Cue-Exposure Therapy to Decrease Alcohol Craving in Virtual Environment

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ABSTRACT

During abstinence from alcohol, craving is elicited by the cues and contexts previously associated with alcohol, which contribute to relapse. To prevent the craving and relapse experienced by alcoholics, cue-exposure therapy (CET) has been used to extinguish the association between alcohol and alcohol-related cues and contexts. This study applied CET, using a virtual reality (VR) system, to eight members of an Alcoholics Anonymous group for eight sessions. Cues and contexts most likely to elicit an urge to drink were selected through a preliminary survey in order to compose VR-CET scenarios: a glass, a bottle, food, and a bar were judged to be the most tempting for people in alcohol dependence and abstinence. Using these cues and contexts, a Japanese-style pub and a western bar were created. Each session was administered for 30 minutes by a psychiatrist and included an introduction, immersion, VR navigation, interviews about feelings, and self-report questionnaires about cravings. The eight sessions consisted of initial and closing sessions and person-, object-, and situation-focused sessions. As a result, a reduction in cue-elicited craving after VR-CET was reported. A mean score of 15.75 ($SD = 10.91$) on the Alcohol Urge Questionnaire in the first session decreased to 11.50 ($SD = 5.76$) in the final session. This study suggests that using virtual reality can enhance the effectiveness of CET.

INTRODUCTION

CRAVING IS CONSIDERED one of the reasons many drug users and alcoholics fail to exercise restraint even after treatment. One of the explanations for craving is based on Pavlovian conditioning: some contexts or objects (e.g., bottles, glasses, and bars) are repeatedly paired with addictive substances (unconditioned stimuli: US) such that the contexts or objects become conditioned stimuli (CS) that can elicit the addict's urge (conditioned response: CR) to use, just as an unconditioned response (UR) to addictive substances occurs. After this conditioning, the addict feels the craving when confronted with the CS. Thus, the cue that evokes cravings is regarded as an activator of addictive behaviors.

Other researchers have offered a different explanation of the cue's effects: Tiffany[1] suggested that rather than eliciting cravings, drug-related cues provoke automatic behaviors, such as drug use, that have been formed through repeated administration. For example, if a person has been accustomed to dropping by a grocery store, buying alcohol, and then drinking every day, the person would buy alcohol and drink automatically after seeing a favorite brand of alcohol in a shop even while he or she is abstinent. In any event, because cues contribute to

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relapse to some extent, many researchers and practitioners have tried cue-exposure therapy (CET) to reduce cue-reactivity.[2] CET aims at extinguishing the associated responses (CR) through repeated exposure to the cues related to addictive substances but without consuming the US.

CET has been applied to the treatment of addictions to a variety of substances, including cigarettes,[3,4] alcohol,[5,6] and illicit drugs.[7,8] However, the effect of CET has not been consistent. Tiffany and Conklin[2] supposed that some CET studies failed to prevent relapse because the treatments were done with just one cue, so extinction of a CR to one cue could not be generalized to the others. That is, the pairing of drug administration with many kinds of objects and contexts should have been considered. In addition, extinction in one context (e.g., hospital) does not have an effect in another context (e.g., a site usually used for drug-taking). This explanation is based on the "renewal effect" from classical conditioning research.[2] Thus, it would be more helpful if the treatment setting were similar to the original conditioned context and had as many related cues as possible.

In terms of the various associations of drug use, previous trials have limitations: most research has been done in a treatment setting, such as a hospital or laboratory, with one or two stimuli. In contrast, VR technology and 3D animation techniques can provide a diverse range of situations and stimuli and a feeling of being in a bar rather than in a hospital. Such techniques would evoke the craving more effectively than traditionally used methods, such as still photos, and allow the generalization of treatment effects into real-life situations. In a previous study,[9] abstinent smokers in VR-CET composed of various smoking-related cues reported "presence" (i.e., the sense of being in a real world) and showed a reduced urge to smoke after VR-CET.

Thus, in this study, we investigated whether CET using VR was an effective method of reducing alcohol craving in alcoholics. Before applying this method for alcoholic outpatients, a precise and detailed survey was required to explore which cues were most likely to induce craving and which locations were most likely to elicit an urge to drink. A VR-scenario was then constructed.

MATERIALS AND METHODS

Preliminary survey and composition of cues and scenarios

To investigate the cues and contexts most likely to elicit cravings, we asked open-ended questions

of three groups: alcohol dependence inpatients (Ward group), abstinent people in an Alcoholics Anonymous group (AA group), and light drinkers (normal group).

The Ward group was recruited from the department of psychiatry at S Hospital in Seoul and consisted of 49 patients diagnosed with alcohol dependence according to DSM-IV criteria. The AA group consisted of 35 people (from S Hospital and from R Hospital in Seoul). Sixty-three light drinkers were selected using the criteria that, at most, they consumed nine standard glasses of alcohol in a week. The Ward group's mean age was 42.98 years ($SD = 87.03$), the AA group's was 42.34 years ($SD = 7.52$), and the normal group's was 39.10 years ($SD = 10.58$). There was no significant difference in age between groups.

Participants in each group were asked: (a) "Which places elicit a craving to drink (list all that apply)?" (b) "Which objects elicit a craving to drink (list all that apply)?" and (c) "Which was more likely to induce cravings, a place or object?"

The results are shown in Figure 1. The results showed that bars and one's own home were perceived to be the most likely places to elicit cravings in the Ward group. Bars and amusement quarters were thought to be the most likely places to elicit cravings in the AA group. Food and bottles were chosen to be the most likely objects to elicit cravings in both the Ward and AA groups. Furthermore, in all groups a large number of participants answered that places evoked more cravings than objects, but more Ward group than AA and normal group participants regarded objects as being highly evocative of craving (Ward = 79.17%; AA = 93.10%; normal = 95.16%). Based on these results, VR-CET scenarios were constructed for two places: a Japanese-style pub and a western bar. Both places had people drinking, side dishes, glasses, some bottles of the participants' favorite alcohol, alcohol advertisement posters, and the types of noises that emanate from real bars (Figure 2).

Participants

Ten participants from an Alcoholics Anonymous group were recruited for the study and signed informed consent statements approved by an institutional review board; however, two participants later dropped out. Because this therapy was exploratory, we couldn't compose a homogenous participant group by some strict diagnoses; however, we used the minimum selection criteria of having a history of being hospitalized for alcohol dependence and currently abstaining from alcohol. The mean age of
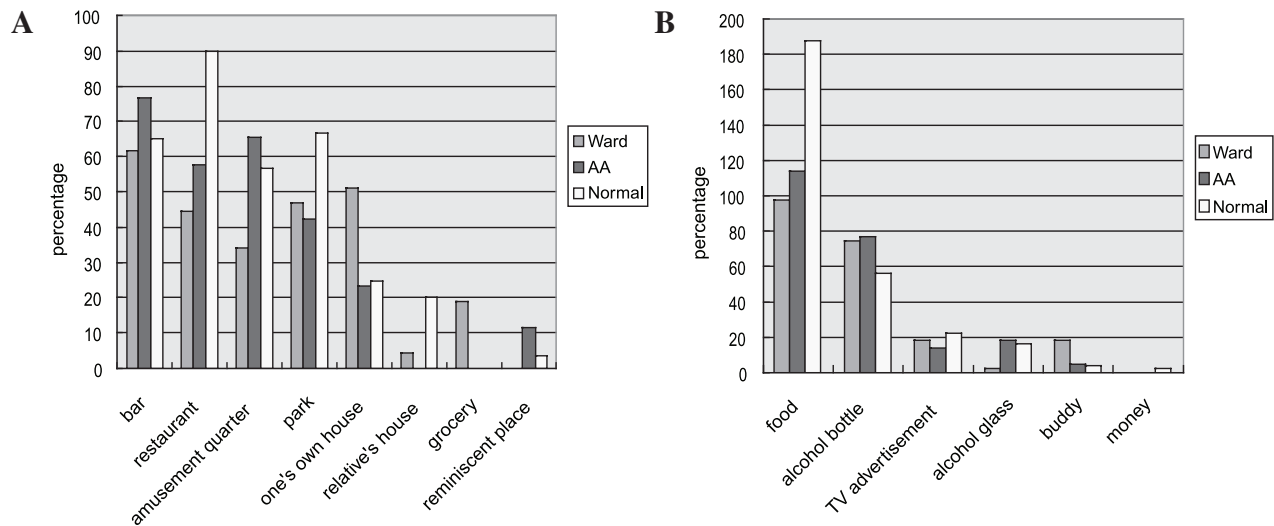
FIG. 1. Places and objects most likely to elicit alcohol cravings (listing all that apply).

the participants was 50.5 years ($SD = 14$). Their average period of abstinence was 58.75 months ($SD = 98.07$, range from 1 month to 263 months), and they used to drink, on average, 28 standard glasses (316.8 ml of pure ethanol) of Soju daily. Soju is an inexpensive, moderate-proof (21%) liquor that is very popular in Korea.

Measurement and VR instrument

Three scales were used for measuring the level of alcohol craving, urge, and alcohol-related thoughts: the Penn Alcohol Craving Scale[10] (PACS), the Alcohol Urge Questionnaire[11] (AUQ), and the Obsessive Compulsive Drinking Scale[12] (OCDS). The PACS is a five-item scale that focuses on the urge that the participant felt to drink during the previous week, using a 7-point scale. The AUQ consists of eight items asking about the present mental state, such as dependence on and preoccupation with alcohol, and also uses a 7-point scale. The OCDS consists of 14 items that quantify thoughts about alcohol and drinking behavior, and it uses a 5-point scale.

The hardware consisted of a Pentium IV PC, Open GL Accelerator VGA card, a beam projector with a 2.4m $\times$ 1.8m screen, and surround speakers.

At the beginning of the VR scenarios, the entrances to two bars in the middle of a hallway were shown. If a user entered a bar, a bartender and a few people drinking at tables were there. Some people drank alone, and others drank with buddies. On the tables were some alcohol bottles, such as beer, Soju, and whiskey, with side dishes, and typical bar

FIG. 2. The Japanese-style pub and the western bar in VR-CET.

noise was ongoing. A poster advertising alcohol was on the wall.

Procedure

The VR-CET was run with all the participants as a group session at R Hospital. Eight participants underwent eight sessions of VR-CET for 4 weeks (i.e., two sessions a week). In Session 1, the whole VR environment was introduced. In Sessions 2, 3, and 4, each cue-exposure was carried out with a different theme considering preliminary survey results: Session 2 focused on person-elicited craving, Session 3 focused on object-elicited craving, and Session 4 focused on situation-elicited craving. These three session types were repeated for Sessions 5, 6, and 7. Finally, Session 8 focused on the prevention of relapse. A detailed description of the contents of each session is shown in Table 1.

Before the first VR-CET session began, participants were asked for their demographic data and medical history. A survey of their drinking behavior (e.g., frequency of getting drunk and experience of injury due to alcohol) was taken, and they were

TABLE 1.   CONTENTS OF THE VR-CET PROGRAM SESSIONS

Session	Theme	VR-CET program content
1	Initial navigation	The participant was free to navigate during the initial session. 1. Have you navigated VR sufficiently? 2. Tell us about what you felt and thought after the VR. 3. How do you feel and think about the objects and situations in the VR?
2	Person-elicited craving	Interview with the participant about the person that elicits craving (open-ended). 1. How do you feel seeing a man drink alcohol alone in the virtual bar? 2. How do you feel seeing a woman drink alcohol alone in the virtual bar? 3. How do you feel seeing people who drink together?
3	Object-elicited craving	Interview with the participant about the object that elicits craving (open-ended). 1. What bottle makes you want to drink? 2. What side dish makes you want to drink? 3. What advertisement poster makes you want to drink?
4	Situation-elicited craving	Interview with the participant about the situation that elicits craving (open-ended). 1. How strongly do you want to drink when you see someone drink in the western bar? 2. How strongly do you want to drink when you see someone drink in the Japanese bar? 3. If you run out of alcohol, do you want more? How would you drink more?
5	Person-elicited craving	Repeat the questions of second session
6	Object-elicited craving	Repeat the questions of third session
7	Situation-elicited craving	Repeat the questions of fourth session
8	Final navigation	The participant was free to navigate during the final session. 1. How do you feel and think now after you've navigated the VR for several sessions? (Compare with the first session) 2. How do you feel and think now about the objects and situations that you saw in the VR, and what do they make you feel like doing? 3. If the VR experience happened to you in real life, what would you do?

TABLE 2. THE MEAN SCORES OF THREE QUESTIONNAIRES

Questionnaires	Pretreatment	Posttreatment	F(1,7)
PACS	7.50 ± 2.62	11.50 ± 5.76	1.436
OCDS	23.25 ± 7.44	24.29 ± 8.38	0.286
AUQ	9.44 ± 2.23	11.50 ± 5.76	2.222

asked to report their desire for alcohol on the three scales. Because AUQ has items that ask immediate urge to drink (i.e., it allows to assess "craving" elicited by alcohol-related cues even though the name AUQ uses the term "urge"), we used it to measure participants' responses to VR-CET immediately after each session, and at the end of the eighth session, the three scales were completed again.

Each of the eight sessions took 30 minutes, and each session was divided into three parts: an introduction and immersion for 5 minutes; VR navigation (a psychiatrist showed the participants VR scenes as if they had walked into the bars) and interview (about their feelings and thoughts) for 20 minutes; and completion of a self-report questionnaire for 5 minutes.

RESULTS

Based on the responses to the three questionnaires, repeated-measures analysis of variance (ANOVA) indicated that the changes from pretreatment (i.e., the baseline score) to posttreatment (i.e., the score immediately after the eighth session) were not significant (Table 2).

However, compared with the mean score 15.75 ($SD = 10.91$) of the first session, on the AUQ, the eighth session score slightly decreased at 11.50 ($SD = 5.76$), although a repeated-measures ANOVA revealed that the reduction was not statistically significant $F(1,7) = 1.32$ (Figure 3). However,
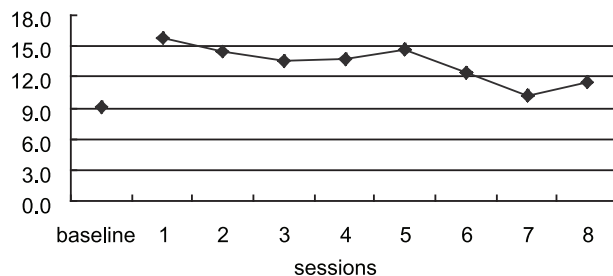

FIG. 3. Mean scores of AUQ measured after each session.

when excluding three people who had abstained from alcohol for more than one year, and then controlling baseline differences on AUQ scores, a repeated-measures ANCOVA showed significant decrease on AUQ scores between the first and eighth sessions $F(1,3) = 57.71$, $p < 0.01$, and the interaction of the baseline score of AUQ and treatment effect (i.e., AUQ score change between first and eighth sessions) was also significant $F(1.3) = 75.998$, $p < 0.01$.

Participants responded to interviews about their feelings and thoughts depending on the focus of the sessions (Table 3). In person-focused sessions, they reported, for example, "Seeing a woman drink alone, I wanted to join her and drink together." In object-focused sessions, they reported, for example, "A Soju bottle makes me crave more for drinking than a beer bottle." In situation-focused sessions, they reported, for example, "The Japanese bar makes me crave more for drinking than the western bar because of familiarity." They also made general comments about the series of sessions; for example, "Audio stimuli made me feel more realistic than visual stimuli" and "The more I was exposed to stimuli, the less tension was produced." Given the variation in responses, the failure to find a significant change despite a decrease in self-reported craving is understandable.

DISCUSSION

This study surveyed the situations and objects that elicited craving in normal, inpatient, and abstinent people in order to create VR-CET scenarios, and it investigated the effectiveness of VR-CET in reducing craving for alcohol in order to prevent relapse. Findings from the preliminary survey showed that in all groups, people craved alcohol when faced with a bar and food and that Ward and AA groups participants felt the urge to drink more at an amusement quarter, at home, and in front of their favorite alcohol bottle than did the normal group. In the results of VR-CET, the mean scores of the three questionnaires were not significantly reduced after eight sessions compared with the base-

TABLE 3.   Subjective Responses to VR-CET

Session	Interview responses to CET sessions
Person-focused sessions	Seeing a woman drink alone, I wanted to join her and drink together.
	If I drank with a woman, I could drink much more.
	I have never thought about drinking with a woman.
	I have never really drunk with a woman, so I really want to drink with a woman.
Object-focused sessions	Soju bottle makes me crave more for drinking than a beer bottle.
	Only a bottle catches my eye in the screen.
	I salivate as soon as I see a Soju bottle.
	Western alcohol bottle was not attractive or realistic.
Situation-focused sessions	The Japanese bar makes me crave more for drinking than the western bar because of familiarity.
	I was evoked even at the hallway, and I wanted to enter other bars.
	Because of repetition, I want to drink a little bit.
	The fact that alcoholics are mostly fond of drinking alone was overlooked.
General comments	Audio stimuli made me feel more realistic than visual stimuli.
	It's not realistic.
	The scene, drinking alone, is more attractive.
	The more I was exposed to the stimuli, the less tension was produced.
	The possibility of keeping abstinence would be increased.
	I became curious.

line scores. However, the participants' urge to drink, as assessed using the AUQ immediately after VR-CET, seemed to decrease gradually. Also, when the baseline differences of participants' urge on the AUQ were controlled and three people who had been abstinent from alcohol for more than one year were excluded from the estimates of treatment effect, the reduction of urge on the AUQ score (from first to eighth session) was statistically significant, and the interaction between the baseline score of AUQ and the reduction of urge was also significant.

As shown in Figure 3, VR-CET appeared beneficial to decrease cravings. This effectiveness of VR-CET is consistent with that of a previous VR-CET study[9] of smoking cessation. However, the treatment effect to decrease craving was ambiguous when pretreatment scores were compared with posttreatment scores on the three questionnaires. This may be primarily because of the high degree of variation in the abstinent period among the eight participants and because the posttreatment scores were obtained immediately after the eighth session. The maximum duration of abstinence of four participants was 3 months; in contrast, however, two participants had remained abstinent for at least 13 years. These two people reported having no urge to drink before the first session and after all sessions. In this regard, we assumed that the treatment effect

would be different according to the baseline of urge. In addition, it is possible that these two people had a large influence on the insignificant changes of the overall mean scores on the three scales, given the small number of participants. Thus, we retested the treatment effect (i.e., the score change on AUQ between the first and eighth sessions) in the five participants who had been abstinent from alcohol for less than one year, controlling the baseline differences on AUQ. Because the retest results showed a significant treatment effect and interaction between treatment effect and baseline differences, we propose that VR-CET may be more effective to those who have an intense urge to drink and are in an early stage of abstinence in which cue-elicited craving is powerful.

Admittedly, the sample size in this study was too small to generalize the effectiveness of VR-CET, and eight sessions might be too few to desensitize the participants to alcohol-related cues, to extinguish previously associated behavior, and to learn new associations (i.e., that alcohol-related cues no longer bring pleasure). Furthermore, because most people drink in a number of different places, two virtual places might be insufficient to cover all participants' familiar places that evoke conditioned responses. Thus, it would be better to increase the number of sessions until the extinguished responses do not

reemerge and to show more places in order to avoid the "renewal effect" mentioned previously.[2] Moreover, the two bar scenes might not elicit some participants to crave, given that they reported that the scene of drinking alone in their home would be more attractive. Similarly, in the preliminary survey, the Ward group reported that one's own house strongly elicited craving. Hence, in the next study, these alcoholics' atypical preferences should be considered. Also, VR-CET would be more effective if adapted to each individual's history and favorite stimuli. In order to practice such individual-focused treatment, an individual treatment setting may be more beneficial than a group setting.

Alcohol and drug cravings include physiological arousal, so self-reports of craving are usually not good predictors of relapse.[13] Thus, to assess an individual's craving and the effectiveness of CET more precisely, psychophysiological assessment is needed.[14] Such studies will clarify the effectiveness of VR-CET for alcoholics, using psychophysiological measures such as functional magnetic resonance imaging (fMRI), event-related potential (ERP), and an eye-tracker.

ACKNOWLEDGMENTS

REFERENCES

1. Tiffany ST. A cognitive model of drug urges and drug use behaviour: the role of automatic and nonautomatic processes. Psychological Review 1990; 97:147–68.
2. Tiffany ST, Conklin CA. Applying extinction research and theory to cue-exposure addiction treatments. Addiction 2002; 97:155–67.
3. Corty E, McFall RM. Response prevention in the treatment of cigarette smoking. Addictive Behaviors 1984; 9:405–8.
4. Niaura RS, Rohsenow DJ, Binkoff JA, Monti PM, Pedraza M., Abrams DB. Relevance of cue reactivity to understanding alcohol and smoking relapse. Journal of Abnormal Psychology 1988; 97:133–52.
5. Rohsenow DJ, Monti PM, Rubonis AV, Gulliver SB, Colby SM, Binkoff JA, Abrams DB. Cue exposure with coping skills training and communication skills training for alcohol dependence: 6- and 12-month outcomes. Addiction 2001; 96:1161–74.
6. Sitharthan T, Sitharthan G, Hough MJ, Kavanagh DJ. Cue exposure in moderation drinking: a comparison with cognitive-behavior therapy. Journal of Consulting and Clinical Psychology 1997; 65:878–82.
7. Dawe S, Powell JH, Richards D, Gossop M, Marks I, Strang J, Gray JA. Does post-withdrawal cue exposure improve outcome in opiate addiction? A controlled trial. Addiction 1993; 88:1233–45.
8. Franken IHA, De Hann HA, Van Der Meer CW, Haffmans PMJ, Hendricks VM. Cue reactivity and effects of cue exposure in abstinent posttreatment drug users. Journal of Substance Abuse Treatment 1999; 16:81–5.
9. Lee JH, Lim YS, Graham SJ, Kim G, Wiederhold BK, Wiederhold MD, Kim IY, Kim SI. Nicotine craving and cue exposure therapy by using virtual environments. CyberPsychology & Behavior 2004; 7:705–13.
10. Flannery BA, Volpicelli JR, Pettinati HM. Psychometric properties of the Penn Alcohol Craving Scale. Alcoholism: Clinical and Experimental Research 1999; 23:1289–95.
11. Bohn MJ, Krahn DD, Staehler BA. Development and initial validation of a measure of drinking urges in abstinent alcoholics. Alcoholism: Clinical and Experimental Research 1995; 19:600–6.
12. Anton RF, Moak DH, Latham P. The obsessive compulsive drinking scale: a self-rated instrument for the quantification of thoughts about alcohol and drinking behavior. Alcoholism: Clinical and Experimental Research 1995; 19:92–9.
13. Tiffany ST, Conklin CA. A cognitive processing model of alcohol craving and compulsive alcohol use. Addiction 2000; 95:145–53.
14. Franken IHA, De Hann HA, Van Der Meer CW, Haffmans PMJ, Hendricks VM. Cue reactivity and effects of cue exposure in abstinent posttreatment drug users. Journal of Substance Abuse Treatment 1999, 16:81–5.

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