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# Reversing the sequence: Reducing alcohol consumption by overcoming alcohol attentional bias

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ABSTRACT

The aims of the research were to (a) compare the alcohol attentional bias (AAB) of social, hazardous, and harmful drinkers and (b) assess the effects of alcohol attention-control training on the AAB and alcohol consumption of hazardous and harmful drinkers. Participants were social drinkers ($N = 40$), hazardous drinkers ($N = 89$), and harmful drinkers ($N = 92$). Paper-and-pencil measures were used to collect information about participants' socio-demographic characteristics, health status, motivational structure, drinking-related locus of control and situational self-confidence, readiness to change, affect, and alcohol consumption. Computerized classic, alcohol- and concerns-Stroop tests were administered. All participants were tested individually, with the order of tests counterbalanced across participants. After the baseline assessment, the hazardous and harmful drinkers were trained with the Alcohol Attention-Control Training Program (AACTP) for two and four sessions, respectively. Both samples completed a post-training assessment, and the harmful drinkers also completed 3-month follow-up. Results indicated that (a) the harmful drinkers had larger AAB than the hazardous and the social drinkers; (b) the attentional training reduced the hazardous and harmful drinkers' AAB; and (c) the harmful drinkers showed post-training reductions in alcohol consumption and improvements on the other drinking-related indices. The harmful drinkers' improvements were maintained at the 3-month follow-up.



## 1. Introduction

Alcohol abuse is a serious, ongoing public-health problem. Excessive drinkers cause much emotional and physical harm to themselves and others; alcohol abuse is also linked to fatal accidents and loss of productivity. Among abusive drinkers who complete treatment, approximately 50% relapse within 3 months (Whitworth et al., 1996). These high failure rates are perplexing, especially because problem drinkers readily acknowledge the negative consequences of their drinking and appear strongly motivated to stop. It would appear that abusive drinkers who relapse after treatment have lost control over their drinking (Tiffany, 1990). In fact, unintentional preoccupation with alcohol despite knowledge of its adverse consequences is one of the criteria for defining alcohol abuse (e.g., Morse and Flavin, 1992; Roberts and Koob, 1997). This question remains: Why are abusive drinkers often unsuccessful at their attempts to control their drinking.

According to one account, abusive drinking is the outcome of faulty decision making (Bernheim and Rangel, 2002). For example, decisions about drinking can be highly automatic (Drobes et al., 2001; Marlatt, 1996; Tiffany, 1990; Tiffany and Conklin, 2000), with drinkers often being unaware of the factors that influence their decisions to drink (e.g., Wiers et al., 2002a). In their motivational model, Cox and Klinger (1988, 1990, 2004) suggest that decisions to drink alcohol result from both conscious and nonconscious processes. For example, in the early stages of excessive drinking, decisions to drink might be intentional, but later drinking might become a major goal in the person's life, with its corresponding motivational state called *current concern* (Cox and Klinger, 1988, 1990, 2004). Current concerns activate, direct, and maintain goal-related cognitive processes in implicit, automatic ways (Klinger and Cox, 2004). Having a current concern about drinking alcohol energizes and directs drinkers' thoughts and behavior toward procuring alcohol. As a result, drinkers develop attentional bias for stimuli related to alcohol of which they might be unaware.

According to Robinson and Berridge's (1993, 2000, 2001) incentive-sensitization theory, repeated administration of alcohol causes the brain to become sensitized to alcohol and its associated stimuli. In turn, these stimuli can trigger a conditional motivational state in the sensitized brain, leading the organism to search for alcohol and ingest it, without experiencing the pleasure previously

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associated with doing so ("drug wanting" in the absence of "drug liking"). The brain responses to alcohol cues involve evaluative processes in the limbic system and ventromedial prefrontal cortex, which contribute to the flawed decisions to drink too much or to break abstinence (Bernheim and Rangel, 2002; Damasio Antonio, 1994). In an fMRI study, Park et al. (2007) showed that when alcohol abusers were exposed to alcohol cues, activation of specific brain areas (i.e., fusiform gyri, temporal gyri, parahippocampal gyrus, uncus, frontal gyri, and precuneus) was correlated with the level of craving that the participants reported. Field and Eastwood (2005) trained one group of participants to attend to alcohol cues and another group to avoid attending to alcohol cues. The results showed that, compared to the later, the former group showed greater distractibility for alcohol-related stimuli, which was associated with increases in their urges to drink and their actual consumption of alcoholic beer during a taste test.

To conclude, alcohol and other substance abusers' attentional bias for addiction-related stimuli has been well documented. The bias is related to the maintenance of and relapsing to the addictive behavior, abusers' craving for the substance, and their actual decisions to use it. Consequently, studying attentional bias for addiction-related stimuli (e.g., alcohol attentional bias; AAB) is necessary for better understanding substance abusers' impaired control over their addictive behavior. For a comprehensive review of the theories of addiction-related attentional bias, see Cox et al. (2006).

Various techniques have been developed to study addiction-related cognitive biases, including memory association (e.g., Stacy, 1997) and implicit-association tasks (e.g., Wiers et al., 2002b); Artificial Grammar Learning (e.g., Pothos and Cox, 2002); and dot-probe (Hogarth et al., 2003), change blindness (Jones et al., 2003), and dual-task (Waters and Green, 2003) paradigms. Various versions of the addiction-Stroop test have also been used extensively to measure attentional bias for addiction-related stimuli (Cox et al., 2006). The addiction-Stroop test is a modified version of the classic-Stroop test (Stroop, 1935) and is often regarded as a variant of the emotional Stroop test (Williams et al., 1996), which is used to study attentional bias for emotional stimuli.

Heavy drinkers' sensitivity to alcohol stimuli has been widely studied with the alcohol-Stroop test. It consists of two categories of stimuli—alcohol-related (e.g., beer, wine) and emotionally neutral (e.g., chair, envelop)—that are written in different font colors. The participant's task is to name the colors while ignoring the meaning of the stimuli. Interference, or attentional bias, is calculated as participants' mean reaction time to the alcohol stimuli *minus* their mean reaction time to the neutral stimuli. The alcohol-Stroop test has been used to assess AAB in both heavy social drinkers (e.g., Cox et al., 1999, 2007; Stewart and Samoluk, 1997) and alcohol abusers (e.g., Bauer and Cox, 1998; Cox et al., 2000, 2002; Fadardi and Cox, 2006; Johnsen et al., 1994; Ryan, 2002; Stetter et al., 1995, 1994; Stormark et al., 2000). The degree of AAB is proportional to the amount of alcohol that participants habitually consume (e.g., abusers > heavy drinkers > social drinkers; Cox et al., 2006; Fadardi and Cox, 2006). In addition, AAB is inversely related to abusive drinkers' ability to control their drinking (Cox et al., 2003, 2007; McCusker, 2001; Roberts and Koob, 1997).

Having an attentional system that is highly sensitized to alcohol, heavy drinkers have alcohol at the focus of their attention, and alcohol-related stimuli thus act as triggers for cognitive, emotional, and behavioral responses, which might be inconsistent with the person's conscious, rational decision not to drink. Moreover, with repeated practice, the act of drinking becomes increasingly automatic, so that the person is unaware of the chain of processes leading to drinking after he or she has encountered the triggering stimuli. For example, when a habitual drinker sees an advertisement for beer on television, a series of cognitive processes is triggered that may lead the person to go through the act of drinking. The sequence begins with exposure to alcohol stimuli, which causes (a) attentional resources to be disproportionately allocated to alcohol-related stimuli, while attention simultaneously is focused away from other stimuli that require controlled processing, and (b) emotional responses to be emitted that fuel the motivation to enact the well-practiced behavioral sequence that culminates in the act of drinking. Such a person would be left feeling perplexed about why he or she drank, having broken the resolve not to do so. This causes the person either to justify the drinking episode, engage in further resolve not to drink but this time with greater hesitation, or loose self-confidence in the ability to control the drinking behavior and feel disappointed. In the person's attempt to cope, these negative emotions might lead to further drinking, initiating a vicious cycle that is very difficult to break. Of course, the importance of attentional bias in the continuation of and relapsing to addictive behaviors is not limited to alcohol use. In fact, theories explaining the origin of addiction-related attentional bias and its relationship to addictive behaviors do not make a distinction between the various substances of abuse (Cox et al., 2006). For reviews of the literature on substance-related attentional bias and the theories explaining it, we refer interested readers to Cox et al. (2006), Field and Cox (2008), and Wires et al. (2007).

Although the evidence for the cognitive basis for the uncontrollability phenomenon is compelling, there is a wide gap between existing knowledge and its practical applications to problematic drinking. Prior researchers using the alcohol-Stroop test have focused on variables related to drinkers' AAB, while not taking into account the potentially important role of drinkers' cognitive reactions to alcohol stimuli in explaining their preoccupation with alcohol (e.g., Stetter et al., 1994). Nevertheless, the prior research clearly suggests the feasibility of training problem drinkers to overcome their attentional bias for alcohol-related stimuli as a means of helping them control their excessive drinking (e.g., Wiers et al., 2006).

There have been various attempts to change drinking behaviors by changing alcohol-related cognitive processes. For example, the expectancy challenge seeks to reduce harmful drinking by changing drinkers' expectations about drinking-related outcomes (Darkes and Goldman, 1993, 1998; Musher-Eizenman and Kulick, 2003; Wiers and Kummeling, 2004). Both Field et al. (2007) and Schoenmakers et al. (2007) used a visual probe task to train heavy drinkers in a single session to avoid attending to alcohol-related stimuli. In both of these studies, the heavy drinkers showed post-training reductions in AAB as measured with the visual probe test, but the reduction in AAB was shown neither to generalize to other measures of attentional bias nor to affect the participants' drinking behavior in the real world.

### 1.1. Alcohol Attention-Control Training Program (AACTP)

The AACTP is a computerized intervention designed to help hazardous and harmful drinkers overcome their AAB and, thereby, to gain more control over their drinking. As Noel et al. (2001) reported, inhibition and working-memory deficits interfere with drinkers' ability to maintain short-term abstinence from alcohol. Specifically, these deficits, measured at the end treatment, predicted relapse to abusive drinking after 2 months. Thus, it would be expected that an intervention aimed at improving drinkers' inhibitory processes would help reduce their risk for relapse. Bowden et al. (2001) demonstrated that alcohol abusers could be trained to gain better control of their executive functions in general (but distraction for alcohol was not the focus of the training). It is noteworthy, however, that apart from a few studies (e.g., Fadardi, 2003; Field et al., 2007; Schoenmakers et al., 2007; Wiers et al., 2006), prior research has not assessed the impact of AAB training on trainees' alcohol

consumption. The present study was the first attempt to measure across time the effects of multiple AAB training sessions on heavy drinkers' AAB and their habitual alcohol consumption in the real world.

The AACTP was developed to help drinkers defuse the automatic chain of drink-seeking and drink-taking behaviors, enabling them to gain better control over their attentional distraction for alcohol-related stimuli. The intervention serves two important functions that potentially underlie the training effects. *First*, it aims to correct the fact that excessive drinkers' are uncontrollably drawn to alcohol stimuli instead of attending to other kinds of stimuli. *Second*, it aims to decrease the length of time drinkers need to divert their attention away from alcohol once it has captured their attention. The deficit in disengaging attention is related to generally slowed reaction times due to poor inhibitory and executive cognitive functioning (ECF) associated with excessive drinking (e.g., Giancola and Moss, 1998), which reduces cognitive sharpness in responding to environmental stimuli (e.g., Stormark et al., 2000). Because of this impairment, heavy drinkers are less able than other people to effectively divert their attention away from distracting stimuli.

### 1.2. Overview of the study

The goals of the present study were as follows: (a) to assess the discriminative validity of the alcohol-Stroop test used in this study by comparing social, hazardous, and harmful drinkers' AAB; (b) to determine whether training hazardous drinkers with the AACTP in just two sessions would reduce their AAB; and (c) to determine whether training harmful drinkers in four sessions would reduce both their AAB and their alcohol consumption and bring about other positive drinking-related outcomes.

## 2. Method

### 2.1. Primary measures

#### 2.1.1. Cognitive flexibility

The classic-Stroop test was used to measure participants' general cognitive flexibility. The stimuli were the names of four colors (viz., red, yellow, blue, and green) written either in a congruent font color (e.g., *red* in red) or an incongruent one (e.g., *red* in yellow). The congruent and incongruent words were presented 12 times each (i.e., $4_{words} \times 3_{colors} \times 4_{times}$) for a total of 96 times.

#### 2.1.2. Attentional bias

Attentional bias for alcohol and other concern-related stimuli was measured with the alcohol and concern-related Stroop tests. To avoid potential practice effects from the baseline to the follow-up administrations of the test, two parallel versions of the Stroop test were used. One version was randomly selected for the baseline administration, and this selection determined whether the three administrations would be counterbalanced as ABA or BAB. All participants saw the same sets of words. The concern-related words were based on descriptions of heavy drinkers' personal concerns that they had given in earlier studies. In each version of the Stroop test, there were seven alcohol-related words, seven concern-related words, and seven control words.[1] Within each category, the words were presented 56 times (i.e., $8_{words} \times 4_{colors} \times 2_{times}$), making a total of 192 trials. The three categories of words were matched for word frequency and length, number of syllables, and semantic relatedness. The concern-related words represented eight life areas with which participants are most frequently concerned. Concern-related interference was measured in order to determine whether improvements in attentional bias from the AACTP training were alcohol-specific or generalized to other personally relevant stimuli. The total spoken and written frequencies of words in British English were taken from CELEX (Baayen et al., 1993), which is the most recent lexical database.

[1] On the Stroop Test Version One, the alcohol-related words were: bar, beer, rum, scotch, tequila, vodka, and whisky; the concern-related words were: appearance, family, health, home, love, studies, and work, and the control words were: ceiling, cupboard, fence, gate, shed, tap, and toilet. On the Stroop Test Version Two, the alcohol-related words were: booze, cider, cocktail, drink, gin, sherry, and spirit; the concern-related words were: confidence, education, friends, household, illness, job, and sex; and the control words were: balcony, bath, fireplace, lamp, porch, sink, and stairs.

#### 2.1.3. Situational confidence

The Situational Confidence Questionnaire (SCQ; Annis and Graham, 1988) was used to measure participants' self-efficacy with respect to specific drinking situations (i.e., pleasant emotions, unpleasant emotions, urges and temptations, positive social situations, social tension, social problems at work, physical discomfort, and testing personal control). On the SCQ, respondents are asked to imagine themselves in various situations, and for each to indicate how confident they are that they will be able to resist the urge to drink in that situation. Responses on the SCQ are made on a Likert scale ranging from 0 (*Not At All Confident*) to 100 (*Very Confident*). The SCQ yields a total score and scores on eight subscales.

#### 2.1.4. Motivation to change

Participants' motivation to change was measured with the Readiness To Change Questionnaire (RTCQ; Heather et al., 1993; Rollnick et al., 1992), which assigns respondents to the precontemplation, contemplation, or action stage. Each question has five response choices that range from *Strongly Disagree* to *Strongly Agree*. A total readiness to change score can also be derived from RTCQ. The RTCQ was used to determine whether the AACTP training affected the hazardous and harmful drinkers' intentions to change their drinking. We hypothesized that participants' awareness of their automatic distraction by alcohol stimuli and the feedback on their progress with controlling it would increase their motivation for change their drinking.

#### 2.1.5. Alcohol consumption

The Typical and Atypical Alcohol Diary (TAAD, Hogan, 2005) measures the frequency of respondents' typical (usual) and atypical (e.g., episodic) drinking and the quantity of alcohol drunk on each occasion. A quantity × frequency index for each kind of drinking is then calculated.

### 2.2. Secondary measures

#### 2.2.1. Positive and negative affect

Participants' affect was measured with the Positive Affect and Negative Affect Schedule (PANAS; Watson et al., 1988), which contains 10 positive and 10 negative affect words, responses to which yield separate Positive Affect (PA) and Negative Affect (NA) scores. For each word, the respondent uses a five-point scale to indicate how much he or she experiences the feeling. The PANAS was included to determine whether the AACTP affected participants' positive and negative affect.

#### 2.2.2. Socio-demographic characteristics and use of services

The Client Socio-Demographic and Service Receipt Inventory (CSSRI, Chisholm et al., 2000) identifies respondents' service utilization and related demographic characteristics as a basis for calculating costs of care. It was included to determine whether the AACTP intervention would affect participants' frequency of service use (e.g., hospital, police) and their medication profile and self-reliance.

#### 2.2.3. Self-rating at intake

The Self-Rating at Intake (SRI, Simpson, 1998) includes nine subscales: Self-Esteem, Anxiety, Decision Making, Self-Efficacy, Childhood Problems, Hostility, Risk Taking, and Social Conformity. On the SRI responses are made on a seven-point Likert scale ranging from *Strongly Disagree* to *Strongly Agree*. The SRI was included because it provides information about important aspects of psychological and social functioning on which individuals in a therapeutic program might benefit.

#### 2.2.4. Drinking-related problems

The Short Inventory of Problems (SIP; CASAA, 1994) was used to measure participants' problems associated with their consumption of alcohol. On the SIP, there are four response options that indicate the extent to which the drinking-related problem has been experienced (from "not at all" to "very much"). The four scales measure physical, intrapersonal, interpersonal, impulse control, and social responsibility problems that might result from excessive drinking.

#### 2.2.5. Drinking-related locus of control

The Drinking-Related Internal-External Locus of Control Scale (DRIE, Keyson and Janda, 1972) includes three subscales and measures drinkers' perception of their own ability to control their drinking versus its being controlled by external factors. The DRIE contains 25 pairs of questions; for each pair, the respondent decides which statement better applies to him or her.

#### 2.2.6. Motivational structure

Motivational structure was measured with the Personal Concerns Inventory (PCI; Cox and Klinger, 2004). On the PCI, respondents describe their current concerns in various life areas and their goal for resolving each concern. They then rate their goal strivings along various dimensions (e.g., degree of control, expected chances of success) that reveal the structure of their motivation (the characteristic manner in which they pursue their goals). The rating scales are answered on an 11-point Likert scale ranging from 0 (the least amount) to 10 (the greatest amount) of each goal-striving dimension. From the rating scales, adaptive motivation scores can be calculated.

**Table 1**
Mean and standard deviations of age, education, weekly mean drinking, and number of days since last drink for study one, separately for males and females.

| Drinker | N | Age | | Education | | Weekly mean drinking | | | | Last drink in days | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Male | | Female | | Male | | Female | |
| | | M | SD | M | SD | M | SD | M | SD | M | SD | M | SD |
| Social | 40 | 30.35 | 12.42 | 10.83 | 2.74 | 12.09 | 10.38 | 6.47 | 7.48 | 2.62 | 3.07 | 8.11 | 9.10 |
| Hazardous | 68 | 22.82 | 3.91 | 12.50 | 1.80 | 47.91 | 33.00 | 41.38 | 27.67 | 2.27 | 3.05 | 2.72 | 3.38 |
| Harmful | 92 | 40.75 | 15.86 | 14.54 | 3.95 | 59.70 | 42.48 | 83.33 | 48.90 | 1.29 | 1.31 | 1.51 | 1.53 |

### 2.3. Procedure

#### 2.3.1. Stroop tests

Before the computerized Stroop tasks were administered, participants were asked to name the colors of the four dots affixed to the "?" [*red*], "<" [*yellow*], "C" [*green*], and "Z" [*blue*] keys on the keyboard (the input device) that corresponded to the four colored patches on the display, in order to ensure that they could differentiate the colors used in the task. Next, participants practiced with warm-up trials, which required them to respond to 50 colored patches. During the tasks, each word was presented in a mixed randomized order, one at a time in *red*, *yellow*, *blue*, or *green*. The stimuli remained on the screen until a response was made or until a 3-s time-limit had elapsed. An intertrial interval (ITI) of 800 ms was used, during which a fixation cross [+] appeared in the center of the display.[2] Manual responses were used because of the technical complexities associated with oral responses, including the necessity to adjust the microphone's sensitivity for each participant and problems controlling extraneous noises (e.g., a participant's coughing) and with accurately recording response errors. Although manual responses might reduce the size of the interference obtained with vocal responses, they still can lead to significant results (Brown and Besner, 2001; MacLeod, 1991; Monahan, 2001). Participants were instructed to ignore the meaning of the stimuli displayed on the screen and to press as *quickly* and *accurately* as possible the color-key that corresponded to the color in which each stimulus was presented. As mentioned, two parallel versions of the Stroop tests were used to reduce practice effects that might result from multiple administrations. The order in which the two versions were administered was counterbalanced across participants.

### 2.4. AACTP training

The AACTP procedure involves three things. *First*, it assesses drinkers' distraction by alcohol-related stimuli, and it helps them understand the meaning and consequences of the distraction and whether or not they could benefit from changing it. *Second*, it actively involves drinkers in the training by helping them to set goals for controlling their distractions. *Third*, it evaluates drinkers' progress while taking part, and it provides them with immediate feedback, in order to increase their motivation to strive for their highest achievable level of performance. The AACTP uses stimuli that are personalized on the basis of the trainee's favorite drinks. The stimuli consist of either alcoholic or nonalcoholic beverage containers that are individually presented on a computer screen in random order. Three increasingly difficult series of stimuli are presented. In the first two series, the alcoholic or nonalcoholic beverage bottles are surrounded by either a background (Series 1) or an outline (Series 2), both of which are in one of four colors—red, yellow, blue, or green. There is a third series of stimuli, in which pairs of bottles (one alcoholic, one nonalcoholic) appear simultaneously on the screen, both of which are surrounded by a colored outline. Whether the alcoholic or the nonalcoholic stimulus is on the right or the left is determined randomly on each trial. In the first two series, the participant's task is to name the color of the background or the outline as quickly as possible, while ignoring the remainder of the stimulus. In the third series, the participant names the outline color of the nonalcoholic container, while ignoring the alcoholic one. On the first and second series, color-naming latencies are recorded, and interference scores are calculated by subtracting mean reaction times to the nonalcoholin stimuli from mean reaction time to the alcohol stimuli. Mean reaction times, number of errors on alcoholic and nonalcoholic trials, and interference scores are used to give immediate feedback to the trainee at the end of each training interval and to determine the speed of the stimulus presentation on the next interval. On the third series, only mean reaction time to the pairs of stimuli is recorded and used for the feedback.

The training occurs in three hierarchical steps, arranged according to increasing level of difficulty. The difficulty varies in terms of (a) which of the three series of stimuli are presented and (b) the time limit set for completing (ranging from 3000 to 600 ms).

#### 2.4.1. AACTP procedure

Two full sets (i.e., Series 1–3) of the AACTP training are given during each session. Before each task is started, the researcher and trainee jointly agree on a time limit that seems achievable for that trainee. The researcher explains the meaning of time limits and suggests a reasonable goal for the person to strive for. If on any trial the participant does not respond before the limit is reached or an incorrect response is made, the trial ends and a warning signal appears. However, to avoid frequent negative feedback, the participant is guided into selecting a time limit that is only somewhat longer than his or her prior mean reaction speed. The participant is given positive feedback via the computer when a performance goal has been reached. The criterion for having made progress is defined as making errors on fewer than 10% of the trials within the pre-defined time limit during a given training session. After completing each stage of the training, the participant is given graphical feedback as follows: (a) mean reaction time in the presence of the alcoholic and nonalcoholic beverage bottles; (b) an alcohol interference score (an index of alcohol attentional distraction); and (c) interpretation of what these scores mean. The goal is to motivate the participant to actively take part in the program in a meaningful and goal-directed way. During each sequential stage of the training, the participant is encouraged to set a goal for decreasing his or her reaction times to the alcoholic bottles until his or her own performance plateau has been reached.

Each training set begins with the stimuli with colored backgrounds (the easiest in the series); continues with the single stimuli with colored outlines (an intermediate level of difficulty); and concludes with the paired stimuli (the most difficult). Practice with each of the three tasks within a set is interspersed by 5 min of rest. The participant is asked to rest for 10 min between the two training sessions within a given day. Finally, the researcher makes every effort to ensure that participants always terminate the training sessions feeling good about the level of progress that they had achieved.

### 2.5. Apparatus

SuperLab Pro (SKD) software for Windows (Cedrus-Corporation, 1999) was used to present the Stroop tests and the AACTP. On the Stroop tests, words (in Century School Book, 48-point bold on a black background) were presented individually in the center of a 17-in. color display. The viewing distance was 36–40 cm. A standard keyboard was used as the input device. A colored dot in either red, yellow, blue, or green was placed on four of the keys; on each trial the participant responded by pressing one of these keys. SuperLab Pro automatically recorded the participant's reaction time, errors (incorrect or delayed responses). The stimuli were randomly presented based on the software's timing option. A template written in Microsoft Office Excel program was used to quickly calculate each participant's errors and mean reaction times for each category of stimuli presented during the Stroop tests and the AACTP training.

### 2.6. Participants

#### 2.6.1. Sample one

Social drinkers ($N = 40$; 14% male) were recruited from the Bangor University School of Psychology's Community Participant Panel and through announcements on the university intranet. The aim of the study was described as to try to identify the processes associated with people's drinking habits and to see how fast drinkers can react to various kinds of words printed in different colors. Participants were told that they would complete computerized task and an alcohol consumption questionnaire. Participants were required to be 18 years old or older and to drink below the U.K. Department of Health's (2005) cut-off points for unhealthy drinking, i.e., 21 units of alcohol/week for males and 14 units/week for females (see Table 1). Participants were also required not to have drunk alcohol for at least 6 h prior to each testing session.

Participants were tested individually. They first gave written informed consent. Then they were administered the classic, alcohol, and concern-related Stroop tests, the PANAS, and the TAAD. Participants were debriefed and were paid for their time.

#### 2.6.2. Sample two

Participants ($N = 68$, 28% male) were recruited through the PCPP and the intranet. An inclusion criterion was that the habitual alcohol consumption was at a hazardous level according to the U.K. Department of Health's guidelines (22–50 units of alcohol/week for males, 15–35 units/week for females; Department of Health, 2005). The study was announced as one that aimed to identify people's thought processes that affect their drinking behavior and to find ways to help people change their drinking habits. Before giving informed consent, participants were informed that they would attend two AACTP training sessions, one after the baseline assessment and the other one immediately before the second assessment 1 week later.

[2] The ITI, the time between two consecutive trials, has not been consistent across studies and has varied from very short (e.g., 32 ms) to very long (e.g., 1500 ms) (e.g., Kindt et al., 1997; Sharma and McKenna, 2001).

At the baseline assessment, participants were administered the Stroop tests, TAAD, PANAS, and RTCQ. They then had the first training session—there was a 15-min gap between testing and training. One week later, they returned for the second AACTP training session and then were given the same tests as at the baseline. One of the two versions of each Stroop test was randomly selected for administration with each participant at baseline, and the other version was administered at the post-training assessment.

*2.6.3. Sample three*

Participants ($N = 92$, 87% male) were recruited through the Community Participant Panel and the intranet, They were required to meet the criterion for harmful drinking, that is, to be a man who drank more than 50 units of alcohol/week or a woman who drank more than 35 units/week (Department of Health, 2005). The study was again announced as one that aimed to identify people's thought processes that are associated with their drinking behavior and to find ways to help drinkers change their behavior. Participants were told that there would be four computerized training sessions and that they would be asked to return for a follow-up assessment 3 months later. Among participants who completed the first baseline assessment, 82.6%, 60%, and 54.3%, respectively, returned for the second baseline, the post-test, and the follow-up assessment. Compared to participants who were still in the study at each assessment point, those who dropped out before the second baseline assessment scored lower on SRI Decision Making ($t_{90} = 2.09$, $p = .03$); those who dropped out before the post-test assessment were higher on hostility ($t_{75} = 2.59$, $p = .011$), SIP Interpersonal ($t_{75} = 3.11$, $p = .012$), SIP Impulse Control ($t_{75} = 2.56$, $p = .011$), SIP Social Responsibility ($t_{75} = 3.05$, $p = .003$), and SIP Total ($t_{75} = 3.04$, $p = .003$), but they were higher on SCQ Unpleasant Emotions ($t_{75} = 2.13$, $p = .031$), SCQ Social Problems at Work ($t_{75} = 2.01$, $p = .021$), SCQ Physical Discomfort ($t_{75} = 2.4$, $p = .023$), and Situational Confidence ($t_{75} = 2.01$, $p = .042$). Participants who completed all four assessments ($N = 50$; 86.0% male) had a mean age of 42.71 ($SD = 16.57$) years and a mean education of 14.60 ($SD = 2.88$) years. On average, they had drunk 10.10 ($SD = 6.43$) units of alcohol on their last drinking occasion, which had occurred 1.10 ($SD = 1.51$) days prior to their first baseline assessment.

To determine whether improvements in participants' AAB and alcohol consumption from before to after the AACTP training were due to the training, participants completed the two baseline assessments that were separated by 4 weeks. At the first baseline and the follow-up assessments, participants were given the CSSRI, SRI, SIP, SCQ, PANAS, DRIE, RTCQ, TAAD, PCI, and the Stroop tests. At the second baseline and post-test assessments, they were given all of these measures except for the CSSRI, SRI, and the PCI. Alternating versions of the alcohol- and concern-related Stroop tests were randomly selected for administration to a given participant at each assessment point. Participants completed four sessions of the AACTP training. The first training session occurred immediately after the second baseline assessment; thereafter, each session occurred at weekly intervals. The post-training assessment was given 15 min after the last training session. The follow-up assessment was given 3 months later.[3]

## 3. Results

### 3.1. Discriminative validity

First, classic, alcohol, and concern interference scores were calculated, respectively, as mean RT on incongruent color words minus mean RT on congruent color words; alcohol-related words minus control words; and concern-related words minus neutral words (see Table 2). Next, to compare the two versions of each Stroop test, preliminary analyses of variance were conducted on the three kinds of interference scores. For the hazardous and the harmful drinkers, Stroop interference scores were calculated from the first baseline assessment. Results confirmed that two versions of the classic [$F(1, 130) = 1.79$, $p = .18$], alcohol [$F(1, 130) = 0.22$, $p = .64$], and concern [$F(1, 130) = 1.59$, $p = .21$] Stroop tests were equivalent. To determine the discriminative validity of the classic, alcohol, and concern-related Stroop tests, a multiple analysis of variance was conducted in which the three samples of drinkers (i.e., social, hazardous, and harmful) were compared on the three kinds of Stroop interference. The results showed that there was a main effect (Wilks' Lambda) for Group, $F(6, 390) = 3.68$, $p = .001$, $\eta^2 = .03$ on (a) classic interference, $F(2, 197) = 3.35$, $p = .04$, $\eta^2 = .18$; and on (b) alcohol interference, $F(2, 197) = 7.42$, $p = .001$, $\eta^2 = .04$; but not on (c) concern-related interference, $F(2, 197) = 2.53$, $p = .08$. Pair-wise comparisons showed that on classic-Stroop interference the harmful drinkers were higher than the social drinkers ($p = .039$) and on alcohol interference, both the harmful and hazardous drinkers were higher than the social drinkers ($p < .004$).

Additionally, to confirm that the AAB was proportional to the amount of alcohol that participants consumed, the alcohol interference scores were regressed onto participants' alcohol consumption, gender, age, PA and NA, and classic-Stroop interference scores controlled. The alcohol interference scores, in fact, accounted for a 2.6% increase in the variance in alcohol consumption, $F(1, 192) = 3.54$, $p = .003$, over the proportion (i.e., 7.2%) that was already explained by the other variables in the model, $F(5, 193) = 2.98$, $p = .013$, thus confirming the hypothesized relationship.

### 3.2. Effects of AACTP training

*3.2.1. Hazardous drinkers.* If training with the AACTP is alcohol-specific, alcohol but not concern interference should decrease from pre- to post-training. However, classic interference would be expected to decrease for the reasons explained below. This hypothesized pattern of reductions in interference (or the lack of them) would confirm that improvements in alcohol-Stroop interference from pre- to post-AACTP training result from the training and are not due merely to practice with the keyboard. To test these assumptions, a repeated-measures analysis of variance was performed on the pre- and post-training interference scores, in which level of alcohol consumption (low: $M = 10.36$ units/week; $SD = 5.41$; medium: $M = 39.79$; $SD = 11.71$; high: $M = 75.75$; $SD = 20.35$)[4] were between-participants variable and classic, alcohol, and concern-related interference scores were the dependent variables. There were main effects for Interference, $F(2, 130) = 57.64$, $p = .004$, $\eta^2 = .47$; and Time, $F(2, 65) = 8.35$, $p = .005$, $\eta^2 = .11$; and a significant interaction between Time (i.e., pre-training vs. post-training) and Interference (i.e., classic, alcohol, concern-related), $F(2, 130) = 6.15$, $p = .003$, $\eta^2 = .08$. The other two-way and three-way interactions were not significant. Post hoc $t$-tests for dependent samples showed a significant reduction from pre- to post-training in classic interference, $t(67) = 3.79$, $p = .001$; and in alcohol interference, $t(67) = 2.42$, $p = .02$, but not in concern-related interference, $t(67) = 0.094$, $p = .92$.

To determine whether the AACTP training affected the hazardous drinkers' motivation to change their drinking, a repeated-measures analysis of variance was conducted in which Time (i.e., Pre- and Post-Training) and RTCQ Stages of Change scores were the within-participants factors, and level of alcohol consumption (low, medium, or high) was the between-participants factors. There were significant interactions between (a) Time and Alcohol Consumption, $F(4, 130) = 5.16$, $p = .001$, $\eta^2 = .14$; and (b) RTCQ Stages of Change and Time, $F(2, 130) = 3.65$, $p = .03$, $\eta^2 = .05$. Post hoc $t$-tests for dependent samples showed that the heaviest drinkers' ($N = 23$, Mean Weekly Drinking = 74.88 units, $SD = .20.35$) RTCQ Action Stage scores increased from pre-training ($M = -.04$, $SD = 2.8$; 2.26% of the participants were in the Action State) to post-training ($M = .10$, $SD = 3.24$; 4.24% of the participants were in the Action Stage), $t(22) = 2.34$, $p = .03$. Thus, the AACTP training not only reduced drinkers' AAB; it also increased the heaviest drinkers' motivation to change their drinking.

[3] In summary, the AACTP training procedure was the same for hazardous and harmful drinkers, except that the hazardous drinkers received the training twice. The hazardous drinkers completed fewer tests than the harmful drinkers, and they had only one baseline assessment and no follow-up assessment. The hazardous drinkers' alcohol consumption was not measured at the post-training assessment because that assessment occurred only 1 week after the baseline assessment.

[4] Levels of drinking were calculated to determine whether changes in participants' level of alcohol consumption co-varied with their interference scores. The levels were determined through SPSS ranking command, which divided the sample into three equal halves.

**Table 2**
Mean and standard deviations of classic, alcohol- and concern-related Stroop interference, separately for social, hazardous, and harmful drinkers.

| Stroop interference at first-pretest | Social drinkers | | Hazardous drinkers | | Harmful drinkers | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Classic Stroop | 73.55 | 61.22 | 81.79 | 57.73 | 97.14 | 71.34 |
| Alcohol Stroop | −2.30 | 45.12 | 18.04 | 49.86 | 24.20 | 45.17 |
| Concerns Stroop | −0.40 | 35.83 | 11.57 | 42.75 | 8.26 | 39.12 |

### 3.2.2. Harmful drinkers.

*3.2.2.1. Primary analyses.* To determine whether the AACTP helped harmful drinkers reduce their attentional bias and whether the reductions were alcohol-specific, a repeated-measures analysis of variance was run in which interference scores (classic, alcohol, and concern-related) were the dependent variables and level of alcohol consumption (low: $M = 14.30$ units/week; $SD = 3.35$; medium: $M = 37.33$; $SD = 11.02$; high: $M = 105.18$; $SD = 84.32$) and RTCQ (low, medium, and high) were the between-participants factors, and Time (across four assessment points) was the within-participants factor. A similar pattern of results was obtained as with the hazardous drinkers. There were significant main effects for Interference (AAB), $F(2, 78) = 94.30$, $p = .001$, $\eta^2 = .71$, and Time, $F(3, 117) = 14.82$, $p = .001$, $\eta^2 = .28$. In addition, there was a significant interaction between Time and Interference (AAB), $F(6, 234) = 3.10$, $p = .006$, $\eta^2 = .074$, but the three-way and four-way interactions were not significant. Post hoc *t*-tests for dependent samples showed that (a) on classic-Stroop interference, there were significant reductions from Baseline 1 to Baseline 2, $t(47) = 2.30$, $p = .026$; and from Baseline 2 to Post-Training, $t(47) = 2.94$, $p = .005$; but no change from Post-Training to Follow-Up, $t(47) = 1.40$, $p = .16$. (b) On alcohol-Stroop interference, there was not a significant reduction from Baseline 1 to Baseline 2, $t(47) = -1.07$, $p = .28$; however, there was a significant reduction from Baseline 2 to Post-Training, $t(47) = 3.47$, $p = .001$; but no change from Post-Training to Follow-Up, $t(47) = 1.46$, $p = .15$. (c) On concern-related Stroop interference, there was no significant reduction from Baseline 1 to Baseline 2, $t(47) = 1.49$, $p = .14$; from Baseline 2 to Post-Training, $t(47) = 0.03$, $p = .97$; or from Post-Training to Follow-Up, $t(47) = 0.36$, $p = .71$.

To determine whether the AACTP training resulted in reductions in the harmful drinkers' alcohol consumption, a repeated-measures analysis of variance was conducted on participants' alcohol consumption across the four assessment points. The results indicated a significant main effect for consumption, $F(3, 135) = 5.92$, $p = .001$, $\eta^2 = .12$ (see Fig. 1). Post hoc *t*-tests for dependent samples showed that there was no change from Baseline 1 to Baseline 2, $t(47) = 0.78$, $p = .43$; a significant reduction from Baseline 2 (i.e., Baseline 2) to Post-Training (Post-Training), $t(47) = 3.24$, $p = .002$; and no change from Post-Training to Follow-Up (i.e., Follow-Up).

In a repeated-measures analysis of variance, RCT scores were entered as the dependent variable and Time (i.e., four assessment points) was entered as the within-participants factor. There were significant main effects for Time, $F(3, 138) = 5.54$, $p = .001$, $\eta^2 = .10$; RTCQ, $F(2, 92) = 10.64$, $p = .0001$, $\eta^2 = .18$; and the interaction between Time and RTCQ, $F(6, 276) = 4.18$, $p = .0001$, $\eta^2 = .08$. Post hoc *t*-tests for dependent samples showed a significant increase in RCT Action scores from pre- to post-training, $t(47) = 2.62$, $p = .01$.

*3.2.2.2. Secondary analyses.* The goal of the secondary analyses was to determine (a) whether improvements in participants' functioning other than their alcohol consumption (e.g., alcohol-related problems, self-efficacy, affect) occurred as a result of the AACTP training, and (b) whether participants' characteristics at baseline predicted the outcome of the AACTP training.

First, to determine whether participants' motivational structure at baseline affected the training outcome (at the post-training and follow-up), an analysis of variance was conducted in which the dependent variable was alcohol consumption at each assessment point and the fixed factor was three levels of adaptive motivation at Baseline 1 (low, medium, and high). The results showed a main effect for adaptive motivation, $F(2, 49) = 5.21$, $p = .009$. Pairwise comparisons showed that AACTP trainees who were highest on adaptive motivation at the first baseline drank significantly less alcohol at the follow-up than those who were medium or low on adaptive motivation ($p < .02$).

Additional analyses of variance were conducted to assess the effect of motivational structure at baseline on alcohol-control indices at follow-up. The results showed main effects for Self-Efficacy, $F(2, 49) = 3.27$, $p = .04$; External Locus of Control, $F(2, 49) = 3.50$, $p = .04$; and Interpersonal Control, $F(2, 49) = 4.93$, $p = .01$. Pair-wise comparisons showed that AACTP trainees who at the first baseline were highest on adaptive motivation improved more on self-efficacy and the control indices than those who were medium or low on adaptive motivation ($p < .02$).

To assess the other indices of improvement across the four assessment points, repeated-measures of analyses of variance were conducted on the PANAS, SIP, SCQ, DRIE, SRI, and CSSRI scores (see Table 3). Although there was a reduction in PA from Baseline 1 to Baseline 2, PA significantly increased from Baseline 2 to both post-training and follow-up; there was no change in NA across the four assessment points. On SIP total scores, there was a significant reduction from Baseline 1 to post-training and from Baseline 2 to the follow-up. On the SCQ, total scores were significantly higher at follow-up than at any other assessment points. On the SCQ subscales, there were increases from post-training to the follow-up on confidence to control Urges and Temptations, Positive Social Situations, and Testing Personal Control.

Additionally, DRIE total scores (external locus of control) decreased from Baseline 2 to post-training and from post-training

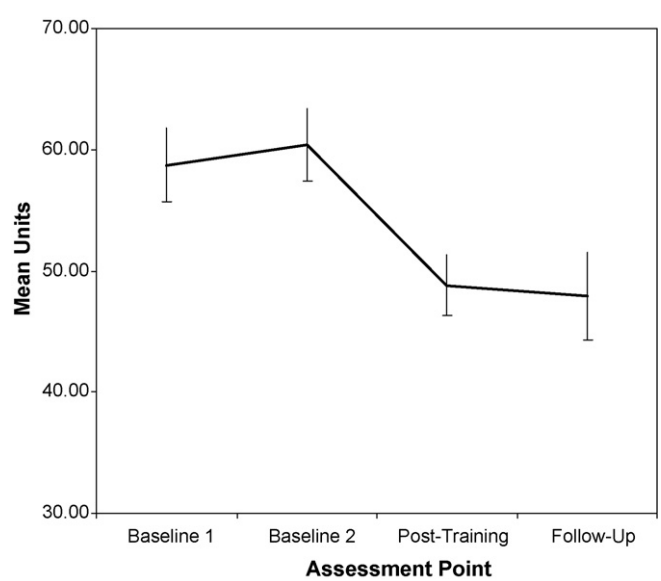


**Fig. 1.** Changes in alcohol abusers' weekly mean alcohol consumption from the first baseline to the follow-up. The AACTP training occurred between second baseline and the post-training assessment.

**Table 3**
The results of repeated-measures of analyses of variance to test changes in drinking-related indices from pre- to post-training.

| Dependent variable | Effect | d.f. (factor) | d.f. (error) | *F* | *p* | ES ($\eta^2$) | Pair-wise comparison |
|---|---|---|---|---|---|---|---|
| Positive Affect and Negative Affect Schedule (PANAS) | PANAS | 1 | 47 | 35.15 | .001 | .42 | PA: Baseline 1 > Baseline 2 < Post-Training < Follow-Up*; NA: no significant change |
| | Time | 3 | 141 | 3.20 | .032 | .06 | |
| | PANAS × Time | 3 | 141 | 9.31 | .001 | .16 | |
| Drinking-Related Problems Total Score (SIP Total) | SIP Total | 3 | 147 | 4.99 | .003 | .09 | Baseline 1 > Post-Training**; Baseline 2 > Follow-Up** |
| SIP Sub-Scales | SIP | 4 | 172 | 8.29 | .001 | .16 | |
| | Time | 3 | 129 | 7.51 | .007 | .09 | |
| | SIP × Time | 12 | 516 | .72 | .73 | .02 | |
| Situational Confidence Total Score (SCQ Total) | SCQ Total | 3 | 141 | 4.99 | .003 | .09 | Baseline 1 = Baseline 2 = Post-Training < Follow-Up** |
| Situational Confidence (SCQ subscales) | SCQ Subscales | 7 | 308 | 34.23 | .001 | .44 | SCQ in urges and temptations, positive social situations, and testing personal control: Post-Training < Follow-Up** |
| | Time | 3 | 132 | 2.82 | .04 | .04 | |
| | SCQ Subscales × Time | 21 | 924 | 2.33 | .001 | .05 | |
| Drinking-Related Internal-External Locus of Control Scale Total Score (DRIE External) | DRIE External | 3 | 144 | 10.77 | .001 | .18 | External Locus of Control: Baseline 2 = Post-Training > Post-Training = Follow-Up** |
| Subscales of DRIE | DRIE Subscales | 2 | 94 | 30.98 | .001 | .40 | Intrapersonal: Baseline 2 > Post-Training**; Interpersonal: Post-Training > Follow-Up*; General Control: Baseline 2 > Post-Training** |
| | Time | 3 | 141 | 7.91 | .001 | .14 | |
| | DRIE Subscales × Time | 6 | 282 | 3.23 | .004 | .06 | |
| Subscales of SRI | SRI Subscales | 8 | 360 | 54.45 | .001 | .56 | Depression: Baseline 1 > Follow-Up**; Self-Efficacy: Baseline 1 < Follow-Up** |
| | Time | 1 | 45 | 3.45 | .07 | .07 | |
| | SRI Subscales × Time | 8 | 360 | 3.55 | .001 | .07 | |
| Subscales of CSSRI | CSSRI Subscales | 10 | 490 | 16.13 | .001 | .24 | Time Spent in Primary Services: Baseline 1 > Baseline 2** |
| | Time | 1 | 49 | 4.06 | .04 | .08 | |
| | CSSRI Subscales × Time | 10 | 490 | 3.99 | .001 | .08 | |

* $p < .05$.
** $p < .01$.

to the follow-up. On the DRIE subscales, there were significant reductions (i.e., greater internal control) on (a) the Intrapersonal scale from Baseline 2 to post-training; (b) the Interpersonal scale from post-training to follow-up; and (c) the General Control scale from Baseline 2 to post-training. On the SRI, depression decreased and self-efficacy increased from Baseline 1 to follow-up. On the CSSRI, there was a significant reduction from Baseline 1 to Baseline 2 in time spent in primary services.

## 4. Discussion

The goals of the present study were (a) to compare the AAB of social, hazardous, and harmful drinkers in order to determine whether these drinkers' AAB co-varied with the amount of alcohol consumed that they habitually consumed, (b) to determine whether AACTP training would reduce hazardous and harmful drinkers' alcohol-specific distractions and improve their readiness to change their drinking, and (c) to determine whether reductions in harmful drinkers' AAB would be accompanied by reductions in their alcohol consumption and improvements in their well-being. We also aimed to identify drinkers' baseline characteristics (e.g., motivational structure, readiness to change) that would moderate the alcohol-specific improvements resulting from the training.

Both the hazardous and the harmful drinkers showed significantly higher AAB than the social drinkers on the Stroop tests used in the current study. This result supports the validity of the alcohol-Stroop test as a measure of alcohol-related attentional bias (see Cox et al., 2006). Moreover, the harmful drinkers showed larger interference on the classic-Stroop test than the social drinkers, a result that is consistent with earlier findings (e.g., Curtin and Fairchild, 2003; Fadardi and Cox, 2006) and which suggests that harmful drinking adversely affects drinkers' cognitive flexibility and inhibitory control. Participants' AAB was also positively correlated with the amount of alcohol that they habitually consumed, after the effects of age, gender, mood, and classic-Stroop interference had been controlled. This result supports Fadardi and Cox's (2006) finding that AAB is not an artifact of drinkers' general cognitive flexibility, and it suggests that AAB occurs independently of participants' current mood. The latter possibility, however, needs to be confirmed in future research in which participants' mood is experimentally manipulated while they take an alcohol-Stroop test.

During the initial, 1-month waiting period, neither the harmful drinkers' AAB nor their alcohol consumption decreased, nor did any of the indicants of their well-being improve. Following training with the AACTP, however, their AAB but not their concern-related attentional bias decreased, and the reduction was maintained across a 3-month period. Similar to the hazardous drinkers, the pattern or reductions in harmful drinkers' AAB across the four assessment points indicates that the AACTP training had an alcohol-specific effect. That is, if the reduction in participants' AAB were due to a general practice effect, a similar reduction in the hazardous and harmful drinkers' concern-related attentional bias from before to after the training should have been observed. The classic-Stroop interference of participants who received the AACTP decreased. This outcome was expected because the AACTP requires participants to focus on a demanding task and to maintain their focused attention for the duration of the training. It also requires them to try to increase their precision and speed in ignoring irrelevant dimensions of the task. It is reasonable, therefore, to expect that the trainees' newly developed skill at avoiding attending to alcohol stimuli would also improve their performance on the classic-Stroop task. Nevertheless, it is not yet clear whether the two kinds of improvement are reciprocal, i.e., whether improvement in general cognitive functioning also improves alcohol-attention control.

The most important finding of all, however, was that the reduction in the harmful drinkers' AAB was accompanied by reductions in their alcohol consumption, and both kinds of improvements were maintained at the 3-month follow-up. Training with the AACTP

was also accompanied by improvements in the drinkers' readiness to change, drinking-related locus of control, positive and negative affect, and situational confidence.

It should be noted that, methodologically, the ideal design for evaluating a new intervention is a randomized control trial, in which participants are randomly allocated to either an experimental group or a control group (in which control participants might receive the intervention after the experimental participants have completed the post-treatment assessment). In addiction research, the bulk of the evidence shows that waiting-list control participants do not change during the waiting period (e.g., Bien et al., 1993; Dolan et al., 2003; Moyer et al., 2002; Moyer and Finney, 2004–2005). For example, Miller et al. (1988), who evaluated the Drinker's Check-Up as a brief intervention for early stage problem drinkers, randomly assigned heavy drinkers to one of the three groups. Group A received immediate feedback from the Drinker's Check-up; Group B received the same treatment as Group A in addition to a list of resources and treatment available to them; Group C was placed on a waiting list. All participants were followed up after 6 weeks. In contrast to Groups A and B, Group C showed no improvement during the waiting period. In other words, neither the fact that Group C had a baseline assessment of their alcohol consumption, their awareness that they are in an alcohol intervention study, nor the passage of time altered their drinking behavior.

From their review of research on marital therapy, Baucom et al.'s (2003) suggested that because the majority of studies had shown that waiting-list control participants had not improved, researchers trying to develop a "real-world" intervention might consider using effect-size estimates based on previous studies rather than using "scarce resources" to assign distressed participants as waiting-list controls. In the current research, a primary reason for having a group that received the intervention after a waiting period was the scarcity of resources. That is, it was very difficult to recruit a sufficient number of harmful drinkers from the community in the short period of time in which the study had to be conducted. Our participants received a baseline assessment both before and after the 1-month waiting period, and during that time they showed changes neither in their alcohol attentional bias nor their alcohol consumption. Significant improvements occurred only when the intervention was subsequently introduced.

Despite these encouraging results, it is premature to conclude that the reduction in participants' AAB caused the reduction in their alcohol consumption and the other improvements. For example, participation in the research might have had positive effects, or participants might have been responding to demand characteristics of the research. They might have reduced their drinking of their own accord without participating in the research, but the fact that their drinking did not decrease during the initial, 1-month waiting period suggests that this was not the case. Future research needs to tease apart these and other possible explanations, such as (a) the moderating and mediating role of other drinking-related improvements (e.g., readiness to change) in the relationship between AAB and alcohol consumption, and (b) the brain mechanisms involved in the AACTP training and the brain changes, if any, that occur as a result of the training.

The present results underscore the importance of harmful drinkers' adaptive motivation (Cox and Klinger, 2004) in their success in reducing their drinking. That is, among the drinkers who completed the AACTP training, those who were higher on adaptive motivation at baseline showed greater improvements than those who were low on adaptive motivation. Specifically, at the follow-up, those high on adaptive motivation drank less and improved more on self-efficacy, locus of control, and interpersonal control. These results support earlier findings (Fadardi and Cox, 2008) that both motivational structure and attentional bias predict alcohol consumption and further suggest that a motivational intervention aimed at increasing participants' adaptive motivation given simultaneously with AACTP training would lead to better outcomes than AACTP training alone. This is because the effects of the AACTP might not endure if drinkers lack the motivational skills to find emotional satisfaction without using alcohol. For this reason, we are now evaluating the individual and combined effects of attentional training and motivational restructuring (Life Enhancement and Advancement Program—LEAP; Fadardi et al., 2006) on reductions in excessive drinkers alcohol consumption.

To conclude, the results of the current study support theories of drinking and prior empirical results that suggest that alcohol attentional bias helps to account for the automatic nature of excessive drinking (see Cox et al., 2006; Wiers et al., 2006). They suggest that alcohol attention-control training can be used to improve the effectiveness of treatments for excessive drinking.

## Conflict of interest

Both authors declare that they have no conflicts of interest.

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*Contributors*: The two authors jointly designed the study, wrote the protocol, and managed the literature searches and summaries of previous related work. Fadardi played a major role in the statistical analysis and preparation of the first draft of the manuscript. Cox played a major role in shaping the final version of the manuscript. Both authors contributed to and have approved the final manuscript.

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