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Attentional Bias Modification with a New Paradigm: The Effect of
the Detection Engagement and Savoring Positivity (DESP) Task on Eye-tracking of Attention

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Highlights

- Addresses the effects of Attentional Bias Modification (ABM) on Eye-Tracking of Attention.
- Tests an Innovative ABM; the Detection Engagement and Savoring Positivity (DESP) Task.
- The DESP task increases the attentional bias toward positive stimuli and significantly more than a placebo task.
- The savoring instruction embedded in the DESP task increases more the positive attentional bias than a control task excluding this instruction.
- The increase in positive attentional bias induced by the DESP task remains significant even one week after the training.

Abstract

Background and Objectives: We test the effect of a new attentional bias modification (ABM) task - the Detection Engagement and Savoring Positivity (DESP) task - on attentional biases. The DESP is innovative in that it involves a procedure of savoring the positivity of various pictures.

Methods: Participants were randomly assigned to the DESP or to a placebo control condition (experiment 1; $n = 38$) or a condition controlling for savoring (experiment 2; $n = 54$) in a pre-post/training experimental design. During one week, the participants completed the DESP or the control task once a day between three and six times. We assessed the effects of the DESP task on various attentional biases (i.e. positive, negative and threat) by computing dwell time from an eye-tracking technology before and after the training, and also one week after the post-training session in experiment 2.

Results: In both experiments, the attentional bias toward positive stimuli between the pre- and the post-training increased significantly more in the DESP task condition than in the control conditions. Negative and threat attentional biases were not significantly affected by the experimental manipulations. Experiment 2 revealed that the DESP task – including the savoring instruction - increased significantly more the positive attentional bias than a task excluding this step and that this effect remained significant one week after the post-training session.

Limitations: Our samples were mainly composed of women participants. This prevents generalization of the findings.

Conclusions: The DESP task offers promising perspectives for sustainably improving attention to positive information.

Keywords: attentional bias modification, DESP task, savoring, eye-tracking of attention.

1. Introduction

The regulation of emotions plays a central role in both psychological and physical health (Carl, Soskin, Kerns, & Barlow, 2013; Gross, 1998; Tugade & Fredrickson, 2007). Emotional regulation refers to a more or less controlled and conscious process that allows the individual to change or modulate the appearance, nature, duration, or frequency of emotional experiences, whether positive (e.g. joy) or negative (e.g. sadness; Carl et al., 2013; Gross, 1998). This regulation process is mainly motivated by (a) “maintaining desirable states and terminating undesirable emotional states” (Wadlinger & Isaacowitz, 2011, p.2); (b) approaching situations that are a source of well-being; and (c) avoiding situations that are not congruent with this need (Elliott, 2006). The purpose is to maintain a stable and optimal emotional state, as proposed in the hedonic contingency model (HCM; Wegener & Petty, 1994).

Among emotional regulation strategies, attention deployment was identified by Gross (1998) as a regulatory process consisting of directing one's attention in a differentiated manner to internal or external stimuli. This allows one to modify the emotional experience induced by a particular situation before the emotions are triggered. The strategy enables avoidance of the negative emotional experience (distraction) and/or fully focusing on another target (concentration) and/or ruminating on the focus of attention (rumination) to restore some kind of emotional homeostasis (Carl et al., 2013; Wadlinger & Isaacowitz, 2010). Unfortunately, this kind of strategy can induce attentional biases, i.e. an altered allocation of attentional resources on stimuli with a valence, compared to neutral ones. In “healthy” people, the use of this strategy is adapted since individuals will direct their attention over a longer period of time and more frequently towards positive cues from their environment (i.e. positive bias; e.g. Armstrong & Olatunji, 2012). This bias has been highlighted in a fairly robust way via eye-tracking measures; a technology that evaluates eye movements and

selective attention in a more precise and direct manner than reaction times procedures (Caseras, Garner, Bradley, & Mogg, 2007). On the other hand, some individuals with emotional disorders may use inappropriate attentional deployment and focus on environmental cues congruent with their emotional state (Noguchi et al., 2006). Such responses would favor the development and maintenance of the emotional disorder (Billieux, Ceschi, & Van der Linden, 2015). People with depressive symptoms tend to prefer cues associated with sadness during a sufficiently long exposure (Lazarov et al., 2018), while anxious people move more quickly toward threatening cues (Armstrong & Olatunji, 2012). In addition to their biased attention towards negative stimuli, these individuals also present an insensitivity to positive stimuli—a response that impairs their emotional regulation (Carl et al., 2013; Wadlinger & Isaacowitz, 2010). This prevents their disengaging from negative stimuli that maintain their emotional disorder or engaging their attention on positive stimuli (Armstrong & Olatunji, 2014; Duque & Vasquez, 2015). The regulation of positive and negative emotions should be considered as two independent neuropsychological processes (Garland et al., 2010). However, the ability to experience positive emotions by increasing the likelihood of their occurrence, via an attentional focus on them, can affect the frequency, duration, and nature of negative emotions (Gruber et al., 2011; Tugade & Fredrickson, 2007).

The importance of the function of positive emotions on well-being and the relevance of attentional training towards positive stimuli have given rise to studies which highlight the interest of targeting this attentional deployment process as an intervention track for both clinical and nonclinical populations (Ferrari et al., 2016; Grafton, Ang, & MacLeod, 2012; Tamir & Robinson, 2007; Wadlinger & Isaacowitz, 2006, 2008, 2010). Attentional deployment is a malleable process that can be trained, without a too costly cognitive and emotional effort, to automate the maintenance of positive affectivity (Handley et al., 2004). Therefore, it represents an interesting track of action to improve emotional regulation and

psychological health. Consistently, attentional bias modification (ABM) paradigms have become widespread (e.g. MacLeod & Mathews, 2012; for anxiety disorder, see De Voogd et al., 2016; for depressive disorder, see Möbius, Ferrari, van den Bergh, Becker, & Rinck, 2018). The first ABM paradigms were aimed at reducing negative attentional bias (see Grafton et al., 2012) by training people to disengage from negative cues (e.g. Sanchez & Vasquez, 2014). More recently, ABM paradigms have been developed with the objective of increasing attention toward positive information or source of reward in clinical or nonclinical populations (Grafton et al., 2012; Taylor, Bomyea, & Amir, 2011; Wadlinger & Isaacowitz, 2008).

These recent studies have yielded encouraging results. However, according to the meta-analysis of Mogoase et al. (2014), the mechanisms of ABM still remain unclear and no direct link has been established between preexisting attention bias and symptom reduction. These limits are likely due to various methodological issues. Among them, we can mention the kind of task used (Duque & Vasquez, 2018); the type and number of stimuli (Ferrari et al., 2018); the number of trials and sessions required (Ceschi, Heeren, Billieux, & Van Der Linden, 2015); the type of instruction (avoid negative stimuli / approach positive stimuli; e.g. Heuer, Rinck, & Becker, 2007); and the implementation of modalities while taking into account the type of population (in terms of age and disorder) toward which the ABM is addressed. The central point is an ecological validity problem, resulting in the tasks being unattractive and unmotivating. However, the new tasks which aim at increasing visual attention to positive stimuli appear to be relevant and useful.

Under this perspective, we administered the Detection Engagement and Savoring Positivity (DESP) task. Following a transdiagnostic approach (Brown & Barlow, 2009), we selected both nonspecific (Becker et al., 2015) and non-autobiographical (Dunn et al., 2004) stimuli. Each trial of the task comprises three phases. First, participants must *detect* a positive

stimulus (faces or scenes; Ferrari et al., 2016) among three others (negative and neutral). Second, they must *engage* themselves toward the stimulus in both selecting and moving the positive picture at the center of the screen (i.e. approach motivation toward positivity). Third, they must maintain their attention on the selected picture (Ferrari et al., 2016; Grafton et al., 2012) and to proceed on a *savoring* phase. During each trial, the three other pictures do not disappear, i.e. they stay all around the positive one even during the savoring phase. This procedure slowly leads the participant to enjoy the positive picture without avoiding the negative ones. In other words, they are indirectly led to accept negative pictures as something being present in the environment. This task was created on the basis of recent studies (Ferrari et al., 2016; Wadlinger et al., 2016) which have demonstrated that detection and engagement (i.e. approaching through a motor action) toward positive stimuli have beneficial effects on emotional regulation (Tamir, 2009). The choice of maintaining all the pictures in the screen background during the savoring phase was inspired by Action and Commitment Therapy (ACT; Hayes, 2004). According to this therapeutic approach, experiential avoidance is a common process to emotional disorders which maintains them through psychological inflexibility (e.g. Hayes et al., 1996). In order to avoid valuing experiential avoidance by suggesting that when a positive picture is selected, others (the negative ones specifically) disappear (Campbell-Sills, Barlow, Brown, & Hofman, 2006), we have deliberately chosen to maintain their appearance. Finally, we wanted to increase the attention toward positive stimuli by incorporating a *savoring* instruction.

Savoring is “the process whereby one appreciates the pleasurable features of an event as well as positive emotions that arise from encountering it” (Garland & al., 2017; p. 3), which is considered as a mechanism extending the affective benefits of positive emotions and favoring the alleviation of anxious and depressed symptoms (Bryant & Veroff, 2017). According to Bryant and Veroff (2017), savoring involves three main components: (a) a

sense of immediacy with an experience taking place in the present moment; (b) a focus and a mindful connection to the experience; and finally, (c) a feeling that is free from social and self-esteem needs. It represents an adapted alternative to rumination strategies, even positive ones, which are not always beneficial for people (Feldman et al., 2008; Gruber et al., 2011). It also permits one to overcome the use of dampening strategies, which tend to decrease positive emotions in depressed people (Eisner et al., 2009). It can be viewed as a complementary coping process in the sense that, if people can learn to manage their negative experiences, they also can improve their ability to maintain and enhance well-being by savoring positive ones. Thus, the DESP task was designed to improve this ability.

Overview of the Research and the Hypotheses

Using an eye-tracking procedure, the main aim of this research was to examine the potential beneficial effect of the DESP task on attentional biases. The participants were randomly assigned to the DESP or to a placebo control condition (experiment 1; $n = 38$) or a condition controlling for savoring (experiment 2; $n = 54$) in a pre-/post-training experimental design. During one week, the participants completed the DESP or the control task once a day between three and six times. We assessed the effects of the DESP task on various attentional biases (i.e. positive, negative and threat) by computing dwell time from an eye-tracking technology before and after the training, and also one week after the post-training session in experiment 2. First, we predicted a modification of attentional biases in the DESP condition. Specifically, in this condition, we expected an increase of positive attentional bias, a decrease of the negative attentional bias, and no changes for the threat bias. We also predicted these changes would be significantly greater in the DESP condition than in a placebo condition (experiment 1) or a condition without the savoring instruction (experiment 2). Finally, the persistence of the changes in attentional biases induced by the DESP will be evaluated, in the second experiment, with a one-week follow-up.

2. Experiment 1

2.1. Method

2.1.1. Participants

Thirty-eight participants were recruited for this study. The sample was composed of 29 women and nine men aged from 18 to 50 years old (*Mean age* = 22.53, *SD* = 7.20). All were students in psychology at the University of Clermont Auvergne (UCA) in France. They did their inscription voluntarily in the setting of validation of academical credits.

2.1.2. Materials

2.1.2.1. Stimuli and design of the DESP task.

All stimuli were extracted from the International Affective Picture System (IAPS; Lang & Bradley, 2007), from the Open Affective Standardized Image Set (OASIS; Kurdi, Lozano, Mahzarin, & Banaji, 2016) and the Montreal Set of Facial Displays of Emotion (MSFDE; Beaupre & Hess, 2005). Three categories of pictures were selected: positive, negative, and neutral.¹ Pictures were faces and scenes (*i.e.* landscapes, meeting, daily life scenes).

The design and the computer programs were produced with E-prime software (Version 2.0). The DESP task consisted of a simultaneous and randomized presentation of four pictures (one or two negative, one positive and one or two neutral) at the four corners of the computer during 50 trials divided into two levels. The first five trials of each level were used to familiarize the participant with the task's instructions. For the first level, during 20 trials, participants were confronted with four pictures of faces. The first 10 trials were composed of two neutral, one negative and one positive face; the 10 remaining trials were composed of one neutral, one negative and one positive face. For the second level, pictures of scenes were presented following the exact same procedure as for the first level (*i.e.* faces).

For each trial, the participants were asked to follow three consecutive phases. The first was the *detection* phase, which consisted of locating the positive picture among three others by clicking with the mouse on it. For the second phase, called the *engagement* phase, the participant had to use the mouse to move the positive image to a frame located at the center of the screen. If the participant selected a wrong picture, he/she could not move it to the center. Finally, when the participant was ready, he/she could begin the *savoring* phase. This phase lasted 10 seconds and was divided into three progressive steps. First, the participant was invited to attentively observe the image. In the second step, the participant was to “soak up” on the emotion emanating from the image. Finally, the last step invited the participant to fully appreciate and enjoy this positive emotion.

2.1.2.2. Stimuli and design of the placebo task.

All pictures were selected from the picture databases mentioned above. The difference here is that the stimuli were all neutral², but the same as in the DESP task. The presentation was the same as the one of the DESP task (i.e. same number of trials and same difficulty levels). However, the instruction was different. In the first level, one symbol (a blue cross) was randomly placed above one of the four pictures. The participants had to detect it and move this image to the center of the screen. For the second level of difficulty, one specific symbol was placed above each picture. The participant had to detect a particular symbol (a red cross) among the four. The *savoring* instruction was replaced by an *observation* instruction in which the participant merely had to observe the picture for 10 seconds and evaluate how much they thought they had succeeded in fully observing it.

2.1.2.3. Eye-tracking procedure.

Assessment of visual attentional behavior was measured with an eye-tracking system³. For our study, we used a 120 Hz sampling rate and extracted one data for our statistical analyses. This data is *dwell time* (i.e. total time spent on a particular stimulus) and we used it as a dependent variable. This parameter was computed using areas of interest (AOIs) which corresponded to the total area of each stimulus. The eye-tracking procedure was created with the E-prime software. We used the same material and procedure as in Kellough et al.'s (2008) study. The eye-tracking task consisted of presenting 32 sets of four pictures⁴ (negative, positive, threatening, and neutral). It was a free visual search task during which participants had to freely watch each set appearing on the computer screen⁵. In the instructions, the participants were asked to watch each set as if they were watching a television screen in a natural way and without turning their head. Before each trial, a cross appeared in the center of the screen and participants had to stare it (the cross appeared for 3 seconds) and sets were then displayed. Each set was presented for 10 seconds.

2.1.3. Procedure

The participants were randomly assigned to the experimental (i.e. DESP) or the placebo condition. Nineteen persons were in the DESP condition and nineteen were in the placebo group. The study was divided into three major phases: the pre-session, the training sessions (during one week), and the post-session. Upon arrival at the laboratory, the participant first completed the eye-tracking task. Then he/she completed self-report scales before completing the DESP (or placebo) task. During the training phase, participants were invited to return to the laboratory to train on the task assigned to them (i.e. DESP vs. placebo). They could

perform at least one training and a maximum of four trainings during the week, with a maximum of one training per day (DESP: $M = 4.79$; $SD = 1.03$; placebo: $M = 4.47$; $SD = 0.96$). There were no differences between the two experimental conditions in terms of frequency of training ($t < 1$, $p > .33$). When they arrived at the third and final phase (*i.e.* post-session), the participants began the DESP vs. placebo task for the last time and completed the eye-tracking task.

Extreme data (*i.e.* dwell time that were 2.5 SD lower or higher than the mean for each picture and for each condition) were recoded as missing value (0.99%). Finally, due to a technical problem, the eye-tracker system failed to record the data of one participant at the pre-training session and one participant at the post-training session in the placebo condition. The final sample consisted of 19 participants in the DESP condition and 17 participants in the placebo condition.

2.2. Results

2.2.1. Effect of the DESP task on attentional biases.

We performed a 2 (condition: DESP vs. placebo) x 4 (valence of pictures: threat vs. negative vs. neutral vs. positive) x 2 (time: pre-training vs. post-training) mixed ANOVA on the scores of dwell time⁶. The results are presented in Figure 3. A significant effect of valence, valence x condition, time x valence and time x valence x condition emerged (Greenhouse-Geisser correction, respectively, $p < .001$, $\eta^2_p = .54$; $p < .001$, $\eta^2_p = .19$; $p < .001$, $\eta^2_p = .37$; and $p < .01$, $\eta^2_p = .14$). At pre-training, in both conditions, participants spent a significantly greater time on threat, negative, and positive pictures than on neutral ones (all $ps < .01$). At post training, the effect of valence significantly interacted with the condition ($p < .001$, $\eta^2_p = .24$). The effect found at pre-training was also significant at post-training in both conditions (all $ps < .05$). Participants also spent significantly more time on positive pictures than on other pictures in the DESP (all $ps < .001$) and in the placebo conditions (all $ps < .05$).

In addition, the participants spent significantly more time on negative than threat pictures in the DESP condition ($p < .026$). Decomposition of the predicted three-way interaction revealed that the participants spent a significantly greater time on positive pictures at the post-training session in the DESP task condition than in the placebo condition ($p < .02$, Cohen's $d = 0.81$). This was not the case at the pre-training session ($p > .21$). In both conditions, the mean dwell time for positive pictures was significantly greater at the post-training than at the pre-training session (DESP: $p < .001$, Cohen's $d = 0.97$; placebo: $p < .011$, Cohen's $d = 0.70$).

2.3. Discussion

This first experiment aimed to compare the effects of the DESP vs. a placebo task on attentional biases. We hypothesized that the increase in positive attentional bias and the decrease in negative attentional bias would be greater in the DESP task than in the placebo task condition. The results confirmed our first hypothesis, but not our second one. Thus, the DESP task seems to be more effective at enhancing positive attentional bias than at reducing negative bias.

Our placebo control task seemed to engender a positive effect on positive bias despite the neutral valence of stimuli and the lack of a *savoring* instruction. Some studies (see Armstrong & Olatunji, 2012, for a meta-analysis) have explored the effect of training people to disengage from negative faces through a dot probe task with two faces (a negative and a neutral one). This raises the possibility that the combination of both sustained attention and exposure to neutral stimuli can buffer or increase emotional regulation strategies.

The current experimental design did not allow us to isolate the effect of the savoring instruction on the increase in positive attentional bias. Within this perspective, Experiment 2 was designed to evaluate more directly its effect. Thus, we create a clone of the DESP task

without the savoring instruction (i.e. DEP task) and we compare the effects of these two tasks on attentional biases using the same eye-tracking procedure.

Finally, this first experiment allowed us to only explore the short-term effect of the DESP task. It would be relevant to include at least a one-week follow-up to examine the persistence of the change. Thus, a one-week follow-up was carried out in Experiment 2.

3. Experiment 2

3.1. Method

3.1.1. Participants

Fifty-four participants were recruited for this study. The sample was composed of 49 women and five men aged from 18 to 23 years old (*Mean age* = 19.09, *SD* = 1.28). All were students in psychology at the University of Clermont Auvergne (UCA) in France. They did their inscription voluntarily in the setting of validation of academical credits.

3.1.2. Materials

3.1.2.1. Stimuli and design of the DESP vs. DEP task.

The design was the same as in experiment 1. In order to improve the ecological validity of the task, the pictures were selected in various open access image banks (i.e. Unsplash, Pexels and Pixabay). The categories of pictures were the same (i.e. positive, negative, neutral, faces and scenes). The DEP task was the exact clone of the DESP except that the *savoring* instruction was not present. The two tasks were produced with Unity 3D software.

3.1.2.3. Eye-tracking procedure.

We used the exact same eye-tracking procedure as in Experiment 1.

3.1.3. Procedure

The participants were randomly assigned to the experimental (i.e. DESP) or the control for savoring condition (i.e. DEP). Twenty-seven participants were in the DESP condition and twenty-seven were in the DEP group. The study was divided into four major phases: the pre-

training session, the training sessions (during one week), the post-training session, and the follow-up session one week after the post-training. Upon arrival at the laboratory, the participant first completed the eye-tracking task. During the training phase, participants were invited to return to the laboratory to train on the task assigned to them (i.e. DESP vs. DEP). They should perform five trainings during the week, with a maximum of one training per day. The frequency of training was identical in the two conditions ($M = 4.93$; $SD = 0.27$). When they arrived at the post-training session, the participants began the DESP vs. DEP task for the last time. Finally, they completed the eye-tracking task. Finally, when they came at final phase one week after the post-training session, they completed the eye-tracking for the last time.

Extreme data (i.e. dwell time that were 2.5 SD lower or higher than the mean for each picture and for each condition) were recoded as missing value (0.33%). One participant in the DESP condition did not participate to the post-training session. Concerning the one-week follow-up session, 10 participants were absent (DEP = 6; DESP = 4). In addition, due to a technical problem, the eye-tracker system failed to record the data of two participants in the DEP condition at this session. For the pre/post-training session comparison, the final sample consisted of 26 participants in the DESP condition and 27 participants in the placebo condition. Concerning the follow-up, the final sample consisted of 23 participants in the DESP condition and 19 participants in the placebo condition.

3.2. Results

3.2.1. Effect of the DESP vs. DEP task on attentional biases between the pre/post-training sessions.

We performed a 2 (condition: DESP vs. placebo) x 4 (valence of pictures: threat vs. negative vs. neutral vs. positive) x 2 (time: pre-training vs. post-training) mixed ANOVA on the scores of dwell time⁶. The results are presented in Figure 4. A significant effect of

valence, valence x condition, time x valence and time x valence x condition emerged (Greenhouse-Geisser correction, respectively, $p < .001$, $\eta^2_p = .48$; $p < .01$, $\eta^2_p = .10$; $p < .001$, $\eta^2_p = .29$; and $p < .05$, $\eta^2_p = .07$). At pre-training, in both conditions, participants spent a significantly greater time on threat, negative, and positive pictures than on neutral ones (all $ps < .01$). At post training, the effect of valence significantly interacted with the condition ($p < .01$, $\eta^2_p = .11$). The effect found at pre-training was also significant at post-training in both conditions (all $ps < .05$). Participants also spent significantly more time on positive pictures than on other pictures in the DESP (all $ps < .001$) and in the placebo conditions (all $ps < .01$). Decomposition of the predicted three-way interaction revealed that the participants spent a significantly greater time on positive pictures at the post-training session in the DESP task condition than in the placebo condition ($p < .03$, Cohen's $d = 0.62$). This was not the case at the pre-training session ($p > .87$). In both conditions, the mean dwell time for positive pictures was significantly greater at the post-training than at the pre-training session (DESP: $p < .001$, Cohen's $d = 0.74$; placebo: $p < .05$, Cohen's $d = 0.42$).

3.2.2. DESP's Follow-up.

In order to examine the persistence of the increase in attentional deployment toward positive pictures in the DESP condition, we performed a 2 (condition: DESP vs. placebo) x 3 (time: pre-training vs. post-training vs. one week after the post-training) mixed ANOVA on the scores of dwell time⁶. This analysis revealed a significant main effect of time (Greenhouse-Geisser correction, $p < .001$, $\eta^2_p = .16$) and a marginal interaction effect (Greenhouse-Geisser correction, $p < .10$, $\eta^2_p = .06$). A significant effect of condition also emerged ($p < .05$, $\eta^2_p = .10$), indicating that participants spent more time on positive pictures in the DESP than in the DEP condition. The effect of time was not the same in the two conditions (see Figure 5). In the DESP condition, the increase in attention toward positive pictures between the pre-training and the one-week follow-up session was significant ($p <$

.01, Cohen's $d = 0.58$). This was not the case in the DEP condition ($p > .23$). In both conditions, the difference between the post-training and the follow-up was not significant (all $ps > .28$).

3.3. Discussion

Consistent with Experiment 1, the DESP significantly increased the positive attentional bias, but did not significantly affect the negative and the threat attentional biases. However, the design of Experiment 2 permitted to control for the effect of savoring. As expected, the increase in positive attentional bias was significantly greater in the DESP task condition than in the control condition without the savoring instruction. Thus, training to savoring represents an effective way at enhancing positive attentional bias. Nonetheless, the control task without the savoring instruction also succeeded to significantly increase the positive attentional bias between the pre-/post-training sessions. This suggests that detection and engagement also may contribute to the attentional modification toward positive stimuli involved in the DESP task.

Finally, the follow-up revealed that the increase in positive attentional bias in the DESP condition between the pre-/post-training sessions persisted one week later. The question of the transfer of ABM techniques, such as the DESP task, to another situations is an important question (e.g. Mogoase et al., 2014). The fact that the effect of the DESP task on the positive attentional bias persisted one week later on a distinct task (i.e. eye-tracking recording) using an entirely different set of images provides a promising avenue.

4. General Discussion

This research aimed to test a new attention bias modification task in response to limits highlighted by literature reviews. We have focused on positivity bias as a process allowing the alleviation of symptoms of emotional disorders and/or improving some dimensions of well-being. Across two experiments, we found support for the hypothesis that the DESP task

(a) significantly improves positive attentional bias and (b) is more effective at enhancing this attentional bias than at reducing the negative one. This result confirms the independence between negative and positive affective processing (Garland et al., 2010; Noguchi et al., 2006); an increase in positive attentional bias does not systematically mean a decrease in negative attentional bias.

The DESP comprises three distinct processes: detection, engagement and savoring positivity. Results of Experiment 2 revealed that the increase in positive attentional bias was greater in the presence of the savoring instruction than in its absence. In the DESP, the participants were repeatedly trained to observe attentively the image, to soak up on the emotion emanating from the image, and to fully appreciate and enjoy this positive emotion. Thus, participants were trained to savor positive images, in the sense that they learned to appreciate the pleasurable features of a picture depicted on a computer screen as well as positive emotions that arise from observe it deeply. Savoring has been found to correlate positively with affect intensity, optimism, life satisfaction, mindfulness, frequency of happiness, quality of life and negatively with depression, emotional distress and hopelessness (Bryant, 2003; Garland & al., 2017). The present research confirms this pattern and permits to extent the beneficial effect of savoring to attentional deployment toward positive stimuli.

Our samples were mainly composed of women participants. This prevents generalization of the findings. A replication with a more representative sample would be necessary. It also would be relevant to examine the effect of the DESP task on attentional biases among a clinical population characterized by anxiety and/or depression disorder. The ability of the DESP to change attentional biases in a clinical population would be determinant.

The question of the transfer of ABM such as the DESP task to more real life situation is also an important question (e.g. Mogoase et al., 2014). Future studies should explore

profitably the extent to which the change in positive attentional bias predicts better attentional and emotional regulation in an unrelated adverse situation such as a stressful or sadness induction (e.g. Johnson, 2009; Tamir & Robinson, 2009; Wadlinger & Isaacowitz, 2009).

Finally, the DESP task can be fully integrated into a comprehensive and unified treatment for emotional disorders (Brown & Barlow, 2009) and as a facilitator of engagement in other tasks more difficult to undertake (e.g. Ostergaard et al., 2018). It could be suitable to institute a priming to increase psychological flexibility and openness to Action and Commitment Therapy-type treatments, even in a clinical population with physical afflictions such as cancer (e.g. Chan, Ho, Tedeschi, & Leung, 2011). In addition, ABM interventions are totally fitted to new technologies and could be used in the field of “positive technologies” (e.g. Botella et al., 2012). This pathway would make it easier to implement this task in different contexts (de Voogd et al., 2016). We can even mention virtual reality (VR) or augmented reality (AR) as new tools to potentiate the ecological nature of attentional bias modification tasks (Ventura, Baños, & Botella, 2018). In any case, it seems that the numerous studies carried out thus far gradually make it possible to propose new ABM paradigms that are better adapted to the populations and contexts to which these tasks are addressed.

Compliance with Ethical Standards:

Conflict of Interest: Authors declare that they have no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of Clermont Auvergne University and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Author Contributions: MC designed and executed the experiments, treated the eye-tracking recordings, and wrote the paper. DA: collaborated with the design and the execution of the experiments. JG: collaborated in the programming of the DESP and the placebo tasks in experiment 1 and collaborated with the execution of experiment 1. MB: programed the DESP and the placebo tasks in experiment 1. PC: programed the eye-tracking procedure. CL: programed the DESP and the DEP tasks in experiment 2. MD: designed the experiments, analyzed the data, and wrote the paper.

Data Availability Statement: These data are available at figshare.com:

<https://doi.org/10.6084/m9.figshare.7948931.v1>

Footnotes

¹ The positive ones are selected arbitrarily with a rating higher than a value of 6 (OASIS) and 7 (IAPS), neutral ones with a rating near to the value of 4 (OASIS) and 5 (IAPS) and negative ones with a rating lower than 3 (IAPS) and 2 (OASIS) (on a scale from 1 to 9 for the IAPS and 1 to 7 for OASIS).

² Their ratings turned around a value of 4 for the OASIS database and 5 for the IAPS database.

³ Model RED-M from SensoMotoric Instruments. This was a “free head eye-tracker,” i.e. a bar put in front of the participant at a distance between 50 and 75 centimeters. It measures pupil size, eye movements, eye position, acceleration, and blinking (saccades, fixations).

⁴ Picture size was 72 x 100 mm, and the resolution was 1024 x 768.

⁵ Before the task, an eye movement calibration in 9 points was done to fit the eye-tracking system to the participant, thereby obtaining the best gaze capture.

⁶ Similar results were found with the number of fixations as a DV.

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Figure 1. Example of one DESP task trial (detection phase – Experiment 1)

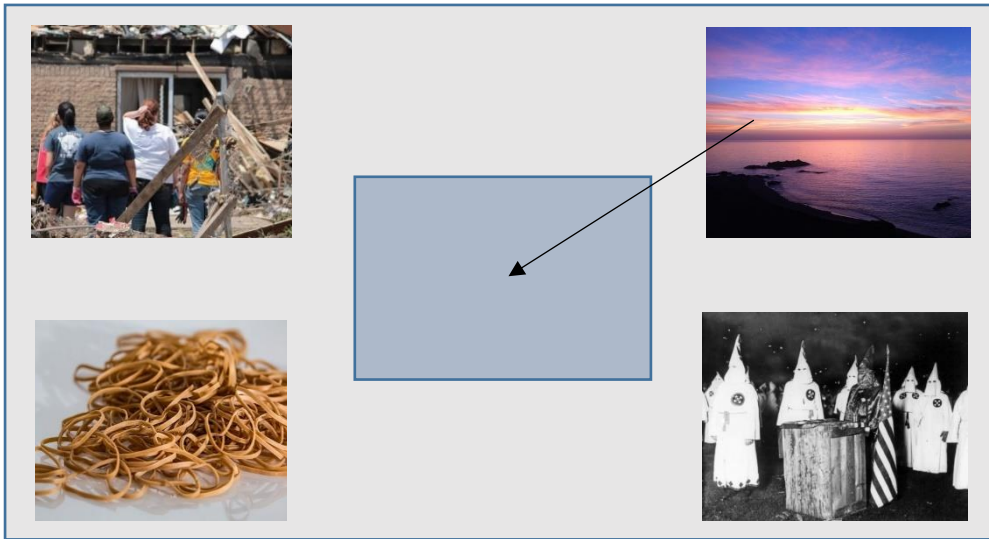
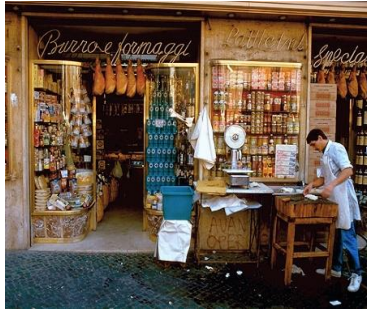


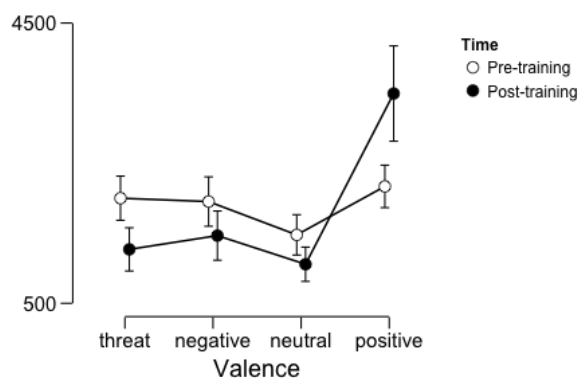
Figure 2.
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et al.'s
(2008)



One set of
from IAPS
the Kellough
procedure

Figure 3. Dwell time at pre/post-training as function of valence and experimental condition (Experiment 1; $N_{\text{DESP}} = 19$, $N_{\text{placebo}} = 17$).

condition: DESP



condition: Placebo

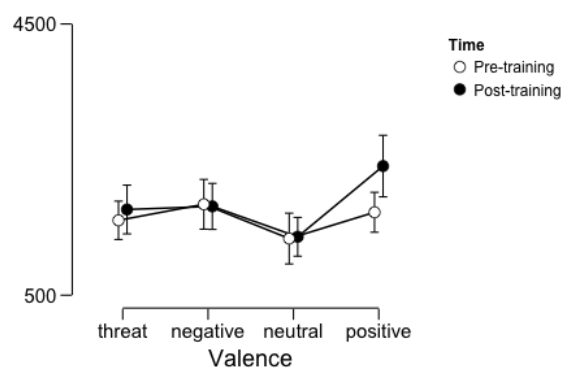
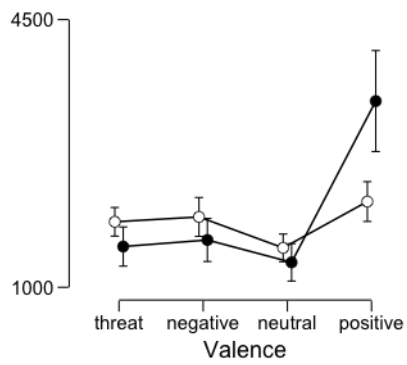


Figure 4. Dwell time at pre/post-training as function of valence and experimental condition (Experiment 2; $N_{\text{DESP}} = 26$, $N_{\text{placebo}} = 27$).

condition: DESP



condition: DEP

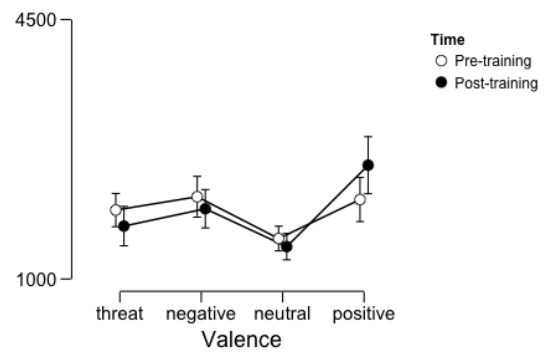
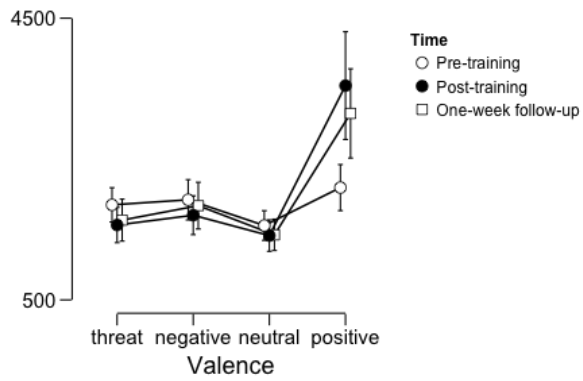


Figure 5. Dwell time at pre/post-training/one-week follow-up as function of valence and experimental condition (Experiment 2; $N_{\text{DESP}} = 23$, $N_{\text{placebo}} = 19$).

condition: DESP



condition: DEP

