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The Impact of Cue-Elicited Multisensory Imagery on Alcohol Craving: A Randomised Controlled Trial

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Keywords

Multisensory imagery · Mental imagery · Craving · Alcohol · Elaborated intrusion theory

Abstract

Introduction: Elaborated intrusion theory suggests that imagery is central to craving; however, the possibility that cue-elicited multisensory imagery produces such urges has not been studied enough in the literature. Thus, we investigated the role of cue-elicited multisensory imagery on alcohol craving in individuals who are hazardous and social drinkers compared to mental and neutral imagery conditions. ***Methods:*** In an online experiment, hazardous and social drinkers (N = 348) between 18 and 45 years old were randomised to multisensory, mental, and neutral imagery exposure. The level of craving intensity was measured before and after imagery exposure. Also, participants rated vividness and sensory features scales after the exposure. ***Results:*** The level of craving was significantly higher in multisensory imagery condition compared to neutral condition (b = 1.94, p < 0.001, SE = 0.30, t(344) = 6.52, standardised mean difference [SMD] = 0.89) and in mental imagery condition compared to neutral condition (b = 1.82, SE = 0.30, t(344) = 6.52, p < 0.001, SMD = 0.83). The difference between the level of craving intensity between the multisensory and mental was not significant (b = 0.12, SE = 0.22, t(344) = 0.53, p = 0.594, SMD = 0.06). Moreover, craving intensity in response to multisensory versus neutral imagery was significantly stronger among hazardous drinkers (b = −2.90, SE = 0.83, t(341) = −3.50, p < 0.001). The level of vividness was not significantly different between any conditions. The difference between levels of sensory features was higher in multisensory imagery condition compared to neutral (b = 0.95, SE = 0.30, t(345) = 3.17, p = 0.002, SMD = 0.49) and mental imagery condition (b = 0.67, SE = 0.23, t(345) = 2.36, p = 0.004, SMD = 0.35). ***Conclusion:*** Results suggest that cue-elicited multisensory imagery may be a useful tool for eliciting alcohol craving responses and provide an additional means for better understanding the multi-layered mechanism of craving.

Introduction

The World Health Organisation [1] estimated that approximately three million people die each year from alcohol consumption, representing about 5.1% of all deaths in the world. Many individuals diagnosed with

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alcohol use disorders (AUDs) experience several relapses after treatment and a decreased quality of life because of the chronic nature of the disorder [2]. As a result, more research is urgently needed to understand the multilayered mechanism of craving which was found to be a significant predictor of relapse [3–5] and is the biggest obstacle while treating AUDs [6].

Drummond et al. [7] hypothesised that the obstacle to successful treatment is the ubiquitous presence of classical conditioned environmental and contextual cues that trigger a craving. To this respect, elaborated intrusion (EI) theory [8] proposes that desire thoughts are considered cognitive and affective events with frequency and duration which can cause an individual craving episode because of spontaneous thoughts and imagery of particular substance. Moreover, May et al. [9] argue that craving episodes persist because individuals create mental images of the desired substance that gives them pleasure and relief. In addition to this, EI theory suggests that imagery is central to desires and craving and moreover propounds that alcohol-related imagery is associated with greater frequency and amount of drinking [10]. Therefore, a component of craving draws increasing attention to the role of imagery [11–13].

A growing body of literature highlights the key role of multisensory imagery in alcohol cravings. Multisensory imagery refers to the ability to simulate the sight, sound, smell, taste, and feel of an experience mentally without the presence of a target [14]. Meanwhile, mental imagery – *also known as visual imagery* – is a form of sensory imagination consisting of subjective experiences commonly described as similar to perception in the absence of external stimuli [15]. According to the literature, when people crave, they have vivid images of the desired substance [13, 16–18], and more vivid and realistic imageries reveal greater pleasure [19]. Moreover, for alcohol, taste imagery predicted the consumption of four or more drinks in a single session, while smell imagery predicted the consumption of the maximum number of drinks [17]. Moreover, since the frequency of craving imagery also predicts relapse and treatment dropout among patients with AUDs, multisensory imagery is crucial for the prevention of relapses. Additionally, script-guided imagery exposure to alcohol resulted in increased alcohol cravings among social drinkers [20].

Consistent with the EI theory, multisensory imagery is a strong trigger for craving. In the literature, research on cue-elicited alcohol-related imagery is only supported by a few self-reported observational studies or laboratory research in non-clinical samples [16, 17]. There is a gap in the literature examining the role of cue-elicited multisensory imagery on alcohol craving experimentally among individuals who have hazardous alcohol consumption.

Findings from such studies may reveal an important mechanism underlying AUDs and cravings and may ultimately inform specific psychological intervention modalities. Therefore, this research seeks to address this gap by investigating the role of cue-elicited multisensory imagery on alcohol craving in individuals who are hazardous and social drinkers. Thus, the following hypotheses were formulated:

Primary hypothesis:

- H1: cue-elicited alcohol-related multisensory imagery (visual, olfactory, gustatory, tactile, auditory) induced cravings are stronger than (i) unisensory (mental) imagery, and (ii) a neutral imagery control condition; and (iii) unisensory (mental) imagery induced cravings are stronger than neutral imagery.

Secondary hypothesis:

- H2: cue-elicited alcohol-related multisensory imagery is associated with higher levels of vividness than (i) unisensory (mental) imagery, and (ii) a neutral imagery control condition; and (iii) unisensory (mental) imagery is associated with higher vividness than neutral imagery.
- H3: cue-elicited alcohol-related multisensory imagery is associated with sensory features consistent with greater elaboration than (i) unisensory (mental) imagery, and (ii) a neutral imagery control condition; and (iii) unisensory (mental) imagery is associated with higher vividness than neutral imagery.
- H4: compared to social drinkers, hazardous drinkers will display stronger craving reactions to (i) multisensory and (ii) mental imagery conditions, relative to the neutral imagery control condition; higher vividness in relation to (iii) multisensory and (iv) mental imagery conditions, relative to the neutral imagery control condition; and sensory features consistent with greater elaboration to (v) multisensory and (vi) mental imagery conditions, relative to the neutral imagery control condition.

Materials and Methods

Design and Participants

A double-blind, parallel-group randomised controlled experimental design was used with three imagery conditions (multisensory, mental, and neutral imagery). Outcome variables were craving intensity, vividness, and sensory features of imagery. The independent variables were imagery conditions for exposure and the type of drinkers determined based on the scores of the Alcohol Use Disorders Identification Test (AUDIT) [21]. Baseline craving was calculated as a covariate in the analysis.

The target sample size was set at 140 for the multisensory and mental imagery conditions and 60 for the neutral condition. Participants were allocated randomly using a simple randomisation approach following a 2:2:1 ratio by online software Qualtrics (Qualtrics, Provo, UT). An unequal allocation ratio was employed since effect sizes were anticipated to be smaller for the comparison of the multisensory and mental imagery conditions, compared to the comparison for the multisensory imagery and neutral conditions. Specifically, basing effect sizes on a review of existing studies [16, 20], a target sample size of 140 per group allows for 80% power to detect an effect size of $d = 0.34$, and sample sizes of 140 and sample sizes of 50 per group to detect an effect size of $d = 0.47$. Target sample sizes were inflated to account for attrition.

Eligibility requirements for participation included age between 18 and 45 years old, consuming an alcoholic beverage in the last 12 months, scoring more than 1 (individuals who did not drink alcohol were not eligible) and less than 15 (the cut-off for AUDs) on AUDIT [22] and providing informed consent. All data were collected through Qualtrics online survey by advertising on social media (e.g., Facebook, LinkedIn). Participants were not reimbursed for their participation in the study.

Materials and Measures

Alcohol Consumption

The Alcohol Use Disorders Identification Test (AUDIT) was applied to assess alcohol intake by the participants to capture their intensity of drinking to differentiate whether they were hazardous or social drinkers. AUDIT has high reliability ($r = 0.86$) [23]. In the present study, individuals who scored between 1 and 7 on AUDIT were allocated to the social drinker/low-risk group [21, 24], and those scoring between 8 and 14 were allocated to the hazardous drinker group [22].

Alcohol Craving

Based on the EI theory of desire [13], the Imagery scale of the Alcohol Craving Experience (ACE-Imagery) [25] measures five sensory aspects of craving (e.g., imagining taste, smell, or sensations of drink in the mouth, sensations in the body, picturing drinking) when craving was maximal during the previous week (ACE-S: strength), and to assess the frequency of desire-related thoughts in the past week (ACE-F: frequency). ACE is significantly associated with problem drinking and other features of craving [25]. In this study, only the ACE-S was used and scored on an eleven-point scale from 0 (*not at all*) to 10 (*extremely*). The ACE-Imagery has excellent internal reliability ($r = 0.94$) and construct validity [25].

Sensory Imagery

The Plymouth Sensory Imagery Questionnaire (PSI-Q) is a Likert scale (0–10) consisting of 35 items [26]. PSI-Q is a sensitive measure of the vividness of imagery across a range of modalities (vision, sound, smell, taste, touch, bodily sensation, and emotional feeling). Participants rated items from 0 (*no image at all*) to 10 (images *as clear and vivid as real life*). PSI-Q has acceptable internal reliability ($r = 0.71$) [26].

Vividness

Vividness scale was adapted from Yates and Kamboj [16], and it is a Likert scale (1–10) measuring individual differences in the vividness of imagery. Vividness related to "crispness, clarity, and sense of realness of the imagery," and participants were asked to rate it on a 1 = *not at all* to 10 = *extremely* scale.

Sensory Features

Sensory features scale was also adapted from Yates and Kamboj [16], and it is a Likert scale measuring individual differences in sensory features of imagery. Participants rated items on a scale ranging from 1 (*not at all*) to 10 (*extremely*) on the presence of visual, auditory, olfactory, gustatory, and tactile characteristics.

Imagery Scripts

Imagery scripts started with the description of related imagery conditions (multisensory, mental, and neutral imagery). Then, participants were given common instructions about imagery conditions retrieved from Fox et al. [27]. Afterwards, cue-elicited (multisensory and mental) imagery or neutral imagery was prompted (see online suppl. material for imagery scripts; for all online suppl. material, see https://doi.org/10.1159/000531844).

Procedure

The experiment was created and conducted online using Qualtrics software, version 9.2021 of Qualtrics (Copyright © [2021] Qualtrics; http://www.qualtrics.com). The study lasted approximately 15 min. At the beginning of the study, all participants gave online informed consent for the study and data protection. Figure 1 displays the study flow and timing of exposure. The procedure consisted of three phases: (a) collection of demographic information, an assessment of participants' eligibility (the experiment was automatically ended for those who are below 18 years old and over 45 years old after the demographic questionnaire, and those who scored less than 1 and more than 14 on AUDIT scale), measuring baseline craving on ACE, and an assessment of sensory imagery on PSI-Q; (b) a description and instruction of the imagery procedure and exposure to cue-elicited imagery conditions (multisensory, mental, and neutral); (c) measuring craving on ACE after imagery exposure, an assessment on vividness, and sensory features of three imagery scripts. PSI-Q was administered as a distraction to reduce the possibility of carryover alcohol cravings from the baseline craving questionnaire (ACE). For each script, participants were given 1 min to read the script and draw from their own imagination. At the end, participants were thanked for their participation, and provided with a debriefing sheet including alcohol services in the area, if desired.

Ethics

The study was approved by the university's Institutional Review Board (protocol number: 578), and all participants were treated in accordance with APA ethical guidelines [28]. Also, the study was conducted in accordance with the principles expressed in the Declaration of Helsinki [29]. The scores above 8 on AUDIT indicate alcohol dependence [24], therefore in order to prevent possible harm that the experiment might cause to this clinical sample, individuals scored above 14 on AUDIT were not recruited.

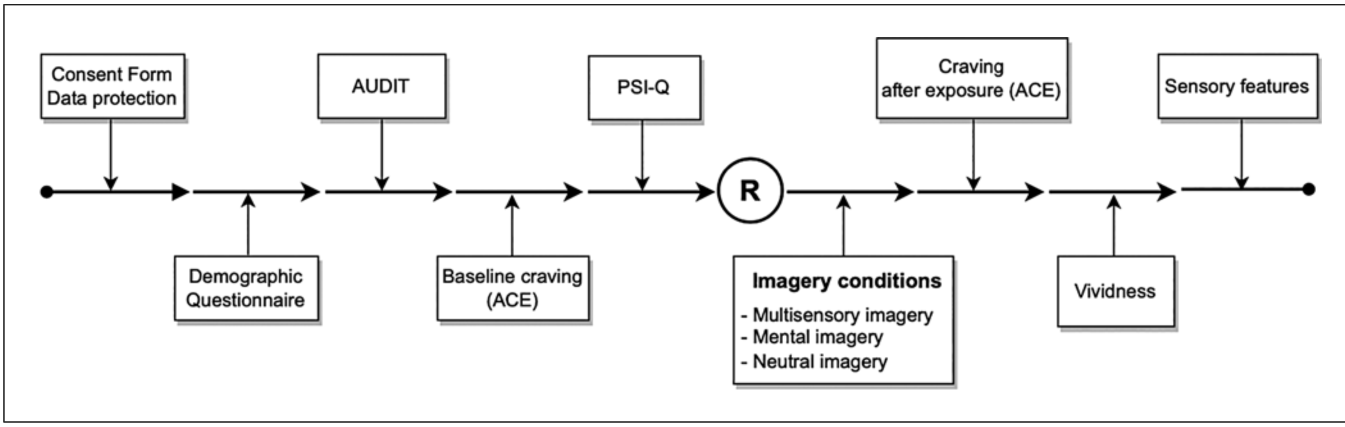

Fig. 1. Study flow. AUDIT, Alcohol Use Disorders Identification Test; ACE, Alcohol Craving Experience; PSI-Q, Plymouth Sensory Imagery Questionnaire; R, randomisation (participants were allocated to one of the imagery conditions and were given 1 min).

Statistical Analyses

All analyses were conducted in accordance with the intention to treat principle with participants analysed in the groups to which they were randomised. The analysis did not include those who did not provide complete data and as such treatment effect estimates are under the assumption that data are missing completely at random. Alpha was set at 5% for all analyses.

The intervention effect for craving (primary outcome) was estimated as the adjusted difference in means between groups using a multiple linear regression model, along with 95% confidence intervals. Craving intensity at the post-randomisation assessment was included as the outcome variable and regressed on dummy-coded indicator variables for the allocated group (multisensory, mental, neutral) and the baseline level of craving. The same models were estimated for vividness and sensory features with baseline craving included as a covariate. Vividness and sensory features were not measured at baseline and thus were not relevant to include. The magnitude of the effect of the adjusted mean differences was described as the standardised mean difference (SMD), where this is the estimated adjusted mean difference divided by the pooled standard deviation, which is equivalent to Cohen's *d*.

To assess effect modification by drinking type, the regression models were extended to include drinking type (hazardous vs. social) as a dummy coded variable along with interaction terms for the group allocation and drinking type dummy variables. All comparisons were considered: multisensory versus neutral, mental versus neutral, and multisensory versus mental. The marginal means with 95% confidence intervals are displayed graphically to aid the interpretation of the interactions.

Results

Sample Characteristics

In total, 725 participants responded to the recruitment advert and were assessed for eligibility. Among them, 345 failed to meet eligibility criteria and 380 participants were randomised – multisensory imagery: 158, mental imagery: 160, and neutral imagery: 62. The analysis sample consisted of 348 participants of the 380 randomised (91.6%) after excluding those who withdrew after randomisation (see Fig. 2). Withdrawal after randomisation was approximately equal across conditions (6.5%–10%). The average participant's age was 26.6 years old with a maximum age of 45 and a minimum of 18. 55.8% of the sample ($N = 220$) was between 22 and 26 years old. Most participants were female (64.1%, $N = 223$), European (92.5%, $N = 322$), and have a bachelor's degree (47.7%, $N = 166$). 32.8% of participants ($N = 114$) reported an annual income lower than EUR 20,000 (see Table 1 for participant characteristics for each imagery condition). Using AUDIT scores, participants were divided into hazardous (8–14, $N = 298$) and social drinkers (1–7, $N = 50$).

Imagery and Craving

A multiple linear regression was estimated to test if, in line with H1, there were differences in imagery conditions in participants' craving intensity, adjusting for baseline craving. Means and between-group differences are provided in Table 2. As hypothesised the level of craving was significantly higher in the multisensory imagery condition compared to the neutral imagery condition ($b = 1.94$, SE = 0.30, $t(344) = 6.52$, $p < 0.001$) and for the mental imagery condition compared to the neutral imagery condition ($b = 1.82$, SE = 0.30, $t(344) = 6.52$, $p < 0.001$). The magnitude of the differences for both experimental conditions compared to the neutral condition was large: SMD (multisensory-neutral) = 0.89, SMD (mental-neutral =

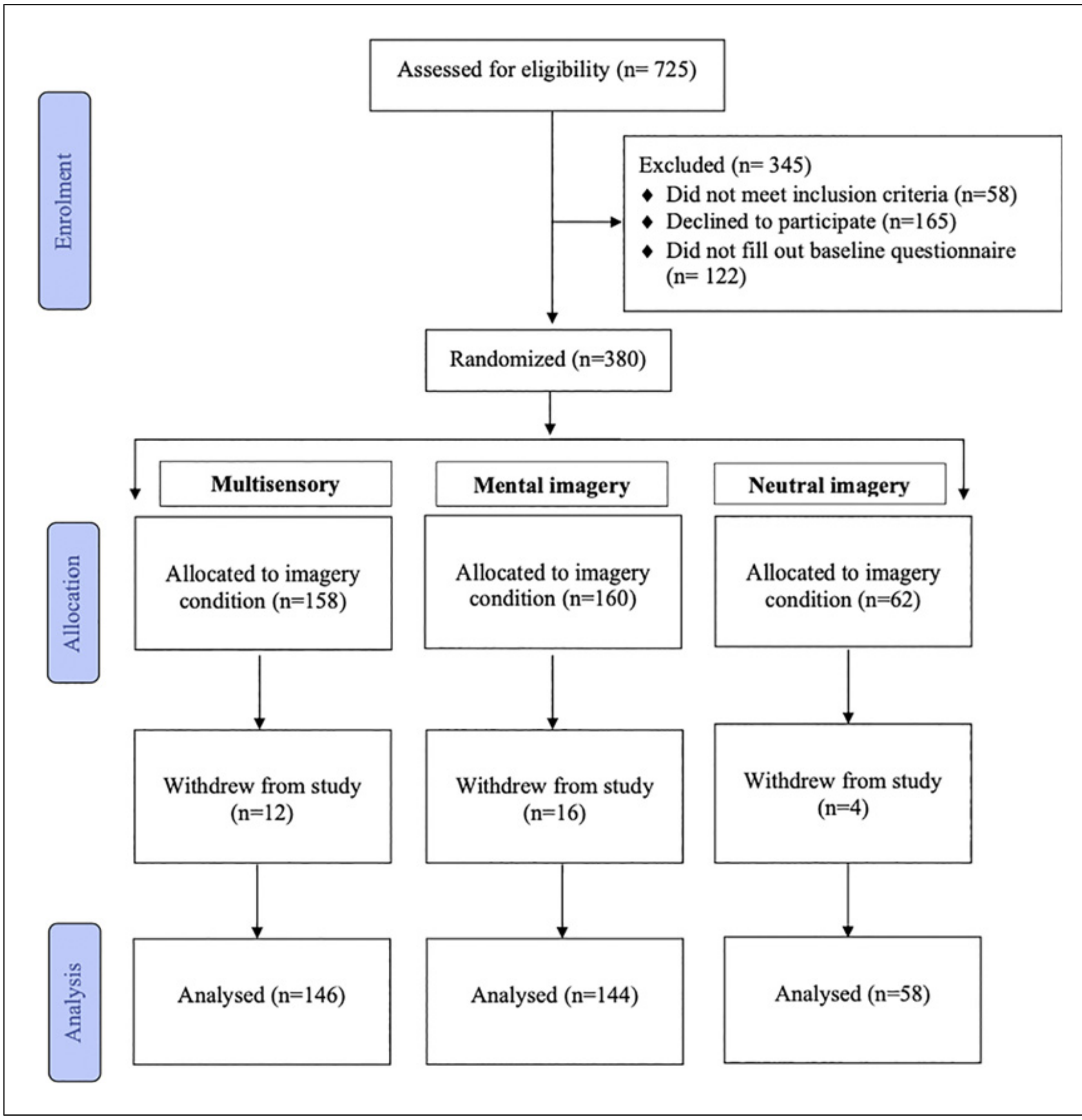

Fig. 2. Consort flow diagram of the three imagery conditions: multisensory, mental, and neutral imagery.

0.83). However, the level of craving was not significantly different between the multisensory imagery condition compared to the mental imagery condition (b = 0.12, SE = 0.22, $t(344)$ = 0.53, p = 0.594) and the effect size was small (SMD = 0.06).

It was hypothesised that cue-elicited multisensory imagery would be associated with higher levels of vividness and sensory features of imagery than mental and neutral imagery, and that mental imagery would be associated with higher levels of vividness and sensory features than neutral imagery. The difference in the level of sensory features was large: SMD (multisensory-neutral) = 0.49, SMD (multisensory-mental) = 0.35, and significant for the multisensory imagery condition compared to the neutral imagery condition (b = 0.95, SE = 0.30, $t(345)$ = 3.17, p = 0.002) and compared to the mental imagery condition (b = 0.67, SE = 0.23, $t(345)$ = 2.36, p = 0.004). However, the level of sensory features was not significantly different between the mental imagery condition compared to the neutral imagery condition (b = 0.29, SE = 0.30, $t(345)$ = 0.95, p = 0.340), and the effect size was small (SMD = 0.15). Furthermore, no significant differences were observed between any of the conditions in terms of vividness (Table 2), with the magnitude of the

Table 1. Demographic and baseline characteristics of participants across imagery conditions (N = 348)

Participant's characteristics	Multisensory imagery (n = 146)	Mental imagery (n = 144)	Neutral imagery (n = 58)
Age, mean (±SD)	26.6 (5.61)	26.8 (5.98)	25.8 (5.18)
Gender, n (%)			
Male	49 (33.56)	59 (40.97)	17 (29.31)
Female	97 (66.43)	85 (59.03)	41 (70.69)
Ethnicity, n (%)			
European	132 (90.41)	134 (93.05)	56 (96.55)
Middle Eastern	5 (3.42)	7 (4.86)	0
Asian	4 (2.73)	1 (0.69)	2 (3.45)
African	2 (1.36)	1 (0.69)	0
Other	3 (2.04)	1 (0.69)	0
Education, n (%)			
Secondary, <14 years	1 (0.68)	0	1 (1.72)
High school, 14 to 19 years	32 (21.91)	39 (27.08)	16 (27.58)
Bachelor	75 (51.36)	68 (47.22)	23 (39.65)
Master	32 (21.91)	29 (20.13)	14 (24.13)
PhD	6 (4.10)	8 (5.55)	4 (6.89)
Income, n (%)			
Less than EUR 3,999	17 (11.64)	18 (12.5)	4 (6.89)
Between EUR 4,000 and 12,999	14 (9.58)	7 (4.86)	4 (6.89)
Between EUR 13,000 and 19,999	20 (13.69)	23 (15.97)	7 (12.06)
Between EUR 20,000 and 34,999	36 (24.65)	28 (19.44)	11 (18.96)
Between EUR 35,000 and 54,999	40 (27.39)	36 (25)	17 (29.31)
Between EUR 55,000 and 76,999	10 (6.84)	19 (13.19)	7 (12.06)
Between EUR 77,000 and 97,999	3 (2.05)	7 (4.86)	4 (6.89)
Between EUR 98,000 and 149,999	2 (1.36)	1 (0.69)	3 (5.17)
More than EUR 150,000	4 (2.73)	5 (3.47)	1 (1.72)
AUDIT, mean (±SD)	4.2 (4.34)	5.06 (3.39)	4.02 (3.01)
PSI-Q, mean (±SD)	8.65 (1.45)	8.59 (1.29)	8.31 (1.78)
ACE, mean (±SD)	5 (2.36)	4.96 (2.12)	3.23 (1.92)

Table 2. Between-group differences in outcome

Outcome	Condition	Observed values			Difference versus neutral				Difference versus mental			
		N	mean	SD	b	SE	p value	SMD	b	SE	p value	SMD
Craving	Neutral	58	3.2	1.9								
	Mental	144	5.0	2.1	1.82	0.30	<0.001	0.83				
	Multisensory	146	5.0	2.4	1.94	0.30	<0.001	0.89	0.12	0.22	0.594	0.06
Vividness	Neutral	58	7.2	2.0								
	Mental	144	7.1	2.2	−0.11	0.32	0.74	−0.05				
	Multisensory	146	7.3	2.1	0.04	0.32	0.90	0.02	0.15	0.24	0.548	0.07
Sensory features	Neutral	58	5.5	2.0								
	Mental	144	5.8	1.9	0.29	0.30	0.34	0.15				
	Multisensory	146	6.5	2.0	0.95	0.30	0.002	0.49	0.67	0.23	0.004	0.35

Differences are adjusted mean differences estimated by linear regression models controlling for baseline craving. SMD, standardised mean difference.

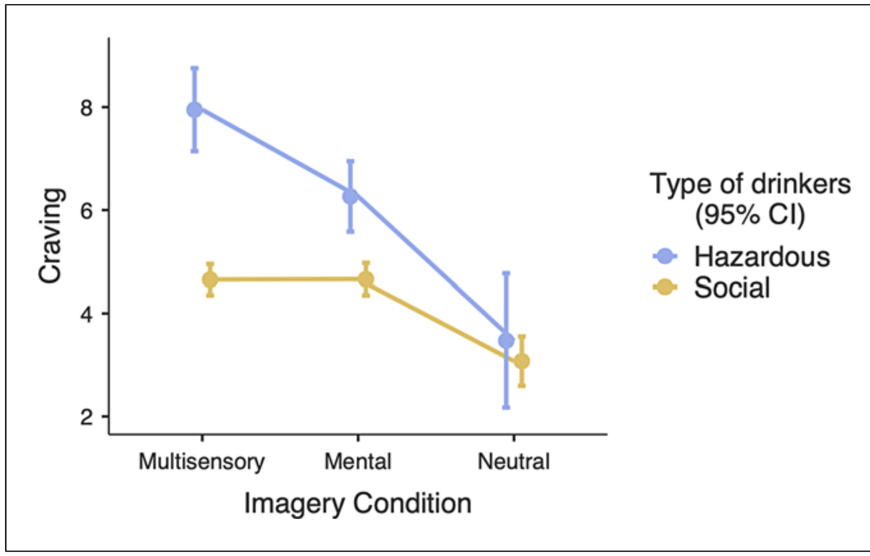

Fig. 3. Alcohol craving intensity across imagery conditions for hazardous and social drinkers.

differences all being small: SMD (multisensory-neutral) = 0.02, SMD (mental-neutral) = −0.05, SMD (multisensory-mental) = 0.07.

Effect Modification by Drinking Type

The linear regression model for craving was extended to include drinking type (hazardous vs. social) and drinking type by condition interaction terms in block 2. This was to test the hypothesis that hazardous drinkers will display stronger craving reactions to both multisensory and mental imagery conditions, relative to the neutral imagery control condition. The estimated marginal means are displayed in Figure 3. As hypothesised, the effect of multisensory imagery compared to neutral imagery was statistically significantly larger for hazardous versus social drinkers ($b = -2.90$, SE = 0.83, $t(341) = -3.50$, $p < 0.001$, SMD = 1.32). Moreover, the effect of multisensory imagery compared to mental imagery was also statistically significantly larger for hazardous versus social drinkers ($b = -1.70$, $t(341) = -2.92$, $p = 0.004$, SE = 0.58, SMD = 0.77). Examining the simple main effects and contrasts of imagery type within each drinking type subgroup indicated that hazardous drinkers in the multisensory imagery condition experience higher craving intensity than those in mental and neutral imagery conditions; $t(341) = -3.13$, $p = 0.002$, and $t(341) = -5.75$, $p < 0.001$, respectively, and that social drinkers in the multisensory condition experience higher cravings than those in the neutral condition; $t(341) = -5.47$, $p < 0.001$, but craving intensity of social drinkers does not differentiate between mental and multisensory imagery conditions; $t(341) = -0.04$, $p = 0.965$.

Effect Modification for Vividness and Sensory Features

Further analyses considered effect modification for vividness and sensory features (Fig. 4, 5). There was a significant interaction representing a larger effect of multisensory imagery compared to neutral imagery on vividness for hazardous versus social drinkers ($b = -2.28$, SE = 0.97, $t(342) = -2.35$, $p = 0.020$, SMD = 0.99). The interaction indicating the effect of mental imagery compared to neutral imagery on vividness by social versus hazardous drinkers was also statistically significant ($b = -2.50$, SE = 0.94, $t(342) = -2.66$, $p = 0.008$, SMD = 1.09). For sensory features, the interaction representing the effect of multisensory imagery compared to neutral imagery was not significant for hazardous versus social drinkers ($b = -1.76$, SE = 0.91, $t(342) = -1.93$, $p = 0.055$, SMD = 0.82) and neither was the interaction for the effect of mental imagery compared to neutral imagery for hazardous versus social drinkers ($b = -0.09$, SE = 0.88, $t(342) = -0.11$, $p = 0.914$, SMD = 0.04).

Discussion

This study investigated the role of cue-elicited multisensory imagery on alcohol craving in an online experiment. Consistent with our hypothesis, exposure to the multisensory imagery condition resulted in increased alcohol cravings. Further validating the script, participants who scored as hazardous drinkers had particularly stronger alcohol craving intensity to the multisensory imagery condition than in mental and neutral imagery conditions. These findings demonstrate that like

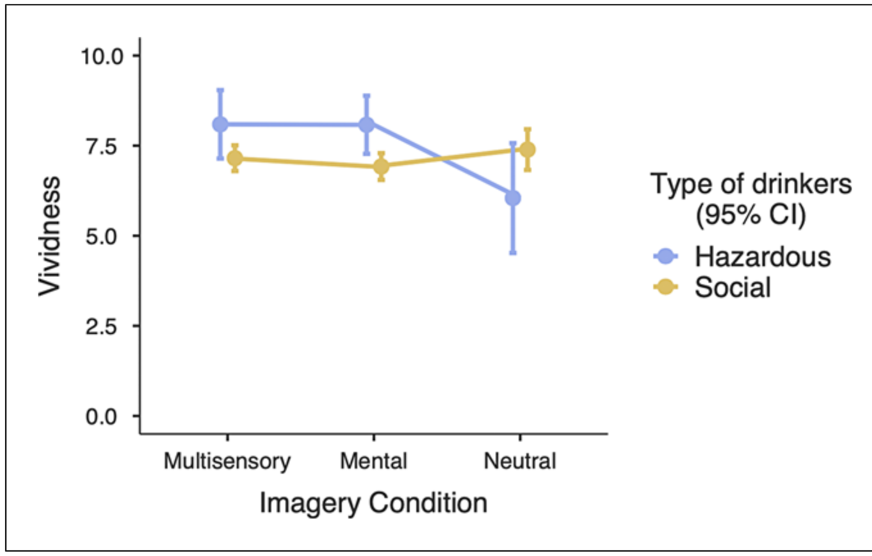

Fig. 4. The vividness level of imagery across imagery conditions for hazardous and social drinkers.

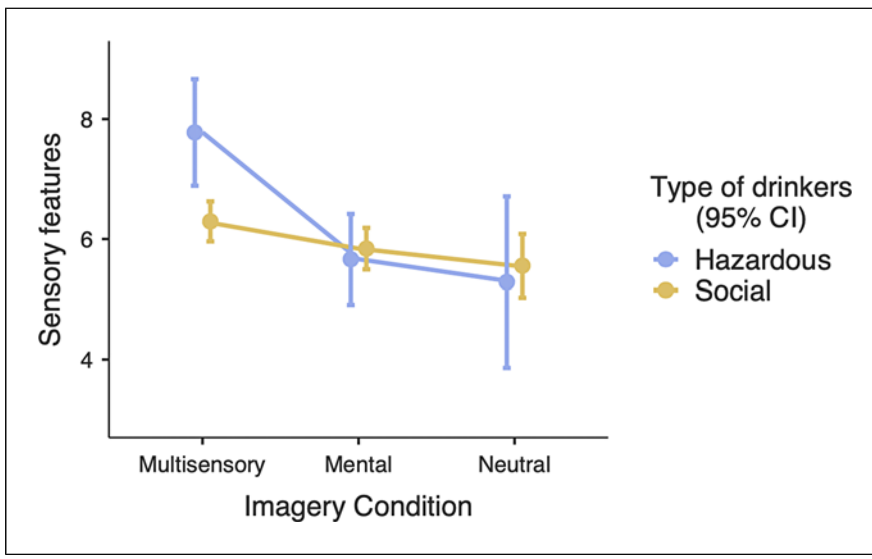

Fig. 5. The sensory features level of imagery across imagery conditions for hazardous and social drinkers.

laboratory paradigms for other drugs [20, 30], cue-elicited multisensory imagery exposures are capable of inducing cravings for alcohol. Moreover, both the imagery conditions and type of drinkers were not significant predictors of the vividness of the imagery. However, the interaction between imagery conditions and the type of drinkers on the vividness of imagery was significant. Additionally, while there was a significant effect of imagery conditions on sensory features, the effect of the type of drinkers on sensory features was not significant. Participants who were exposed to multisensory imagery and hazardous drinkers experienced the sensory features of the alcohol-cued scripts significantly higher than social drinkers in the same group. That means the presence of alcohol-cued multisensory imagery was a more important factor in inducing sensory features than mental and neutral imagery.

The present study had several strengths in addressing the key overarching aim. Firstly, the questionnaires were designed to get "at-the-time" responses from alcohol craving. This is a more accurate representation of the craving experience compared to retrospective responses, which might be biased according to individuals' stereotypes of craving. Secondly, the presence of neutral imagery condition as a control group allowed us to distinguish specific effects of alcohol-cued multisensory and mental imagery versus neutral imagery without an alcohol cue on participants. Thirdly, the presence of a group of social drinkers as a control group enabled assessing more accurately potential changes in alcohol craving among the general population.

We acknowledge several limitations. Firstly, individuals who have social or hazardous drinking behaviour were recruited. Therefore, the findings of this study cannot necessarily be generalised to individuals who have AUDs. Secondly, we tested the craving intensity through an online experiment rather than in a controlled laboratory environment, in which naturalistic alcohol cravings could be assessed in a more controlled environment. Thirdly, laboratory assessments such as mood ratings, heart rate, blood pressure, and salivary measurements could not be measured to strengthen the confidence in self-reported craving data.

There are several theoretical and practical implications of this study. The results suggest that cue-elicited guided multisensory imagery could be easily applied to everyday cravings, and could potentially be utilised as an adjunct, in-the-moment technique alongside structured therapy. The evidence in the literature suggests that imagery-based techniques can strengthen behavioural change strategies and increase the chance of success in treatment [31, 32].

The cue-elicited multisensory imagery task could be further developed to provide a reliable method of helping individuals who are hazardous drinkers or have AUDs to control their cravings. An individualised craving management technique that uses multisensory imagery may be successful after treatment to prevent relapses. Further research into the theory and the tasks that interfere with craving imagery may result in the development of successful methods of relapse prevention.

Results from this study lay important groundwork for future studies. Future studies should investigate the impact of multisensory imagery among clinical samples of individuals with AUDs. Moreover, the imagery conditions in this study are based on hazardous drinking and alcohol cravings. The application of these methods to other addictions is necessary to see if similar effects would be observed when using other addictive disorders such as substance use disorders, eating disorders, etc. Findings from such studies may also shed light on important mechanisms underlying addiction and provide insight to develop novel approaches for individualised treatment for AUDs. Further research should also investigate the development of multisensory imagery as an intervention technique more thoroughly. The EI theory and this research can be developed to help people control their hazardous drinking. Teaching individuals the methods for controlling craving and demonstrating that these skills are sufficient may greatly improve the outcome of the treatment of AUDs.

Conclusion

The results of this study provide support for the predictions of the Elaborated Intrusion Theory of Desire. Consistent with EI Theory, imagery appears to be a strong motivator of craving. Interventions targeting alcohol craving could include techniques that block multisensory imagery. Moreover, interference with alcohol imagery may have a premise as a preventive or early intervention target in young people at risk.

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Statement of Ethics

The study was approved by the University of Milano-Bicocca's IRB (protocol number: 578). Informed consent to participate was not directly obtained but inferred by the completion of the questionnaire.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

C.K. conceptualised and designed the study, performed data collection, conducted the data analyses, and wrote the paper. E.P. contributed to project administration, conceptualisation, and design, and supervised the project. P.D. co-supervised the project and contributed to conceptualisation and design. S.N. and M.E.S. assisted in data analysis and interpretation of findings. All authors approved the final version of the paper for submission.

Data Availability Statement

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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