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Cognitive Behavioral Therapy, and Cognitive Bias Modification in Internet-Based Interventions for Mood, Anxiety, and Substance Use Disorders

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Matthijs Blankers, Elske Salemink, and Reinout W. Wiers



Abstract

In this chapter, the theoretical background of (digital) cognitive behavioral therapy (CBT) is presented, along with cognitive bias modification (CBM), a novel set of interventions in which cognitive processes involved in a disorder are directly targeted. Next, the effectiveness of digital CBT and CBM for common mental health disorders (depression, anxiety disorders, and substance use disorders, SUDs) is evaluated based on recent meta-analyses and supplemented with recent studies. Based on the reviewed literature, there is a reasonably strong evidence base for the effectiveness of digital CBT interventions for depression, anxiety, and SUDs. The evidence base for CBM interventions depends on the type of intervention and disorder. There is accumulating evidence that CBM training targeting interpretations reduces anxiety, but there is less evidence for its effects on depression. The evidence for emotional symptom reduction after CBM targeting attention is inconsistent. In SUD, there is accumulating evidence for increased abstinence after supplementing CBT treatment for alcohol use disorder for one type of CBM: approach bias modification, and preliminary, less consistent evidence for other types. Therefore, it is concluded that based on the currently available evidence, CBM could be a useful add-on to digital CBT in the clinical treatment of common mental health disorders.

14.1 Introduction

The past 10 years have witnessed a huge growth in the utilization of the Internet to disseminate e-mental health interventions for common mental disorders such as mood disorders, harmful alcohol use, and other SUDs and anxiety disorders. Nowadays, a large variety of services and interventions are available, ranging from information provision to screening with tailored advice and unguided self-help modules to multisession-guided Internet-based psychotherapy interventions. The advantages are evident: Internet services are ubiquitously accessible, at any time,

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and costs are low. The possibility of using the services anonymously can be attractive for users as well, especially in the case of stigmatized disorders (e.g., SUDs). Internet services and interventions might therefore contribute to narrowing the treatment gap: the relatively large proportion of untreated persons with mental health disorders within a given population. For example, less than 10% of all persons with an alcohol use disorder are in treatment in Europe [1], while the economic costs of SUDs including alcohol use are among the highest of all mental and brain problems in Europe [2].

From this perspective, it is somewhat surprising that the implementation of Internet services has not been disseminated more widely yet, in particular in regions with suboptimal access to mental health facilities. This cannot be caused by a lack of evidence on the effectiveness of Internet interventions for common mental disorders. The development and implementation of Internet interventions have been accompanied by many randomized clinical trials (RCTs) and other research projects. The evidence for the effectiveness and cost-effectiveness of many interventions has been demonstrated in recent reviews and meta-analyses [3–9]—although effects are often of modest size. Still, given the high prevalence of common mental disorders and the relatively low marginal costs of providing Internet interventions to additional users, the potential economic gains are enormous [4, 9].

Many of the tested and implemented e-mental health interventions for common mental disorders are based on cognitive behavioral therapy (CBT) [10]. CBT has primarily been developed as a method to treat depression by Aaron Beck in the 1960s, while he was a psychiatrist at the University of Pennsylvania [11]. Since then, CBT has established itself as the therapeutic underpinning of many psychotherapy interventions and protocols, and more recently (digital) CBT has become one of the standard therapeutic orientations for Internet interventions. In general, we have mainly seen a process of assimilation in the developmental trajectory from traditional face-to-face interventions for common mental disorders to technology- and Internet-enabled interventions in the past decade. In analogy to Piaget's theory of cognitive development [12], new technology is currently incorporated in already existing cognitive schemas, without changing the overall schemas of treatment. In terms of Internet interventions, digital technology is often used to deliver the traditional, previously existing CBT intervention content that has already been delivered for years or even decades to address a variety of disorders. What this field may profit from, in the same analogy from cognitive development, would be accommodation. This would be a process of incorporating new developments by altering existing cognitive schemas in order to fit in these new developments. In terms of Internet interventions, this would encompass that the content of the interventions itself is enhanced, to optimally utilize technology. The guiding question should be: "What kinds of new interventions are now possible if we use new (Internet) technology?" instead of "How can we offer existing interventions using this new technology?"

Over the past two decades, many of the new findings in clinical psychology stem from cognitive, experimental psychopathology research. Findings have led to a number of new, experimental treatment modalities, including technology-enabled interventions such as cognitive bias modification (CBM) as an adjunct to (digital)

CBT [13]. In CBM, a cognitive process involved in the disorder is directly targeted in an intervention. For example, in SUDs, an attentional bias and an approach-bias to substance-related stimuli have been distinguished. Both can be directly targeted in a dedicated digital intervention, with promising first results (review: [14]). One question we address is whether the advent of technology- and Internet-based interventions proves to be an opportunity for the integration of more recent findings from (clinical) psychology into clinical practice.

In this chapter, the theoretical background of CBT will first be summarized. Next, the effectiveness of digital CBT for common mental disorders will be evaluated based on recent meta-analyses. Taking these findings into account, opportunities for accommodation of the current generation of Internet interventions will be explored. Hence, in the second part of this chapter, CBM, which is one of the promising means of accommodating CBT interventions to the technical opportunities provided by Internet technology, will be introduced. The evidence regarding the effectiveness of CBM as an adjunct to (digital) CBT will be evaluated and the advantages and disadvantages of CBM and practical applications of CBM will be discussed. The central theme of this chapter is: Will the advent of technology- and Internet-based interventions prove to be an opportunity to accommodate the clinical practice of common mental disorders to recent psychological research findings?

14.2 Theoretical Background of Digital CBT

14.2.1 Background of CBT

CBT is a structured, short-term psychotherapy, which aims at solving current problems through restructuring and modifying inaccurate or unhelpful thinking. The therapist tries to find ways to produce cognitive change, for example, through modifying a client's thinking and belief system, behavioral experiments, or exposure, in order to produce emotional and behavioral change. CBT was initially developed for depression but is nowadays being used for a variety of disorders, including anxiety disorders, substance use disorders, and eating disorders. The main constituents of a CBT intervention for depression include a focus on problem solving, behavioral activation, identifying, evaluating, and responding to depressed and negative thoughts, self-perception, and discussing the patient's future [10].

CBT builds upon previous research in the field of psychology and is based on various theories including those by Karen Horney, Alfred Adler, George Kelly, Albert Ellis, Richard Lazarus, and Albert Bandura. CBT itself is a source or predecessor for other therapeutic approaches. Those therapeutic approaches include problem-solving therapy, behavioral activation, cognitive behavior modification [10], and acceptance and commitment therapy [15]. Many outcome studies involving CBT have been performed and published, the first one already in 1977 [16]. Nowadays, more than 500 outcome studies report evidence on the efficacy of CBT for various psychiatric disorders, psychological problems, or psychological

components of medical problems (e.g., pain in cancer patients). Positive results have been found in clinical settings, as well as in other settings such as community settings [17]. In more recent years, digital CBT interventions have been shown to be effective (e.g. [8, 18, 19]).

There are ten basic principles of CBT: [[10], p. 7–11].

1. Cognitive behavior therapy is based on an ever-evolving formulation of patients' problems and an individual conceptualization of each patient in cognitive terms.
2. Cognitive behavior therapy requires a sound therapeutic alliance.
3. Cognitive behavior therapy emphasizes collaboration and active participation.
4. Cognitive behavior therapy is goal-oriented and problem-focused.
5. Cognitive behavior therapy initially emphasizes the present.
6. Cognitive behavior therapy is educative, aims to teach the patient to be her own therapist, and emphasizes relapse prevention.
7. Cognitive behavior therapy aims to be time-limited.
8. Cognitive behavior therapy sessions are structured.
9. Cognitive behavior therapy teaches patients to identify, evaluate, and respond to their dysfunctional thoughts and beliefs.
10. Cognitive behavior therapy uses a variety of techniques to change thinking, mood, and behavior.

Although the basic principles apply to all patients, CBT can vary depending on the individual client, their problems or disorders, their age or life-stage, gender, intellectual level, and cultural background. Also, the goals the client set, their ability to build a strong therapeutic alliance, their motivation to bring about change, and earlier therapeutic experiences shape the contents of each individual therapy [10].

14.2.2 Background of Digital CBT

Over the past two decades, CBT has on an accumulating scale been offered using digital technology. There are several potential advantages of using digital CBT in treatment delivery. Two of the most important potential advantages are enhanced access to evidence-based psychotherapy and a reduction in therapy costs. By decreasing the amount of therapist time needed to achieve significant improvements in symptoms, a greater number of people can receive treatment by trained CBT therapists [20]. Another possible advantage of digital CBT could be that patients are reached who otherwise may not have accepted traditional therapy because of stigma or negative attitudes about treatment. The use of technology may also give patients more control and insight into the flow and progress of their therapy [20]. In recent years, both patients and professionals have tended to become more positive about the use of digital technology for mental health care [21]. The COVID-19 pandemic has functioned as a catalyst for the further implementation of digital CBT and telecare through videoconferencing in the mental health care practice, with similar outcomes as traditional in-person care [22]. Yet another potential advantage of using

digital technology is to teach the basic principles of CBT or to provide learning opportunities in a way that is more efficient and self-guided than would be possible in traditional therapy [20]. For example, in a study on drug-free patients with major depressive disorder, [23] it was found that the digital CBT group showed a larger increase in CBT knowledge and a larger improvement in dysfunctional attitudes than the control group, which was provided standard CBT, while the total time spent with the therapist was reduced in the digital CBT group compared to the control group. As the digital psychoeducational intervention component in the digital CBT group was designed to educate patients and develop skills through multimedia interactions and interactive exercises, this may also have led to a more consistent and engaging educational component than would typically be the case in standard therapist-led CBT [20].

However, there are also concerns regarding the acceptability and potential adverse consequences of digital CBT in comparison with traditional CBT. In a review [24], barriers to the uptake of digital CBT were systematically evaluated. The authors focused on the acceptability, accessibility, and adverse consequences associated with digital CBT. Among the main results, the authors report that recruited patients have only a 38% chance of actually starting digital CBT, with little data on why this is. When patients do start therapy, personal circumstances still negatively influence adherence in many. Though travel is eliminated by (Internet-based) digital CBT, time to participate in the intervention is still a limiting factor. Some additional concerns are coined regarding the accessibility to the technology—it is not known how screen readers (for partially sighted users) cope with digital CBT interventions. Also, some patients might find digital therapy too demanding, patronizing, or fast-paced and might prefer face-to-face therapy [24]. In addition to the patients, therapists may not all be enthusiastic about the use of digital telecare such as video communication as an alternative to face-to-face care, depending on their patient population, based on an evaluation during the COVID-19 pandemic [25].

14.3 Effectiveness of Digital CBT

Over the past two decades, many RCTs and systematic reviews on the effectiveness of various forms of digital CBT have been performed. In this section, the results with regard to the effectiveness of digital CBT for mood disorders, anxiety disorders, and SUDs will briefly be reviewed.

14.3.1 Mood Disorders

There is compelling evidence that both guided (therapist or counselor supported) and unguided digital CBT interventions efficaciously reduce (subclinical) mood disorders. A recent individual patient data meta-analysis (IPDMA) [26] combined data from 39 RCTs and 9751 patients to assess the effectiveness of guided and

unguided digital CBT interventions. Patients were recruited from community, clinical, workplace, or mixed samples. Studies were conducted across 12 countries in Europe, North America, and China. Comparisons were made post-treatment and at approximately 6 and 12 months post-randomization. At post-treatment and at six months post-randomization, both guided and unguided digital CBT interventions significantly outperformed the control conditions (treatment as usual or waitlist) in terms of effectiveness, measured using the Patient Health Questionnaire-9 or equivalent instruments. Only at post-treatment, guided interventions significantly outperformed the unguided interventions. Baseline depression scores were found to be an important moderator of this relative effectiveness of guided vs. unguided interventions at post-treatment: the higher the baseline severity, the larger the benefit of therapeutic guidance. Hence, in this IPDMA, both guided and unguided digital CBT interventions led to better outcomes than control conditions and guided digital CBT was associated with larger effects than unguided digital CBT at post-intervention, especially for individuals with moderate to severe depression. The findings of this IPDMA are generally in line with other systematic reviews on guided and unguided digital CBT interventions for depression (e.g [3, 19, 27]).

Probably among the best-known and best-studied digital CBT interventions for depression is MoodGYM. MoodGYM is an innovative, interactive Web program designed to prevent depression. It consists of five modules, an interactive game, anxiety and depression assessments, downloadable relaxation audio, a workbook, and a feedback assessment. MoodGYM was designed and developed by staff at the National Institute for Mental Health Research at The Australian National University, in collaboration with researchers, mental health experts, Web and graphic designers, and software engineers [28]. MoodGYM is available in Chinese, Dutch, English, Finnish and Norwegian. There is some evidence that MoodGYM is helpful for its users [29, 30]. A meta-analysis with comparisons from 11 MoodGYM studies indicated its effectiveness for depression symptoms post-intervention, although the pooled effect size was in the small range ($g = 0.36$, 95% confidence interval: 0.17–0.56) [31]. One trial also found that the effects are still observable after 12 months [32].

14.3.2 Anxiety Disorders

There are a number of systematic reviews and meta-analyses on digital interventions for anxiety disorders. The effects of therapist-supported digital CBT for anxiety disorders in adults were assessed in a Cochrane review [33]. The included RCTs assessed social phobia (11 trials), panic disorder with/without agoraphobia (8 trials), generalized anxiety disorder (5 trials), post-traumatic stress disorder (2 trials), obsessive-compulsive disorder (2 trials), specific phobia (2 trials), and eight other trials, which assessed a range of anxiety disorders. The included RCTs were from Sweden (18 trials), Australia (14 trials), Switzerland (3 trials), the Netherlands (2 trials), and the USA (1 trial). The authors concluded that therapist-supported digital CBT appears as an efficacious intervention for anxiety in adults. More specifically,

findings suggest that these interventions are more efficacious than waiting lists or information, or online discussion group-only control options. Given the lack of data, it is unclear to what extent therapist-supported digital CBT is more effective than unguided CBT. The authors also indicated that the effects of therapist-supported digital CBT may be rather similar to those of face-to-face CBT in reducing anxiety. These findings were generally corroborated by other recent systematic reviews (e.g., [34, 35]).

The effectiveness of guided digital CBT interventions for affective disorders including anxiety disorders in routine care was assessed in a systematic review [36]. In this review, the acceptability, effectiveness, and any negative effects under routine care conditions were assessed. The 19 nonrandomized pre-post studies included in the analysis provide evidence for the acceptability and effectiveness of guided digital CBT interventions for the treatment of affective disorders including anxiety in routine care.

Over the last decade, a few reviews have addressed the cost-effectiveness of digital anxiety interventions, and these report preliminary positive results while they stipulate that more research is needed in this area [7, 9, 37].

With regard to the use of digital CBT interventions for anxiety disorders tailored to specific populations, there is accumulating evidence for its effectiveness among college students [38], limited evidence for its effectiveness among pregnant women [39], and among children and adolescents with long-term physical conditions [40]. A recent systematic review indicated that digital mental health interventions including those based on CBT are at least moderately effective in reducing depression and anxiety symptoms in low- and middle-income countries [41].

14.3.3 Substance Use Disorders

Most of the research on digital CBT interventions for SUDs has focused on interventions to reduce alcohol, tobacco, and cannabis use.

Based on an individual patient data meta-analysis (IPDMA), digital interventions have been shown to be effective in moderating adult problem drinking in diverse settings [8]. This IPDMA included patient-level data obtained from 19 RCTs and performed various moderator and effectiveness analyses on the pooled dataset. Many of the included RCTs had evaluated CBT-based digital interventions. Results indicated that digital alcohol interventions in both community and health-care populations can be efficacious in reducing weekly alcohol consumption and in achieving adherence to low-risk drinking limits. It was also found that interventions

focusing on normative feedback only were less effective than interventions using integrated therapeutic approaches, including CBT. Human-guided interventions led to better drinking outcomes than unguided interventions, although this finding may in part be impacted by the selected control conditions. A review of reviews published a year before the IPDMA reported findings that largely corroborate the results of the IPDMA, although it was highlighted that in some relevant areas, such as longer-term follow-up outcomes, or effectiveness in populations such as employees and cultural minority groups, evidence is lagging behind [42].

Digital interventions have also been found to be at least moderately effective for tobacco use cessation. A 2017 Cochrane review identified 67 RCTs with data from over 110,000 participants; they were able to pool data from 35,969 participants [43]. The evidence from RCTs among adults suggests that interactive and tailored digital interventions with or without additional behavioral support are moderately more effective than non-active controls at six months or longer, while no evidence was found that these interventions outperformed other active smoking treatments. A Cochrane review on mobile phone text messaging and app-based interventions for smoking cessation [44] concluded that there is moderate-certainty evidence that automated text message-based smoking cessation interventions lead to greater quit rates than minimal smoking cessation support, while the amount of evidence comparing smartphone apps with less intensive support was very limited. Whether specifically CBT-based interventions for smoking cessation are more or less effective than others is not clear from the reviewed literature.

With regard to cannabis, a systematic review on the short- and long-term effects of digital prevention and treatment interventions for cannabis use reduction [45] evaluated data from 10 prevention interventions targeting 8138 participants (aged 12–20) and 20 treatment interventions targeting 5195 Cannabis users (aged 16–40). They concluded that these interventions show small, significant reductions in cannabis use among various populations, compared to their controls at post-treatment short-term follow-ups. For prevention interventions only, the post-treatment effects were maintained at follow-up up to 12 months later.

With regard to opioids and stimulants, a 2017 systematic review synthesized the evidence and found some support for effectiveness to address opioid use but not to address stimulants use, while the amount and quality of evidence were rather limited [46].

Figure 14.1 provides a schematic representation of a CBT (and motivational interviewing) based digital substance use intervention.

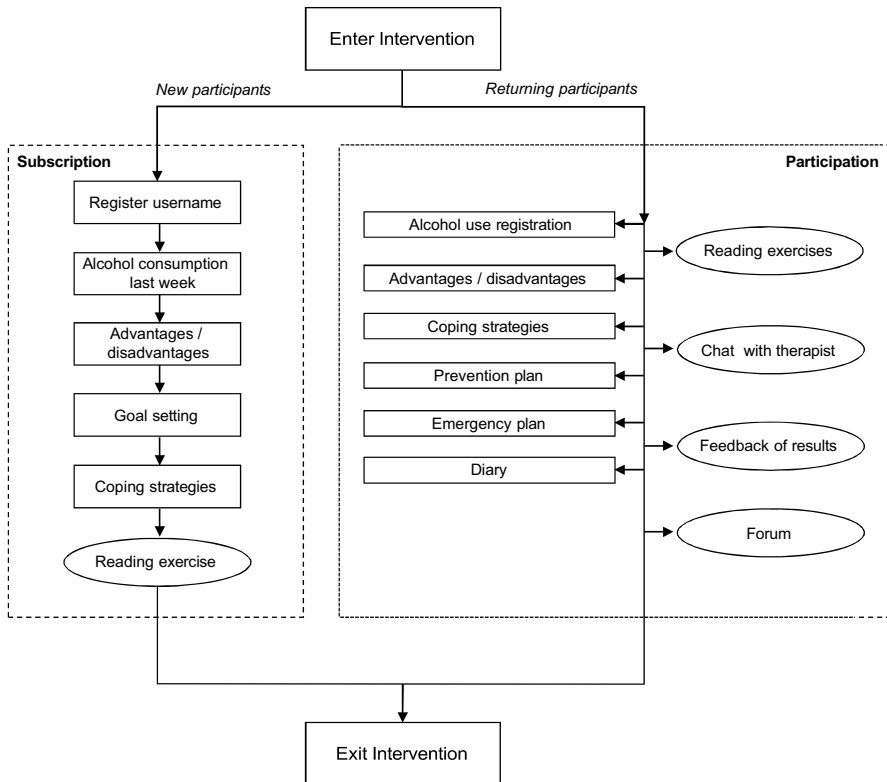


Fig. 14.1 Schematic representation of a CBT-based digital alcohol intervention. Note. Figure 14.1 presents the different modules and exercises of a CBT-based digital alcohol intervention (see [47, 48]). During the subscription procedure, the participant is first asked to report his or her alcohol use in the last week. Next, the advantages of quitting/moderation and the disadvantages of drinking are reviewed. Then a personal goal is set: to moderate alcohol use, or to abstain from drinking. After the personal drinking goals are set, attention is focused on how this goal can be achieved. To conclude the subscription procedure, a reading exercise is provided on how to cope with alcohol cravings. Only after the subscription is completed, participants can enter the participant area. Here, the six main treatment modules, four reading exercises, and a result feedback page are available. In the therapist-led version of the intervention, a chat module is available for the participant and the therapist to have one-on-one chat therapy contact. A forum provides opportunities for peer support or for reading previous posts of fellow intervention participants

14.4 Practical Applications of Digital CBT

Based on the current evidence base and practical experiences, several influential global professional organizations and treatment guidelines have recognized the effectiveness and potential of digital CBT interventions in mental health care (see e.g.: [49–52]). Digital CBT interventions are often recommended as an add-on to standard care, rather than as a replacement. Treatment guidelines emphasize the

importance of using digital CBT interventions, which have been found to be effective, or at least based on evidence-based underpinnings. The importance of developing interventions that are user-friendly, accessible across different devices, and suitable for diverse populations is also emphasized. Digital CBT interventions should also aim to provide tailored or personalized treatment experiences as personalization can help to optimize engagement and outcomes. On the security side, digital interventions should adhere to relevant data protection laws such as the general data protection regulation (GDPR) in the EU. Some guidelines suggest integrating therapist support, for example, via messaging, virtual sessions, or check-ins to provide guidance and monitor progress. Last but not least, the need for ongoing evaluation and improvement of digital CBT interventions is underlined, e.g., by collecting user feedback, performing research, and refining the interventions based on this evidence and user experiences.

14.5 Theoretical Underpinning of Cognitive Bias Modification

Positive effects have been reported regarding digital CBT interventions, although further accommodation to what is possible when using computer technology would be desirable. A promising development in this regard could be to supplement digital CBT with CBM. In the following sections, the theoretical underpinning and the effectiveness and possibilities of interventions based on CBM (specifically attentional bias modification, interpretive bias modification, and action tendency bias modification) will therefore be discussed. Cognitive theories argue that biases in information processing (attentional bias, interpretive bias, and action tendency bias) play a crucial role in psychopathology [53, 54]. CBM started from the perspective of investigating the causal status of these cognitive processes in relation to a disorder.

14.5.1 Attentional Bias Modification

In their seminal first study, MacLeod and colleagues [55] selected students with a medium anxiety level, and randomly assigned them to one of two conditions: one in which their attention was trained toward threatening stimuli, and one in which their attention was trained away from threatening stimuli. They did this by modifying an assessment instrument (visual probe test). In the original test, the probe to which the participant reacts (e.g., an arrow pointing up or down) appears equally often in the location of a threat stimulus and a neutral stimulus. The attentional bias (AB) is then calculated by subtracting the reaction time on threat trials from the reaction time to non-threat trials. In a modification or training version of the task, a contingency is introduced, with the probe appearing more often on the location occupied by the threat stimulus (to induce a bias), or more often on the location occupied by the neutral stimulus (to reduce a bias) (see Fig. 14.2 for an example in the field of alcohol use). Results across two studies indicated that the attentional bias modification

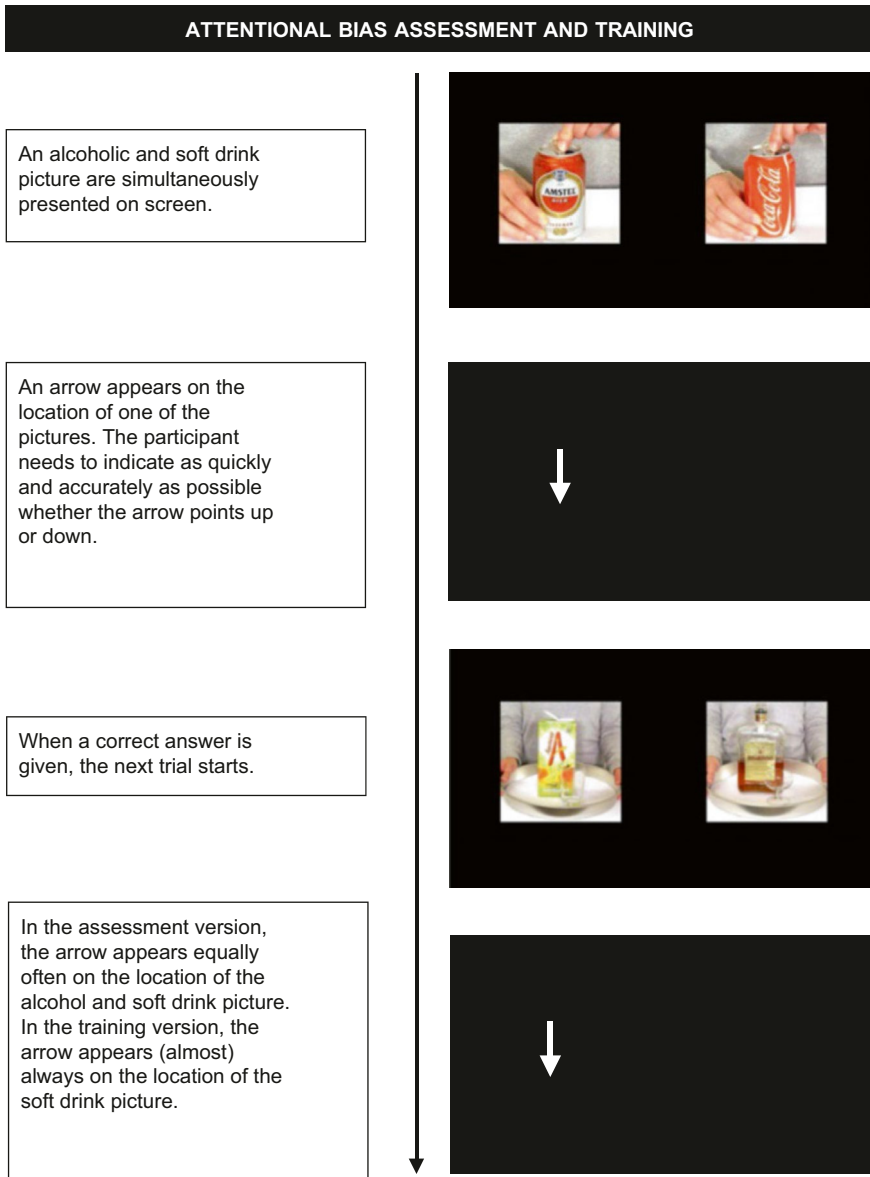


Fig. 14.2 Attentional bias assessment and training

had been successful, as assessed with different stimuli in the same task (close generalization), and further generalization was found in a subsequent stress-inducing task, with participants in the attend threat condition showing greater distress than participants in the attend neutral condition [55]. Subsequent research in this domain investigated clinical applications, typically with multiple training sessions. Initial

studies in clinically anxious patient groups [56, 57], and in unselected and targeted prevention (respectively [58]; [59]) had promising findings. However, it should be noted that after initial successes, later large Internet studies on retraining attentional bias in patients with anxiety disorders showed more heterogeneity in effects on symptoms.

While studies examining attentional retraining in the field of anxiety have proliferated, testing the effects of this training on depression has lagged behind. Initial studies suggested that multiple sessions of attentional retraining in dysphoric students resulted in improvements in symptoms in students with mild depressive symptoms (and replicated, see [60]), but increased depressive symptoms in students with moderate to severe symptoms (Experiment 1; [61]). In a sample of depressed in- and outpatients (Experiment 2; [61]), the attentional retraining was unsuccessful in changing attentional bias and depressive symptoms. Generally, meta-analyses evaluating the clinical effectiveness of attentional retraining in anxiety and depression [62, 63] indicated that effects in anxiety have been stronger than in depression.

Subsequent research applied the same logic of attentional retraining in SUDs, with initial studies testing the effect of a single-session attentional bias manipulation (see Fig. 14.2). The effects of single-session training across studies and substances (alcohol, smoking) can be summarized as follows: like a threat-related attentional bias, a substance-related attentional bias can be manipulated in both directions [64], but the effects do not generalize to untrained stimuli, nor to behavior [65–67]. When added to the treatment of SUDs, results have been heterogeneous, with the largest study finding a positive effect (12% reduction in relapse one year later [68]), but a recent study in which a gamified version of attentional retraining was used, finding no add-on effects [69]. However, this study was much smaller and included patients treated for alcohol and cannabis use disorder, who either had an abstinence or moderation goal. Given the strong consistent evidence for an add-on effect to the abstinence-oriented treatment of alcohol use disorders for another variety of CBM, discussed below (approach bias modification), and the similar effects reported in this context for attentional retraining [68], this intervention still holds promise.

14.5.2 Cognitive Bias Modification of Interpretive Bias (CBM-I)

In a similar vein, another cognitive bias was addressed in manipulation studies: an interpretation bias. Mathews and Mackintosh [70] developed a scenario-based training to modify interpretations. Participants read ambiguous social scenarios, for which half of the participants were required to generate emotionally positive outcomes, and the remaining half negative outcomes. The scenarios were three lines of text in length and remained ambiguous in terms of their emotional meaning until the final word of the text. This last word was a word fragment, the completion of which produced either a positive or negative disambiguation/interpretation of the scenario. Because there was only one possible meaningful solution for each fragment, participants were forced to disambiguate the fragment in either a benign or a threatening

way. Their studies with mid-range anxious students revealed that the training is capable of changing interpretations and subsequently affecting self-reported anxiety. The initial effects in anxiety have been replicated with the same type of scenario-based training [71], with other types of interpretive bias modification training [72], and extended to anxious non-clinical populations [73–75] and clinical populations [76–78]. Importantly, it has been shown that effects on anxiety were mediated by changes in interpretations [76, 79] and that effects are not restricted to self-report measures as effects have been observed on clinician-rated symptoms [80] and in heart rate response to a stressor [81]. In a review of multiple meta-analyses, Jones and Sharpe [82] showed that CBM-I training has a significant effect on changes in interpretation biases, and thus conclude that CBM-I training can reliably modify interpretation biases. With respect to transfer effects on anxiety symptoms, Jones and Sharpe [82] concluded that CBM training (combining the findings for CBM-I training with the findings for attentional bias modification (ABM), trainings designed to change attentional biases) consistently reduced anxiety symptoms. These effects on anxiety are consistent with the conclusions drawn in a recent network meta-analysis [63] where CBM-I training outperformed both waitlist and sham-training control conditions in reducing anxiety symptoms.

In the context of depression, interpretation retraining has been used in a more imagery-based format. Given the importance of mental images in emotions and affect, CBM-I training paradigms have been developed that use images and pictures instead of sentences as stimuli, with positive scenarios being presented auditorily (e.g., [83]). Several studies have shown positive effects on mood in healthy adults [84] and depressive symptoms in clinical populations [83, 85, 86]. Two sessions of interpretation retraining in individuals diagnosed with major depressive disorder resulted in participants reporting more positive interpretations, and more positive memory intrusions, and showing a smaller increase in heart rate in response to a stressor [87]. Though results have been inconsistent across studies, as also null findings have also been reported [88].

While there is some evidence that SUDs are associated with substance-related interpretive bias [89, 90], and attempts to apply this technique in SUDs have not had consistent effects on substance use [91, 92].

14.5.3 Action Tendency Bias Modification

In the field of SUDs, a third cognitive bias was addressed, an action tendency to approach disorder-related stimuli. This bias has been observed with different instruments, for different substances, including alcohol [93, 94], cannabis use [95, 96], cigarette smoking [97], and even for non-substance addiction gambling [98]. Applying the same logic as developed in attentional retraining, Wiers and colleagues developed a training version of the alcohol approach avoidance task [99]. This task started with an equal contingency. Half of the alcohol pictures and half of the non-alcohol pictures were to be responded to by pulling a joystick toward themselves, the other half were to be pushed away. Participants react to a feature of the

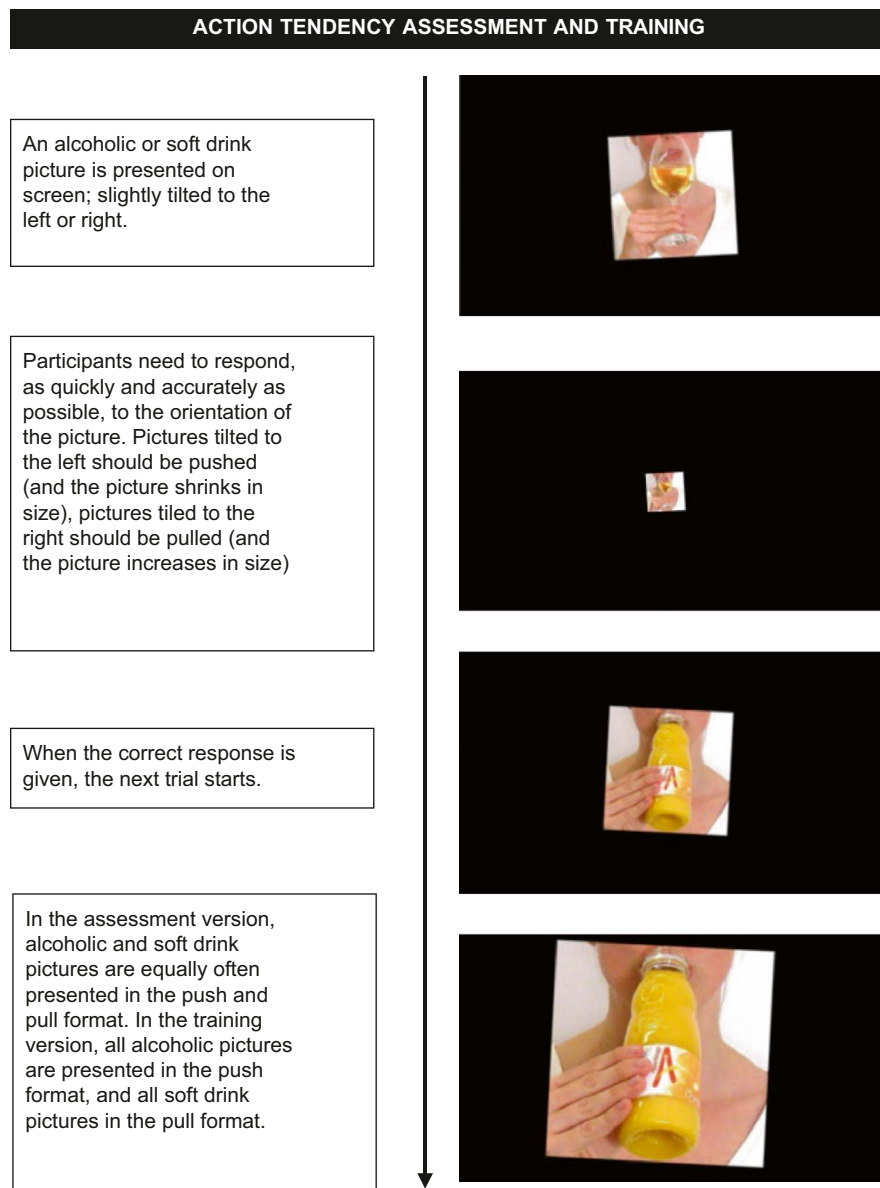


Fig. 14.3 Alcohol approach avoidance task

stimulus unrelated to the contents, for example, the format or a little tilt left or right (see Fig. 14.3). Without notification, the contingencies changed, so that half of the (socially drinking) students were pulling most of the alcohol pictures (approach alcohol condition), and the other half were pushing most of the alcohol pictures (avoid alcohol condition). This brief intervention resulted in generalized effects,

both to untrained pictures in the same task and to a different test of associations using words rather than pictures (the alcohol approach/avoidance implicit association test—IAT, see [100]). Moreover, those heavier-drinking students whose approach bias was successfully retrained toward avoidance drank less beer in a subsequent taste test than those heavier-drinking students trained toward approaching beer [99].

In the first clinical application of this approach-bias retraining paradigm [101], 214 alcohol-dependent patients were randomly assigned to one of two experimental conditions, in which they were trained to avoid alcohol (with or without explicit instruction, which did not differ for the results), or to one of two control conditions, in which they received no training or sham training (which also did not differ for the results). Four sessions of training preceded regular inpatient treatment, primarily CBT. In the experimental conditions only, patients' approach bias changed into an avoidance bias for alcohol. This effect generalized to untrained pictures in the task used and to an IAT, in which alcohol and soft drink words were categorized with approach and avoidance words. Patients in the experimental conditions showed better treatment outcomes a year later (13% less relapse), which was significant after controlling for gender. The clinical effect was not significantly related to either the change of bias as assessed with the AAT or with the IAT, although further analyses did confirm mediation by a subset of responses in the approach/avoid IAT [102]. In a first replication study [13], 509 alcohol-dependent patients received either 12 sessions of approach-bias retraining or no training (sham training was left out because no difference was found between sham training and no training in [101]). Clinical effects 1 year after treatment discharge were again found (now 9% less relapse), and in this study mediation and moderation were both found: the effect on clinical outcome was mediated by a change in the approach bias for alcohol, and the strongest training effect was found for participants with the strongest approach bias for alcohol, who received the training. Later studies in which approach bias modification was added to the treatment of alcohol use disorders confirmed effectiveness [68, 103]. Interestingly, the latter study found a stronger add-on effect for alcohol-dependent patients with a comorbid internalizing disorder (anxiety or depression), than for patients without. Manning and colleagues tested the effectiveness of approach bias modification during detox and found positive effects [104–106].

While these effects of CBM as adjunct to clinical CBT treatment are promising (a small but consistent add-on effect), online-only studies found no differential effects of CBM (attentional retraining or approach-bias retraining) as compared with placebo training; participants in all conditions reduced their drinking [107, 108]. This suggests that a combination with CBT is necessary to obtain differential effects [14, 107]. For that reason, the combination of digital CBT and CBM appears promising. Recently, researchers have started investigating the potential of action tendency training in the field of anxiety with some initial promising results with respect to contamination fear [109] and social phobia [110, 111].

Based on proof-of-principle studies into the working mechanisms of approach bias modification, recently a new variety has been proposed, ABC-training [112], in which action tendencies are trained in reaction to personalized antecedents (A), for

which a personally relevant behavioral alternative (B) is trained, in relation to the consequences (C) of the participant's own long-term goals. While no clinical studies have been performed yet, the first studies in volunteers indicate better effects than for regular CBM.

14.6 Effectiveness of Cognitive Bias Modification

14.6.1 Depression and Anxiety Disorders

In the context of CBM's effects on anxiety and depression; a review of multiple meta-analyses [82] and a network meta-analysis [63] were recently published. In the review of meta-analyses, it was concluded that CBM training (combining the findings for attentional and interpretation bias training) consistently reduced anxiety symptoms. With respect to potential differences between attention and interpretation training, they concluded that "CBM-I training may have more power as a paradigm in symptom reduction compared with action tendency bias modification." ([82]: p. 179). These effects on anxiety are consistent with the conclusions drawn in a recent network meta-analysis [63] where CBM-I training outperformed both waitlist and sham-training control conditions in reducing anxiety symptoms. While there is variability in the effects of CBM-I training on anxiety in individual studies, across all studies, there seems to be a promising effect on anxiety.

The CBM-I effects on depressive symptoms seem less compelling as Fodor et al. [63] concluded that CBM-I only outperformed waitlist control conditions (and not sham-training) in reducing depressive symptoms. Similarly, [82] indicated that CBM effects (again action tendency bias modification and CBM-I combined) on depressive symptoms are less robust and smaller than the effects on anxiety.

When taking together the recent meta-analyses, the findings for CBM-I as an anxiolytic intervention have been quite positive and underscore the conclusion formulated by Fodor et al. [63]: "CBM-I emerged as a promising treatment." (p. 507). For depression, there is insufficient evidence to draw conclusions.

14.6.2 Substance Use Disorders

A first meta-analysis on the effects of CBM in SUDs [113] concluded that CBM had an effect on the bias, but not on substance use and was therefore not clinically useful. However, this meta-analysis was criticized [114], because it combined many proof-of-principle studies in volunteers (typically students) who were not motivated to reduce or quit their drinking, but participated for course credit or free beer, with a few studies in which CBM was added to the treatment of SUDs, which all found positive effects. It is invalid to combine these, as they constitute different phases of the experimental medicine approach to treatment development [114, 115]. For example, in proof-of-principle studies, a cognitive bias is typically manipulated in two directions, either temporarily increased or decreased, in order to study effects

on disorder-related behavior (e.g., stress in anxiety, [55]; alcohol-tasting in addictive behaviors [99]). In clinical RCTs, patients either receive the intervention that reduces the cognitive bias or no training or sham training (e.g., [68, 101]). A second meta-analysis [116] included only studies with a clinical purpose: participants were motivated to participate to moderate or quit their substance use (alcohol or cigarette smoking). As there were not many clinical studies yet, a Bayesian individual patient data approach was taken. It found evidence for CBM decreasing the targeted cognitive bias and for an effect on abstinence, but not for reduced use. The latter is likely related to the fact that the positive studies all added CBM to abstinence-oriented inpatient treatment, while the negative outcomes were mostly internet studies in which participants typically wanted to reduce their use. As noted above, this pattern of results has continued since, with positive outcomes in the context of add-ons to the abstinence-oriented treatment of alcohol use disorders [68, 104–106], and non-differential effects in online-only studies [107, 117]. Effects have been more mixed for smoking, with some positive effects in an online attentional retraining where abstinence was required [118], but also negative findings, even when CBM was added to CBT for smoking cessation [119].

In summary, the picture so far is that CBM is a useful add-on to CBT in the clinical treatment of alcohol use disorders, with improved clinical outcomes of about 10% less relapse one year after treatment discharge (a small effect but similar to the effect size of current medications). However, there is no evidence so far that it can work as a stand-alone intervention, and should rather be seen as a useful add-on to regular CBT and should be tested as an add-on to digital CBT.

14.7 Practical Applications of CBM

One advantage of CBM is that it can be offered online in a flexible way, with 24/7 access. In this way, it could be offered as a stand-alone intervention, and also as an adjunct to (digital) CBT. CBM might be used as a pre-treatment training completed for example during the time an individual is on a waitlist for treatment, or training could be offered in parallel to CBT treatment as an adjunct or be offered after treatment to prevent the return of fear, depression, or relapse. This may be particularly helpful for patients for whom CBT alone is not sufficient, because they have trouble acting on their higher-order goals (to remain abstinent), in the face of temptations. Indeed, there is a literature in non-SUD adolescents that in those individuals with relatively poor executive control, automatically activated cognitive processes are a more important predictor of substance use and problems than in adolescents with well-developed executive control functions [120–123]. This would suggest that CBM is especially useful for participants with relatively weak executive control functions (for an indication in anxiety, see [124]). However, this was not confirmed in the recent large trial [13], while better results were found for older participants (which could have suppressed the effects of executive control, the measure used was also not optimal). Second, adding CBM would seem especially useful for those with a strong bias (moderation). This has been confirmed in a large study [13], but it

should be noted that the reliability of the attentional bias and action tendency bias measures is relatively poor (and better for interpretation bias measures), permitting no prediction yet at the individual level. However, new assessment methods are being developed with much better reliability (e.g., [125]).

Regarding disadvantages, one important caveat to the usefulness of CBM as an add-on to (digital) CBT is that many patients regard the training as boring and use less, especially attentional retraining using a variety of the visual probe test [126]. One way out is to increase motivation to train by providing information on the effects of automatically triggered processes in a motivational interviewing style, thus increasing motivation to train (see [127]). Another way is to develop more engaging playful varieties of training (e.g., [58, 128]) and/or to introduce game elements (anxiety: [129]; review SUDS: [130]) and/or combine with virtual reality [131]. However, while this may increase motivation to train, we believe it is also essential to link the training to further treatment goals, as activated in CBT. In fact, this is done in the new ABC training [112].

14.8 Discussion and Conclusions

In this chapter, the theoretical background and effectiveness of clinical applications of digital CBT and CBM have been discussed. Based on the reviewed literature, there is a reasonably strong evidence base for the effectiveness of digital CBT interventions for depression, anxiety, and substance use disorders. The evidence base for standalone CBM interventions is strong for interpretive bias modification for anxiety symptoms and more inconsistent for attentional bias modification and effects on depression. The evidence base for CBM as an adjunct to CBT interventions is accumulating with (in general) positive findings regarding the effectiveness in alcohol use disorders, although it should be noted that these positive findings are only found when CBM is added to face-to-face abstinence-oriented treatment for alcohol use disorders. A good test of the add-on effects of CBM to (guided) digital CBT is yet to be done. Recently, studies have evaluated the delivery of CBT and CBM interventions using mobile devices such as smartphones and tablets, which are now the most common platforms for newly developed digital health interventions. Among the therapeutic orientations present in the evaluated mobile interventions was CBT. Also, CBM could be administered using mobile devices. Interpretation bias training offered on a smartphone was shown to be successful in changing the bias and changing anxiety [132] and smoking cessation [133] the bias was successfully changed, but no effects on behavior could be reported. This was not surprising in the study on smoking, as these were smokers who did not intend to quit. Another promising future development is the optimization of the integration of CBM with digital CBT. To what extent can CBM and digital CBT create the synergy needed to interfere with dominant action tendencies in an emotional situation (e.g., negative mood, desire, cf., ABC training [112, 134])? All in all, attempts at answering this question will lead to advancement in the delivery of mental health interventions and progress in the accommodation of depression, anxiety, and SUDs to the possibilities of

digital technology. Based on the currently available evidence, CBM is an interesting tool to study further as an add-on to digital CBT in the treatment of common mental health disorders.

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