J. Behav. Ther. & Exp. Psychiat. 57 (2017) 25–31

Contents lists available at ScienceDirect

Journal of Behavior Therapy and Experimental Psychiatry

journal homepage: www.elsevier.com/locate/jbtep

Attention bias modification training under working memory load increases the magnitude of change in attentional bias

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ARTICLE INFO

Article history:
Received 15 September 2016
Received in revised form
16 December 2016
Accepted 10 February 2017
Available online 21 February 2017

Keywords:
Attention bias modification
ABM
Cognitive bias modification
CBM
Working memory load
Cognitive load
Anxiety
Anxiety disorders
Attentional bias
Selective attention

ABSTRACT

Background and objectives: Attention bias modification (ABM) procedures have shown promise as a therapeutic intervention, however current ABM procedures have proven inconsistent in their ability to reliably achieve the requisite change in attentional bias needed to produce emotional benefits. This highlights the need to better understand the precise task conditions that facilitate the intended change in attention bias in order to realise the therapeutic potential of ABM procedures. Based on the observation that change in attentional bias occurs largely outside conscious awareness, the aim of the current study was to determine if an ABM procedure delivered under conditions likely to preclude explicit awareness of the experimental contingency, via the addition of a working memory load, would contribute to greater change in attentional bias.
Methods: Bias change was assessed among 122 participants in response to one of four ABM tasks given by the two experimental factors of ABM training procedure delivered either with or without working memory load, and training direction of either attend-negative or avoid-negative.
Results: Findings revealed that avoid-negative ABM procedure under working memory load resulted in significantly greater reductions in attentional bias compared to the equivalent no-load condition.
Limitations: The current findings will require replication with clinical samples to determine the utility of the current task for achieving emotional benefits.
Conclusions: These present findings are consistent with the position that the addition of a working memory load may facilitate change in attentional bias in response to an ABM training procedure.

1. Introduction

Attention bias modification (ABM) procedures have shown promise as an intervention for a range of emotional and non-emotional conditions, with the majority of research having focused on the effects of ABM tasks on anxiety (MacLeod & Clarke, 2013). Some research into the potential benefits of ABM has been highly encouraging, with a number of studies demonstrating significant reductions in emotional vulnerability for individuals with anxiety disorders across a range of symptoms (e.g. Amir, Beard, Burns, & Bomyea, 2009; Eldar et al., 2012; Schmidt, Richey, Buckner, & Timpano, 2009). Other, recent findings have been more mixed however, with a number of studies failing to observe benefits of ABM (e.g. Boettcher, Berger, & Renneberg, 2012; Carlbring et al., 2012). Given such inconsistent findings, there has been some confusion regarding the distinction between ABM as a training procedure and ABM as an effect on patterns of attention. In line with recent recommendations (MacLeod & Grafton, 2016), in the following we consistently distinguish between 'ABM training procedures and/or tasks' which are designed to, but may or may not achieve intended changes in biased attention, from the consequent impact of such tasks on change in attentional bias. As such, the term 'ABM training procedure/task' is used in reference to the intended purpose of the task, which is distinct from the degree to which it achieves its intended goal of 'change in attentional bias'.

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http://dx.doi.org/10.1016/j.jbtep.2017.02.003
0005-7916/

In light of these inconsistent findings, there are three distinct issues that are critical when evaluating the clinical relevance of ABM procedures. The first is whether the delivery of an intended ABM procedure contributes to improvements in emotional vulnerability, *regardless* of whether it succeeds in achieving the intended change in attentional bias. This question has been the focus of a number of recent reviews and meta-analyses which have suggested that intended ABM procedures may not reliably contribute to emotional benefits (Cristea, Kok, & Cuijpers, 2015; Cristea, Mogoase, David, & Cuijpers, 2015). The second question concerns whether current ABM tasks are capable of achieving the desired change in attentional bias. The answer to this appears to be 'yes', with the proviso that these tasks are not always successful in achieving the desired change in bias (Mogoaşe, David, & Koster, 2014). The final question, which is crucial to informing whether ABM is worthy of pursuit as an intervention into the future, has been overlooked in recent meta-analyses (Cristea, Kok, et al., 2015; Cristea, Mogoase, et al., 2015). This concerns whether the mechanistic link between change in attentional bias and consequent change in emotional vulnerability is indeed sound. If bias change is a genuine agent of therapeutic action, then studies that achieve changes in attentional bias should also observe concurrent changes in emotional vulnerability, whereas those that fail to change bias should not. In a recent commentary and subsequent systematic review, we showed that such a pattern of effects is overwhelmingly consistent across ABM studies (Clarke, Notebaert, & MacLeod, 2014; MacLeod & Clarke, 2015). Specifically, of the 36 studies reviewed, the overwhelmingly consistent pattern was that successful bias change reliably led to changes in emotional vulnerability, and when bias change did not succeed, emotional benefits were not forthcoming. This consistent pattern clearly suggests that the therapeutic potential of ABM is likely to be best realised by determining the cognitive task conditions that are most conducive to achieving change in attentional bias. In line with this over-arching goal, the specific aim of the current study was to determine if ABM delivered under conditions of working memory load will increase the magnitude of bias change produced by a standard ABM task.

It has commonly been assumed that the contingency used in ABM tasks to encourage bias change is registered without explicit awareness (MacLeod, Koster, & Fox, 2009). This is consistent with the observation that, despite measurable changes in attentional bias, participants largely have no awareness of this contingency (e.g. Amir, Beard, Taylor, et al., 2009; Grafton, Mackintosh, Vujic, & MacLeod, 2014). Interestingly, MacLeod, Rutherford, Campbell, Ebsworthy, and Holker (2002) found that while ABM-induced changes in attentional bias were observed at 500 ms stimulus exposure durations, such bias change was not observed at brief (20 ms) exposure durations. This suggests that while bias change may occur without awareness, it may not immediately result in rapid direction of attention at brief stimulus exposure durations. Therefore, the observation that changes in attentional bias and emotional symptoms can occur in the absence of awareness of task goals and training contingency suggests that bias change can occur outside of conscious awareness.

Of relevance to this, one of the few studies that failed to show a link between successful bias change and changes in emotional vulnerability involved an ABM procedure delivered with explicit contingency awareness. In one experimental condition, Grafton et al. (2014) told participants that probes would consistently replace either the negative or neutral word in each pair (depending on ABM condition allocation), and they should shift their attention towards this stimulus on each trial. Results showed that a standard version of the ABM training task resulted in the expected change in attentional bias and consequent emotional effects, however the instructed version of the task showed no emotional effects despite an observed bias change. Such a finding is consistent with the possibility that explicit contingency awareness may contribute to more fragile bias change, while conditions that discourage explicit processing of the contingency may more effectively contribute to bias change.

Converging evidence for this perspective comes from the implicit learning literature which postulates that conscious, reflective strategies, and efforts to learn, may interfere with the learning of implicit rules (Reber, 1989). This is thought to be because explicit learning is associated with active attempts to remember and strategically apply rules, which will be easily disrupted by changes in context or cognitive processing priorities (Green & Flowers, 2003). Consistent with this, some research has shown that conditions which limit conscious awareness of learned rules via the addition of a secondary task (i.e. working memory load task) may result in superior performance on implicit learning tasks (Hayes & Broadbent, 1988). Thus, if the addition of a working memory load can indeed discourage potential interference that may occur via explicit processing, the addition of a working memory load during ABM could conceivably enhance change in attentional bias.

A recent study by Booth, Mackintosh, Mobini, Oztop, and Nunn (2014) sought to compare bias change under conditions of high and low working memory load. Interestingly, the authors made the reverse prediction to that proposed above. Specifically, they reasoned that because change in attentional bias has been associated with cortical regions related to 'top-down' attentional control, the addition of a working memory load would likely impair top-down control and decrease bias change. They found that evidence of bias change was restricted to a low working memory load condition.

There are, however some limitations with Booth et al. (2014) study that suggest caution in drawing firm conclusions on the basis of this initial finding. Firstly, the study did not compare patterns of bias change under working memory load to a standard ABM task delivered under no-load. Rather, they compared the magnitude of bias change across a high load and a low load condition. As such, the study was unable to determine whether the addition of *any* working memory load produced superior pattern of bias change to a standard ABM task. Furthermore, while Booth et al. delivered ABM under high and low load conditions, they assessed biased attention under no load only. Because an attentional bias may be detected more readily under the same conditions in which it was acquired, it is important to assess bias change under conditions of both load and no-load.

Thus, the aim of the current study was to examine whether ABM task conditions that discourage explicit contingency awareness will contribute to more change in attentional bias as compared to standard ABM training. A secondary aim was to assess whether the degree of bias change observed, will differ across attentional bias assessment tasks that either do, or do not involve a working memory load. To achieve this, we delivered between-subject ABM training under one of four conditions: either towards (attend-negative) or away from (avoid-negative) negative stimuli, under conditions that either did, or did not include a working memory load. The magnitude of change in attentional bias was assessed under conditions of both load and no-load. If task conditions that discourage explicit contingency awareness contribute to greater bias change, then we would expect to observe greater magnitude of change in attentional bias (towards and away from negative information) under task conditions that involve ABM training under load, compared to task conditions that involve ABM training under no-load (i.e. standard ABM).