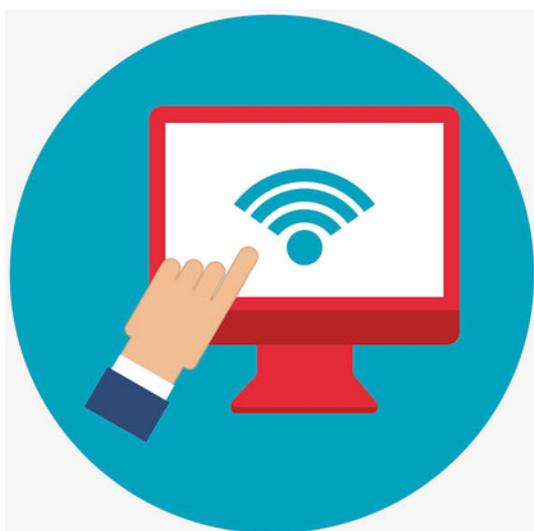


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# Cognitive Behavioural Therapy and Cognitive Bias Modification in Internet-Based Interventions for Mood, Anxiety and Substance Use Disorders

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193

## Contents

10.1	Introduction .....	194
10.2	Theoretical Background of Computerized CBT.....	196
	10.2.1 Background of CBT .....	196
	10.2.2 Background of Computerized CBT.....	197
10.3	Effectiveness of Computerized CBT .....	198
	10.3.1 Mood Disorders.....	198
	10.3.2 Anxiety Disorders.....	199
	10.3.3 Substance Use Disorders .....	200
10.4	Practical Applications of Computerized CBT.....	202
10.5	Theoretical Underpinning of Cognitive Bias Modification .....	202
	10.5.1 Attentional Bias .....	202
	10.5.2 Interpretive Bias .....	204
	10.5.3 Action Tendency Bias.....	205
10.6	Effectiveness of Cognitive Bias Modification .....	207
	10.6.1 Depression and Anxiety Disorders.....	207
	10.6.2 Substance Use Disorders .....	208
10.7	Practical Applications of CBM.....	208
10.8	Discussion and Conclusions .....	209
	References.....	209

### Abstract

In this chapter, the theoretical background of (computerized) cognitive behavioural therapy (CBT/c-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 computerized CBT and CBM for common mental health disorders (depression, anxiety disorders and substance use disorders) is evaluated based on recent meta-analyses. Based on the reviewed literature, there is a reasonably strong evidence base for the effectiveness of computerized CBT interventions for depression, anxiety and substance use disorders. The evidence base for stand-alone CBM interventions is not very strong as research findings are heterogeneous – some studies report positive findings whereas others do not. The evidence base for CBM as an adjunct to computerized CBT interventions is accumulating with positive findings regarding the effectiveness. Therefore, it is concluded that based on the currently available evidence, CBM could be a useful add-on to computerized CBT in the clinical treatment of common mental health disorders.

## 10.1 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 anxiety disorders. Nowadays, a large variety of services and interventions are available, ranging from information provision,

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, and costs are low. The possibility of using the services anonymously can be attractive for users as well, especially in case of stigmatized disorders (e.g. substance use disorders, SUDs). Internet services and interventions might therefore contribute to narrow the treatment gap: the relative 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 evidence on the effectiveness of Internet interventions for common mental disorders. The development and implementation of Internet interventions has 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 [3–7] – although effects are often of modest size. Still, given the high prevalence of common mental disorders, the potential economic gains are enormous [4].

Many of the tested and implemented e-mental health interventions for common mental disorders are based on cognitive behavioural therapy (CBT) [8]. 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 [9]. Since then, CBT has established itself as the therapeutic underpinning of many psychotherapy interventions and protocols, and more recently (computerized) 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 last decade. In analogy to Piaget's theory of cognitive development [10], 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 neurocognitive research. Neurocognitive 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 (computerized) CBT [11]. 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 computerized intervention, with promising first results (review: [12]). 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 and computerized CBT will first be summarized. Next, the effectiveness of computerized 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 (computerized) CBT will be evaluated and advantages and disadvantages of CBM and practical applications of CBM will be discussed. 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?

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## 10.2 Theoretical Background of Computerized CBT

### 10.2.1 Background of CBT

CBT is a structured, short-term psychotherapy, which aims at solving current problems and in which inaccurate or unhelpful thinking is modified. The therapist tries to find ways to produce cognitive change, for example, through modifying a client's thinking and belief system, behavioural experiments or exposure, in order to produce emotional and behavioural change. CBT was initially developed for depression, but is nowadays being used for a variety of psychopathologies, including anxiety disorders, substance use disorders and eating disorders. The main constituents of a CBT intervention for depression include a focus on problem solving, behavioural activation, identifying, evaluating and responding to depressed and negative thoughts, self-perception and client's future [8].

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 dialectical behaviour therapy, problem-solving therapy, exposure therapy, behavioural activation and cognitive behaviour modification [8]. Many outcome studies involving CBT have been performed and published, the first one already in 1977 [13]. Nowadays, more than 500 outcome studies report evidence on the efficacy of CBT for various psychiatric disorders, psychological problems or psychological

components to 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 [14]. In more recent years, computerized CBT interventions have been shown to be effective (e.g. [15]) [8].

There are ten basic principles of CBT: [8, p. 7–11]

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

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 sets, 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 [8].

## 10.2.2 Background of Computerized CBT

Over the past two decades, CBT has on an accumulating scale been offered using digital technology. There are several potential advantages of using computerized CBT (c-CBT) in treatment delivery. Two of the most important potential advantages are enhanced access to evidence-based psychotherapy and a reduction in therapy cost. 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 [16]. Another possible advantage of c-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 in the flow and progress of their therapy [16].

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 [16]. For example, in

a recent study on drug-free patients with major depressive disorder [17] it was found that the c-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 c-CBT group compared to the control group. As the digital psychoeducational intervention component in the c-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 [16].

However, there are also concerns regarding the acceptability and potential adverse consequences of c-CBT in comparison with therapist-led CBT. In a recent review [18], barriers to the uptake of c-CBT were systematically evaluated. The authors focused on the acceptability, accessibility and adverse consequences associated with c-CBT. Among the main results, the authors report that recruited patients have only a 38 % chance of actually starting c-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 c-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 c-CBT interventions. Also, some patients might find computerized therapy too demanding, patronizing or fast-paced and might prefer face-to-face therapy [18].

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## 10.3 Effectiveness of Computerized CBT

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

### 10.3.1 Mood Disorders

There is compelling evidence that both guided (therapist or counsellor supported) and unguided Internet-based self-help efficaciously reduces (subclinical) mood disorders [3, 19–22]. Most of the research has focused on interventions to address symptoms of depression. Guided CBT Internet interventions for depression show similar effect sizes as regular face-to-face therapy [22]. In general, guided Internet interventions lead to larger reductions in symptoms than unguided interventions [21], although exceptions do exist [23, 24].

Probably the best known Internet-based CBT intervention 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 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 [25]. MoodGYM is available in Chinese, Dutch, English, Finnish and Norwegian. There is some evidence that MoodGYM is helpful for its users [26, 27]. One trial also found that the effects are still observable after 12 months [28].

Another evidence-based Internet intervention for symptoms of depression is the Dutch intervention “Kleur je leven” (Colour your life). Colour your life comprises eight modules and is based on CBT. Both a guided and an unguided version of this intervention have been shown to be effective in reducing symptoms of depression compared to an untreated waiting list [29, 30]. There is also some evidence regarding favourable cost-effectiveness of the guided version of Colour your life in comparison to a brief intervention provided by the general practitioner – although differences in effects were not found to be significant [31].

### 10.3.2 Anxiety Disorders

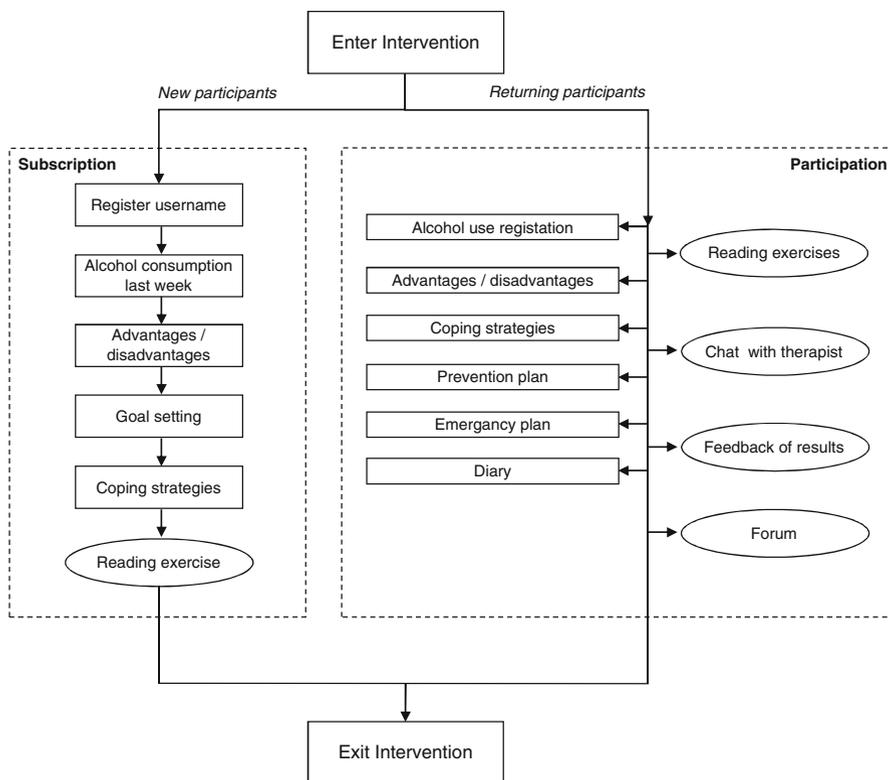
There are few systematic reviews and meta-analyses on Internet-based interventions for anxiety disorders. In their systematic review on Internet interventions for depression and anxiety, Griffiths and colleagues [32] found 16 trials in which anxiety disorders were addressed. Disorders included panic disorder, social phobia, and post-traumatic stress disorder (PTSD). Most interventions involved some level of therapist guidance, with two interventions that included face-to-face contacts. All interventions were based on CBT. Effect sizes were relatively heterogenic and ranged from 0.29 to 1.74 for participants with a diagnosed anxiety disorder. The authors concluded that guided and unguided Internet interventions for anxiety disorders are promising as self-help applications [32]. A meta-analysis by Cuijpers and colleagues [6] tested the hypothesis that Internet-based CBT for anxiety disorders is as effective as face-to-face CBT. Included studies tested Internet-based stand-alone computer, palm top or virtual reality psychotherapy interventions for adults. Addressed disorders were panic/agoraphobia, social phobia, spider phobia, flight phobia, mixed phobias, post-traumatic stress disorder and obsessive-compulsive disorder. It was found that there was no significant difference between computer-aided and face-to-face psychotherapies at post-intervention (13 studies) or at 1–3 month (three studies) or 6 month follow-ups (six studies). Drop-out rates did not significantly differ between computer-aided psychotherapy and face-to-face psychotherapy either (eight studies). The authors concluded that computer-aided psychotherapy was as effective as face-to-face psychotherapy, although a cautionary note was made regarding the results in the light of a number of methodological limitations [6]. In another review in which CBT was the dominant therapeutic tradition, Christensen and colleagues [33] concluded that recent studies have confirmed the utility of computerized interventions for anxiety. Future research should focus on identifying the active constituents of effective programmes, evaluate programmes targeted at specific populations and focus on clarifying what the optimal degree of

guidance in these interventions is [19]. Two recent reviews [7, 34] report some preliminary positive results regarding the cost-effectiveness of Internet-based CBT for anxiety disorders, although the amount of evidence is rather limited.

### 10.3.3 Substance Use Disorders

Most of the research on Internet-based CBT interventions for SUDs has focused on interventions to reduce alcohol use or tobacco smoking. Based on a recent meta-analysis of RCTs [4], both guided and unguided CBT Internet interventions for problem drinking can be considered effective. Most of the RCTs have tested the effectiveness of unguided alcohol Internet interventions. Many of the studies indicate a small positive effect of unguided Internet-based interventions in comparison to waitlisted participants or information-only control condition [4]. There is at least one study however that fails to find evidence for effectiveness [35]. With regard to Internet-based therapy interventions addressing alcohol use, fewer studies have been performed, although the available studies show positive effects. Effect sizes of guided Internet interventions tend to be larger than unguided Internet interventions for problem drinkers [36–38], although this is not always found [4]. There are some studies on the cost-effectiveness of Internet-based CBT interventions for problem drinking. One study tested the effect of c-CBT as adjunct to a CBT in a RCT, and reported support for the cost-effectiveness of a therapist-guided Internet-based CBT intervention in comparison with the same intervention offered as self-help, without guidance [39], against a conventional cost per quality-adjusted life year (€15,000 and up) (see Fig. 10.1 for a schematic impression of the therapeutic elements of the intervention). Another study [40] used a modelling approach to present the public health cost and effects of wide implementation of Internet-based alcohol interventions in the Netherlands. The interventions on which the effects in this study were based use CBT techniques. It was found that the cost-effectiveness of the health care system to address alcohol use disorders would improve after further implementation of Internet-based alcohol interventions [40].

For smoking cessation, a number of Internet interventions have been developed and tested in RCTs. CBT and associated intervention approaches (e.g. acceptance and commitment therapy [41]) are together with techniques stemming from motivational interviewing the dominant therapeutic approach [5]. Two meta-analyses [42, 43] and a Cochrane review [5] indicate positive results of guided and unguided Internet interventions for smoking cessation in comparison to waiting list controls or minimal information-based interventions, although a substantial minority of the studies fails to find an effect, and the effect sizes of those studies that do find an effect are small. Some authors [43] conclude that only Internet interventions aiming at tobacco smokers who are motivated to quit tend to show positive results. A recent cost-effectiveness review on computer and other electronic aids for smoking cessation [44] indicates that making electronic support available to smokers actively seeking to quit is highly likely to be cost-effective. This is true if the computer intervention is delivered alongside brief advice as well as in combination with more intensive counselling [44].



**Fig. 10.1** Schematic representation of a CBT-based Alcohol Internet Intervention. Note. Figure 10.1 presents the different modules and exercises of CBT-based Alcohol Internet Intervention (see [39]). During the subscription procedure, the participant is first asked to report his or her alcohol use in the last week. Next, the advantages and disadvantages of drinking and moderation 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 craving. Only after 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

For substances other than alcohol and tobacco the amount of research is limited. A German RCT on the unguided Internet-intervention “Quit the Shit”-intervention aimed at reducing cannabis use resulted in a significant decrease in use, three months after randomization [45]. In a recent RCT performed in Switzerland on unguided Internet-based CBT to address cocaine use found no difference between intervention and control group, 6 weeks after randomization [46]. However, both studies suffered from a relatively large number of participants who discontinued their participation in the study.

## 10.4 Practical Applications of Computerized CBT

All in all, after consideration of the advantages and disadvantages of (Internet-based) c-CBT, the British National Institute of Health and Clinical Excellence (NICE) has recommended a selection of e-mental health interventions for the delivery of c-CBT accessed via a referral from a general practitioner (GP). Three of the recommended interventions address depression (Beating the Blues, COPE and Overcoming Depression), one addresses panic/phobia (FearFighter) and one addresses obsessive-compulsive disorder (OCFighter) [47]. One of the considerations that have led to this decision is that the availability of c-CBT programmes permits increased treatment flexibility, especially for individuals who do not wish to interact with a therapist face-to-face. According to NICE, c-CBT can also be used to support therapist sessions. c-CBT may also be of benefit to individuals with, for example, agoraphobia or social phobias as it can be delivered at home. A minimal amount of therapist time is necessary for the c-CBT interventions that can be conducted at home, and the therapy has 24-h availability for the individual to access the interventions at his or her convenience [47].

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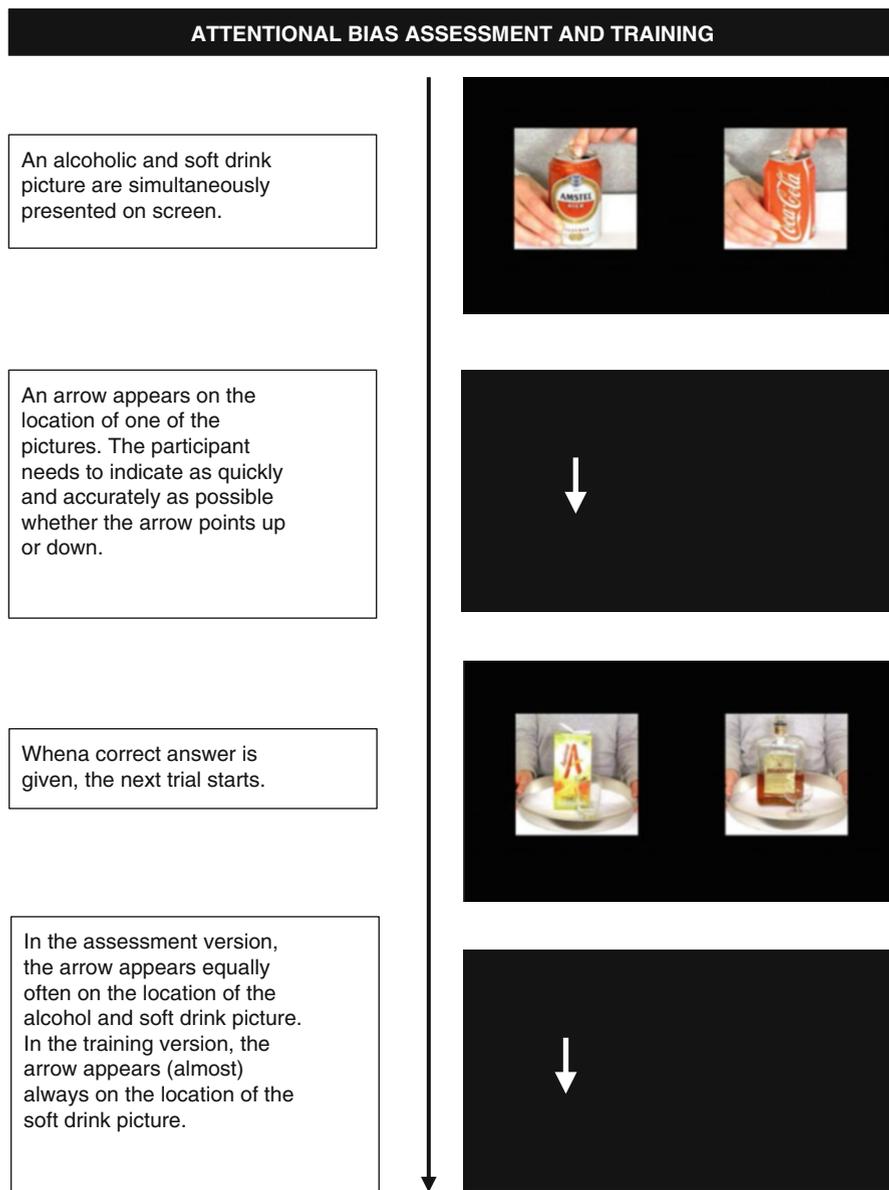
## 10.5 Theoretical Underpinning of Cognitive Bias Modification

Positive effects have been reported regarding Internet-based 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 c-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 [48, 49]. CBM started from the perspective of investigating the causal status of these cognitive processes in relation to a disorder.

### 10.5.1 Attentional Bias

In their seminal first study, MacLeod and colleagues [50] selected students with a medium anxiety level, and randomly assigned them to one of two conditions: one in which their attention was trained towards 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 by 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. 10.2 for an example in the field of alcohol use). Results across two studies indicated that the attentional



**Fig. 10.2** Attentional bias assessment and training

bias modification 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 [50]. Subsequent research in this domain investigated clinical applications, typically with multiple training sessions, with recent successful studies in clinically anxious patient groups [51, 52], and in unselected and targeted prevention (respectively [53]; [54]). However, it should be noted that after initial successes, many recent large Internet-studies on retraining attentional bias in patients with anxiety disorders or SUDs were less successful.

While studies examining attentional retraining in the field of anxiety have proliferated, testing the effects of this training in depression has lagged behind. One of the first studies revealed that multiple sessions of attentional retraining in dysphoric students resulted in small improvements in symptoms in students with mild depressive symptoms, but increased depressive symptoms in students with moderate to severe symptoms (Experiment 1; [55]). In a sample of depressed in- and outpatients (Experiment 2; [55]) the attentional retraining was unsuccessful in changing attentional bias and depressive symptoms. The findings in mildly depressed students were replicated [56]; there was a stronger decrease in depressive symptoms in individuals who had received the training, and these effects were mediated by change in attentional bias. Generally, effects in anxiety have been stronger than in depression. A recent meta-analysis evaluating the clinical effectiveness of attentional retraining in anxiety and depression [57] also indicated that observed effects on symptoms were mainly driven by studies on anxiety. 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. 10.2). 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 [58], but the effects do not generalize to untrained stimuli, nor to behaviour [59–61].

### 10.5.2 Interpretive Bias

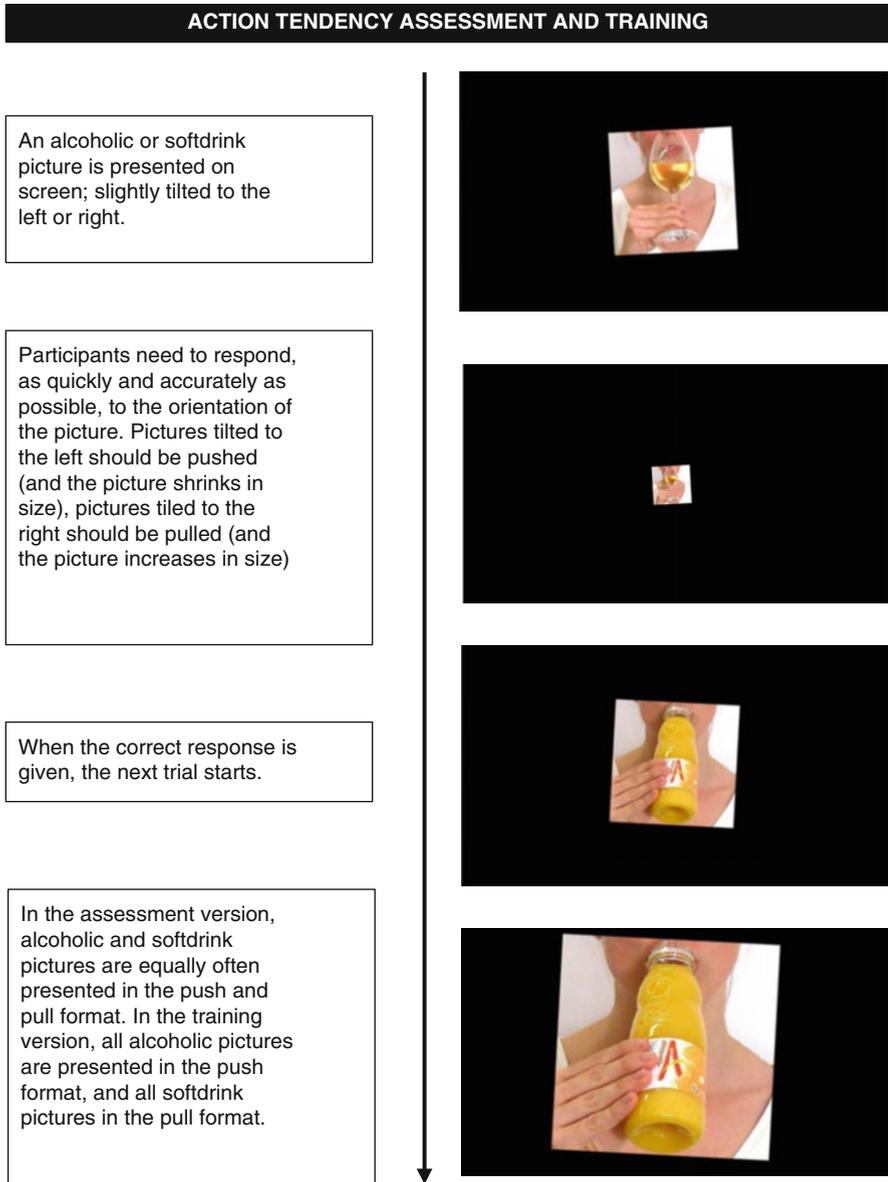
In a similar vein, another cognitive bias was addressed in manipulation studies: an interpretation bias. Mathews and Mackintosh [62] developed a scenario-based training to modify interpretations. Participants read ambiguous social scenarios, for which half of the participants were required to generate 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 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. These

effects have been replicated [63] and extended to anxious populations [64–66]. Importantly, it has been shown that effects on trait anxiety were mediated by change in interpretations [67]. Note that while these effects on interpretations are consistently found, effects on emotions have been more mixed (for a review see [68]). Meta-analyses have indicated that mental imagery might increase training effects [69]. In the context of depression, interpretation retraining has been used in a more imagery-based format, where positive scenarios were presented auditorily (e.g. [70]). Several studies have shown positive effects on mood in healthy adults [71] and depressive symptoms in clinical populations [70, 72], while there is some evidence that SUDs are associated with substance-related interpretive bias [73, 74], and initial attempts are made to apply this technique in SUDs [75].

### 10.5.3 Action Tendency Bias

In the field of SUDs, however, 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 [76, 77], cannabis use [78, 79] and cigarette smoking [80]. Applying the same logic as developed in attentional retraining, Wiers and colleagues developed a training version of the alcohol approach avoidance task [81]. 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 towards themselves, the other half were to be pushed away. Participants react to a feature of the stimulus unrelated to the contents, for example, the format or a little tilt left or right (see Fig. 10.3). 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 [82]). Moreover, those heavier drinking students whose approach-bias was successfully retrained towards avoidance drank less beer in a subsequent taste test than those heavier drinking students trained towards approaching beer [81].

In a first clinical application of this approach-bias retraining paradigm [83], 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



**Fig. 10.3** Alcohol approach avoidance task

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 [84]. In a recent replication study [11], 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 [83]). 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. While these effects of CBM as adjunct to clinical CBT treatment are promising, a recent online-only study found no differential effects of CBM (attentional retraining or approach-bias retraining) as compared with placebo training; participants in all conditions reduced their drinking [85]. This suggests that a combination with CBT is necessary to obtain differential effects [12, 85]. For that reason, the combination of online CBT and CBM appears promising and is currently being tested in an RCT [86]. 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 [87] and social phobia [88, 89].

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## 10.6 Effectiveness of Cognitive Bias Modification

### 10.6.1 Depression and Anxiety Disorders

In contrast to CBM in addiction where the added value of CBM on top of CBT has often been investigated, anxiety-related CBM has most often been applied as a stand-alone intervention. Two studies have examined the effectiveness of combining attentional retraining with CBT and results suggested that attentional retraining does not improve treatment outcome [90, 91] (but see [92] for augmentation effects in anxious children). However, in both studies, attentional retraining failed to modify attentional bias with attentional retraining. This is an important point. While it has been argued that attentional retraining is unsuccessful in the domain of anxiety [93], further analyses of results indicated that, in line with the theoretical rationale of CBM, those studies in which the bias was successfully changed almost invariably also demonstrated clinical effects, while the studies in which the bias was not successfully changed did not [94].

A recent meta-analysis revealed small effect sizes for CBM in anxiety and depression, with often non-significant effects when outliers were excluded [95]. Note, however, that CBM's effectiveness was moderated by several factors. CBM targeting interpretations was more successful than CBM targeting attentional bias (see also [96]). CBM significantly affected anxiety and depression in subclinical samples, but not in clinical samples [95]. However, that latter finding is inconsistent with another recent meta-analysis specifically directed at the clinical efficacy of attentional retraining [97], which provides support for attentional retraining as a novel evidence-based treatment for anxiety disorders. Both meta-analyses revealed that "location of training" significantly moderated its effectiveness; training was more effective in the lab [95] or in the clinic [97] compared to home-based training. As home-based training is often accomplished online, these data suggest that it might be a challenge to successfully use CBM online.

## 10.6.2 Substance Use Disorders

There are no meta-analyses on CBM in addiction yet. However, as summarized above and in a recent review [12], the findings so far can be summarized as follows: studies of a single session of CBM have generally not yielded good results; while the bias could be trained, effects did not generalize to untrained stimuli or to behaviour (with some exceptions: [81, 98, 99]). In clinical samples, CBM has been added to CBT for alcohol use disorders in three studies [81, 83, 100], all of which found improved clinical outcomes for patients to whom CBM was given on top of CBT, in comparison with patients who did not receive CBM or received a placebo/sham control version. However, when used as a Web-based stand-alone intervention, CBM did not reduce alcohol use and problems more than the placebo-training variety [85]. Note that a different type of training over the Internet, working memory training, did show some differential effects in reducing alcohol use and problems, in a subgroup of participants with strong automatically activated positive associations with alcohol (moderated mediation [101]), and the same intervention also showed promise in a clinical sample of stimulant use disorder patients [102]. However, this type of training is much longer (typically 25 sessions vs. CBM 4–12 sessions) and more tedious, which limits its applicability. Hence, the picture so far is that CBM is a useful add-on to CBT in the clinical treatment of SUD, with improved clinical outcomes. 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.

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## 10.7 Practical Applications of CBM

One advantage of CBM is that it 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 [103–106]. This would suggest that CBM is especially useful for participants with relatively weak executive control functions (for an indication in anxiety, see [107]). However, this was not confirmed in the recent large trial [11], 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 [11], but it should be noted that the reliability of the measures is relatively poor, permitting no prediction yet at the individual level. Perhaps new variance-based scoring algorithms (cf., [108]) might increase the usefulness of matching patients to targeted CBM on their pretest bias scores.

Regarding disadvantages, one important caveat to the usefulness of CBM as an add-on to (online) CBT is that many patients regard the training as boring and useless, especially attentional retraining using varieties of the visual probe test [109].

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 [110]). Another way is to develop more engaging playful varieties of training (e.g. [53, 111]) and/or to introduce game elements (review: [112]). 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.

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## 10.8 Discussion and Conclusions

In this chapter, the theoretical background and effectiveness of clinical applications of c-CBT and CBM have been discussed. Based on the reviewed literature, there is a reasonably strong evidence base for the effectiveness of c-CBT interventions for depression, anxiety and substance use disorders. Evidence regarding the cost-effectiveness is accumulating. The evidence base for stand-alone CBM interventions is not very strong as research findings are heterogeneous. The evidence base for CBM as an adjunct to c-CBT interventions is accumulating with (in general) positive findings regarding the effectiveness, in alcohol use disorders. Recently, studies have evaluated the delivery of CBT and CBM interventions using mobile devices such as smart phones and tablets. Two recent reviews on mobile apps for the delivery of health interventions including depression, anxiety disorders and SUDs concluded that the evidence regarding those interventions is not yet strong [113, 114]. Among the therapeutic orientations present in the evaluated mobile interventions was CBT. Also CBM could be administered using mobile devices based on at least two recently published studies on reducing social anxiety [115] and smoking cessation [116]. In both studies the bias was successfully changed, but no effects on behaviour 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 c-CBT. To what extent can CBM and c-CBT create the synergy needed to interfere with dominant action tendencies in an emotional situation (e.g. negative mood, desire)? 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 computer technology. Based on the currently available evidence, CBM is an interesting tool to study further as an add-on to c-CBT in the treatment of common mental health disorders.

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