Asymmetrical transfer effects of cognitive bias modification: Modifying attention to threat influences interpretation of emotional ambiguity, but not vice versa

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Article Info
Article history:
Received 20 February 2012
Received in revised form 2 August 2016
Accepted 24 August 2016
Available online 26 August 2016

Keywords:
Cognitive bias modification
Attention
Interpretation
Transfer effects
Anxiety

ABSTRACT
Background and objectives: It is well established that attention bias and interpretation bias each have a key role in the development and continuation of anxiety. How the biases may interact with one another in anxiety is, however, poorly understood. Using cognitive bias modification techniques, the present study examined whether training a more positive interpretation bias or attention bias resulted in transfer of effects to the untrained cognitive domain. Differences in anxiety reactivity to a real-world stressor were also assessed.

Methods: Ninety-seven first year undergraduates who had self-reported anxiety were allocated to one of four groups: attention bias training (n = 24), interpretation bias training (n = 26), control task training (n = 25) and no training (n = 22). Training was computer-based and comprised eight sessions over four weeks. Baseline and follow-up measures of attention and interpretation bias, anxiety and depression were taken.

Results: A significant reduction in threat-related attention bias and an increase in positive interpretation bias occurred in the attention bias training group. The interpretation bias training group did not exhibit a significant change in attention bias, only interpretation bias. The effect of attention bias training on interpretation bias was significant as compared with the two control groups. There were no effects on self-report measures.

Limitations: The extent to which interpretive training can modify attentional processing remains unclear.

Conclusions: Findings support the idea that attentional training might have broad cognitive consequences, impacting downstream on interpretive bias. However, they do not fully support a common mechanism hypothesis, as interpretive training did not impact on attentional bias.

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1. Introduction

Cognitive models emphasise the critical role that selective processing plays in the onset and maintenance of anxiety (e.g., Beck & Clark, 1997; Eysenck, 1997; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Williams, Watts, MacLeod, & Mathews, 1997). Extensive research generated from these models has shown that anxious individuals disproportionately attend to threat-related stimuli in the environment (attention bias; cf. Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Fox, Russo, & Dutton, 2002; MacLeod, Mathews, & Tata, 1986) and perceive threat-consistent meanings when processing ambiguous information (interpretation bias; cf. Eysenck, Mogg, May, Richards, & Mathews, 1991; Mathews & MacLeod, 2002). Modifying attentional and interpretive bias using experimental procedures (Cognitive Bias Modification; CBM) has demonstrated the causal role of each of these biases in anxiety (see MacLeod & Mathews, 2012, for a review).

In the CBM paradigm, participants carry out repeated trials in which they are trained to interpret emotional ambiguity in either a
negative direction (e.g., Salemink, van den Hout, & Kindt, 2007) or a positive direction (e.g., Beard & Amir, 2008; CBM for interpretation, CBM-I); to attend to threat (e.g., White, Suwaiy, Pine, Bar-Haim, & Fox, 2011), or to attend away from threat stimuli on the computer screen (e.g., Browning, Holmes, & Harmer, 2010; Hakamata et al., 2010; CBM for attention, CBM-A). CBM-I to promote positive interpretation and CBM-A to encourage attention away from threat have been shown to reduce symptoms of anxiety in clinical and high anxious samples (e.g., Amir, Beard, Burns, & Bomyea, 2009; Amir & Taylor, 2012; Brosan, Hoppitt, Shelfer, Silence, & Mackintosh, 2011; Linetzy, Pergamin-Hight, Pine, & Bar-Haim, 2015; Salemink, van den Hout, & Kindt, 2009; Schmidt, Richey, Buckner, & Timpano, 2009). However, whilst this research is consistent with the theory that the presence of one or more of these biases underpins anxiety, it is not known whether these biases reflect one common neurocognitive mechanism. For example, models such as Mathews and Mackintosh (1998) and Bishop (2007) propose that both attentional and interpretive biases arise from the outcome from competition of bottom-up (a relatively automatic threat evaluation system) and top-down (cognitive control) cognitive processes. As these models predict that both biases arise from the same system, it is possible that modifying the system to alter one bias (e.g., attentional) will also impact on the presence of the other bias (e.g., interpretation). Cognitive bias modification paradigms therefore allow us to address such interesting theoretical questions regarding the interacting nature of these two biases, by modifying one bias and assessing impact on the other.

Additionally this can help answer important therapeutic questions, such as whether modifying one bias (e.g., attention bias) is sufficient to alter cognitive processing in other areas (e.g., in interpretation). In order to investigate these ideas, White et al. (2011) trained participants to attend to threat using the dot-probe task and then assessed its impact on a test of interpretive bias. In the training phase, two faces (one angry and one neutral) were presented on the computer screen above and below a central fixation point. After 500 ms they disappeared, were replaced by an arrow pointing either up or down, and participants were required to indicate in which direction the arrow was pointing. In the attend threat condition the probes consistently replaced the threat-related faces, and in the placebo condition probes replaced threat-related and neutral faces with equal probability. In a subsequent test of interpretation of emotional ambiguity, attend threat training appeared to increase the tendency of participants to make threat-related initial interpretations of emotionally ambiguous sentences.

These results provide initial evidence that attentional and interpretive biases result from a common neurocognitive mechanism, as opposed to being orthogonal. However, the results do not allow us to speculate on the temporal nature of these biases. That is, it might be that biases in attention precede and subsequently influence interpretive bias in a downstream manner (Ouimet, Gawronski, & Dozois, 2009), with the influence of interpretive processing on upstream attentional processing being more difficult. Two studies have tested the impact of modifying interpretive bias on attentional bias (Amir, Bomyea, & Beard, 2010; Mobini et al., 2014). Consistent with a common mechanism hypothesis (in which modifying either bias impacts on a central mechanism related to the other bias) modifying threat-related interpretive bias did have an impact upon threat-related attentional bias.

Although preliminary work appears to be consistent with attentional and interpretive biases sharing a common mechanism, these initial exciting findings clearly need replication. The prior investigation of transfer from attentional retraining to interpretive bias (White et al., 2011) did not assess the impact of therapeutic CBM-A versus a control group, instead retraining attention towards threat. We therefore concentrated on positive (non-threat focussed) CBM (multiple sessions of either CBM-A or CBM-I) in a high anxious sample, enabling us to address the applied question of whether either CBM-A or CBM-I has broader effects on the cognitive biases underpinning anxiety, and as such whether one or the other might be most beneficial to use therapeutically, a question that is currently unanswered. The present study aimed to replicate previous findings that CBM-A modifies interpretive selectivity (White et al., 2011) and CBM-I modifies attentional selectivity (e.g., Amir et al., 2010; Mobini et al., 2014), and develop these findings by testing the comparative transfer effects of neutral CBM on alleviating threat-related attentional and interpretive biases. We sought to further understand the relationship between attentional and interpretive selectivity by training one group of participants to interpret emotional ambiguity in a positive direction (using CBM-I) and another group to focus their attention on non-threat (as opposed to threat-related) stimuli (CBM-A). Two control groups served as a comparison, (placebo training and no training). The placebo training condition alongside a no training control group allowed us to ensure that any effects of training would be unlikely to be due to placebo/demand characteristics. If there were no differences between either the CBM-I/CBM-A groups with the placebo training group, but these three groups all showed improvement relative to our fourth control group (no training), we would be able to determine that the results are likely to be due to a placebo effect or demand characteristics. In line with a common mechanism hypothesis, we predicted that training attention away from threat stimuli would encourage participants to interpret emotional ambiguity in a more positive manner, and that inducing a positive interpretive bias would lead to participants finding it easier to attend away from threat stimuli. In addition to these specific hypotheses, we also predicted that participants in the two training groups (CBM-I and CBM-A) would show reductions in symptoms of anxiety and depression. Finally, we asked participants to keep a diary during the study to assess whether they encountered any major life events throughout the training and to generally assess how they were settling into university life.

2. Methods

2.1. Participants

Ninety-seven University of East Anglia first year undergraduates (67 females and 30 males, mean age 18.9 years, $SD = 2.06$) were recruited at the start of their first term via emails and a poster campaign. Four eligibility questions emailed to all interested students had determined that participants were native English speakers who felt anxious and/or overwhelmed about starting University, had no difficulties reading or understanding text from a computer screen and had not previously completed a University course. Participants were randomly (with the constraint that group size would be approximately equal) assigned to one of four conditions¹: attention bias training ($n=24$; 17 females and 7 males; mean age 19.08 years, $SD = 2.93$), interpretation bias training ($n=26$; 15 females and 11 males; mean age 18.96 years, $SD = 2.44$), control task training ($n=25$; 20 females and 5 males; mean age 18.84 years, $SD = 1.11$) and no training ($n=22$; 15 females and 7 males).

¹ It should be noted that participants for this study were recruited at the beginning of two academic years (2008 and 2010). At the start of the first academic year of testing, participants were randomly allocated to CBM-A ($n=12$), CBM-I ($n=13$) and the placebo control condition ($n=15$). At the start of the second academic year of testing participants were randomly allocated to CBM-A ($n=12$), CBM-I ($n=13$), placebo control condition ($n=10$) and no training control ($n=22$) with the restriction that group sizes would be approximately equal.
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