 12 female) selected on emotional intensity ratings from the Radboud Faces Database (Langner et al., 2010) that differed from those used during the training procedure. During the task, participants were exposed to a total of 192 trials including 24 neutral-angry face pairs that appeared four times (96 trials = 24 faces pairs × 2 faces positions × 2 probe positions), 24 neutral–neutral face pairs that appears two times (48 trials = 24 neutral faces × 2 probe positions) and 24 angry–angry face pairs (48 trials = 24 angry faces × 2 probe positions) that appears two times, representing all combinations of the locations and probe types. These pairs of faces appeared in a different random order for each participant. Pictures were 238 pixels high, 166 pixels large, and were separated by 160 pixels.

For the word-version of the dot-probe task, stimuli consisted of 12 threatening-neutral pairs selected from the threatening-neutral word-pairs database developed by Leleu, Douilliez, and Rusinek (2014). Words of each pair were matched on length and frequency in French. During the task, participants were exposed to a total of 144 trials including 12 neutral-threat word pairs that appeared four times (96 trials = 12 words pairs × 2 word positions × 2 probe positions × 2 repetition), 12 neutral–neutral words pairs that appears two times (24 trials = 12 neutral words pairs × 2 probe positions) and 12 threat–threat word pairs (28 trials = 12 angry words pairs × 2 probe positions) that appears two times, representing all combinations of the locations and probe types. These pairs of words appeared in a different random order for each participant. Words were presented in lowercase white letters (19–30 pixels) against a black background, in the center of the screen.

Table 1
Participants Characteristics (SD in parentheses).

	Mean (SD)
Demographic measures	
n	77
Age	26.85 (11.54)
Gender ratio (female/male)	45/32
Education level	9.92 (2.91)
Depression and anxiety scores	
BDI	12.84 (9.52)
Trait version of the STAI	47.81 (13.01)
State version of the STAI at t_1	50.25 (7.94)
State version of the STAI at t_2	48.67 (8.19)

Note. Education level was assessed according to the numbers of years of education completed since starting primary school. BDI-II is Beck Depression Inventory-II; STAI is State and Trait Anxiety Inventory, t_1 is the baseline assessment at two weeks before ABM; t_2 is the baseline assessment just before ABM.

2.3. Attention bias modification

The ABM procedure was based on the dot-probe paradigm modified in such a way that the probe nearly always (i.e., 95% of the trials) replaced the neutral stimulus, thereby redirecting subjects' attention to non-threat cues. Each trial began with a central fixation cross ("+") presented in the center of the screen for 500 ms. Immediately following termination of the fixation cue, two faces of the same person appeared on the screen, one face on the top and one on the bottom, with each pair displaying neutral-angry facial expressions. After the presentation of the faces for 500 ms, a probe appeared in the location of one of the two faces. Participants were instructed to indicate whether the probe was the letter E or F by pressing the corresponding arrow on the keyboard using their dominant hand. The probe remained on screen until a response was given. The inter-trial interval was 1500 ms. During each session, various combinations of probe type (E/F) and probe position (top/bottom) were presented twice (i.e., 480 = 60 stimuli × 2 positions × 2 cue type × 2 repetitions). The stimuli were angry and neutral faces of males and females (30 men, 30 women), based on a validation study (Goeleven, De Raedt, Leyman, & Verschuere, 2008) of the Karolinska Directed Emotional Faces (Lundqvist, Flykt, & Öhman, 1998), which is a standardized set of emotional expressions. All faces were adjusted to the same size (326 × 329 pixels).

2.4. General procedure

The procedure consisted of the AB assessment using both a face-version and a word-version of the dot-probe task at several time points: two weeks before ABM (t_1), just prior to ABM (t_2), and after ABM (t_3). At the first session, participants first completed a demographic questionnaire and the STAI (State version). We then administered the first AB assessment (t_1) using face-version and word-versions of the dot-probe task. Two weeks later, at the second session, participants first completed the STAI (State version) and performed the second AB assessment (t_2). Then, all the participants were submitted to the same ABM procedure. After ABM, they were administered again the AB assessment (t_3). Participants were debriefed at the end of the experiment. For each AB assessment time point, the order of the AB tasks (i.e. word-versus face-version)

Table 2
Description of the Attentional bias score as a function of time.

Time points	Baseline assessment two-weeks prior to ABM (t_1)		Baseline assessment just prior to ABM (t_2)		Post-ABM assessment (t_3)	
	Mean (SD)	% Participants exhibiting AB	Mean (SD)	% Participants exhibiting AB	Mean (SD)	% Participants exhibiting AB
Face version	15.51 (25.80)	73.68%	17.92 (33.27)	68.42%	9.50 (30.08).	56.58%
Word version	−2.47 (29.09)	35.53%	−3.07 (25.71)	38.15%	−3.79 (26.96)	40.78%

Note. *d* score represents the subtraction of the mean latency when the probe appeared in the same location as the threatening stimuli from the mean latency when the probe and the threatening stimuli appeared at different locations. A positive bias score indicates faster detection of probes replacing threat. Percentage of participants exhibiting AB reflects the percentage of participants who demonstrate a *d* score strictly superior to 0 (i.e. *d* score >0). ABM is Attention bias modification; t_1 is the baseline assessment at two weeks before ABM; t_2 is the baseline assessment just before ABM, t_3 is the assessment after ABM.

was counterbalanced across participants. Each participant was tested individually in a quiet room and all sessions were completed in the same laboratory. All the tasks were programmed using E-Prime 2 Professional® (Psychology Software Tools, Pittsburgh, PA, USA) and ran on a Windows XP computer with a 75 Hz, 19-inch color monitor. Participants received financial compensation (15 Euros) for their participation. We obtained written informed consent for each participant. The study was approved by the Ethical Committee of the Université Catholique de Louvain (UCL, Belgium).

3. Preparation of the data and data analytic plan

3.1. Data reduction

3.1.1. AB tasks

For each version of the dot-probe task and each time point, we addressed outliers and errors of each individual separately following Ratcliff's (1993) recommendations. First, trials with incorrect responses were excluded (less than 1% of the data). Second, RTs lower than 200 ms or greater than 2000 ms were removed from analyses (less than .2% of the remaining data). Third, RTs of more than 1.96 standard deviations below or above each participant's mean for each experimental condition were excluded as outliers (less than .5% of the remaining data). These rates did not differ across time points (*ts* < 1, *ps* > .52). Then, to determine AB scores at each time point for each participant, mean reactions times were calculated for each trial type separately. Consistent with MacLeod et al. (1986), we computed a bias score[1] (*d* score) for each participant and each version of the task separately by subtracting the mean latency when the probe appeared in the same location as the threatening stimuli from the mean latency when the probe and the threatening stimuli appeared at different locations. A positive bias score indicates faster detection of probes replacing threat i.e. AB for threat. Data of each time point are presented in Table 2.

3.1.2. ABM procedure

First, trials with incorrect responses were excluded from these analyses (about .75% of the data). Then, to gauge learning gains in task performance during ABM, we computed learning gains for each participant by calculating the mean RT of the first 100 trials minus the mean RT of the 100 last trials, divided by the mean RT of the first 100 trials. These gains reflect the percentage of RT reduction through the ABM procedure, with positive values indicating improvement in performance. Our decision to compute learning gains was based on two main criteria. First, Abend, Pine, Fox, and Bar-Haim (2014) demonstrated that high-trait anxious specifically exhibit a selective difficulty in improving on such gain index during ABM. Second, the use of performance gains as indicator of improvement during a training task becomes a common approach to examine learning processes in the field of neurocognitive rehabilitation (e.g., Abend et al., 2013; Doyon et al., 2009; Korman et al., 2007).

3.2. Data analytic plan

To estimate the effects of stable and dynamic components of AB, we used a linear regression method based on a hybrid of static-score and change-score models for panel data (Finkel, 1995; Srivastava et al., 2009). For each version of the dot-probe task, analyses focused on 2 components of AB prior to ABM: a stable component (STABLE), representing variance shared between the two baseline points (t_1 and t_2), and a dynamic component (DYNAMIC), representing variance that is specific to that point (t_1 or t_2). Based on previous studies using such an approach (e.g., Srivastava et al., 2009, p.888), we can infer that the two measurements – i.e. AB_{t1} and AB_{t2} – mirror three sources of variance, STABLE, $DYNAMIC_{t1}$, and $DYNAMIC_{t2}$:

$$AB_{t1} = STABLE + DYNAMIC_{t1}, \tag{1}$$

$$AB_{t2} = STABLE + DYNAMIC_{t2}, \tag{2}$$

As the STABLE is the same at t_1 and t_2, we can base this on the change score:

$$\Delta AB = AB_{t2} - AB_{t1}, \tag{3}$$

$$\Delta AB = (STABLE + DYNAMIC_{t2}) - (STABLE + DYNAMIC_{t1}), \tag{4}$$

$$\Delta AB = DYNAMIC_{t2} - DYNAMIC_{t1}. \tag{5}$$

This decomposition provides the rationale regarding why entering the baseline score (AB_{t1} or AB_{t2}) and the difference score (ΔAB) simultaneously into a regression equation as follows allows to differentiate between the effects of STABLE and DYNAMIC components of AB at baseline on the dependent variable – AB after ABM (AB_{t3}):

$$AB_{t3} = b_0 + b_1(AB_{t1}) + b_2(\Delta AB). \tag{6}$$

[1] In addition to the usual *d* score, we initially planned to also differentiate facilitated attention toward threat from difficulties in disengagement from them by computing two complementary bias scores (Cisler, Bacon, & Williams, 2009; Koster, Crombez, Verschuere, & De Houwer, 2004). Based on these articles, facilitated attention bias score is computed by subtracting the mean latency when the probe appears in the same location as the threatening stimuli from the mean latency of trials depicting two neutral stimuli. In contrast, difficulty in disengagement from threat is computed by subtracting the mean latency when the probe and the threatening stimuli appear at different locations from the mean latency of trials depicting two neutral stimuli. Positive scores indicate facilitated attention toward threat and difficulty in disengagement from threat, respectively. However, since there were no previous studies using these two complementary bias scores with a detection version of the dot-probe task, we decided to do not report it directly in the present contribution.

When the steps (1) and (4) are substituted, this equation become as follows:

$$AB_{t3} = b_0 + b_1(\text{STABLE} + \text{DYNAMIC}_{t1}) + b_2(\text{DYNAMIC}_{t2} - \text{DYNAMIC}_{t1}). \quad (7)$$

As regression coefficients reflect the effect of each variable while holding the other constant, the variance that is shared across both terms in the regression – i.e. DYNAMIC $_{t1}$ – cancels out, making b_1 the estimate of the effect of STABLE on AB_{t3} and b_2 the estimate of the effect of DYNAMIC $_{t2}$ on AB_{t3} (Finkel, 1995; Srivastava et al., 2009).

$$AB_{t3} = b_0 + b_1(\text{STABLE}) + b_2(\text{DYNAMIC}_{t2}). \quad (8)$$

Because of the subtraction in the equation, the analyses estimate effects of only two (i.e. STABLE and DYNAMIC_{t1}) components even if the decomposition orbits around three components (i.e. STABLE, DYNAMIC_{t2}, and DYNAMIC_{t2}). However, when we ran the analyses using AB_{t2} (instead of AB_{t1}) and ΔAB as predictors, the coefficients for AB_{t2} (which according to the decomposition depicted above refers to the STABLE component) were identical to the coefficients for AB_{t1} (see the analyses below). The coefficient ΔAB – DYNAMIC $_{t1}$ – then reflects the variance in AB that was unique to t_1 (Finket al., 1995; Srivastava et al., 2009).

For each version of the dot probe task, *d* scores at baseline were decomposed regarding the STABLE and DYNAMIC components depicted above and were examined using distinct regression models with the corresponding post-ABM *d* score (AB_{t3}) and the learning gains during the ABM procedure.[2] We first examined these effects with the data of the face version of the dot-probe task as predictors. We then examined theses effects with those of the word version.

4. Results

4.1. Manipulation check

We first examined whether the ABM procedure did reduce AB as intended. To be consistent with previous studies that aimed at modifying AB through a single-session of ABM (e.g., Amir, Weber, Beard, Bomyea, & Taylor, 2008; Eldar & Bar-Haim, 2010), we compared AB prior (AB_{t2}) to after ABM (AB_{t3}). Paired *t*-tests revealed that AB significantly decreased for the *d* score of the face-version of the dot-probe task, $t(76) = 2.00$, $p < .05$. Regarding the word-version, there were no significant changes from baseline to post-training, $t(76) = .12$, $p = .90$. Data are presented in Table 2. Second, we computed a one-sample *t*-test to ensure that participants' performance did improve during the ABM procedure. Data revealed that learning gains were significantly different from 0 (no gain), $t(76) = 5.76$, $p < .001$, with a mean improvement in task performance of 19.96% ($SD = 29.83$).

4.2. Stability and dynamic components: face version of the dot-probe task

4.2.1. Change in AB

For the face-version, a multiple regression analysis was conducted to predict the impact of STABLE and DYNAMIC components of AB at baseline on post-ABM indices of AB (AB_{t3}). We entered the *d* score at t_1 (STABLE) and the difference scores between *d* scores at t_1 and t_2 (DYNAMIC) simultaneously into a regression equation as predictors. The overall model was significant [$R^2 = .10$, $F(2,74) = 3.80$, $p < .05$]. The *d* score at post-training was significantly predicted by the STABLE component ($b = .35$, $t = 2.73$, $p < .01$), while the DYNAMIC component did not ($b = .21$, $t = 1.68$, $p = .10$). This shows that if individuals have a more stable AB, they will show a greater AB after ABM.[3]

4.2.2. Performance gain during ABM

The overall linear regression model on the performance gain was significant [$R^2 = .14$, $F(2,74) = 6.01$, $p < .01$]. Performance gain was significantly predicted by both the DYNAMIC ($b = .50$, $t = 3.44$, $p < .001$) and the STABLE ($b = -.38$, $t = 2.62$, $p < .05$) components of AB. This shows that, while the performance improvement during ABM is positively related by the dynamic component, the stable component is negatively associated with performance improvement.

4.3. Stability and dynamic components: word version of the dot-probe task

4.3.1. Change in AB

Similarly to the face-version, we entered the STABLE and DYNAMIC component of the *d* score at baseline simultaneously into a regression equation as predictors. The overall model was not significant [$R^2 = .02$, $F(2,74) = .72$, $p = .49$].

4.3.2. Performance gain during ABM

The overall linear regression model was not significant [$R^2 = .02$, $F(2,74) = .623$, $p = .53$].

4.4. Complementary analyses[4]

To test for potential biasing effect of situational anxiety, two additional multiple regression analyses were performed for the AB indices of the face-version. The *d* score indices of AB_{t3} remains positively predicted by the STABLE component when entering DYNAMIC component, Trait-anxiety, State-anxiety at t_1, and State-anxiety at t_2 simultaneously into a regression equation as predictors. In the same vein, performance gain during ABM remains negatively predicted by the STABLE component and positively predicted by the DYNAMIC one when controlling for trait-anxiety scores as well as scores for state anxiety at t_1 and t_2.

5. Discussion

There is increasing recognition for the idea that ABM should be improved and that examination of potential individual differences moderating the efficacy of ABM is crucial (Abend et al., 2014; Clarke et al., 2014). Understanding who profits from ABM is decisive

[2] As the variance of AB_{t2} was already included in the model as predictor, we decided to used post ABM *d* score (AB_{t3}) and not the difference between $AB_{t3} - AB_{t2}$ to avoid that the variance of AB_{t2} was included in the model as both a predictor and a dependent variable.

[3] For the interested readers, we also differentiate the effect of facilitated attention toward threat from difficulty to disengage attention from threat (see Footnote #1). Regarding the face-version, the overall model was significant [$R^2 = .08$, $F(2,74) = 2.16$, $p < .05$]. Facilitated attention bias score at t_3 was positively predicted by STABLE component ($b = .32$, $t = 2.16$, $p < .03$), while DYNAMIC component did not ($b = .07$, $t = .50$, $p = .62$). Regarding the difficulty to disengage attention from angry faces, the overall model was not significant [$R^2 = .05$, $F(2,74) = 2.10$, $p = .13$]. However, it should be noted that there were no significant effects for the word-version.

[4] We were unable to examine whether individuals who exhibit a positive *d* score (indicating the presence of AB toward threat) at both t_1 and t_2 significantly differ from those exhibiting a negative *d* score (indicating the presence of AB away from threat) at both t_1 and t_2 as only nine individuals exhibited this latter pattern. However, it should be noted that we re-run all the analyses without these individuals and that the patterns of results were identical.

before it can be reliably applied in clinical settings. The current study provides new insights into some potential mechanisms that facilitate AB alteration. Our main goal was to address how stable, representing variance shared between the two baseline points (t_1 and t_2) and dynamic components of AB before ABM, representing variance that is specific to that time point (t_1 or t_2), are predictive of AB after ABM as well as performance improvement during ABM. Results revealed that the stable component was predictive of the maintenance of AB toward threat after ABM, while the dynamic component did not. Results also revealed that the dynamic component positively predicted performance gain, while the stable one negatively predicted it.

Although the previous and current findings share the idea that preexistent AB impacts on AB post-ABM, the current findings may seem to be at odds regarding the direction of this impact. Indeed, while previous studies reported that preexistent AB at a single time-point prior to ABM predicts larger alterations in AB after the training (e.g., Amir et al., 2011; Kuckertz et al., 2014; Mogoase et al., in press), we found that the stable component (i.e., the variance shared between the two baseline points) is more predictive than the dynamic one in the maintenance of AB after ABM. In contrast, we also showed that, while the performance improvement during ABM is positively related to the dynamic component, it was negatively related to the stable component. Since previous studies examining the influence of preexistent AB only included a single time-point assessment, one cannot exclude that their predictions were contaminated by both the stable and the dynamic (i.e., context-dependent variables) components. We think that this slight difference could potentially explain the present counter-intuitive findings.

The current study shows the utility of a broader framework to understand the true predictive value of preexistent AB on ABM. It highlights that neither a trait-like nor a contextual conceptualization of preexistent AB is sufficient on its own. The current results are in line with recent developments arguing that the observation at a single time point of a process involved in emotion regulation is likely the mirror of both stable personal factors and dynamic (characterized by change) responses to the current situational context (Bonanno et al., 2004; Hoeksma et al., 2004; Srivastava et al., 2009). Extending this work, the present results highlight the contribution of both the stable individual differences and dynamic enactment of preexistent AB. The framework we used is also consistent with warnings against the arbitrary distinction between states and traits (Allen & Potkay, 1981) and points to the importance of moving the conceptualization of AB beyond the person-situation debate by the use of challenging assessment of within-person variability (Fleeson, 2004).

At the clinical level, the current findings suggest that individuals should already exhibit dynamic variations in the temporal expression of preexistent AB to benefit from ABM, as the temporal dynamics of preexistent AB is associated with better performance improvement during ABM. As noted by Srivastava et al. (2009), the notion of a dynamic component is suggestive of something characterized by change and regulatory processes. Accordingly, it has been argued that AB provides an important component of emotion regulation, as it regulates subsequent emotional responses by tuning one's filters for initial attention and subsequent processing (for a review, see Todd, Cunningham, Anderson, & Thompson, 2012). As a consequence, an important road map for future research in this topic will be to grasp the factors that can increase the within-person variability in the temporal expression of AB, and, in turn, develop specific interventions to increase this temporal dynamics.

There are some limitations of the current study. It should be noted that the findings depicted above only appeared with the face-version of the dot-probe task, as there was no significant effect with the word-version. There are various explanations for this lack of effect. First, it could be that the dynamic and static properties of the preexistent AB are directly linked to the material used in the training. Future studies should further explore this issue by directly crossing the material used during the training with those of the AB assessment. Second, it may be that the absence of predictive value of either stable or dynamic components of AB with the word-version of the dot-probe task merely mirrors the absence of AB change from baseline to post-ABM for that word-version. This latter absence may merely reflect that there was no generalization from the faces used in the training to the words used on that assessment task. One cannot exclude that the use of a single-session training may account for this lack of generalization. Future studies would benefit from including more sessions. Finally, it may be that the presence of AB is specific to one material. The absence of correlations between the face- and word-version at each time point ($-.22 < rs < -.06$; $ps > .05$) corroborated this suggestion. Finally, uncertainty remains regarding the mechanisms that may increase the dynamic component of AB. We found that state-anxiety at t_1 and t_2 did not influence the results in the present study. Future studies should thus benefit from taking into account both additional features of the environment that may impact on individuals similarly and goal-oriented processes that may differ among them.

In follow-up research several issues require further research. First the temporal resolution and scope of the design could be extended. Indeed, dynamics can occur on many different time-scales, often requiring designs to optimally study them (e.g., Finkel, 1995; Srivastava et al., 2009). It is important to acknowledge that the findings might have been different if we focused on a scope of minutes, weeks or months. For instance, Zvielli, Bernstein, and Koster (in press) recently reported that temporal fluctuations of AB using a trial-level approach already lead to distinct association with psychopathology. In the same vein, a design with more measurement points would have allowed for growth-mixture models, which would have permitted us to examine potential subgroups of anxious with different growth patterns such as anxious with stable-high AB, stable-low AB, AB increasers, AB decreasers, and those who always exhibit an unstable AB. Second, we used a detection version of the dot-probe task (i.e., detecting whether the X appears on left or right) while most of the previous ABM experiments used a discrimination version (i.e., discriminating between E or F). Although the results of one study suggest that the detection task may be superior to the differentiation task (Salemink, van den Hout, & Kindt, 2007), one serious methodical problem with the detection version is that a participant does not necessary need to be attending to the location of the probe to determine its position (i.e. if the probe is not in the attended location, it must by default be in the opposite position). Future studies may benefit from directly using a discrimination version of the dot-probe task to ensure the generalizability of the present results.

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