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Exploring Elements of Fun to Motivate Youth to Do Cognitive Bias Modification

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Abstract

Objective: Heavy drinking among young adults poses severe health risks, including development of later addiction problems. Cognitive retraining of automatic appetitive processes related to alcohol (so-called cognitive bias modification [CBM]) may help to prevent escalation of use. Although effective as a treatment in clinical patients, the use of CBM in youth proves more difficult, as motivation in this group is typically low, and the paradigms used are often viewed as boring and tedious. This article presents two separate studies that focused on three approaches that may enhance user experience and motivation to train: a serious game, a serious game in a social networking context, and a mobile application.
Materials and Methods: In the Game Study, 77 participants performed a regular CBM training, aimed at response matching, a gamified version, or a placebo version of that training. The gamified version was presented as a stand-alone game or in the context of a social network. In the Mobile Study, 64 participants completed a different CBM training, aimed at approach bias, either on a computer or on their mobile device.
Results: Although no training effects were found in the Game Study, adding (social) game elements did increase aspects of the user experience and motivation to train. The mobile training appeared to increase motivation to train in terms how often participants trained, but this effect disappeared after controlling for baseline motivation to train.
Conclusions: Adding (social) game elements can increase motivation to train, and mobile training did not underperform compared with the regular training in this sample, which warrants more research into motivational elements for CBM training in younger audiences.

Background

Despite the risks involved, use of alcohol among adolescents and young adults remains commonplace.[1] Heavy alcohol use at this age can induce significant health problems, as well as school dropout,[2] and increases the risk of alcohol dependence later in life.[3] Although the focus of many prevention and treatment programs is on explicit drug education, their efficacy appears to be limited.[4,5] An alternative and less explicit approach comes from the field of cognitive psychology, through Dual Process Models of addiction (see, for example, Deutsch and Strack[6] and Wiers et al.[7]). These models posit that an imbalance between two types of cognitive processes can lead to the development of addiction problems. On the one hand, repeated use leads to the development of automatic reactions toward alcohol-related objects over time. For example, heavy alcohol users often show a biased attention toward alcohol-related stimuli[8] and are quicker to approach them, relative to nonalcoholic stimuli.[9] On the other hand, heavy users also tend to have weaker cognitive control abilities, such as working memory[10] and inhibition.[11] These abilities then fail to regulate the relatively strong automatic tendencies, which can explain the problematic drinking behavior. To restore balance to the system, cognitive control can be trained,[12,13] and the biased automatic processes can be retrained through cognitive bias modification (CBM), showing a decrease of symptoms in long-time heavy users (for a review, see Wiers et al.[14]).

Although effective in long-time heavy users and clinical patients,[8,12,15] these training paradigms are often long and tedious and could be viewed as boring.[16] As youth often perceive more positive than negative effects of their alcohol use,[17] any motivation to train they may have may decline during the training, which can lead to smaller training effects and drop out before completion. Adding elements of fun to the training paradigms may therefore be the key to increase the chances of success in this population.

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In this study, we looked at three elements that may increase the user experience of the training, and hence increase motivation to train. The first element we studied was *gamification* of the training task (cf. Gladwin et al.[18]). Indeed, Dovis et al.[19] showed that the inclusion of game elements in a working memory task increased motivation to train in children with attention deficit hyperactivity disorder. Building on this first element, the second element concerned the inclusion of a *social* game aspect to the training (cf. Adams[20]). In the first pilot study we focused on a social and non–social gamified version of an Alcohol/No-Go training, aimed at altering positive associations with alcohol in memory.[21] The third element examined is the way the training's *ease of use* affects user experience. Usually CBM training paradigms are done on a computer, either in a lab setting or at home, through a Web-based interface.[22] The necessity of computer access may, however, still inhibit people from training as frequently as they can. Two studies[23,24] showed that mobile application of CBM can be effective in changing attentional processes, and a preliminary swipe version of an approach/avoidance paradigm has already been developed.[25] As such, the second pilot study presents a mobile version of an alcohol approach bias retraining.[26]

Part I—The Game Study

The goal of the study was twofold. First, we looked at whether adding (social) gaming elements increased the user experience and motivation to train. Second, we assessed the training effectiveness in terms of change in alcohol-related memory bias and actual alcohol use after the training.

Study design and procedure

In the Game Study we compared four versions of the Alcohol Go/No-Go training[22]: the original training (GNG-T); a neutral placebo training (GNG-P); a gamified version (GNG-G), where several game elements were added to the original task; and a social version of the game (GNG-SG) placed in a social network context (Facebook). At baseline, participants were randomly allocated to one of the four conditions. Gaming experience and experience with other alcohol studies, alcohol problems and use, and the Go/No-Go task were assessed, and the first training was started immediately after. The training consisted of three sessions, at least 1 day and at most a week apart. At the end of the third training session the motivation and user experience questionnaires and the Go/No-Go assessment were done. A week later, participants received a follow-up questionnaire (Timeline Follow-Back [TLFB]) about alcohol use by e-mail.

Participants

A sample of regularly drinking undergraduate students ($n = 77$; mean ± standard deviation [SD] age, 22.7 ± 3.1 years; age range, 18–29 years, 50.6 percent male) was recruited to participate in the training study in exchange for study credits. Participants were given the option to train either in the lab ($n = 35$) or from home ($n = 42$). At baseline, participants were informed about the study's training goal and procedure (but without mention of the game aspect, as this could potentially have a negative influence on those who did not receive game training) and provided informed consent to participation. The study was approved by the Ethics Committee of the University of Amsterdam (Protocol number 2014-DP-3628).

Materials

User experience and motivation. User experience was measured with a set of questions based on the Player Enjoyment Evaluation Model.[27] This model is structured on the theory on flow and consists of the following eight elements: concentration, challenge, player skills, control, clear goals, feedback, immersion, and social interaction. The resulting questionnaire included 21 questions that were rated on a 5-point Likert scale going from "strongly disagree" to "strongly agree." Thirteen questions regarding motivation to train and playing the game were based on the attention, relevance, confidence, and satisfaction subscales by Liu and Chu[28] and rated on the same Likert scale.

Alcohol use and problems. A shortened version of the TLFB questionnaire[29,30] was used to measure alcohol consumption per day over the past week. An additional question assessed whether participants drank more than 4 (female participants) or 5 (male participants) glasses of alcohol during one occasion in the past week to determine the number of binge drinking occasions. Alcohol-related problems were measured with the Alcohol Use Disorder Identification Test (AUDIT).[31] This questionnaire included 10 multiple-choice questions regarding alcohol consumption and alcohol-related problems. The overall AUDIT score ranges between 0 and 40, with a score of 8 or higher indicating an increased risk of alcohol-related problems in normal samples and 11 or higher in student samples.[32]

Alcohol-related memory bias. The Alcohol Go/No-Go assessment task looked similar to the version described by van Deursen et al.[22] Here, it consisted of 14 practice trials with neutral images and 80 assessment trials, each showing either an image of an alcoholic or nonalcoholic beverage. On each picture, a cue (the letter P or F) was shown in one of the corners of the image, indicating whether the participant had to press a key (the spacebar) or not. For example, a participant could be instructed to press the response key as quickly as possible whenever the letter P (i.e., the Go cue) was visible, but not to press whenever the letter F (i.e., the No-Go cue) was shown. This cue-response matching was counterbalanced across participants. Each picture was paired with a Go cue equally often as with a No-Go cue. The bias score is calculated as the average reaction time on the alcohol-Go trials minus the average reaction time on the non–alcohol-Go trials.

Intervention

The Alcohol No-Go training, which was the basis for all of the four training conditions, was visually similar to the assessment version, except for the pairing of the image content and cues. In the training conditions (GNG-T, -G, and -SG), images of alcohol were always paired with the No-Go cue and nonalcohol images with the Go cue. In the placebo training (GNG-P) there was no relation between the image content and the cues, similar to the assessment version. Each training session consisted of 200 training trials, showing images of beverages, mixed with 20 filler trials, showing neutral objects. The fillers were included to slightly mask the contingency between image content and Go/No-Go cue (cf. Houben et al.[33] and Schoenmakers et al.[34]). The interface of the regular Go/No-Go task is displayed in Figure 1.

The Game and Social Game versions of the Alcohol/No-Go training were called the ''Cheese Ninja Game.'' The aim of this Game version was to include mechanics, backstory, and esthetics game aspects, as suggested by Schell,[35] while attempting to preserve as many of the key features of the paradigm. The main character in the game was a ninja mouse that walked through a hallway, passing by posters of the same beverages as used in the regular versions of the training. In front of each poster, a cue was presented in the form of something good or bad for the mouse, such as some cheese or a cat, respectively. The mouse had the ability to drop these objects, and the goal of the game was to collect as many good objects as possible while ignoring harmful objects. Similar to the regular training condition, the Go cues were consistently paired with nonalcoholic beverages on the posters, and the No-Go cues with alcoholic beverages.

In the Social Game condition, the game was registered as an application on the social network site Facebook (www.facebook.com). Participants were provided with premade test accounts, personalized with their first name and a neutral but unique profile picture. After each level the player could choose to post his or her level score and achievement to his or her Facebook timeline, which could be viewed, liked, and commented on by the other GNG-SG participants. The interface of the social game within the Facebook environment is shown in Figure 1.

Game Study Results

Seven participants who missed the postintervention assessment were excluded from the analyses. Next, all dependent variables were screened for univariate extreme outliers based on inspection of stem-and-leaf and box plots, which led to the exclusion of one outlier in the Task Clarity factor of the user experience questionnaire.

Baseline characteristics

The average amount of alcohol consumed in the week before the pretraining assessment was 13.6 standard glasses (SD = 12.5). The mean AUDIT score was 10.2 (SD = 5.5), with 68.8 percent of the participants scoring ≥ 8 and 41.3 percent ≥ 11, indicating hazardous drinking in a large proportion of the sample.[31,32] Nevertheless, and contrary to what was expected, they did not show a significant bias for alcohol ($t_{76} = 1.053$, $P > 0.05$). Finally, participants differed with regard to their gaming habits: participants in the social game condition appeared to play games slightly more often (Table 1).

User experience and motivation to train

Exploratory factor analysis of the user experience questionnaire was carried out to test the factors composing the scale. A principal axis factor analysis was used with orthogonal Varimax rotation. Four factors with eigenvalues[36] of >1 and a minimal 5 percent explained variance were identified. Table 2 shows these factors, which were labeled Task Clarity, Ease of Use, Task Immersion, and Task Demand, with a total explained variance of 53.6 percent. Five items were discarded for not loading (minimal factor loading[37] of 0.35) onto any factor. Similar analysis (without rotation) of the motivational questionnaire revealed only one factor explaining 52.94 percent of variance. This factor included all but two items, which did not load significantly (factor loading below 0.35). Cronbach's alpha was 0.89.

Using these factors, we examined whether adding (social) gaming elements increased the user experience and motivation to train. For this purpose we contrasted both game conditions with the nongame conditions, as well as the social game versus the regular game. Analysis of variance (ANOVA) on the Task Clarity factor (after one outlier was removed) revealed no significant difference between the groups ($F_{3, 64} = 1.978$, $P > 0.05$).

A Kruskal–Wallis test on Ease of Use factor (due to violation of normality assumption) showed a significant group difference ($H_3 = 26.101$, $P < 0.001$). Follow-up Mann–Whitney pairwise tests showed that the game conditions together (median = 3.00) were rated significantly less easy to use than the combined nongame conditions (median = 4.00; $U = 319.5$, $z = -3.38$, $P = 0.001$, $r = -0.41$), but the game condition (median = 4.00) was rated significantly easier to

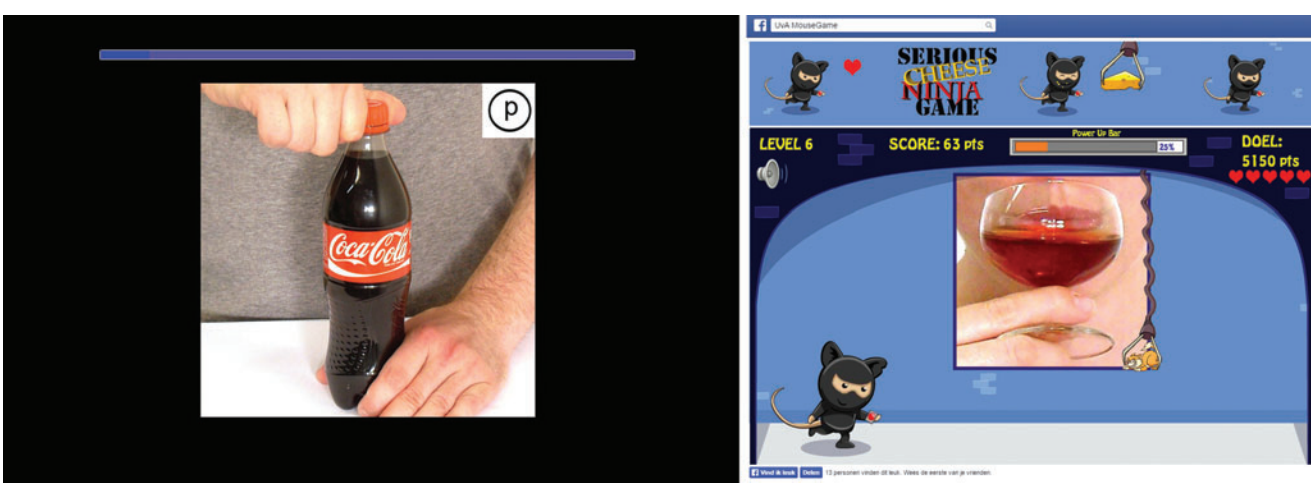

FIG. 1. The Alcohol Go/No-Go training: **(left panel)** the original task and **(right panel)** the Social Game version. (Color images available at www.liebertonline.com/g4h)

Table 1. Baseline Characteristics by Group (Game Study)

	Placebo (GNG-P)	*Original (GNG-T)*	*Game (GNG-G)*	*Social game (GNG-SG)*	*Total*	P
Total *n* (male *n*)	23 (9)	17 (9)	18 (8)	19 (13)	77 (39)	0.27
Age (years)	22.5 (3.1)	23.2 (3.3)	23.1 (3.3)	22.2 (3.1)	22.7 (3.1)	0.70
AUDIT	8.5 (5.3)	10.1 (5.0)	10.3 (4.5)	12.3 (6.5)	10.2 (5.5)	0.16
TLFB (drinks)[a]	10.7 (10.4)	11.2 (9.0)	14.5 (7.9)	18.6 (19.0)	13.6 (12.5)	0.19
GAME XP[b]	3.4 (1.5)	3.3 (1.5)	3.3 (1.5)	2.2 (1.0)	3.1 (1.5)	0.03[c]
Alcohol bias (milliseconds)	1.2 (33.6)	–8.9 (37.0)	–13.4 (32.3)	3.0 (29.4)	–4.0 (33.2)	0.37

Data are mean (standard deviation) unless indicated otherwise.
[a]One outlier was removed.
[b]The frequency of playing games (GAME XP), where 1 = daily, 2 = weekly, 3 = monthly, 4 = yearly, and 5 = never;
[c]Significant at the $P = 0.05$ level.
AUDIT, Alcohol Use Disorder Identification Test; GNG-P, Go/No-Go placebo training; GNG-T, Go/No-Go original training; GNG-G, Go/No-Go gamified training; GNG-SG, Go/No-Go gamified training in social context; TLFB, Timeline Follow-Back (shows the number of standardized drinks during the week prior to the pretraining assessment).

use than the social game condition (median = 2.33; $U = 45.0$, $z = -3.44$, $P = 0.001$, $r = -0.59$).

ANOVA on the Task Immersion factor also revealed a significant difference between groups ($F_{3,\ 65} = 4.520$, $P = 0.006$), with the social game (mean = 3.29, SD = 0.77) being evaluated as more immersive than the normal game (mean = 2.34, SD = 0.62; $t_{65} = 3.646$, $P = 0.001$, $r = 0.41$).

Finally, ANOVA on the Task Demand factor revealed a significant difference between groups ($F_{3,\ 65} = 5.154$, $P = 0.003$), where the game conditions together (mean = 3.13, SD = 0.77) were rated as more demanding than the combined nongame conditions (mean = 2.47, SD = 0.64; $t_{65} = 3.769$, $P < 0.001$, $r = 0.42$).

ANOVA on the motivational questionnaire revealed a significant difference between groups ($F_{3,\ 66} = 4.136$, $P = 0.010$), where the social game (mean = 3.23, SD = 0.51) was rated more motivating than the normal game (mean = 2.64, SD = 0.71; $t_{66} = 2.806$, $P = 0.007$, $r = 0.33$).

Training effects

No bias change ($F_{3,\ 65} = 0.605$, $P > 0.05$) or change in drinking behavior ($F_{3,\ 65} = 1.111$, $P > 0.05$) was found after the training (Table 3). We also examined the number of errors made on the Go/No-Go assessment task. These were very low in all groups (mean error rates between 0.9 percent and 1.8 percent), indicating that in general participants were extremely accurate.

Part II—The Mobile Study

The goal of this pilot study was to test reported user experience, motivational aspects, and preliminary effectiveness of a mobile CBM intervention targeting automatic motivational approach tendencies toward alcohol, in comparison with the standard computerized version, in a sample of young regular drinkers. This CBM intervention aims at training the participant to specifically avoid or approach a specific type of

Table 2. Rotated Factor Solution for the User Experience Questionnaire (Game Study): Item Content, Factor Loadings (>0.35), and Cronbach's Alpha for Each Factor

Item	*Task clarity*	*Ease of use*	*Task immersion*	*Task demand*
It was clear to me what was expected of me during the task.	0.734[a]			
It was clear to me how I performed during the exercise.	0.705[a]			
I thought all information that was shown on the screen during the exercises was clear.	0.567[a]	0.394		
I had the idea that I kept improving at the exercises.	0.555[a]			
I thought that there were no redundant elements in the exercises.	0.542[a]			
I had the idea that I had complete control during the task.		0.848[a]		
The controls of the exercises were easy.		0.751[a]		
I thought the other visual elements on the screen were distracting.		–0.730[a]		
I forgot about the time while doing the exercises.			0.753[a]	
I was completely immersed in the task.	0.383	–0.378	0.568[a]	
While I was doing the exercises, I was unaware of my environment.			0.702	
I got easily distracted from doing the exercises.			–0.464[a]	
The exercises were sufficiently challenging for me.				0.421[a]
The objects that I had to focus on were hard to discriminate.		–0.397		0.607[a]
The exercises required my full concentration.				0.846[a]
I didn't have to concentrate much to do the exercises.	0.351			–0.450[a]
Cronbach's alpha	0.78	0.82	0.73	0.63

Cross-loading items have been assigned to one factor based on the highest factor loading and content relevance. Items with a negative factor loading must be reverse scored.
[a]Items composing each factor within the column.

Table 3. Training Outcomes (Game Study)

	Placebo (GNG-P)	*Original (GNG-T)*	*Game (GNG-G)*	*Social game (GNG-SG)*	P
Alcohol bias change	–18.9 (47.3)	–20.2 (44.6)	–3.2 (29.2)	–6.6 (57.1)	0.614
TLFB change	2.3 (9.7)	–4.0 (7.8)	4.1 (20.5)	0.2 (10.2)	0.351

Data are mean (standard deviation) values.
GNG-P, Go/No-Go placebo training; GNG-T, Go/No-Go original training; GNG-G, Go/No-Go gamified training; GNG-SG, Go/No-Go gamified training in social context; TLFB, Timeline Follow-Back.

stimuli.[15,26,38] Typically, it is a modified version of an assessment task, such as the Approach-Avoidance Task (AAT),[38,39] with a built-in contingency that recasts it to the retraining paradigm. However, performing such a task repeatedly on a computer may hinder motivation to train and training adherence,[16] particularly with young adults.[18] The deployment of CBM interventions on a mobile device could then maximize their effects and improve compliance.

User experience with the mobile condition was expected to be more positive than with the standard computerized condition, because of the perceived greater accessibility, convenience, and versatility of a mobile application (Hypothesis 1). Training technology was expected to predict number of completed training blocks after controlling for intrinsic motivation to train at baseline (Hypothesis 2). Alcohol use and approach bias were expected to decrease after the intervention in both conditions as a function of number of completed training blocks (Hypothesis 3).

Design and procedure

Participants were allocated to the mobile or computerized training intervention according to their smartphone operating system and gender. Participants with a non-Android™ (Google, Mountain View, CA) smartphone were assigned to the computerized training condition, whereas participants owning an Android smartphone were assigned to either condition stratified by gender.

At baseline, participants were screened for alcohol-related problems, whereas alcohol use and approach bias were assessed at baseline and after the intervention in the lab. Between the assessment sessions, participants could train for 14 days on their assigned device as much as they desired. Motivation to train was assessed at baseline and at the end of each training round. User experience was evaluated post-intervention. Two weeks later, participants completed an online follow-up assessment of their alcohol use.

Participants

Recruited participants were 64 university students (mean ± SD age, 22.44 ± 2.58 years; age range, 18–35 years; 60.94 percent female); 31 were assigned to the mobile training (100 percent Android devices) versus 32 to the computerized training (15.6 percent Android devices). One participant who did not fully complete the postintervention session was excluded from the study. At baseline, participants were fully informed about the study goal and procedure and provided informed consent to participation. They were rewarded with two research credits or €20 upon completion of all assessment sessions. In addition, they received €0.80 for each completed training block. The study was approved by the Ethics Committee of the University of Amsterdam (Protocol number 2015-DP-4286).

Materials

Alcohol use and problems. Alcohol-related problems and total amount of standard units of alcohol consumption in the last 2 weeks was assessed with the AUDIT[31] and TLFB,[29] respectively.

Approach bias. Besides a standard AAT, a second computerized reaction–time task was used to assess alcohol approach bias, namely, the Stimulus Response Compatibility (SRC) task,[40,41] in order to avoid practice effects due to the use of the modified AAT for training. Both tasks involved reacting as quickly and as accurately as possible to alcoholic and nonalcoholic pictures by responding to the actual content of the picture (alcohol or soft drink) in the SRC and to an irrelevant feature of the picture (i.e., tilt direction) in the AAT.

In the SRC, participants were instructed to move a manikin away or towards a specific image by pressing two response keys (U or B) on the keyboard. The task was composed of a practice block (16 trials) and two test blocks (48 trials each) presenting 12 alcohol and 12 soft drink images repeated twice. In the ''alcohol approach'' test block, participants had to move the manikin toward alcohol images and away from soft drink images, whereas in the ''alcohol avoid'' test block instructions were reversed. Block order was counterbalanced across participants. The SRC score is computed by subtracting mean reaction time in the ''approach alcohol'' block from mean reaction time in the ''avoid alcohol'' block.

In the AAT, participants were instructed to push pictures tilted to the left away and pull pictures tilted to the right closer by pressing and holding two keys (up and down arrow keys) on the keyboard. Cue/response pairing was counterbalanced across participants. Upon response, a zooming effect occurred, which increased picture size in the pulling closer response and decreased it in the pushing away, mimicking actual approach and avoidance.[9] The task was composed of a practice block (10 trials) with filler pictures (office supplies) and one test block, which consisted of 96 critical trials presenting six alcohol and six soft drink stimuli repeated four times, mixed with 12 filler trials. The AAT score is computed by subtracting the difference in mean reaction time between soft drink/avoid and soft drink/approach trials from the difference in mean reaction time between alcohol/avoid and alcohol/approach trials. All stimuli were taken from the Amsterdam Beverage Picture Set (ABPS).[42]

Motivation to train. At baseline, four questions asked about expectancies about the intervention and motivation to train.

Each question was rated on a 5-point Likert scale from ''totally disagree'' to ''totally agree.'' Mean score across the four items was used for the analyses. As a proxy of motivation to continue training, participants indicated how much they enjoyed the training after each training round on a scale from 0 to 10.

User experience. A questionnaire based on the User Experience Questionnaire[43] assessed user experience with both technologies by focusing on aspects such as ease of use, efficiency, stimulation, and enjoyment of the training application. Questions were evaluated on the same 5-point Likert scale. (Note that the user experience questionnaire used in this study differs from the one used in the Game Study. The reasons for this are twofold: First, there seems to be no golden standard in the literature when it comes to assess a user's experience, which prompted us to develop [and evaluate] a set of questions of our own, based on the relevant literature. Second, as the environments assessed in these studies were quite different [a (social) game setting versus a mobile environment], the questions were also different.)

Intervention

The AAT was adapted for training by manipulating the stimulus–response contingency as to always avoid alcohol stimuli and approach soft drink stimuli.[15,26,35,44] The letters P and F were superimposed on the stimuli and used as response cues for push-away and pull-closer responses. Letter and response pairing was counterbalanced across participants. The training program was composed of 12 blocks of 72 trials presenting alcohol and soft drink stimuli mixed with 8 filler trials. Six sets of six alcohol, soft drink, and filler pictures were randomly presented throughout the 12 blocks. Stimuli were taken from the ABPS set.[42] After completion, the block sequence started over, allowing for unlimited training.

Both AAT training versions were visually similar to the assessment version of the task (Fig. 2). In the mobile version of the training, participants were instructed to respond with a swipe gesture on their touch screen, with one hand holding the smartphone and the other swiping the stimuli away or toward themselves.[25] Like in the original AAT, a zooming effect was also implemented as well as an automated gliding motion animation to further emphasize an image moving toward or away from the user. Both training versions were programmed with Adobe ActionScript 3 (Adobe Systems, San Jose, CA). Adobe Integrated Runtime (AIR) was then used to compile the application for Android by adjusting AIR settings to allow for maximum compatibility (from Android version 2.3 and above).

Mobile Study Results

Before running the analyses, all dependent variables were screened for univariate extreme outliers based on inspection of stem-and-leaf and box plots, which led to the exclusion of two outliers in the number of completed training blocks, one outlier in the post-TLFB scores, and one and six outliers in the baseline and posttest SRC scores, respectively.

Baseline characteristics

In the 2 weeks before the baseline assessment session, participants consumed on average 25.28 standard units of alcohol (SD = 20.10). The mean AUDIT score was 11.27 (SD = 5.31), and 71.4 percent of participants reported an AUDIT score ≥ 8, with 58.7 percent ≥ 11, indicating hazardous drinking in a large proportion of the sample.[31,32]

FIG. 2. The Alcohol/Avoid training: **(left panel)** the personal computer version and **(right panel)** the mobile version. (Color images available at www.liebertonline.com/g4h)

Table 4. Baseline Characteristics by Group (Mobile Study)

	Computer	*Mobile*	*Total*	P
Total *n* (male *n*)	32 (11)	31 (14)	63 (25)	0.38
Age (years)	22.0 (0.3)	23.0 (0.6)	22.5 (2.6)	0.12
AUDIT	11.3 (5.0)	11.3 (6.1)	11.3 (5.3)	0.99
TLFB	25.4 (19.1)	25.1 (21.4)	25.3 (20.1)	0.95
Motivation to train	2.9 (0.5)	3.1 (0.5)	9.0 (0.5)	0.09
Alcohol approach bias				
SRC	–40.8 (76.2)	–1.8 (92.2)	–21.9 (85.9)	0.07
AAT	33.3 (74.8)	4.2 (83.7)	19.0 (80.0)	0.15

Data are mean (standard deviation) values unless indicated otherwise.

AAT, Approach Avoidance Task; AUDIT, Alcohol Use Disorder Identification Test; SRC, Stimulus Response Compatibility task; TLFB, Timeline Follow-Back.

Nonetheless, at baseline participants showed an alcohol avoidance bias score significantly different from 0 in the SRC task ($t_{61}=-2.007$, $P=0.049$, $r=0.25$) and no alcohol bias in the AAT ($t_{62}=1.889$, $P=0.064$). Group comparisons did not evidence any baseline difference for all relevant variables (Table 4).

Hypotheses 1 and 2: user experience and motivation to train

Exploratory factor analysis was carried out on the user experience questions to identify the underlying factor structure. A principal axis factor extraction was used with Varimax orthogonal rotation. Four factors presenting eigenvalues[36] of >1.00 and accounting for at least 5 percent of variance were identified. Six items did not significantly load onto any factor (factor loadings[37] of <0.35) and were discarded. The final four-factor solution explained 43.08 percent of the total variance. Table 5 shows the structure of the four factors, which were labeled Ease of Use, Task Enjoyment, Player Involvement, and Task Compliance.

A Mann–Whitney U test (due to violation of normality assumption) did not identify any significant difference between the two training conditions in Ease of Use and Task Compliance ($U=439.5$ and $U=382.5$, respectively; $P>0.05$ for both). Player Enjoyment scores were also similar between technologies ($t_{61}=-0.119$, $P>0.05$), whereas Player Involvement showed a marginal difference ($t_{61}=-1.899$, $P=0.06$), with a potentially greater involvement in the mobile group (mean = 11.23, SD = 2.12) than the computerized group (mean = 10.13, SD = 2.46). Mean scores of motivation to continue with training computed over all training rounds did not differ between the two conditions ($t_{54}=0.542$, $P>0.05$).

A one-tailed Mann–Whitney U test showed that participants completed slightly more training blocks in the mobile training version (median = 53, mean = 72.38, SD = 65.73) than in the computerized one (median = 17.00, mean = 59.22, SD = 79.26; $U=348.00$, $z=-1.679$, $P=0.046$, $r=-0.21$). However, this effect disappeared after controlling for overall motivation to train at baseline with hierarchical regression analysis ($R^2=0.091$, $F_{1,\ 59}=5.816$, $P=0.019$; $\beta=0.293$, $P=0.025$).

Table 5. Rotated Factor Solution for the User Experience Questionnaire (Mobile Study): Item Content, Factor Loadings (>0.35), and Cronbach's Alpha for Each Factor

Items	*Ease of Use*	*Player Enjoyment*	*Player Involvement*	*Task Compliance*
The task instructions were clear.	0.708[a]			
The task was easy to use.	0.757[a]			
Based on the instructions, the task functioned as I expected.	0.738[a]			
The task loaded quickly.	0.754[a]			
Swiping on the smartphone or pressing on the keyboard felt accurate.	0.466[a]			
I thought the task was fun to do.		0.558[a]		0.431
I quickly lost my interest in the task.		–0.605[a]	0.505	
I was very motivated to do the task.		0.588[a]		
I thought it was frustrating to do the task.		–0.509[a]		
Completing each task gave me a satisfied feeling.		0.660[a]		
I felt impatient while doing the task.		–0.607[a]		
I felt I had to concentrate hard during the task.			–0.428[a]	
I thought the task was very easy.			0.371[a]	
The task crashed often.			–0.469[a]	
I did the task while I was bored.			0.598[a]	
I didn't care whether I made a mistake.				–0.608[a]
I did the task because I felt the need to do so with regards to my drinking behavior.				0.534[a]
I thought the repeating of the swiping on the smartphone or pressing on the keyboard was exhausting.				–0.488[a]
Cronbach's alpha	0.80	0.77	0.51	0.57

Cross-loading items have been assigned to one factor based on the highest factor loading and content relevance. Items with a negative factor loading must be reverse scored.

[a]Items composing each factor within the column.

Hypothesis 3: training effects

Training effect on TLFB and SRC and AAT approach bias scores was examined with repeated-measures ANOVAs with number of completed training blocks as the covariate and training condition as the between-subject factor.

The repeated-measures ANOVA on TLFB scores did not retrieve any main effect of time ($F_{2,\ 88}=1.804$, $P>0.05$), number of blocks ($F_{1,\ 44}=0.333$, $P>0.05$), or condition ($F_{1,\ 44}=0.030$, $P>0.05$). *Post hoc* pairwise comparisons with Bonferroni's correction found a significant difference between TLFB score at baseline (mean = 25.54, SD = 18.57) and at follow-up (mean = 20.12, SD = 16.92) ($t_{49}=3.321$, $P=0.002$). The repeated-measures ANOVA on SRC and AAT approach bias scores did not retrieve any main effect of time ($F_{1,\ 53}=0.365$ and $F_{1,\ 55}=0.895$, respectively; $P>0.05$ for both), number of blocks ($F_{1,\ 53}=2.351$ and $F_{1,\ 55}=1.849$, respectively; $P>0.05$ for both), or condition ($F_{1,\ 53}=3.647$ and $F_{1,\ 53}=3.539$, respectively; $P=0.06$ for both). *Post hoc* pairwise comparisons with Bonferroni's correction found a marginal difference between AAT scores at baseline (mean = 22.76, SD = 80.18) and at posttest (mean = –0.18, SD = 42.40; $P=0.06$), indicating a slight decrease in alcohol approach bias over time.

Discussion

This article presented two pilot studies on motivational elements in CBM training. The Game Study showed that, although no effect of training was found on the bias score or drinking behavior, the games were seen as more demanding and harder to use than the regular trainings. Presenting the game in a social context also made it more immersive and more motivating compared with the stand-alone game. The Mobile Study showed a statistical trend indicating that players appeared to be more involved in the mobile group. The other measures of user experience, however, revealed no significant difference between the two technologies. Initial analyses indicated the mobile trainers did complete more training blocks, but motivation to train prior to the training appeared of much greater influence, canceling out the significance of this effect. Finally, although several marginal effects of training were found, these did not substantially differ between the conditions.

As these studies were pilot studies, several limitations have to be taken into account. For example, the Mobile Study did not include a placebo control condition, so the effects of the training cannot be solely attributed to the AAT. Also, the monetary reward appeared to be a very good motivator to some participants (with many earning well over €100). It remains unclear how many blocks would have been done if no money was involved. Another limitation is the samples used in these studies. Although the participants did drink substantially, no significant bias scores were detected at baseline (in the Game Study), and only the SRC, but not the AAT, was significant in the Mobile Study. Although this does not make it impossible to find effects of training, higher bias scores do allow for larger reductions as well.[15] Finally, some of the measures used were not optimal. For example, the self-developed user experience questionnaire used in the Mobile Study revealed two scales that were relatively unreliable (Cronbach's alpha <0.60).

A more general point is that whenever significant adjustments are made to CBM paradigms (i.e., by transforming them into mobile or gamified applications), some elements will inevitably end up differently from their original, evidence-based counterparts. In these studies, for example, the introduction of movement of the stimuli, different controls, and the added element of fun or mobility may make the training more challenging, but may also lead to more variability in reaction times or, in the extreme case, may even render the training ineffective.[45] The difficulty of predicting which elements may have this effect, however, stresses the importance of performing these pilots.

Given that the main reason for training in the Mobile Study seemed to be having a strong motivation to train to begin with, perhaps future research should invest more in using elements of fun for maintaining any preexisting motivation to train, rather than attempting to elicit it. If the next step in CBM research is to go mobile (e.g., Kerst and Waters[46] and Enock et al.[47]), in order to accommodate users' needs and technology preferences and take advantage of greater accessibility of mobile applications, it is necessary that training on a computer or on a mobile device does not result in different effects. Although based on the present results one could conclude that there is no real added value of going mobile with, or to introduce swiping gestures to, the alcohol avoidance training, it should be noted that the mobile training also did not perform worse than the regular training in this sample. As such, additional, placebo-controlled research to validate the efficacy of mobile training seems warranted, preferably in clinical samples. Moreover, as the (social) game elements did seem to increase motivation, future research could investigate their combination in mobile game versions of CBM.

Conclusions

The current studies indicate that adding (social) game elements can increase fun and motivation to train using CBM. Introducing ease of use elements, such as mobility, may increase motivation to train, but this seems less influential than initial motivation to train. Nevertheless, the mobile version did not underperform, which opens up new avenues for CBM training among younger participants. More research is needed to increase power and determine whether clinical effects can also be attained in the target populations.

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