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RESEARCH ARTICLE

Physical sensations of craving in binge drinking and severe alcohol use disorder: A phenomenological approach

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Abstract

Background: Craving is a key concept in addictive disorders. However, despite seminal results identifying the pivotal role of its physical component, craving remains conceptualized as being centrally underpinned by psychological and cognitive processes. To explore the phenomenological dimension of physical craving in addiction, we measured self-reported body sensations of craving among individuals with subclinical (binge drinking, BD) or clinical (severe alcohol use disorder, SAUD) alcohol use disorders.

Methods: We used a body mapping technique, allowing for the free report of the bodily counterparts of psychological phenomena, among 76 binge drinkers and 97 recently detoxified patients with SAUD. We measured the taxonomy, localization, intensity, and pleasantness of the craving bodily sensations.

Results: Physical sensations of craving were reported (1) for individuals with BD habits, mostly in the shoulders/thorax (53.95%), mouth (47.37%), and forehead (31.58%), in the form of palpitations, dryness, and tension; (2) for patients with SAUD, most often and with the highest average intensity in the hands (31.96%), forehead (24.74%), and shoulders/thorax (22.68%), in the form of tremors, perspiration, and palpitations. In BD, craving sensations were described as slightly unpleasant to pleasant. Conversely, in SAUD patients, craving was perceived as slightly to very unpleasant.

Conclusions: These findings bring forth a novel perspective of the bodily mechanisms involved in craving. They support a dissociation between subclinical and clinical populations of excessive alcohol drinkers, as body sensations related to craving might generate alcohol consumption through positive reinforcement (to extend positive sensations) for subclinical populations and through negative reinforcement (to alleviate unpleasant body sensations) for clinical populations. More widely, we highlight the need to add perceived bodily sensations to the predominantly and exclusively cognitive focus that characterizes the craving research field, since craving is also underpinned by physical sensations.

KEYWORDS
addiction, alcohol, alcohol use disorder, body mapping, physical craving

INTRODUCTION

Craving, defined as the irrepressible urge, desire, or need to think about, approach, or consume a substance despite its negative consequences (Tiffany & Wray, 2012), is a key process in substance use disorders (Gauld et al., 2023; Kervran et al., 2020). It is conceptualized as encompassing obsessive (e.g., intrusive thoughts) and compulsive (e.g., approach behaviors) components (Kavanagh et al., 2009) and constitutes a well-established risk factor for excessive consumption (Fatseas et al., 2015) and relapse (Cleveland et al., 2021). The importance of craving is further highlighted by its inclusion as a diagnostic criterion in the DSM-5 nosography (Diagnostic and Statistical Manual of Mental Disorders [5th ed.; DSM-5; American Psychiatric Association, 2013]). Recent findings found craving to be the most central symptom in the etiology of substance use disorders (Gauld et al., 2023). Beyond variations across theoretical models, craving is consistently conceptualized as a cognitive phenomenon, namely as centrally related to high-level psychological and behavioral processes (e.g., thoughts, approach tendencies), without considering its underlying physical dimension. Indeed, in the DSM-5, craving is defined as an "intense desire or urge" for the substance that highjacks thinking abilities (American Psychiatric Association, 2013). Accordingly, major addiction models focus on the psychological/cognitive nature of craving by defining it as related to dysregulated affective states (dual-affect model; Baker et al., 1986), impaired executive functions ("preoccupation-anticipation" stage of addiction; Koob & Volkow, 2010, 2016) or exacerbated desire for consumption-related gratification (relapse prevention model; Marlatt & George, 1984).

The physical dimension of craving is, conversely, neglected in most addiction models that, at best, consider it as secondary and confined to preaddictive stages (e.g., in conditioning-based models; Skinner & Aubin, 2010). However, recent empirical data underline the key role played by body-related craving sensations in the development and maintenance of addictive disorders. A seminal study found that lesions of the insula (responsible for the detection and processing of afferent bodily signals; Craig, 2003, 2009; Craig et al., 2000) among patients with tobacco use disorders resulted in craving fading (Naqvi et al., 2007). Thus, the bodily sensations associated with a substance might be involved in craving onset and maintenance. Through the bidirectional connections of the insula with the amygdala-striatal neural system and prefrontal cortex (Noël et al., 2013), these bodily sensations could be associated with the pleasurable effects of a substance, while hijacking cognitive control systems (Naqvi & Bechara, 2010; Verdejo-Garcia et al., 2012) to trigger and maintain substance seeking (Koob & Volkow, 2016; Verdejo-Garcia et al., 2012). However, beyond these neuroimaging data, direct behavioral measures of the physical sensations of craving are lacking.

In view of this theoretical neglect of the bodily components of craving, few studies have documented the physical manifestations of craving or developed dedicated tools to assess them. Research has been confined to "cue-induced physiological activation," only measuring physiological arousal (e.g., cardiac and electrodermal activity; van Lier et al., 2022) during (Kaplan et al., 1985) and after (Sinha et al., 2009) exposure to substance-related cues or the bodily sensations associated with acute substance consumption (Leganes-Fonteneau et al., 2025). The first limitation of such an approach is that physiological arousal is considered a mere consequence of craving (Wang et al., 2019) rather than a core mechanistic component, craving per se being assessed through questionnaires that focus only on its cognitive dimension (Reid et al., 2006). Second, because measures of physiological arousal index global autonomic activation, they are not specific to the craving experience and have proved unable to distinguish different craving correlates across substances (e.g., similar cardiac and skin conductance measures among patients presenting with methamphetamine or alcohol use disorder; Kaplan et al., 1985; Reid et al., 2006). Third, these various physiological arousal measures are only weakly intercorrelated (Robbins et al., 1997), and their associations with subjective cognitive craving measures are inconsistent (Marissen et al., 2005; Toneatto, 1999).

Novel perspectives on the role of bodily sensations in substance use disorders can unveil mechanisms underlying craving beyond its cognitive component. Theoretical neurocognitive models of addiction share commonalities: they hypothesize a switch from use to abuse that is related to a change in cognitive craving diathesis, with a shift from impulsive hedonic drives to compulsive negative drug seeking (Koob & Volkow, 2010). In the first stage of substance consumption (i.e., "binge/intoxication"; Koob & Volkow, 2010), the incentive for drug consumption relies notably on positive reinforcement, favoring consumption for the pleasurable acute effects of the substance (Koob & Le Moal, 2008). Such theorization does not exclude the bodily dimension of craving, as its pleasurable effects could encompass pleasurable *bodily* effects (Naqvi & Bechara, 2010; Verdejo-Garcia et al., 2012). Acute ethanol effects are related to effects on the gustatory sensory axis (through its taste and chemosensory effect in the pharynx; Naqvi & Bechara, 2010; Verdejo-Garcia et al., 2012) and lead to an arousal of the sympathetic nervous system, with manifestations such as heart rate increase (Pennings et al., 2002). According to cognitive craving models, when the switch to substance use disorder happens, negative reinforcers principally underlie the need for substance consumption through negative reinforcement: compulsive consumption is associated with anxiety and stress prior to consumption, and alleviation of these negative affects after consumption (Koob & Le Moal, 2008; Koob & Volkow, 2010). Therefore, according to such a model, craving corresponds to negative affects and thoughts. The physical counterpart of such theorization would thus be unpleasant physical sensations when experiencing craving. Accordingly, tools developed to assess craving should provide an exploration of the physical sensations of craving, as well as the valence of these sensations. In line with this, the only direct empirical investigation of the physical sensations of craving confirmed that they share similarities with the bodily effects of the substance: patients presenting with cocaine

use disorder reported physical sensations such as palpitations, chest tightness, and cocaine taste in their throat when experiencing craving (Childress et al., 1993).

Questionnaires for self-reported craving also mainly focus on cognitive aspects. For example, in alcohol use disorder, only a single questionnaire (i.e., Jellinek Craving Questionnaire; Ooteman et al., 2006) assesses the bodily sensations of craving (Kavanagh et al., 2013). The same paucity of questionnaires evaluating the body sensations of craving is observed beyond addiction research (Miele et al., 2023). To reduce this discrepancy between evidence for the core role of craving embodiment in substance use disorder and the paucity of research regarding the bodily sensations of craving, we directly explored, for the first time in problematic alcohol consumption, the bodily sensations associated with craving. We used body maps that allowed participants to freely report their physical craving experience. Although originally used in qualitative (de Jager et al., 2016) and case (Margolis et al., 1986) studies, body maps have recently been used in quantitative studies that explored the bodily correlates of various processes (e.g., emotions; Nummenmaa et al., 2014). Such tools are postulated to constitute sound instruments to investigate the bodily manifestations of a process (here, craving) because they offer the possibility to simultaneously provide information regarding the taxonomy ("name the physical sensations associated with your craving"), localization ("indicate where in the body this sensation manifests"), intensity ("determine the intensity of this sensation"), and pleasantness ("evaluate to what extent this sensation was pleasant or unpleasant") of bodily signals. To directly test the proposal that the body sensations related to craving are associated with the switch from positive to negative reinforcement following the evolution of alcohol use disorder, we administered this paradigm to both subclinical (participants with a binge drinking pattern of alcohol consumption; BD) and clinical (recently detoxified patients with severe alcohol use disorder; SAUD) samples. We hypothesized (1) that the physical sensations associated with craving would be notably related to the specific (e.g., bodily sensations associated with the gastrointestinal tract; Naqvi & Bechara, 2010; Verdejo-Garcia et al., 2012) and nonspecific (e.g., palpitations related to changes in heart rate) effects of ethanol, and (2) that craving would be mostly related to pleasant body sensations promoting positive reinforcement at the subclinical level (BD) and to unpleasant sensations promoting negative reinforcement at the clinical level (SAUD).

MATERIALS AND METHODS

Participants

We included two samples of individuals with problematic alcohol consumption, namely a subclinical sample of BD and a clinical sample of recently detoxified patients with SAUD. Both groups underwent the exact same study protocol, which followed the Declaration of Helsinki's ethical standards and was approved by the Ethics Committee of the Psychological Sciences Research Institute. All participants provided their informed consent prior to study participation.

Individuals with BD habits

We recruited 76 BD (47 females) through social networks and emails, after ensuring their eligibility through a Qualtrics survey (Qualtrics Software; Qualtrics LLC, Provo, UT). The study per se was fully conducted in situ. Participants were students at the UCLouvain (Belgium) who presented a BD pattern of alcohol consumption according to Maurage et al.'s (2020) conceptualization. We ensured, through an in-depth evaluation of drinking habits via Qualtrics survey completion that BD reported, over a period of 12 months: (1) physiological BD episodes (i.e., blood alcohol consumption threshold of 0.08%), (2) psychological BD episodes (i.e., self-reported feelings of drunkenness), (3) 30% of drinking episodes as being physiological and/or psychological BD episodes, (4) bimonthly physiological and/or psychological BD episodes, (5) physiological BD episodes that were reached within 2–3 h, and (6) 3 days of abstinence per week. In addition, BD had to score at least 24 on Townshend and Duka's (2005) BD score, indicating intense BD habits. Exclusion criteria for BD were past/current diagnosis of major medical/neurological/psychological disorders, personal or familial past/current SAUD diagnosis and past/current polysubstance use. BD had to abstain from drinking alcohol at least 2 days prior to testing (mean abstinence duration: 4.95 days).

Patients with SAUD

We enrolled 97 individuals (21 females) undergoing a detoxification stay as inpatients in the Addiction Medicine Department of the Caen University Hospital (France). Trained psychiatrists diagnosed all patients as presenting with SAUD (DSM-5 criteria; American Psychiatric Association, 2013). Thirty-one patients had a history of abuse/dependence on other substances, including cannabis ($n = 29$), opiates ($n = 11$), cocaine ($n = 5$), and/or benzodiazepines ($n = 3$). At testing time, 41 patients were receiving acamprosate treatment to reduce craving for alcohol and the relapse risk (mean daily dose: 1961 mg), 52 patients were receiving benzodiazepine treatment to treat withdrawal symptoms (mean daily standardized dose: 48.48 mg), and 10 patients were receiving substitute treatment for prior opioid abuse/use disorder (mean daily dose of buprenorphine: 6.93 mg). Patients were all abstinent at testing (mean abstinence duration: 8.59 days). Patients spoke French fluently and presented no current major medical/neurological disorders or history of them.

Body map measure

To ensure that participants specifically reported craving-related physical sensations when completing the body maps, we provided,

before their completion, a detailed definition of the craving concept (i.e., "a very strong urge, desire, need to consume alcohol"). We also used open-ended questions to ensure that participants could identify craving-related past experiences and their triggers: questions related to the last episode of craving occurrence, frequency/intensity of craving, and type of situations that generated craving. Finally, we explained the need for participants to focus solely on physical sensations (i.e., to exclude cognitive correlates such as thoughts or emotions). Although we performed testing after patients' acute withdrawal period, we also specified the importance of dissociating craving sensations from withdrawal sensations, to reduce the contamination of the reported body sensations by present or recent withdrawal symptoms among SAUD patients.

The body map used represented a full human body, front and back (Figure 1). We asked all participants to recall their last experience of intense alcohol craving and to report the physical sensations felt during this experience (see Supplementary Material for the complete body map questionnaire). Rationale for relying on memory recall and reexperience of the last strong craving episode was that patients' craving decreases during an alcohol detoxification stay (Petit et al., 2017). Because we wanted to ensure that participants would rely on a craving episode strong enough to elicit sensations, we asked them to refer to their last intense craving episode. Moreover, to ensure a correct understanding of the task, we provided an example of a completed body map, but explicitly told participants that this was only an example and that they did not have to necessarily report the sensations represented.

When completing the body maps, participants reported on four factors as they recalled the physical sensations of craving: *taxonomy* (define/name the sensation), *localization* (indicate with a cross on the body map where you feel this sensation), *intensity* (indicate, through the number of crosses, the intensity of the sensation: very weak [X], weak [XX], moderate [XXX], strong [XXXX], or very strong [XXXXX]), and *pleasantness* (next to the sensation name, indicate by using a number whether this sensation was very unpleasant [1], unpleasant [2], a bit unpleasant [3], neutral [4], a bit pleasant [5], pleasant [6], or very pleasant [7]). All data are available from the Open Science Framework at https://osf.io/7g5pz/?view_only=46197faad2f0484db05b3d9bc9df45a0.

Procedure

For BD, demographic and alcohol-related information had been collected prior to testing through online Qualtrics questionnaires. For SAUD patients, trained psychiatrists first collected demographic information and assessed alcohol use disorder characteristics and withdrawal symptoms at testing time (Cushman scale; Cushman Jr et al., 1985). Experimenters trained in body map administration then ensured the individual completion of the questionnaires. Participants filled in the questionnaires with the help of the experimenters.

All participants also underwent a cognitive assessment: the Brief Evaluation of Alcohol-Related Neuropsychological Impairments (BEARNI; Ritz et al., 2015) for those younger than 65 years, or the Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005) for those aged 65 years or more. We selected this procedure because the BEARNI is not validated in older populations, and the MoCA is tailored to assess cognitive difficulties in the older population. Evaluating cognitive abilities permitted us to determine whether potential cognitive difficulties impeded the accurate completion of body maps.

Statistical analyses and computation of indices

We conducted all descriptive analyses related to the sample characteristics by using Jamovi 2.2.5 (R Core Team, 2019; The Jamovi Project, 2020). We computed indices of the physical sensations of craving from the measures collected through the body maps (i.e., taxonomy, localization, intensity, and pleasantness). Regarding the taxonomy of the physical sensations of craving, we grouped the sensations per body subregion, enabling us to explore the most frequently experienced physical sensations of craving and whether they differ depending on the body parts.

We then explored the average intensity of physical sensations of craving per body subregion, independently of sensation type. This method established whether the perceived intensity of craving sensations differed across body subregions. Participants rated the intensity of a craving sensation from 1 out of 5 (very weak) to 5 out of 5 (very strong), or reported no sensation (i.e., a score of 0 out of 5), which provided two variables. The first variable was the average intensity of sensations per subregion for the entire sample, calculated by averaging the scores from 0 out of 5 (no intensity reported for a given bodily subregion) to 5 out of 5 (very strong intensity). For the sake of clarity, we recomputed scores into decimal numbers (from 0 for 0 out of 5 to 1 for 5 out of 5). The second variable was the average intensity of physical sensations per subregion—solely for participants reporting a sensation—for which we averaged scores ranging from 1 out of 5 (i.e., 0.2) to 5 out of 5 (i.e., 1). This second index allowed us to identify the subregions that generated no sensation in most participants but that conversely generated a strong sensation in a specific subsample.

We also explored the frequency, that is, for each subregion, the percentage of participants who reported a sensation, based on binomial scores (0 when the participant reported no sensation for the subregion; 1 if they reported a sensation, independently of the intensity).

We computed the mean pleasantness of the sensations reported in each body subregion among participants who reported a sensation for that subregion. Participants rated their manifestations of craving from very unpleasant (1) to very pleasant (7). We conducted between-group comparisons (i.e., independent-samples *t*-tests) on the reported pleasantness per body subregion. As only one SAUD patient reported a sensation for the upper back, the ears, and the eyes, we conducted one-sample *t*-tests with the median of SAUD pleasantness value as reference. We did not control for variables that differed between groups, as Spearman's rank correlation analyses showed no association between the pleasantness scores and age (SAUD: $r=0.05$, $p=0.72$; BD: $r=-0.00$, $p=0.99$), years of

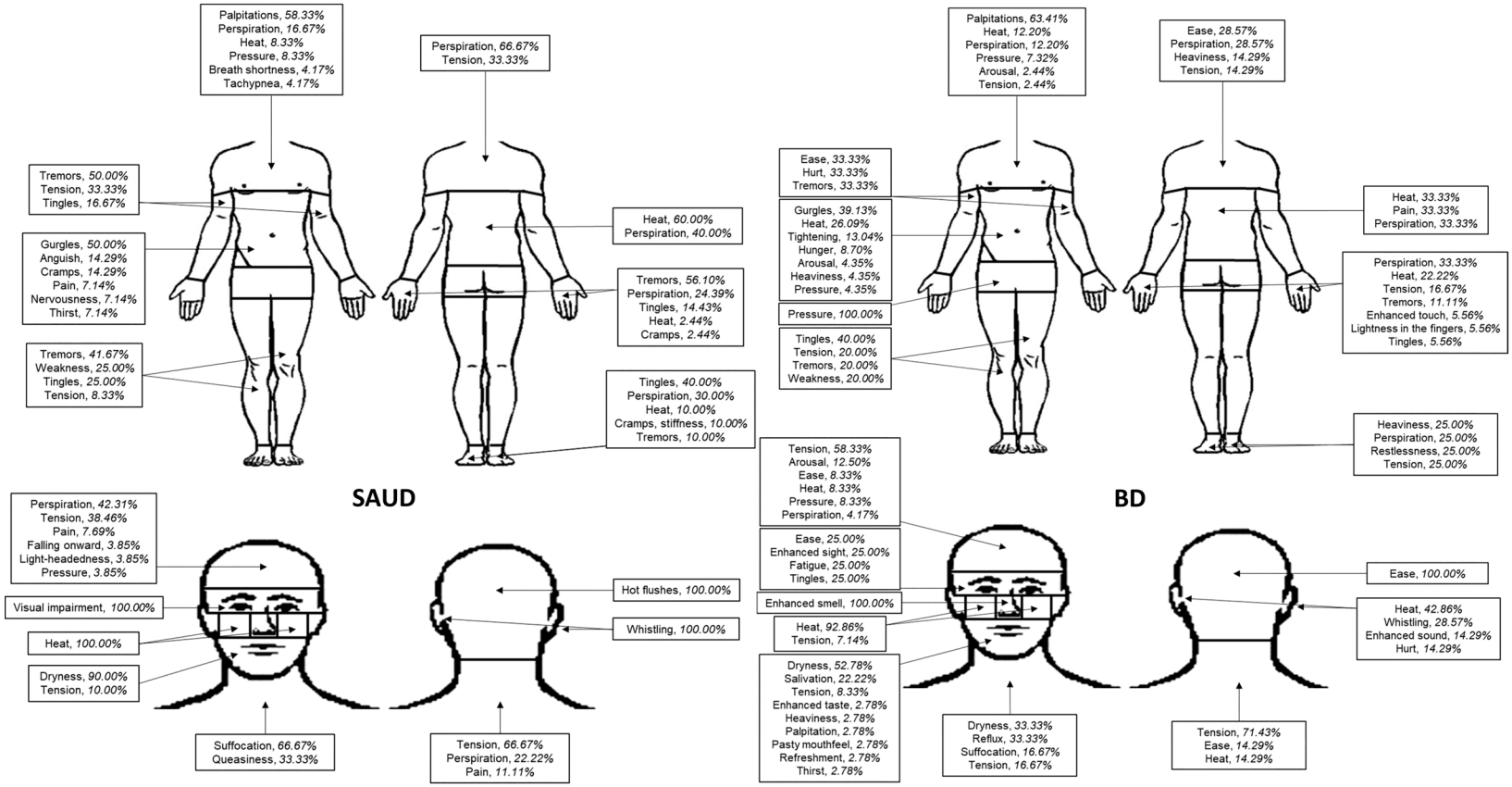

FIGURE 1 Representation of the reported physical sensations of craving, per subregion, for patients with severe alcohol use disorder (SAUD, $n = 97$; left part of the Figure) and binge drinkers (BD, $n = 76$; right part of the Figure). Percentages (presented in decreasing order) represent the proportion of each physical sensation of craving reported in comparison to all sensations reported for that subregion.

TABLE 1 Sociodemographic, clinical, and alcohol-related variables for patients with severe alcohol use disorder (SAUD) and binge drinkers (BD).

Variable	Number, mean (SD)		Group comparison
	SAUD, $n=97$	BD, $n=76$	
Sociodemographic			
Age (years)	49.10 (10.28)	21.11 (2.30)	$U=46.50$, $p<0.001$
Education level (years, starting in primary school)	11.98 (2.77)[12]	13.47 (1.72)	$U=1916.50$, $p<0.001$
Gender, female (%)	21.65	61.84	χ^2 (1, 173) = 28.86, $p<0.001$
Neuropsychological assessment			
BEARNI (total score); when <65 years old	14.80 (4.71)[13]	24.20 (2.91)	$t(115.00)=14.27$, $p<0.001$
MoCA (total score); when ≥65 years old	22.92 (5.48)[1]	N/A	/
Alcohol-related			
Number of DSM-5 SAUD diagnosis criteria	9.52 (1.73)[12]	N/A	/
Age at first alcohol consumption (years)	16.15 (5.46)[8]	15.21 (1.49)	$U=2937.00$, $p=0.14$
Duration of alcohol use disorder (years)	13.59 (9.05)[9]	N/A	/
Number of previous detoxifications	1.27 (1.52)[3]	N/A	/
Cushman score (day of body map completion)	2.67 (2.31)[24]	N/A	/
Consumption per day for SAUD patients, per drinking occasion for BD (in standard units)	19.63 (11.49)	6.08 (2.10)	/
Abstinence duration (days)	8.59 (12.44)[11]	4.95 (3.02)[3]	$U=2552.50$, $p=0.05$
AUDIT	N/M	13.32 (3.77)	/
BD score	N/A	37.07 (10.85)	/

Note: Superscript numbers indicate the number of missing data.

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test; BEARNI, Brief Evaluation of Alcohol-Related Neuropsychological Impairments; MoCA, Montreal Cognitive Assessment; N/A, not appropriate; N/M, not measured.

education (SAUD: $r=-0.07$, $p=0.63$; BD: $r=-0.08$, $p=0.54$), age at first drink (SAUD: $r=0.22$, $p=0.12$; BD: $r=0.05$, $p=0.70$), units of ethanol per day for patients (SAUD: $r=0.00$, $p=0.97$) and per week for BD ($r=-0.04$, $p=0.75$), and last day of consumption at completion (SAUD: $r=-0.18$, $p=0.11$; BD: $r=0.20$, $p=0.12$).

Finally, we conducted between-group comparisons (i.e., independent-samples *t*-tests and chi-square tests of independence) on demographic measures, alcohol-related variables, and body map indices. When samples quantitative data had equal variances (assessed through Levene's homogeneity of variance test) and were normally distributed (assessed through Shapiro–Wilk normality test), we conducted independent-samples *t*-tests. When we found unequal variances but normal distribution of the data, we conducted Welch's test instead. When we found the data to be abnormally distributed, we conducted Mann–Whitney *U* tests. To conduct within-group comparisons on the body map indices, we performed Friedman tests followed by Durbin–Conover pairwise comparisons.

RESULTS

Sample characteristics

Individuals with BD habits

The average BD score (Townshend & Duka, 2005) of 37.07 ensured that participants indeed presented a specific BD consumption pattern, and their average score of 13.32 (Min = 02; Max = 20) on the Alcohol Use Disorders Identification Test (AUDIT; Babor & Robaina, 2016; Gache et al., 2005) confirmed that they were hazardous but nondependent drinkers (Table 1). On average, participants consumed 6.08 units of ethanol per drinking occasion. BEARNI assessment revealed that, according to normative data (Ritz et al., 2015), 93.51% of the sample presented normal cognitive abilities, mild cognitive difficulties being reported in only 6.49% of the sample. Spearman's rank correlation analysis between the cognitive assessment scores and body mapping indices showed no correlation with frequency ($r=0.09$, $p=0.47$), intensity ($r=0.12$, $p=0.32$), or pleasantness ($r=0.01$, $p=0.93$) of reported craving manifestations.

Patients with SAUD

Regarding alcohol-related variables, all patients presented a *severe* form of alcohol use disorder according to the DSM-5 criteria (i.e., six or more diagnosis criteria; American Psychiatric Association, 2013) with a mean daily consumption the month prior to detoxification of 19.63 alcohol units (a unit corresponding to 10 grams of pure ethanol). Although the experiment took place after the acute withdrawal phase, we minimized the potential influence of residual withdrawal-related body sensations on the results. This was confirmed by the low Cushman scores at testing time ($M=2.67$; $SD=2.31$) and by the absence of significant correlations between these residual withdrawal

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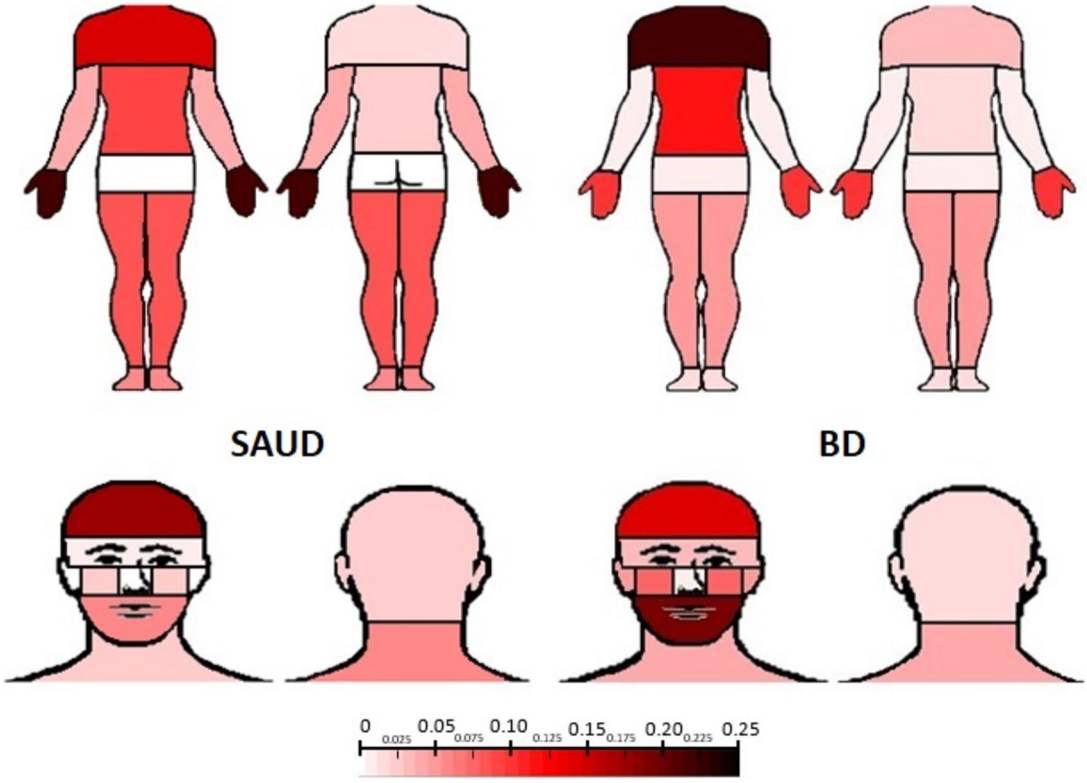

FIGURE 2 Average intensity of the physical sensations of craving per body subregion for patients with severe alcohol use disorder (SAUD, $n=97$; left part of the Figure) and binge drinkers (BD, $n=76$; right part of the Figure). The scale, initially ranging from 0 (no intensity reported) to 1 (very strong intensity), has been limited to the 0–0.25 range for the sake of clarity, as the mean intensity did not exceed 0.25 in any body subregion.

symptoms and body map results. As frequently reported in similar samples, BEARNI and MoCA evaluations showed that, according to normative data (Nasreddine et al., 2005; Ritz et al., 2015), 17.44% of the sample presented mild cognitive difficulties and 53.49% had severe cognitive difficulties. These cognitive difficulties did not seem to have hampered the completion of the body maps: Spearman's rank correlation analyses between the scores for cognitive assessments and the body mapping indices showed no correlation with intensity (BEARNI: $r=-0.02$, $p=0.85$; MoCA: $r=0.17$, $p=0.60$), frequency (BEARNI: $r=-0.03$, $p=0.83$; MoCA: $r=0.15$, $p=0.65$), or pleasantness (BEARNI: $r=0.11$, $p=0.47$; MoCA: $r=-0.26$, $p=0.74$) of the reported manifestations of craving.

Between-group comparisons

SAUD patients were older than BD participants ($U=46.50$, $p<0.001$) and had a lower education level ($U=1916.50$, $p<0.001$). The SAUD sample comprised a lower proportion of females (χ^2 (1, 173) $=28.86$, $p<0.001$). SAUD patients scored lower than BD participants at the BEARNI ($t(115.00)=14.27$, $p<0.001$). Concerning alcohol-related variables, BD participants and SAUD patients did not differ significantly on either the age at which they started drinking ($U=2937.00$, $p=0.14$) or the number of days they had been abstinent when completing the body map ($U=2552.50$, $p=0.05$).

Physical manifestations of craving

Intensity (all participants included)

The bodily subregions for which the BD sample reported the most intense craving sensations were in the shoulders and thorax (mean intensity: 0.21), where craving was experienced by more than half of the participants as palpitations (Figures 1–2, Table 2 and Tables S1–S3). For the SAUD sample, it was in the hands that the most intense craving sensations were reported (mean intensity: 0.22), where craving was experienced by half of the patients as tremors.

For the subclinical group, the second bodily region where the most intense craving sensations were reported was the mouth (mean intensity: 0.20), where craving took, for half of the BD, the form of dryness. At the clinical level, it was in the forehead (mean intensity: 0.18), where craving was experienced principally as perspiration.

The third bodily subregion where BD reported the most intense craving sensations was the forehead (mean intensity: 0.14), where craving took the form of tension for more than half of the participants. For SAUD patients, it was the shoulders and thorax (mean intensity: 0.14) where, for more than half of the sample, craving took the form of palpitations.

BD within-group comparisons revealed that participants reported overall significantly different intensity ratings depending on the bodily regions (χ^2 (18) $=386.56$, $p<0.001$). Concerning the three

TABLE 2 Intensity for the whole sample, frequency of report, intensity among respondents (i.e., among patients who reported a sensation in this subregion) and pleasantness of physical sensations of craving for patients with severe alcohol use disorder (SAUD, $n=97$) and binge drinkers (BD, $n=76$).

	Intensity (all sample, mean)		Frequency (%)		Intensity (respondents, mean)		Pleasantness (respondents, mean)		
Subregion	SAUD	BD	SAUD	BD	SAUD	BD	SAUD	BD	*p*-Value
Hands	0.22	0.10	31.96	23.68	0.69	0.46	2.08	3.28	<0.001[A]
Forehead	0.18	0.14	24.74	31.58	0.73	0.45	2.04	3.96	<0.001[A]
Shoulders and thorax	0.14	0.21	22.68	53.95	0.63	0.40	2.22	4.00	<0.001[A]
Abdomen	0.09	0.12	14.43	30.26	0.66	0.41	2.00	3.87	<0.001[A]
Legs	0.08	0.05	12.37	6.58	0.65	0.72	1.64	3.20	0.009[B]
Neck	0.06	0.04	10.31	9.21	0.62	0.40	1.56	3.43	0.01[A]
Feet	0.06	0.02	10.31	5.26	0.60	0.45	2.00	2.75	0.34[B]
Mouth	0.06	0.20	10.31	47.37	0.60	0.44	2.33	3.75	0.006[A]
Arms	0.04	0.01	6.19	3.95	0.60	0.33	1.40	3.00	0.003[B]
Lower back	0.03	0.02	6.19	3.95	0.50	0.40	2.60	2.67	1.00[A]
Cheeks	0.02	0.07	5.15	18.42	0.48	0.39	1.33	3.57	0.005[B]
Head	0.03	0.02	4.12	2.63	0.65	0.70	2.33	6.00	0.045[B]
Throat	0.02	0.04	3.09	7.89	0.80	0.47	2.00	3.50	0.04[B]
Upper back	0.01	0.03	2.06	7.89	0.60	0.43	2.00	3.60	0.03[C]
Ears	0.01	0.05	2.06	9.21	0.20	0.51	3.00	2.71	0.57[D]
Eyes	0.01	0.03	1.03	5.26	0.60	0.55	2.00	4.50	0.03[C]
Hips	0.00	0.01	0.00	1.32	/	0.80	/	3.00	/
Nose	0.00	0.01	0.00	1.32	/	1.00	/	5.00	/

Note: Intensity is coded from 0 (no sensation at all) to 1 (very intense sensation). Frequency measures the percentage of participants reporting a sensation in the subregion. Pleasantness is coded from 1 (very unpleasant) to 7 (very pleasant). A = Mann–Whitney *U*-test; B = Welch's *t*-test; C = one-sample *t* test; D = Wilcoxon signed-rank test.

bodily parts for which BD participants reported the most intense physical sensations of craving, post-hoc tests revealed that shoulders and thorax and mouth intensity ratings did not differ significantly ($p=0.08$), nor did mouth from forehead ratings ($p=1.00$). However, the intensity reported in shoulders and thorax was significantly higher than the one in the forehead ($p<0.001$). Concerning SAUD within-group comparisons, patients differed overall on the intensity ratings per bodily subregion (χ^2 (17) = 186.40, $p<0.001$). Concerning the three body parts for which patients reported craving sensations most often and with the highest intensity, post-hoc tests found the hands ratings to be significantly more intense than the shoulders and thorax ($p=0.007$) and the forehead ($p=0.048$) ones. Forehead intensity ratings did not significantly differ from the shoulders and thorax ratings ($p=0.46$). Tables S1–S3 present the statistical indices of all post-hoc tests for both groups.

Frequency

Frequency reports were in line with intensity reports, as the three body parts generating the most frequent reports of craving sensations for BD were the shoulders and thorax (53.95%), the mouth (47.37%), and the forehead (31.58%). For SAUD patients, the body parts generating the most frequent reports were the hands (reported by 31.96% of the sample), the forehead (24.74%), and the shoulders and thorax (22.68%).

Intensity (respondents)

For each body part, we looked more specifically at the intensity of craving sensations, but only among individuals who reported sensations for this body part (see Tables S1–S3 for full results). We observed that, for some body parts, sensations were rarely reported, but when they were, they were intense. For example, although only 1.32% of BD reported sensations in the nose, such sensations were felt with the highest intensity level (mean intensity: 1.00) and took the form of enhanced smell. Such an effect was also found at the clinical level, with only 3.09% of patients with SAUD reporting craving sensations in the throat, but with the highest intensity level (mean intensity: 0.80); these sensations were reported to take the form of suffocation (67%) and queasiness (33%). This finding suggests that some body parts might be related to less frequent but more intense craving sensations.

Pleasantness (respondents)

In BD, the analysis of reported pleasantness and the taxonomy of the sensations showed that craving was mostly characterized as being overall pleasant with sensations ranging from a bit unpleasant to pleasant. Conversely, for SAUD patients, craving was characterized by unpleasant sensations and pain, with sensations ranging from very unpleasant to unpleasant. Independent and one-sample *t*-tests concurred with the fact that, at the subclinical level, craving was overall much more pleasant: for 13 of the 16 body subregions, sensations were reported as being significantly more pleasant by BD (see Table 2 for the *p*-values of group comparisons in each subregion). Exceptions were the ears, where SAUD patients felt the least unpleasant craving experience, and the lower back and feet, where BD felt the most unpleasant craving experience. Such a group difference regarding the pleasantness of craving sensations was also observed in the words used to describe craving. Although BD reported sensations related to pleasant experiences (e.g., arousal in the forehead, ease reported in six body subregions), SAUD patients used words mostly related to negative feelings or pain (e.g., tachypnoea in the thorax region, tremors in the arms, cramps in the abdomen, and pain in the forehead). Moreover, when participants from both groups used similar taxonomy to describe their craving sensations, SAUD patients reported these sensations as being more unpleasant. For example, participants at both clinical (58.33%) and subclinical (63.41%) levels reported craving to principally take the form of palpitations in the shoulders and thorax, the main difference being that this sensation was felt as more unpleasant for SAUD patients (2.38) than for BD (4.12) (see Tables S1–S3 for full results).

Between-group comparisons

Groups did not differ on the global intensity of reported sensations ($U = 3320.00$, $p = 0.26$) but, when looking more specifically at the intensity of sensations within participants who reported physical sensations of craving, SAUD patients reported significantly more ($M = 0.66$; SD = 0.18) intense sensations than BD ($M = 0.42$; SD = 0.16; $t(119.00) = 7.81$, $p < 0.001$). SAUD patients ($M = 2.14$, SD = 1.03) reported significantly lower pleasantness than BD participants ($M = 3.77$, SD = 0.97; $U = 365.00$, $p < 0.001$).

When looking more specifically at bodily subregions, SAUD patients reported significantly less frequently sensations than BD in the shoulders and thorax (χ^2 (1) = 13.51, $p < 0.001$), abdomen (χ^2 (1) = 5.45, $p = 0.02$), mouth (χ^2 (1) = 21.89, $p < 0.001$), cheeks (χ^2 (1) = 7.67, $p = 0.006$), and ears (χ^2 (1) = 4.42, $p = 0.04$). SAUD patients did not differ significantly from BD on the frequency of sensations reported in the hands (χ^2 (1) = 2.56, $p = 0.11$), forehead (χ^2 (1) = 0.66, $p = 0.42$), legs (χ^2 (1) = 1.61, $p = 0.20$), neck (χ^2 (1) = 0.06, $p = 0.81$), feet (χ^2 (1) = 1.46, $p = 0.23$), arms (χ^2 (1) = 0.46, $p = 0.50$), lower back (χ^2 (1) = 0.43, $p = 0.51$), head (χ^2 (1) = 0.28, $p = 0.59$), throat (χ^2 (1) = 1.99, $p = 0.16$), upper back (χ^2 (1) = 3.21, $p = 0.07$), eyes (χ^2 (1) = 2.72, $p = 0.10$), hips (χ^2 (1) = 1.28, $p = 0.26$), and nose (χ^2 (1) = 1.28, $p = 0.26$).

Chi-squared between-group comparisons conducted on the frequency of report for each sensation type independently of the bodily subregions revealed that groups differed significantly solely for the frequency of report of arousal (BD = 7%, SAUD = 0%, χ^2 (1) = 6.57, $p = 0.01$), dryness (BD = 28%, SAUD = 9%, χ^2 (1) = 10.01, $p < 0.01$), ease (BD = 12%, SAUD = 0%, χ^2 (1) = 12.12, $p < 0.001$), heat (BD = 32%, SAUD = 8%, χ^2 (1) = 15.39, $p < 0.001$), heaviness (BD = 5%, SAUD = 0%, χ^2 (1) = 5.23, $p = 0.02$), palpitations (BD = 34%, SAUD = 14%, χ^2 (1) = 9.38, $p < 0.01$), salivation (BD = 11%, SAUD = 0%, χ^2 (1) = 10.71, $p = 0.001$), tension (BD = 28%, SAUD = 14%, χ^2 (1) = 4.60, $p = 0.03$), tightening (BD = 4%, SAUD = 0%, χ^2 (1) = 3.90, $p = 0.048$), and tremors (BD = 5%, SAUD = 27%, χ^2 (1) = 13.79, $p < 0.001$) (see Tables S1–S3 for full results).

DISCUSSION

We proposed, to our knowledge, the first phenomenological exploration of the physical sensations of craving in a subclinical sample of BD and a clinical sample of SAUD patients, using an innovative body mapping tool. Previous research mainly focused on the cognitive and psychological dimensions of craving, neglecting the physical sensations related to it. Our study could thus identify how physical craving might manifest at the subjective level.

At the subclinical level, the shoulders and thorax, the mouth, and the forehead are the three body regions where BD report the most frequent and highest intensity sensations of craving. These sensations mostly take the form of palpitations, dryness, and tension, respectively. The results might suggest that BD report the most intense and frequent physical sensations of craving in body subregions related to the direct and specific acute effect of ethanol (Leganes-Fonteneau et al., 2025). Indeed, documented acute ethanol effects are dryness in the mouth, arterial hypertension (Fernández-Solà, 2015), "holiday heart syndrome" (i.e., acute cardiac rhythm induced by acute heavy ethanol consumption; Ettinger et al., 1978), increased perspiration rate (Yoda et al., 2005), hyperthermia (Papanicolaou & Fennessy, 1980), and facial redness (Bae et al., 2012), which were reported by BD when remembering the bodily component of craving. Of note, they also report physical sensations of craving that are related to non-specific acute ethanol effects.

At the clinical level, we found that the hands, the forehead, and the shoulders and thorax are the three body parts where patients with SAUD feel craving most frequently and intensely. Such manifestations mostly take the form of tremors, perspiration, and palpitations, respectively. Such a finding might contradict the view that, at the clinical level, craving is mostly related to drug-specific symptoms that depend on the way a substance is consumed and its direct contact with specific body parts (Naqvi & Bechara, 2010; Verdejo-Garcia et al., 2012). For SAUD patients, the bodily sensations of craving could be more related to nonspecific and thus indirect physiological

modifications related to long-term compulsive alcohol use (Koob & Volkow, 2016) and to withdrawal, rather than to its direct impact on the gastrointestinal system. The pathophysiology of long-term ethanol effects has multiple bodily manifestations, including tremors (Baizabal-Carvallo & Morgan, 2022), hyperactivation of the autonomic nervous system (e.g., arrhythmias, arterial hypertension; Fernández-Solà, 2015), gastritis, and cutaneous disorders associated with decreased ability to regulate body temperature (e.g., abnormal sweating) (Mukherjee et al., 2007). In our SAUD sample, the most often reported craving sensations also included tremors and autonomic nervous system activation (palpitations), as well as discomfort in the gastrointestinal tract (stomach gurgles, esophageal suffocation). An overall feverish arousal of the body was also reported, taking the form of heat, hot flushes, perspiration, and tension.

Our results could suggest that craving-related bodily sensations mimic (1) the acute ethanol effects in BD and (2) the negative long-term ethanol effects in SAUD individuals. This proposal is consistent with influential addiction models proposing that the switch from substance use to abuse is related to a transition from positive to negative reinforcement: incentive for one's drinking no longer relies on seeking a pleasurable effect from ethanol, but rather on alleviating the negative effects related to its withdrawal (e.g., in the opponent-process theory of motivation; Koob & Le Moal, 2008). This could be supported by our results showing that craving is experienced as highly unpleasant by SAUD patients and takes notably the form of withdrawal-related sensations. These unpleasant physical manifestations of craving could indeed index the progressive switch from positive anticipation to distressing manifestations, following the transition from subclinical to clinical substance consumption.

Further support for the fact that physical craving at the subclinical level might be underpinned by processes related to positive reinforcement is that physical sensations of craving are much more pleasant for BD than for SAUD patients. This is observed both in the taxonomy of the words used to describe such sensations of craving (e.g., ease for BD versus suffocation for SAUD patients) and in the overall higher positive assessment of the pleasantness felt about these sensations for BD. This is also observed when physical sensations of craving are shared: for example, both groups report the most frequent physical sensation of craving in the shoulders and thorax to be palpitations, but SAUD patients report such a sensation as unpleasant, whereas BD report it to be neutral. As a whole, our results might offer the first phenomenological data showing that the body sensations related to craving are characterized by a switch from positive/pleasant to negative/unpleasant feelings during the evolution from subclinical to clinical stages of alcohol use disorder. We therefore might have identified the subjective physical correlates of the transition from "pleasant anticipation" craving (positive reinforcement or liking) in subclinical populations to "negative urge" craving (negative reinforcement or wanting) in clinical populations, such a transition having been up to now postulated only at the neurocognitive level by addiction models. Of note, in addition to having reported less pleasant sensations, SAUD patients also reported more intense sensations of craving than BD.

Beyond unveiling physical manifestations of craving in problematic alcohol consumption, our results might provide empirical and therapeutic inputs. Regarding the empirical aspect, there is a tendency, in the addiction research field, to explore only the cognitive dimension of the craving experience. Knowing how craving physically manifests at the subjective level, as documented here, will help to better target the sensory axes that could be measured when objectively assessing it: cardiac parameters (e.g., heart rate variability, cardiac inotropy), galvanic skin response, and accelerometry would be of interest because participants report that craving manifests mainly as palpitations, perspiration, and tremors. At the SAUD level, our results question the sole focus of current therapeutic tools on the cognitive manifestations of craving (e.g., cognitive behavioral therapies that focus solely on cognitive strategies such as changing thoughts of temptations; Naqvi et al., 2015). It is essential to include all dimensions of craving (i.e., thoughts, emotions, as well as bodily sensations) in problematic alcohol consumption clinical interventions that target craving, a major relapse risk factor (Gauld et al., 2023). For instance, in mindfulness-based relapse prevention (Bowen et al., 2009), patients pay close attention and accept craving-related thoughts and emotions, as well as physical sensations, in a mindful and nonjudgmental fashion, without attempting to suppress them. Moreover, the current study results show that, regardless of the cognitive abilities of the patients, they can remember their past physical sensations of craving. From this perspective, an exploration of physical sensations of craving by using the body map could be associated with such a technique, allowing for awareness of how craving manifests while targeting specific physical sensations during the mindfulness session. The body map could also be used as a psychoeducation tool to help better distinguish emotional from non-emotional states (Herman et al., 2024).

This study is not without limits. First, we aimed to explore craving manifestations at the subclinical and clinical stages of alcohol misuse. However, as we followed a cross-sectional—rather than longitudinal—design, limits emerged. Notably, as we do not follow a temporal evolution of craving manifestations within the same sample, we cannot ensure that the differences (e.g., positive vs. negative manifestations) are not due to sociodemographic differences (e.g., age, gender, BEARNI scores) rather than to an actual evolution of craving throughout the stages of addiction. In addition, other confounding effects are related to the fact that patients are recent abstainers, hospitalized, and medically treated (e.g., through benzodiazepines and/or acamprosate) while BD participants are still consuming alcohol (they solely had to refrain drinking alcohol 2 days prior to testing) and in their usual environment. It should also be noted that a minority of SAUD patients had a history of polysubstance use, which was not observed in BD participants. Second, the assessment of craving manifestations may have impacted study results. Indeed, we cannot exclude that memory abilities affected the reminiscence of a past craving episode and its recollection. It would thus be of interest to compare our results with a state measure of craving (which was impossible to induce in our SAUD patients for treatment-related reasons). Moreover, we provided participants

with examples of typical craving physical sensations that one could feel when experiencing craving. While caution was applied since such examples were provided by expert patients and psychiatrists and we explicitly instructed participants to refer to their own craving sensations, we cannot exclude that this led to recall and desirability biases. Moreover, while we tried to ensure that patients reported craving and not withdrawal sensations, in particular by explaining in depth to participants the difference between craving and withdrawal and by testing patients with a low Cushman's score (which did not correlate with body map indices), we cannot totally exclude an overlap between physical sensations of craving and withdrawal—especially since patients reported sensations of craving that are part of withdrawal symptoms such as tremors and reported craving to be overall unpleasant. The main difficulty in trying to dissociate craving from withdrawal is that the research field does not allow the evaluation of the length of the overlap between the physical sensations of craving and withdrawal, as this is the first exploration of the physical dimension of craving. Future studies are thus needed to unravel both concepts, which could be done by exploring the physical sensations of craving in patients who have been abstinent for several months or years (thus not experiencing withdrawal anymore), as well as by exploring the physical sensations of craving in patients presenting with a nonsubstance-related addictive disorder such as gambling or gaming disorder (thus without physical withdrawal symptoms). Finally, the body maps provide only a subjective assessment of physical craving, based on self-reports. They should be compared to objective craving measures (e.g., physiological arousal).

Beyond these limitations, we offer the first assessment of the subjective physical manifestations of craving in problematic alcohol consumption. Although craving had been solely conceptualized as being underpinned by cognitive processes, we show that it has a physical counterpart that can be observed at both subclinical and clinical levels. Moreover, we provide an exploration of the intrinsic phenomenology of the manifestations of physical craving, showing that craving is mostly related to positive reinforcers related to acute ethanol effects in subclinical BD and to negative reinforcers related to deleterious long-term effects of ethanol in clinical SAUD. Identifying the manifestations of craving and its bodily sensations through body maps provides an empirical background for future studies, paving the way for the exploration of physical craving in multiple populations, both subclinical and clinical, as well as in relation to other substances. Moreover, the current results highlight the importance of adding a bodily dimension to therapeutic interventions that target the key relapse factor that is craving.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in OSF at https://osf.io/7g5pz/?view_only=46197faad2f0484db05b3d9bc9df45a0.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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