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3 **ABC-TRAINING: A NEW THEORY-BASED FORM OF COGNITIVE**  
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6 **BIAS MODIFICATION TO FOSTER AUTOMATIZATION OF**  
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8 **ALTERNATIVE CHOICES IN THE TREATMENT OF ADDICTION**  
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11 **AND RELATED DISORDERS**  
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16 Short title: ABC-training  
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57 Suggested readings: 5 (3-5).  
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**Abstract**

Recent years have seen a surge in the popularity of interventions that target common distortions in thinking (Cognitive bias modification: CBM). Although there is evidence of their effectiveness as add-ons to regular treatment in (alcohol) addiction, the effects are typically small and recent findings from lab-studies called into question the dominant theoretical underpinnings of CBM. We provide a novel theoretical approach in terms of automatic inferences, that integrates previous findings and suggests ways to improve CBM into ABC-training. In ABC-training, patients are trained in the context of personally relevant antecedents (A) to make behavioral choices (B) that accord with patients' (health) goals, in light of their consequences (C). We discuss preliminary evidence suggesting that ABC-training might be a useful tool in the treatment of addictions and related disorders.

**Keywords:** cognitive bias modification, approach tendencies, attentional bias, inferences, alcohol use disorders, addiction.

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3 Addictions are among the most frequent mental disorders, with tremendous costs for the  
4 individual and society (Effertz & Mann, 2013). Yet, current treatment approaches are limited. For  
5 example, the majority of patients treated for alcohol use disorders relapse within a year (Cutler &  
6 Fishbain, 2005). Not surprisingly, researchers are trying to develop more effective interventions,  
7 based on advancements in psychological science. One promising class of new interventions concerns  
8 varieties of cognitive bias modification (CBM). These procedures were initially based on the notion  
9 that addiction is often maintained through automatic processes (Stacy & Wiers, 2010; Tiffany, 1990).  
10 CBM was developed to change automatic cognitive biases, which could supplement treatment  
11 targeting more controlled cognitive-motivational processes.  
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22 Despite its promise, the empirical evidence supporting CBM's effectiveness has been mixed.  
23 As a consequence, both the underlying mechanisms of CBM as well as its clinical value have been  
24 questioned. We review recent findings and propose a new theoretical framework that addresses  
25 previous concerns and suggests ways to improve CBM. Specifically, we propose a novel approach to  
26 CBM, that involves training personally-relevant behavioral choices (B), triggered by personally-  
27 relevant antecedent cues (A), which have health-relevant consequences (C).  
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### 34 **Theoretical Background of CBM and Clinical Effects**

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CBM was initially developed as a research tool to test the role of cognitive biases (i.e.,  
systematic distortions in mental processes) in predicting abnormal behavior (originally in the context  
of anxiety). Addiction research had demonstrated biases in selective attention, memory-retrieval, and  
action tendencies (Stacy & Wiers, 2010; Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof,  
2013). Different methods have been developed to manipulate these biases to experimentally test their  
impact on addiction-relevant behaviors (review: Wiers et al., 2013). For example, in initial studies,  
healthy volunteers (drinking students) were trained to selectively focus attention away from vs.  
towards alcohol-related cues. Training away from alcohol cues reduced consumption in an ensuing  
taste-test (Field & Eastwood, 2005). Subsequent studies of CBM effects in clinical samples (the next  
phase of intervention development, Sheeran, Klein, & Rothman, 2017; Wiers, Boffo, & Field, 2018),  
demonstrated that adding CBM to the treatment of alcohol use disorders reduced relapse (Eberl et al.,

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3 2013; Rinck, Wiers, Becker, & Lindenmeyer, 2018; Schoenmakers et al., 2010; Wiers, Eberl, Rinck,  
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5 Becker, & Lindenmeyer, 2011).

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7 Despite these encouraging findings, a first meta-analysis (summarizing results over multiple  
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9 empirical studies), suggested that CBM influenced cognitive biases (e.g., the relative speed of  
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11 approaching versus avoiding images of alcohol), but that these changes did not translate into  
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13 clinically-relevant outcomes (Cristea, Kok, & Cuijpers, 2016). However, this meta-analysis combined  
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15 qualitatively different types of studies: proof-of-principle studies (with student-volunteers not  
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17 motivated to change) and randomized controlled trials (RCTs) in clinical samples. These represent  
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19 two different phases of intervention development (Sheeran et al., 2017; Wiers et al., 2018). While  
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21 proof-of-principle studies test potential mechanisms, clinical RCTs provide additional insights into  
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23 factors to be considered for effective treatments. Indeed, when considered separately, RCTs in clinical  
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25 samples showed that adding CBM to treatment resulted in long-term improvements of treatment  
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27 outcomes (Wiers et al., 2018). A recent Bayesian meta-analysis including only clinical RCTs (Boffo  
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29 et al., 2019) confirmed these findings. Thus, CBM appears to be more effective in clinical samples  
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31 than in proof-of-principle studies with non-clinical volunteers. Preliminary evidence further indicated  
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33 that CBM is less effective when provided online than in a clinical context (Wiers et al., 2018). This  
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35 suggests that additional factors (i.e., motivation for change, clinical context) should be considered  
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37 when developing and implementing CBM.  
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41 In the current paper, we build on previous findings and on basic research into cognitive  
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43 mechanisms underlying CBM and provide a new theoretical perspective that addresses previous  
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45 inconsistencies while providing new guidelines to improve the effectiveness of CBM. In what  
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47 follows, we describe this perspective and provide preliminary evidence to support it. We then discuss  
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49 its relevance for the development of more effective CBM applications and suggestions for further  
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## New Theoretical Perspective on CBM's Mechanisms

Initial CBM research was rooted in dual process models and developed to target distortions in automatic mental processes drawing on associative representations (Stacy & Wiers, 2010; Wiers et al., 2013). Accordingly, CBM would change dominant associations underlying mental disorders (e.g., stronger links in memory between representations of alcohol and approach tendencies than between alcohol and avoid tendencies; Figure 1, upper panel). However, recent studies yielded results that do not fit well with associative explanations. For instance, repeated avoidance of addiction-related stimuli in the lab does not always translate to changes in addictive behavior. Rather, the effects depend on important moderators such as beliefs about the implications of the learned relation (e.g., the belief that avoiding alcohol helps to refrain from drinking, see: Van Dessel, Hughes, & De Houwer, 2019). Moreover, approach-avoidance effects can be based on verbal instruction rather than on extensive training (Van Dessel, De Houwer, Gast, & Smith, 2015), and change requires awareness of relevant contingencies (Van Dessel, De Houwer, & Gast, 2016).

These findings are difficult to reconcile with an associative account and are more in line with an inferential account (see for a review, Van Dessel et al., 2019). Accordingly, CBM works not by replacing one association (alcohol-approach) with a new association (alcohol-avoidance), but through changes in propositional representations containing information about how concepts are causally related. Specifically, CBM (e.g., alcohol avoidance training) invokes propositions about the contingencies between stimuli (e.g., alcohol), responses (e.g., avoidance), and outcomes (e.g., positive effects) that translate into behavior. From the inferential perspective, (maladaptive) behavior does not reflect automatic activation of mental associations between stimuli and responses as suggested by associative accounts (and the compulsive habit accounts of addiction, see Hogarth, 2020). Rather, it reflects goal-driven inferences that are learned and evoked based on beliefs about their instrumental relevance to people's goals (cf., Kruglanski & Szumowska, 2020; Moors, Boddez, & De Houwer, 2017).

From this perspective, contextual cues, which can be external (e.g., the sight of beer) or internal (e.g., stress, in case the person often drinks to cope with stress) might automatically trigger

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3 approach-tendencies in a heavy drinker due to expected desirable outcomes (e.g., positive affect,  
4 Figure 1, lower panel). Although current CBM interventions based on associative accounts aim to  
5 evoke automatic changes in associations due to repeated pairings (e.g., alcohol-avoid), the inferential  
6 approach suggests that CBM interventions might be more effective if they are designed to automatize  
7 adaptive goal-directed predictions (Van Dessel, Hughes, & De Houwer, 2018). For instance, during  
8 alcohol avoidance training, participants may learn new inferences about action tendencies (e.g.,  
9 alcohol avoidance) that would result in valued outcomes (e.g., abstinence or recovery). These  
10 inferences can facilitate the implementation of similar (avoid) actions when participants are  
11 confronted with similar contextual cues (alcohol) in the future. When the inferences are well-practiced  
12 (i.e., automatized), they will be more readily available and translated into behavior.  
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24 In the following section, we explore the implications of this inferential account for the  
25 development of more effective CBM interventions in clinical settings.  
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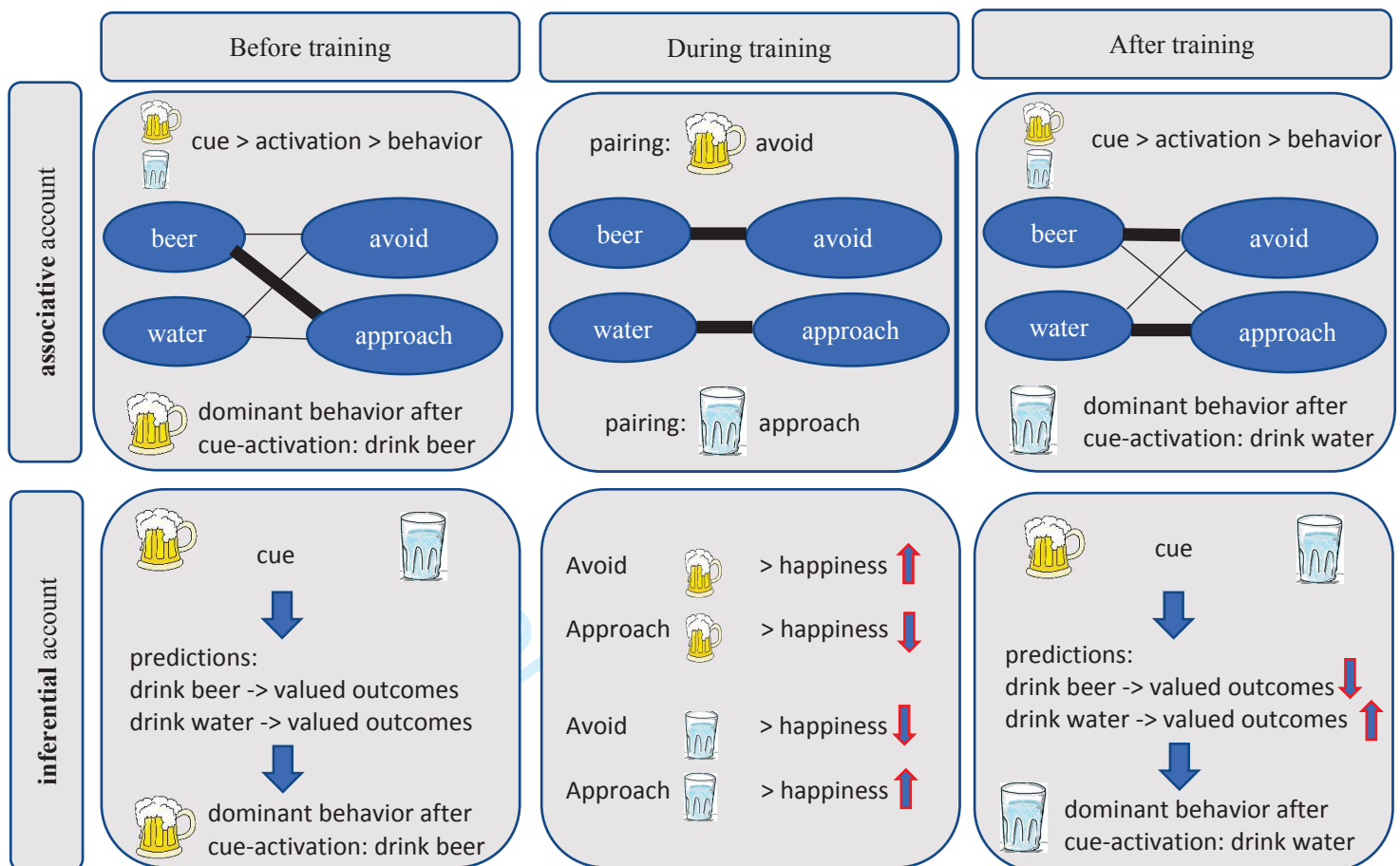


Figure 1. Associative vs. inferential account of CBM effects on alcohol consumption.

## Toward More Effective CBM: ABC-training

We propose three theory-based adaptations of original CBM and explain them in relation to approach bias re-training. This variety of CBM started with a proof-of-principle study (Wiers, Rinck, Kordts, Houben, & Strack, 2010), in which students were trained to avoid alcohol and approach non-alcohol drinks. Specifically, using a joystick, they pulled or pushed pictures that appeared on a computer screen depending on the format of the picture (e.g., pull landscape-format pictures; push portrait-format pictures). The movement was followed by a congruent zoom effect: zoom-in after pulling (approach), and zoom-out after pushing (avoidance). In the experimental condition, participants pushed away (avoided) most alcohol pictures and pulled (approached) most soft-drink pictures. In the other condition, this was reversed. The results showed that 1) participants who had pushed alcohol-pictures were faster to categorize alcohol-words with avoidance (in an Implicit

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3 Association Task) than participants who had pulled alcohol pictures; 2) heavy drinking students who  
4 had successfully been trained to avoid alcohol drank less alcohol in a subsequent taste-test than those  
5 trained to approach alcohol. In subsequent clinical RCTs, alcohol-avoidance training was tested in  
6 patients treated for alcohol use disorders (Eberl et al., 2013; Rinck et al., 2018; Wiers et al., 2011). In  
7 these large RCTs, patients were trained during multiple sessions (4-12) to avoid alcohol, in addition to  
8 standard treatment. One year later, the relapse rate among patients who received the training was  
9 around 10% lower among patients who received alcohol-avoidance training compared with those who  
10 received no training or sham-training. A recent small independent clinical RCT indicated that CBM  
11 effects could be stronger when done during detox (Manning et al., 2016). In contrast, findings for  
12 traditional CBM as add-on to smoking cessation interventions have been less positive (e.g., Kong et  
13 al., 2015; Wittekind et al., 2019). We argue that this difference can be understood from the inferential  
14 account and propose three ways to improve CBM.

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28 **Change-1: Goal-relevant alternative behaviors.** In alcohol CBM, a universally-relevant  
29 behavioral choice is trained: the choice between an alcoholic or non-alcoholic drink. Yet, in other  
30 addictions such universally-relevant choices are typically not available (e.g., there is no universal  
31 alternative to smoking). This might explain why standard CBM was primarily found effective in the  
32 treatment of alcohol use disorders, where a universal alternative choice was trained that fulfills the  
33 goal of remaining abstinent. By contrast, in CBM studies of smoking cessation, visually-matched  
34 alternatives have been used (e.g., somebody holding a pen rather than a cigarette). Although this  
35 contrast makes experimental sense, it is hard to imagine how holding a pen represents an alternative  
36 goal-relevant behavioral choice. Indeed, when behavioral alternatives were personalized (i.e.,  
37 smoking was contrasted with alternative actions that serve the goals otherwise served by smoking,  
38 such as running to reduce stress), effectiveness of the intervention increased (Kopetz, MacPherson,  
39 Mitchell, Houston-Ludlam, & Wiers, 2017). Hence, the first improvement for CBM is to include a  
40 goal-relevant behavioral choice (the B in ABC-training): behaviors leading to personally-relevant  
41 desirable outcomes should be trained.

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58 **Change-2: Personally-relevant consequences.** A second aspect of CBM is that behavioral  
59 choices have consequences. Building on the idea that behavior is determined by the (automatic)  
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3 prediction of relevant action consequences in relation to current goals (Clark, 2013), CBM effects  
4 might require learning relevant consequences of behavioral choices. In other words, the person should  
5 be able to experience the effectiveness of the alternative behavior to accomplish his/her goals. In  
6 clinical treatment where alcohol-avoidance training is effective, the negative consequences of  
7 continued drinking and the positive consequences of abstinence are highlighted. However, this may  
8 not be the case outside the clinical context (e.g., in online training independent of treatment). This  
9 might explain why regular CBM is more effective in clinical than in non-clinical contexts (Wiers et  
10 al., 2018). It further points out that CBM might be more effective if it includes real-life goal-relevant  
11 consequences. A recent proof-of-principle study applied this idea to unhealthy eating (Van Dessel et  
12 al., 2018), a domain where regular CBM has proven largely ineffective. Participants performed a task  
13 in which they were asked to maximize the health of an avatar representing themselves. On each trial,  
14 they would see the avatar stand in front of a fridge with healthy or unhealthy food items and they  
15 decided to approach or avoid the items. Crucially, approaching unhealthy foods resulted in negative  
16 effects and approaching healthy foods in positive effects concerning the avatar's health. Participants  
17 who learned these consequences during training were able to implement it successfully in real-life:  
18 unhealthy eating was significantly reduced in the consequence-based CBM-training compared to a  
19 standard avoid unhealthy food CBM-training, and to a no-training control condition. This illustrates  
20 that adding a relevant consequence (C) might significantly improve the effectiveness of CBM. These  
21 consequences can be personalized to fit with people's goals. For instance, in smoking cessation, in  
22 addition to health, other goals might be important, like saving money, or maintaining a more attractive  
23 physical appearance. Hence, the second improvement concerns adding consequences to actions in  
24 CBM tailored to the patients' own goals.

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49 **Change-3: Personally-relevant antecedent context.** The study discussed above (Van Dessel  
50 et al., 2018) suggests a third change that could improve CBM: the antecedent context (A). Participants  
51 completed the CBM task in a simulated real-life context in which they were standing in front of a  
52 fridge. Incorporating these real-life context-cues (A: fridge) in association with the behavioral choice  
53 (B) and the action consequences (C) might facilitate transfer to real-life. The real-life antecedent can  
54 be a simple stimulus (e.g., a familiar drink as in original CBM), but it can also be extended to high  
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risk-situations, as they are typically identified during treatment (e.g., a specific location, friend, moment, etc.). Importantly, multiple relevant antecedent contexts (and relevant behavioral alternatives) can be identified and trained as part of the intervention, the third proposed change.

To summarize, our proposed ABC-training represents a novel theory-based variety of CBM that involves training goal-relevant behavioral choices (B), triggered by antecedent cues (A), and followed by positive or negative action consequences (C) for the pursuit of specific goals (Figure 2). Thus, instead of training specific a-priori determined associations (e.g., cue-avoidance training in the original CBM, Figure 1), ABC-training aims to automatize behavioral choices relevant to individual's goals in specific contexts. All elements (antecedent contexts, behavioral alternatives and consequences) can be personalized, with help of experienced clinicians in the domain.

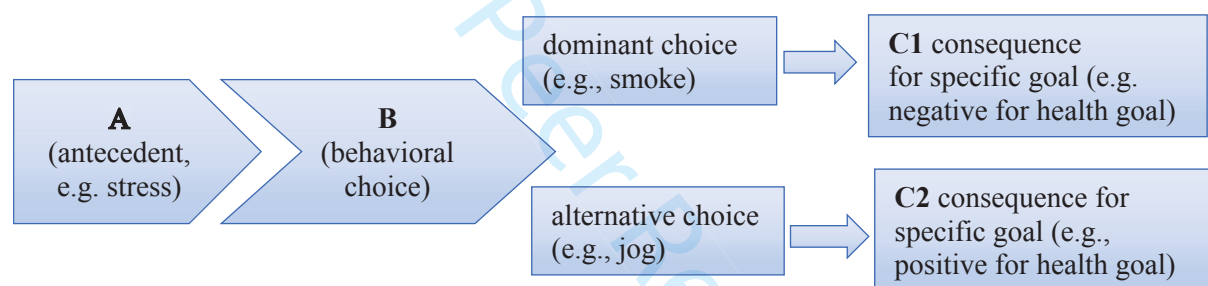


Figure 2. Components of ABC-training.

### ABC-training compared to alternative therapies

ABC-training bears resemblance to (1) cognitive behavior therapy (Beck & Dozois, 2011) and (2) treatments that involve analysis of maladaptive behavior as a function of the antecedents that precede it and consequences that follow it (Dyer, 2013). Despite the apparent resemblance, ABC-training might significantly enhance the effectiveness of these treatments. First, it combines these two approaches. Second and more importantly, it targets automatization of adaptive inferences and related behaviors, which may be crucial in revising difficult to change (habitual) behavior (cf., Marien, Custers, & Aarts, 2019). From this perspective, patients' goals and personally-relevant means to achieve these goals should be identified and related to risk-situations. At this point, personally-relevant ABC-training can be implemented to automatize inferences about goal-relevant action-

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3 outcome combinations in relevant contexts. Similar approaches that attempt to create specific if-then  
4 plans for risk-situations (implementation intentions) have proven effective in several domains of  
5 health behavior (Gollwitzer & Sheeran, 2006). However, the implementation of such action plans is  
6 effortful, at least in the initial phases. By contrast, ABC-training involves practice that aims to  
7 automatize behavioral choices and to reduce the amount of effortful control required. This is  
8 particularly important as a common problem in traditional therapy is that patients (like students) often  
9 experience difficulties doing their homework, in this case practicing alternative adaptive choice-  
10 behaviors. As ABC-training can be delivered online, it increases the chance that patients practice the  
11 relevant alternative behaviors.  
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22 Compared to traditional CBM, which is often experienced as rather meaningless by patients,  
23 personalized ABC-training would seem a more meaningful complement to therapy. The large  
24 majority of people suffering from addictions do not seek professional help but many do seek e-  
25 therapy. Current e-therapy is effective for participants who complete the intervention, but premature  
26 drop-out is the rule rather than the exception (Riper et al., 2018). Furthermore, the effects of  
27 conventional online CBM in addiction are weak at best (Wiers et al., 2018). By adding ABC-training  
28 to guided e-therapy, a more engaging and effective intervention could be created. Clearly, further  
29 research is needed to test the effects of ABC-training in clinical and online contexts, but the theory-  
30 based ingredients and preliminary results show promise (Kopetz et al., 2017; Van Dessel et al., 2018).  
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## 41 **Conclusion**

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44 CBM-training has shown promise as add-on to the clinical treatment of (alcohol) addiction.  
45 However, recent findings are difficult to reconcile with the original theoretical perspective. To  
46 address these issues, we propose a new theoretical perspective based on an inferential account that  
47 integrates previous findings and suggests new implications for the development of effective CBM  
48 interventions. Specifically, we suggest that training can be optimized in a manner in which contextual  
49 antecedents (A) trigger an adaptive behavioral choice (B), in light of goal-relevant (health-related)  
50 consequences (C). New ABC-training might serve as a tool in regular therapy to foster automatic  
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behavioral choices in line with patients' health goals. This suggestion is supported by preliminary findings but awaits empirical support from large clinical trials.

Finally, it is important to note that our perspective does not imply that non-voluntary processes play no role in addiction. There is clear evidence that addiction-related cues, like other rewards, attract and capture attention (Anderson, 2016; Watson, Pearson, Wiers, & Le Pelley, 2019). The effects of CBM appear to go beyond these initial attentional processes (Wiers, Van Gaal, & Le Pelley, in press). For example, the first small RCT on attentional re-training (a type of CBM) in alcohol-dependent patients found no effect of training on speeded detection (200ms), but did find an effect on later attentional capture (500ms) and on relapse (Schoenmakers et al., 2010). Thus, early cognitive biases may be difficult to change, but by training participants to respond differently to cues, CBM may improve clinical outcomes. It is an interesting question for further research whether long-term abstinence and related changes in one's priorities and life-goals could also change these early-stage cognitive biases.

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