Application of Virtual Reality-Cue Exposure Therapy for Reducing Alcohol Craving

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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, in 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, 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 11.57 (SD = 6.88) in the final session. This study suggests that using virtual reality can enhance the efficacy of CET so as to promote craving for alcohol and then to desensitize conditioned reactivity to alcohol.

INTRODUCTION

Craving is considered the reason why many drug users and alcoholics fail to exercise restraint even after treatment. One of the explanations about 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) so that the contexts or objects which 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 suggested (1990) hat, 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 during abstinence. In any event, a cue may contribute to relapse; thus, many researchers and practitioners have tried cue-exposure therapy (CET) to reduce the urge to use a drug and the rate of relapse. CET is used to extinguish the associated responses (CR) through repeated exposure to the cues related to addictive substances, but without the US.

CET has been applied in the treatment of a variety of substance addictions, including smoking (Corty & McFall, 1984; Niaura et al., 1999), drinking (Rohsenow et al., 2001; Sitharthan et al., 1997) and drug using (Dawe et al., 1993; Franken et al., 1999). However, the effect of CET has not been consistent. Tiffany and Conklin (2002) supposed that some CET studies failed to prevent relapse because the treatments were done with just one cue, so that the extinction of a CR to one cue could not be generalized to the others. That is, the fact that drug administration is paired 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 (2002). 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. This 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 (Lee et al., 2004), abstinent smokers in VR-CET composed of various smoking-related cues reported presence (i.e., the sense of being there), 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. This survey is elucidated below with the VR-CET study.

**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 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: 1) which places elicited a craving to drink (list all that apply), 2) which objects elicited a craving to drink (list all that apply) and 3) which place or object was most likely to induce cravings.

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, the Ward and AA group participants answered that places evoked more cravings than objects (Ward = 79.17%; AA = 93.10%; Normal = 95.16%); However, more Ward group participants regarded objects as being highly evocative of craving than the other groups. 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.

**Participants**

Ten participants from an Alcoholics Anonymous group were recruited for the study and wrote their own fully informed consent statements; however, two participants later dropped out. Thus, eight participants underwent eight sessions of VR-CET for 4 weeks (2 sessions a week). The mean age of the participants was 50.5 years (SD = 14), and all had been hospitalized more than once for alcohol treatment. Their average period of abstinence was 58.75 months (SD = 98.07), 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 instruments
Three scales were used for measuring the level of alcohol craving: the Penn Alcohol Craving Scale (PACS: Flannery et al., 1999), the Alcohol Urge Questionnaire (AUQ: Bohn et al., 1995), and the Obsessive Compulsive Drinking Scale (OCDS: Anton et al., 1995). 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 about 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 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 × 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, there were some alcohol bottles, such as beer, Soju, and whiskey with side dishes, and typical bar noise was ongoing. A poster advertising alcohol was on the wall.

<table>
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<tr>
<th>session</th>
<th>Theme</th>
<th>CET program content</th>
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| 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  
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  
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  
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 2nd session |
| 6 | Object-elicited craving | Repeat the questions of 3rd session |
| 7 | Situation-elicited craving | Repeat the questions of 4th 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 1st 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? |
Procedure
The VR-CET was run with all the participants as a group session at R hospital. Before the first VR-CET session, participants were asked for their demographic data, medical history, and a survey of their drinking behavior (e.g., frequency of being fuddled and experience of injury due to alcohol), and asked to report their desire for alcohol on the three scales. After each session, participants again completed the AUQ scale, and at the end of the final session, all 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 part for 5 minutes, a VR navigation (a psychiatrist showed the participants VR scenes as if they had walked into the bars) and interview (about their feelings and thoughts) part for 20 minutes, and a self-report questionnaire part for 5 minutes. In Session 1, the whole VR environment was shown. In Sessions 2, 3, and 4, each cue-exposure focused on a different craving type; 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.

RESULTS
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, compared with normal group. In the main experiment, repeated-measures Analysis of Variance (ANOVA) indicated that the mean scores of the responses to the three questionnaires did not change significantly from pretreatment to post-treatment (Table 2).

The mean score on the AUQ decreased between the first and final sessions (Figure 3), although ANOVA revealed that the reduction was not statistically significant.

Participants responded to interview 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, “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 investigated the effectiveness of VR-CET in reducing craving for alcohol in order to prevent relapse. Although mean scores of craving on the three questionnaires were not significantly reduced after 8 sessions, the participants’ urge to drink, as assessed by AUQ, had decreased gradually after each session. Admittedly, the effect of participant demand characteristics on the experiment should be considered.

As shown in Table 3, various environmental cues in VR-CET were effective in eliciting cravings, at least in early sessions. This effect of environmental cues is consistent with that of

| Table 2. The mean scores of three questionnaires |
|-----------------|-----------|-----------|------|
| Questionnaires | Pretreatment | Posttreatment | F   |
| 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 |
previous VR-CET study (Lee et al., 2004) about smoking cessation. However, eight sessions may be too few to desensitize the susceptibility 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 scenarios may 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 re-emerge, and to show more scenarios in order to avoid the “renewal effect” mentioned above.

The clinical histories of the eight participants varied in severity. The duration of abstinence of four participants was at most 3 months; however, two participants had remained abstinent for at least 13 years. The latter consistently reported that they had no urge to drink. Thus, given the small number of participants, it is possible that the latter had a large influence on the overall insignificant changes of craving. Moreover, a bar scene might not elicit some participants to crave because 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. VR-CET would be more effective if adapted to each individual’s history and favorite stimuli. Even though the dynamic interaction in the group setting is effective to promote participants’ reaction to treatment, in order to practice individual-focused treatment, an individual treatment setting would be more convenient.

Alcohol and drug cravings include physiological arousal so self-reports of craving are usually inconsistent and not good predictors of relapse (Tiffany & Conklin, 2000). Thus, to assess one’s craving and the effectiveness of CET more precisely, psychophysiological assessment is needed (Franken, 2003). Future studies will clarify the effectiveness of VR-CET for alcoholics by using psychophysiological measures such as fMRI, EEG, and an eye-tracker.

ACKNOWLEDGEMENTS

This study was supported by a Korea Research Foundation Grant (KRF-2002-042-B00115).
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