



## Review article

## Cognitive bias modification: A review of meta-analyses



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## ABSTRACT

**Background:** Cognitive bias modification (CBM) is a novel, but controversial intervention with considerable divergence amongst conclusions in individual studies and reviews. This systematic review synthesizes meta-analyses of CBM to determine whether CBM is effective, and what parameters most reliably evoke the process of CBM.

**Methods:** A systematic literature search resulted in twelve meta-analyses in total, from which the published effect sizes were extracted.

**Results:** Attention bias modification (ABM) shifted targeted biases in adults ( $ES = 0.24\text{--}1.16$ ), was effective as a buffer to stressor vulnerability ( $ES = 0.33\text{--}0.77$ ) and in symptom control ( $ES = 0.16\text{--}0.41$ ). Cognitive bias modification for interpretation (CBM-I) modified targeted biases ( $ES = 0.52\text{--}0.81$ ) but did not reliably reduce stressor vulnerability ( $ES = 0.01\text{--}0.24$ ,  $p > .05$ ). CBM consistently reduced anxiety symptoms, but effects on depressive symptomatology were less compelling. The long-term efficacy of CBM was only supported in addiction studies.

**Limitations:** The review included a single CBM-I only meta-analysis, and two meta-analyses with pooled reporting on ABM and CBM-I outcomes.

**Conclusions:** Overall, this synthesis shows CBM is effective in the short-term for anxiety in adults, and highlights some conditions under which CBM is most efficacious. Rather than debating the efficacy of CBM, future research should focus on developing procedures that more reliably induce bias modification and determining the most efficacious clinical applications.

## 1. Introduction

Cognitive bias modification (CBM<sup>1</sup>) refers to procedures that aim to directly change automatic cognitive processes, such as attention and interpretation that are hypothesized to contribute to the development and maintenance of psychopathology. CBM is therefore an implicit process, and is produced by directly modifying a targeted cognitive bias in a particular direction (MacLeod and Mathews, 2012). Research has focused primarily on two types of CBM: attention bias modification (ABM) and cognitive bias modification for interpretation (CBM-I). In ABM, participants are trained to attend to neutral or positive stimuli, and avoid negative, threatening stimuli. Most commonly, the dot-probe paradigm is used to modify biases by changing the contingencies between the target and the probe, such that the probe more frequently

replaces non-threatening stimuli during training. However, other paradigms have also been used for ABM including spatial cueing task (e.g. Fox et al., 2001) and visual search (e.g. Dandeneau et al., 2007). CBM-I, in contrast, requires participants to solve a task that disambiguates a sentence, paragraph, or picture to be either positively or negatively valenced. Doing so leads participants to interpret new ambiguous stimuli in the same manner that matches their training (positive or negative). The most widely used CBM-I training method is the Ambiguous Scenarios (AS) paradigm (e.g. Blackwell and Holmes, 2010), while other training methods include the homograph paradigm (e.g. Grey and Mathews, 2009) and the Word Sentence Association Paradigm (WSAP) (e.g. Amir and Taylor, 2012).

Since the first ABM study published in 2002 (MacLeod et al.), the number of studies of CBM has grown exponentially. The success of early

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Attention Bias Modification (ABM).

Attentional Bias (AB).

Cognitive Bias Modification (CBM).

Cognitive Bias Modification for Interpretation (CBM-I).

Word Sentence Association Paradigm (WSAP).

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experimental paradigms in inducing changes in emotional vulnerability led researchers to see the potential therapeutic benefit of CBM, and as such, recent studies are now targeting anxiety and depressive symptoms in clinical settings.

As the literature on CBM has proliferated, so too has the number of reviews and meta-analyses relating to CBM. The earliest meta-analysis (Hakamata et al., 2010) concluded that ABM was a promising new treatment with moderate to large effect sizes. However, some more recent meta-analyses have suggested CBM is ineffective, or that its effects are so small that they are unlikely to be clinically relevant (Cristea et al., 2016, 2015a, 2015b). It is possible that the varying conclusions of the meta-analyses reflect a novel treatment that showed promise in early, poorly controlled studies, but has not reached its early promise. However, a cursory reading of the available meta-analyses reveals numerous methodological differences between them that could, at least in part, account for these discrepancies. It is therefore timely to provide a narrative synthesis of available meta-analyses to determine whether the source of differences can be determined.

The aim of this study is to review existing meta-analyses to identify the variations in scope and methodology that give rise to the inconsistencies reported. Further, we aim to determine the conditions under which CBM works most effectively. Hence, the research questions are: (a) Does CBM work? And (b) If so, under what conditions is it most effective?

## 2. Method

### 2.1. Literature search

All published meta-analyses on CBM were identified. Meta-analyses had to include more than 4 CBM studies, and needed to meet PRISMA guidelines. A systematic search of the literature was conducted in PsychInfo, Medline, EMBASE and the Cochrane Library databases through January 2017. The following key words were used from the recent meta-analysis by Cristea et al. (2015a): "cognitive bias modification" or "attention\* bias modification" or "attention bias training" or "bias training" or "interpret\* bias modification", which we then combined with "meta-analysis".

### 2.2. Study selection

The search process (see Fig. 1) resulted in 12 meta-analyses. All articles were reviewed by the two authors, with perfect agreement (Kappa = 1).

### 2.3. Summary of analyses

For a brief summary of the included analyses, see Table 1. The current review focused exclusively on ABM and CBM-I studies. The effects of CBM were examined directly using the following outcomes: change in relevant bias, vulnerability to a stressor, and symptom

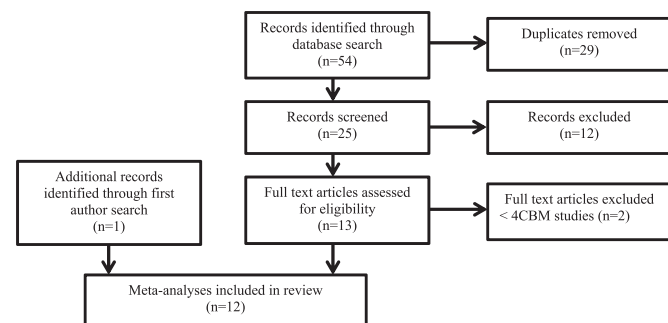


Fig. 1. PRISMA diagram.

reduction. Post treatment outcomes that were reported in only one meta-analysis were not included (n = 2). We also extracted moderating variables examined in the meta-analyses. Reported effect size values are those after outliers were removed. In this way, we have taken a conservative approach to the analysis. While we appreciate that the meta-analyses differ in scope, since scope is not necessarily an indicator of quality, per se, we will report the results and mention the scope of the meta-analysis, where relevant, to the results.

## 3. Results

### 3.1. Do Cognitive bias modification protocols reliably change cognitive biases?

#### 3.1.1. Attention bias modification (ABM)

Nine out of the eleven meta-analyses that examined ABM measured a change in attentional bias (AB). Neither Cristea et al. (2015a) nor Kampmann et al. (2016) assessed change in biases. Of those nine meta-analyses, eight found a significant effect of ABM on AB change (ES = 0.24–1.16). The remaining study used a child only population (Cristea et al., 2015b). Hence, except for a meta-analysis exclusively with children, all meta-analyses found that ABM protocols successfully modified attention bias.

#### 3.1.2. Cognitive bias modification for interpretation (CBM-I)

Only five of the twelve meta-analyses included CBM-I, and only three examined change in interpretation bias. Nonetheless, in all three meta-analyses, a significant effect of CBM-I (ES = 0.52–0.81) on interpretation bias change was found overall. However, in comparing pre-post positive bias change, Menne-Lothmann et al. (2014) found that the effect of benign training only varied reliably from negative training (ES = 0.65), not neutral or no training.

#### 3.1.3. Follow-up outcomes

Mogoşe et al. (2014) was the only meta-analysis to investigate the degree to which bias change was enduring at follow-up. Changes in AB were not maintained when measured between 2 weeks and 4 months after the final ABM session.

### 3.2. Under what conditions do CBM protocols most reliably change biases?

#### 3.2.1. Type of CBM intervention

Two analyses compared the relative success of ABM and CBM-I in changing biases, with one study (Hallion and Ruscio, 2011) finding CBM-I to be more successful, and the other (Cristea et al., 2015b) finding no significant difference.

#### 3.2.2. Age and sex

Of the five studies that assessed age as a moderator of CBM on bias change, only one (Mogoşe et al., 2014) revealed a significant effect. Mogoşe et al. (2014) found that younger participants benefited more from ABM on bias change scores, but only in their anxiety subsample. Similarly, mixed results were found in the three meta-analyses that investigated the moderating role of gender. Menne-Lothmann et al. (2014) revealed benign CBM-I to be more effective for females compared with males, whereas Heeren et al. (2015) and Hakamata et al. (2010) did not find significant effects.

#### 3.2.3. Sample and psychopathology types

In the three studies that investigated type of pathology on AB change, there was little evidence to support a relationship. Beard et al. (2012) did find type of pathology to moderate AB change, but only for training to neutral versus control; and this result was no longer significant when two studies of smoking with small effects were removed.

Sample type as a moderator was examined in six studies, with 2/6 having significant findings. Both Beard et al. (2012) and Menne-

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