Cognitive Bias Modification for Depression

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Abstract

The past decades have witnessed intense research on valence-specific information processing biases in depression. Cognitive bias modification (CBM) is a technique that attempts to experimentally modify processing biases through extended computerized training to understand their causal role in the maintenance of depression. Moreover, reducing maladaptive processing biases has clinical potential. The current paper discusses the current state-of-the-art on CBM at the level of attentional, interpretive and memory processes. Despite strong research progress in this area and several encouraging findings it is clear that further work is needed both at the conceptual as well as at the clinical level to further optimize the understanding of the causal role and malleability of processing biases in depression.

Introduction

The past decades have witnessed intense research on information processing biases and impairments in depression. In addition to broad impairments in overall information processing at the level of attention and memory, which are considered part of the diagnostic criteria for depression [1], much research has focused on differential processing of affective information in depressed compared with non-depressed individuals [2]. Based on seminal cognitive theories of cognition and depression [3-5] the main idea is that depression would be characterized by mood-congruent or schema-congruent biases. As such, depressed individuals would focus more on negative information (mood-congruency) and would process internal and external information in a way that would be in line with core beliefs (e.g., "I am a failure") that are based on past experiences (schema-congruency).

A wealth of research has investigated the presence of affective biases at different levels of information processing and there is supportive evidence for the presence of such biases in attention [6, 7], interpretation [8], and memory [9]. Although there are still quite a number of open questions about the phenomenology of such biases and their underlying mechanisms, the observations gave rise to research examining the contribution of such biases to the etiology and maintenance of depression. In recent years prospective studies have convincingly demonstrated that processing biases can contribute to the maintenance of negative affect [10, 11] as well as to negative thinking styles [12]. Such studies have paved the way for studies examining the causal status of processing biases in the maintenance of depression and to the malleability of such biases.

Provided the challenges encountered in the clinical treatment of depression (e.g., non-response and relapse/recurrence) there is increasing interest in using insights about the mechanisms underlying depression maintenance for therapeutic purposes [13]. Moreover, from a research stance experimentally manipulating processing bias is crucial to examine the causal role of processing bias on depressive symptoms. This led to the development of computerized procedures that aim to modify maladaptive cognitive bias ("cognitive bias modification"; CBM). The basic idea of CBM is to provide an individual with a task where adequate performance benefits from counteracting an existing

bias in favor of adopting a more positive/benign way of processing emotional information [14]. CBM procedures typically involve a great deal of different training trials in order to be able to establish a well-rehearsed more adaptive processing style that is maintained even in circumstances where cognitive resources are depleted (e.g., in stressful situations). Provided its theoretical and clinical potential, the last decades have seen a large research interest in CBM. In the current paper we discuss the state of the art with regard to CBM in depression which will be organized around different levels (attention, interpretation, memory) of information processing bias.

Attentional Bias Modification

MacLeod and colleagues [15] developed a procedure to modify attention (ABM) based on a frequently used task to assess attentional bias, the dot probe task. In the standard version of this task two stimuli (one neutral, one negative) are presented simultaneously at two locations on a screen followed by a probe randomly appearing at the location of the neutral or negative stimulus. Reaction times to the probe allow to infer whether individuals oriented to the neutral or negative stimulus. By manipulating the contingency between stimulus valence and probe location an individual can be trained towards negative information (probe generally presented at the location of the negative stimulus) or away from threat (probe generally presented at the location of the neutral stimulus). This latter condition is thought to be of most clinical relevance where researchers try to diminish attentional bias to negative information.

Initially, ABM was mainly used in the context of anxiety where results with regard to the malleability of attentional bias and the reduction of anxiety were highly promising (for an early meta-analysis, see [16]). Provided that training attention away from threat was successful in reducing negative affect upon receiving a lab stressor [15], researchers also adapted the dot probe training for depression where, based on the nature of attentional bias in depression, sad stimuli were presented for longer durations. In subclinical depression, Wells and Beevers [11] showed that ABM could reduce depressive symptoms where they were able to demonstrate that change in depression scores was due to

changes in attentional bias. Interestingly, using another training procedure, it was shown that ABM can have beneficial effects on self-esteem in a healthy population [17].

These data provided the impetus for studies in clinical populations and settings. In a group of remitted depressed individuals – an important at-risk group for developing a new depressive episode – it was found that ABM training towards positive faces was able to reduce depression levels as well as to normalize the cortisol awakening response [18]. However, a study with clinically depressed individuals where a spatial cueing task was used to train attention away from negative self-referential words and towards positive words failed to find any beneficial effects on depressive symptoms [19]. Other studies have also reported failures to replicate beneficial effects of ABM in subclinical populations [20]. Not surprisingly, a recent meta-analysis of the current status of ABM in depression suggests no significant effects [21]. However, this conclusion is preliminary as the available literature is small and current training procedures could be better geared to depression where for instance gamification techniques could be used to increase the motivation to continue training.

Interpretation Bias Modification

Traditional cognitive techniques have typically targeted disproportional negative cognitions and interpretations [4]. While early studies have provided mixed evidence for the existence of a depressive interpretation bias (selective generation and selection of negative rather than positive interpretations), recent studies have more consistently demonstrated its legitimacy using a broad range of assessment techniques ([8, 22, 23), but see [24]). Accordingly, there has been a recent increase in studies investigating the potential of CBM techniques targeting appraisal processes (CBM-I) as an intervention for depression. Researchers have developed training tasks during which participants are presented with ambiguous situations, followed by presentation of a probe that can only be resolved by interpreting it in a positive manner (e.g., ambiguous situations paradigm), and a reinforcing question related to the content of the situation [25]. Effects of CBM-I on interpretation bias are then assessed by analyzing responses to non-ambiguous situations (i.e., using RT scores, eye tracking measures, ERP). A similar training approach consists of instructed mental imagery of standardized ambiguous

situations that would typically end with a positive interpretation. Research indicates that identification with these situations is important for beneficial training effects to occur [26], as well as presence of a negative bias at baseline [27].

Positive CBM-I has shown to increase mood [28-30] and has beneficial effects on appraisals of recent stressors [31] as well as on emotional vulnerability (i.e., responsiveness to a negative mood- or stress induction) [26, 30]. Moreover, encouraging healthy participants to attain positive interpretations – compared to negative interpretations – reduces the chance of experiencing depressive intrusions following a stressor [32]. Other studies have used CBM-I techniques to target specific forms of biased cognitions (e.g., Beck's cognitive error categories), which has also shown to reduce stress reactivity [33]. Although researchers have not always been successful in demonstrating beneficial effects of positive CBM-I on assessments of interpretation bias and emotional vulnerability [34], these findings have encouraged researchers to further explore the potential of CBM-I to reduce depressive symptomatology.

In a single case series study using a MDD sample (n = 7), Blackwell and Holmes [35] demonstrated the potential of a one week CBM-I training in altering mood as well as decreasing depressive symptomatology. Taking into account the methodological limitations of previous studies, researchers have confirmed the value of repeated CBM-I in reducing depressive symptomatology in MDD populations [36, 37]. Interestingly, Williams, Blackwell, Mackenzie, Holmes, and Andrews [38] have demonstrated the (partially) mediating effect of change in interpretation bias on the reduction of depressive symptomatology following CBM-I. And, research indicates that MDD patients might benefit from combining CBM-I with online CBT [38], whereas CBM-I proved to be equally effective as online CBT in reducing depressive symptomatology in a sample scoring high on social anxiety [39]. However, undergoing only one session of CBM-I did not proof to be sufficient to affect mood and stress reactivity in MDD [40], and repeated CBM-I does not seem to be effective in reducing depressive symptomatology in a subclinically depressed sample consisting of adolescents and young adults [27].

Meta-analytic findings indicate that CBM-I techniques are effective in influencing measures of bias [41, 42] and mood [42]. However, beneficial effects of CBM-I only occurred in studies comparing positive CBM-I to a negative CBM-I control group, while remaining non-significant compared to a neutral or no training condition [42]. Moreover, CBM-I did not influence emotional vulnerability to stressful events [42], and drawing on a pool of early CBM-I and ABM-studies, Hallion and Ruscio [41] did not find significant effects of CBM on depressive symptomatology. However, these analyses are mainly based on healthy and anxious populations, while as to date only a limited amount of studies have evaluated the effects of CBM-I in MDD patients. Importantly, these recent studies have provided evidence for the clinical potential of CBM-I in depression while not relying on positive vs. negative CBM-I group comparisons [35-38]. Finally, meta-analytic findings indicate that the effectiveness of CBM-I could be increased by using multiple sessions, imagery techniques, as well as targeting certain vulnerable subpopulations (i.e., bias at baseline, women, clinical samples) [42]. In sum, although future clinical studies using multiple training sessions are warranted, there is emerging evidence for the effectiveness of CBM-I as (part of) an intervention for depression.

Memory Bias Modification

Compared to the ABM and CBM-I research the literature on modifying memory bias is more sparse and diverted. At the level of memory there is research examining the benefits of training working memory broadly [43, 44]. This non-affective training is not covered here but could also have an impact on affective processing biases. With regard to affective processing, studies have mainly focused on specific aspects of memory that are problematic. Depression is characterized by an overgeneral autobiographic memory style, which is thought to feed into more maladaptive and ruminative thinking styles at the expense of a more focused problem-solving thinking style [45]. Based on the extensive literature linking reduced memory specificity to the maintenance of depression, Raes, Williams, and Hermans [46] developed a procedure to enhance memory specificity and validated this training procedure in a small inpatient MDD sample. In a recent RCT using this training compared with no intervention it was found that bereaved and depressed Afghan refugees profited substantially from training memory specificity and reported less depressive symptoms immediately

after training and at a two month follow-up [47]. Furthermore, researchers are currently studying the efficacy of memory specificity training compared to education and support in a MDD sample [48].

There is also work indicating that recalling positive memories in depression has less beneficial effects on mood because positive memories are recalled in a less concrete, vividly and intense manner ([49, 50], but see [51]). Accordingly, it has been argued that depressed individuals might benefit from interventions that stimulate focusing on concrete memories. Interestingly, Watkins and Moberly [52] developed a training in concreteness – which is also focused on autobiographic memories – that has shown to be useful in depression ([52-54], but see [55]). Overall, studies using several working memory training approaches suggest the potential of working memory bias modification techniques for depression. However, currently the limited amount of evidence enables us to draw firm conclusions.

Future Directions

There is emerging evidence for the value of CBM- and cognitive training techniques in remediating cognitive biases and impairments that have previously been related to depressive symptomatology. Moreover, the presented literature suggests that these techniques can be deployed to target important underlying mechanisms and vulnerability factors for depression, therefore holding the potential to increase effectiveness and long term outcome of existing treatments. Yet, a number of challenges remain. First, it is likely that CBM needs to be embedded within existing psychological treatments rather than used as a stand-alone treatment. This raises the question of how these techniques can be implemented in current approaches (i.e., as homework assignments, as an online preventive intervention), and future studies should further explore the added value of a combined approach (i.e., CBM and CBT). Second, we envision a transition from training approaches that are developed for specific diagnostic groups to a more personalized approach. For instance, future treatment studies could assess the existence of cognitive impairments and biases in patients at baseline and compose an individually tailored, yet structured treatment (i.e., ABM and CBM-I).

A third major challenge is to develop more powerful training techniques that are specifically designed to take into account limited motivation in depression. This would involve a broader range of training tasks where more direct feedback is provided to participants and where difficulty level is individually tailored (e.g., [56]). For instance, attentional training procedures could profit from using a broader range of measures such as eye-tracking to provide online feedback whereas interpretation bias training could benefit from using more personally relevant scenarios and use a broader range of settings where interpretations need to be generated.

In sum, the last couple of years have witnessed increased interest to apply CBM techniques in the context of depression. Findings indicate that processing biases can be changed through CBM. Despite encouraging data with some of the CBM techniques it is clear that further advances are needed at the conceptual and methodological level to enhance the clinical effectiveness and applicability of CBM for depression.

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