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Mechanisms of emotional eating and drinking: Sadness increases approach bias and craving for chocolate and alcohol

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ABSTRACT

Negative affect can trigger overconsumption of appetitive substances, but specific mechanisms and trait-level risk factors remain unclear. In two pre-registered studies, we tested whether negative affect increases approach bias and craving for chocolate and alcohol, with strongest effects expected in individuals with self-reported emotional intake.

In Study 1 ($N = 87$), negative or neutral affect was induced on separate days, followed by an approach-avoidance-task and craving ratings. Study 2 employed a more potent affect induction and larger sample ($N = 132$).

In Study 1, affect induction failed, so we analyzed incidental variations in *self-reported* sadness. Approach biases and cravings to chocolate and alcohol were stronger during sessions with higher sadness. Study 2 replicated and extended this finding by showing that *induced* negative affect increased biases and cravings. Further, trait emotional eaters showed a stronger affect-related increase in chocolate bias, while trait emotional drinkers exhibited stronger biases independent of affect.

Craving and approach bias increases help explain why self-regulation may fail under emotional distress. Consistent findings for chocolate and alcohol suggests their potential generalizability across appetitive substances. Trait questionnaires can be regarded as risk indicators, offering a basis for tailored interventions by identifying who is vulnerable to overconsumption and when.

Overconsumption of alcohol and hyperpalatable food can have harmful consequences such as addiction and obesity (World Health Organization [WHO], 2018, 2022). Unfortunately, interventions are often ineffective in the long run, in part because negative emotions can cause dietary or abstinence failures (Baumeister et al., 2007; Bresin et al., 2018). Such affect-related changes in intake are often attributed to the affect-enhancing capability of appetitive substances, variously described in the literature as ‘coping motives’ (Cooper et al., 2016), ‘affect regulation’, ‘tension reduction’ (Dvorak et al., 2018), ‘negative reinforcement’ (Cho et al., 2019) or ‘emotional self-medication’ (Torres & Papini, 2016). Specifically, negative affect may be relieved by the pleasant taste of a substance, the distraction its intake provides, or its pharmacological effects, and therefore, an individual who experiences this – either by themselves or through others – may learn to use substances to counteract negative affect in the future. As substances whose intake evoke hedonic responses (i.e., pleasure and reward) should be

particularly effective in alleviating affect, most studies focus on such appetitive substances (Ferrer et al., 2020; Macht & Simons, 2011). While palatable food and alcohol differ in important aspects (e.g., pharmacological mechanisms), they both fall into this category. Specifically, participants experience hedonic pleasure after food and alcohol intake, and cues associated with them elicit similar reward-related brain responses in neuroimaging studies (Noori et al., 2016). Accordingly, they should be similar with respect to assumed mechanisms on affect-related intake (Ferrer et al., 2020).

Even though affect-related intake is popular in lay psychology, frequently self-reported on questionnaires, and prominent in theories of substance use, its empirical basis is surprisingly mixed. One meta-analysis in the food domain found that induced negative affect increases food intake (Cardi et al., 2015), but another one did not find this effect in most populations, including emotional eaters (Evers et al., 2018). Some authors question self-reports of emotional eating

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altogether, arguing that individuals blame negative affect for their dietary failures in retrospect, while no prospective relationship exists (Bongers & Jansen, 2016). This, however, contradicts ecological momentary assessment (EMA) studies showing that binge eating is preceded by negative affect which points towards affect-related intake when it comes to disordered eating patterns (Haedt-Matt & Keel, 2011). In the alcohol domain, affect induction studies have established a causal effect of negative affect increasing alcohol intake in the laboratory (Bresin et al., 2018), but a meta-analysis summarizing 69 EMA did not find evidence for increased alcohol intake on days with high negative affect, neither in the general population, nor in participants who report using alcohol to cope with negative affect (Dora et al., 2022). These inconsistencies suggest that our knowledge of when and for whom affect-related intake occurs remains limited.

Is it possible that beliefs rooted in lay psychology lead individuals to self-identify as prone to affect-related intake even though the observed affect-intake relationship is primarily present in other subgroups (e.g., those with disordered intake patterns)? Or could these inconsistencies be due to the way appetitive behaviors are assessed? Most studies – and the meta-analyses based on them – have measured actual *intake*. While overt behavior has high external validity, direct observation or self-reported intake is subject to experimenter demand effects (Robinson et al., 2015). Furthermore, the urge to eat or drink often cannot be immediately acted on due to situational constraints or lack of access to substances, which may obscure the relationship between negative affect and intake, especially in naturalistic EMA studies. Thus, affect-related intake may be more effectively investigated by focusing on the processes which prepare for intake, instead of the intake itself. According to the literature on cue reactivity (Agarwal et al., 2021; Kanoski & Boutelle, 2022), appetitive responses occur on several levels, some of which may be subjectively experienced while others tap into automatically activated psychophysiological, neural and behavioral preparatory action (Drummond, 2000; Nederkoorn et al., 2000). Intake cues can, for example, elicit a strong urge to consume a substance – so-called *cravings* – which are by definition accessible through introspection only. Intake cues can also elicit action tendencies – so-called *approach biases* – which are quantified through reaction times (RTs) on a millisecond-level and thus act on a more automatic level compared to craving (Kakoschke et al., 2019).

In line with our conceptualization of craving and approach bias as two facets of a process facilitating intake, previous studies have already shown both measures to be related to each other (Field et al., 2008; Kahveci et al., 2020). Past studies further already showed that approach biases are sensitive to negative affect, and that this affect-bias relationship depends on specific individual characteristics. In the food domain, the affect-bias relationship has been found to vary based on restrained eating tendencies as well as on binge eating behavior; however, no study to date has investigated whether it is stronger among self-identified emotional eaters (Krehbiel et al., 2021; Neimeijer et al., 2017). In the alcohol domain, the affect-bias relationship depended on motives to use alcohol to enhance positive affect (i.e., enhancement motives) but not on motives to use alcohol to cope with negative affect (i.e., coping motives; Cousijn et al., 2014; Ralston et al., 2013), which may however be due suboptimal psychometric properties of self-reported coping motives (Austin et al., 2020). By examining two intake-related variables, we can not only test more robustly whether negative affect facilitates appetitive responses but also identify potential mediating *mechanisms* of how negative affect causes intake, and that could in turn guide treatment development.

Based on this background, we pre-registered two studies (Study 1: https://aspredicted.org/5HK_9CG; Study 2: https://aspredicted.org/XTB_J4B) to investigate whether sadness, as a representative of negative affect, strengthens cravings and approach biases, and whether these increases are stronger in individuals who report emotional intake. We investigated cravings and approach biases towards two types of reward-related substances, namely chocolate and alcohol. In doing so,

we were able to evaluate whether mechanisms generalize across specific substances, irrespective of their distinct pharmacological characteristics and sociocultural norms. Negative affect was induced by a sad movie in Study 1 and by recall of a negative autobiographical memory in Study 2. Approach biases for these substances were assessed using a feature-relevant manikin-based Approach Avoidance Task (AAT; Krieglmeier & Deutsch, 2010), in which participants navigated a stick figure closer to and away from pictures of chocolate and alcohol. We hypothesized that approach biases and cravings for both chocolate and alcohol would increase with higher sadness¹. We further predicted that these increases would be stronger in individuals with higher self-reported emotional eating and drinking.

1. Study 1

1.1. Methods

1.1.1. Transparency and openness

We report how we determined our sample size (i.e., power analyses) in the pre-registration and online supplement. The data, analysis scripts, pre-registrations, and questionnaires for both studies can be found in our study repository on the Open Science Foundation: <https://osf.io/n8u3t>.

1.1.2. Participants

We recruited 87 participants in Germany and Austria via social media and via the online recruitment system hosted by the University of XX. As a result, our sample comprised a mix of individuals from the general population and students. Participants were eligible if they were 18 years old or older, liked chocolate and alcohol, consumed both at least twice per week, and were not currently on a diet. Sample characteristics for both studies (as well as comparisons) can be found in

Table 1

Comparison of the sample's characteristics across the two studies.

Variable	Study		t (df)	p
	Study 1 M (SD)	Study 2 M (SD)		
Age	25.57 (6.64)	26.24 (7.42)	-.69 (190.97)	0.490
Body Mass Index	23.04 (3.14)	23.38 (4.21)	-0.69 (208.04)	0.489
Alcohol consumption	4.60 (1.57)	4.37 (1.82)	0.98 (190.44)	0.329
Chocolate consumption	4.37 (1.15)	4.22 (1.40)	0.81 (195.22)	0.421
Emotional Drinking (SEDS)	13.63 (3.68)	13.82 (3.41)	-0.37 (163.01)	0.715
Emotional Eating (SEES)	14.02 (2.51)	13.47 (2.51)	1.57 (172.80)	0.119
Trait Alcohol Craving (CEQ-T)	46.15 (21.35)	46.69 (21.14)	-0.18 (176.20)	0.858
Trait Chocolate Craving (CEQ-T)	53.49 (19.04)	51.33 (20.63)	0.78 (187.34)	0.434
Depressive Symptoms (CESD)	14.46 (6.92)	13.43 (8.40)	0.97 (195.11)	0.333

Note. Alcohol consumption was measured with the first two items of the Alcohol Use Disorders Identification Test (AUDIT). These two items were adapted to measure chocolate consumption. Emotional drinking was measured using the Salzburg Emotional Drinking Scale (SEDS). Emotional eating was measured with the Salzburg Emotional Eating Scale (SEES). Trait alcohol and chocolate craving were measured with the Craving Experience Questionnaire-Trait (CEQ-T). Depressive symptoms were measured using the Centre for Epidemiologic Studies Depression scale (CESD). The AUDIT and CESD are described in this study's Online Supplement C.

¹ The analyses for craving were pre-registered for Study 2 only.

Table 1. Due to recording errors for 7 participants in one of the sessions, we collected full data from 40 female and 40 male participants and thus managed to recruit more than our pre-registered sample size of 75.

1.1.3. Questionnaires

In Online Supplement C we describe the questionnaires exclusively used to characterize the sample's amount of chocolate and alcohol consumption, as well as their depressive symptoms.

1.1.3.1. Craving experience questionnaire – state version. Craving for chocolate and alcohol was measured with the German version of the Craving Experience Questionnaire (Röttger et al., 2024). On 10 items, participants rated their craving experience in the current moment. The sum score was reliable for chocolate (Study 1: $\alpha = 0.90$; Study 2: $\alpha = 0.94$) and alcohol (Study 1: $\alpha = 0.93$; Study 2: $\alpha = 0.95$).

1.1.3.2. Salzburg emotional eating scale (SEES) and Salzburg emotional drinking scale (SEDS). The SEES (Meule et al., 2018) and newly developed SEDS assess the extent to which emotional states affect a person's food or alcohol intake, respectively. Specifically, participants indicated whether they eat/drink more or less than usual when they are experiencing 20 emotions which map onto four subscales, namely happiness, sadness, anger, and anxiety. Given that our affect induction targeted sadness and participants rated their momentary affect using the same five emotions loading onto the sadness subscale, we used this subscale to operationalize emotional eating and drinking throughout this manuscript (eating: $\alpha = 0.83$; drinking: $\alpha = 0.87$). Due to correlated subscales, we additionally followed procedures in Schnepfer et al. (2021) and calculated a composite score by averaging the negative subscales (i.e., sadness, anger, and anxiety; eating: $\alpha = 0.88$; drinking: $\alpha = 0.89$). Analyses based on the composite score, rather than the sadness subscale, are provided in Online Supplement B (point 5). The overall pattern of findings remained consistent regardless of whether the sadness subscale or the composite score was used. As the SEDS was specifically developed to parallel the SEES in assessing emotional drinking, its initial validation is provided in the Online Supplement B (point 3). In summary, confirmatory factor analysis partially supported the subdivision of the items into the same four subscales as in the SEES, namely happiness, sadness, anger, and anxiety. Convergent validity was demonstrated through correlations with coping motives, trait alcohol craving, past alcohol intake and harmful consumption patterns, while divergent validity was evidenced by non-significant correlations with chocolate-related variables.

We chose the SEES and SEDS because they allow participants to report not just increased intake but also decreased intake. This is important because it has been suggested that including both increases and decreases in intake helps to reduce bias in recalled intake situations (Bongers & Jansen, 2016). Further, directly observable behaviors (i.e., changes in intake) are likely to be more accurately self-reported compared to unobservable internal motives and states (Austin et al., 2020).

1.1.4. Stimuli

For the manikin task, we selected 16 images depicting chocolate-containing foods from the food-pics_extended database (Blechert et al., 2019), and 16 images depicting beer and wine from the Amsterdam Beverage Picture Set (Pronk et al., 2015) and from the internet to ensure region-specific brands were also included in the stimulus set. Control stimuli included 32 office objects from the food-pics_extended database and from the FRIEDa image database (Foroni et al., 2013).

1.1.5. Manikin approach-avoidance-task

Approach biases to chocolate and alcohol stimuli were assessed using a modified version of the manikin task, originally developed by De Houwer et al. (2001). Each trial started with a picture in the middle of

the computer screen, together with a manikin that was either displayed (randomly but equiprobable) on the left or right side of the picture. Participants used the arrow-keys on the keyboard to approach the picture by moving the manikin towards it, and to avoid the picture by moving the manikin away from it to the border of the screen (Fig. 1). After the manikin reached the border of the picture or screen, the picture disappeared, and a new trial started. When participants made an error, a red X appeared on the screen for one second. We employed feature-relevant task instructions, in which participants were required to approach and avoid stimuli based on the stimulus category (e.g., chocolate, alcohol, or office object) rather than an irrelevant stimulus feature (e.g., portrait or landscape shape). We did so since the feature-relevant AAT is more sensitive to biases and more reliable than the feature-irrelevant AAT (Kahveci et al., 2023; Lender et al., 2018; Phaf et al., 2014). Further, using key presses should be sufficient to measure bias because biases likely arise before actual movement onset (Kahveci et al., 2021) and primarily depend on which type of movement is interpreted as approach or avoidance, independent of what specific muscle is used to implement the behavior (Rinck & Becker, 2007).

The task began with 12 practice trials, featuring images of dogs and butterflies. These were followed by eight task blocks of 32 trials each. Four blocks featured 16 chocolate pictures and 16 control stimuli each, and four blocks featured 16 alcohol pictures and 16 control stimuli each. Instructions alternated from one block to the next, either instructing participants to approach the target stimuli (chocolate and alcohol) and avoid the control stimuli, or vice versa. Blocks were ordered such that two blocks featuring the same stimuli but with reversed instructions were always displayed consecutively. The order of blocks was counterbalanced across participants: a quarter of the participants approached chocolate first, another quarter approached alcohol first, and the other two quarters avoided either chocolate or alcohol first.

1.1.6. Affect induction

To manipulate negative affect between the two sessions, participants watched a sad video (2 min. 10 s.) in one session and a neutral video (2 min. 18 s.) in the other session. The sad video depicted a scene from the movie *The Champ* (1979) in which a boxer is lying severely wounded on a table when his son enters. The neutral video depicted a scene from a documentary about life in a monastery.

1.1.7. Procedure

The study's procedure is displayed in Fig. 2. Participants took part in the study using their own laptop or computer and were asked to conduct the study in a quiet room, sitting upright in front of a table. Links to the two study sessions were sent via e-mail fifteen minutes before the pre-arranged appointment. After participants gave their informed consent,² they indicated their age, gender, education, height, and weight, and then completed the practice trials of the manikin task. Depending on the counterbalanced order, participants were then exposed to either the neutral or sad affect induction, which was followed by the manikin task. Before and after the affect induction as well as after the manikin task, participants rated how lonely, depressed, sad, bored, and frustrated they felt on visual-analog scales anchored from 0 (= not at all) to 100 (= very much). These emotions load on the sadness subscale of the SEES/SEDS. After the last sadness-rating, state craving to chocolate and alcohol was assessed. In the neutral session, participants additionally completed the SEES and SEDS. The second session was conducted on the following day at around the same time.

1.1.8. Data processing and statistical analyses

The data were pre-processed as pre-registered. RT was defined as the time from picture onset until first response. Practice trials were

² Permission to conduct the two studies was granted by the ethics committee of the University of Salzburg (EK-GZ: GZ 54/2020).

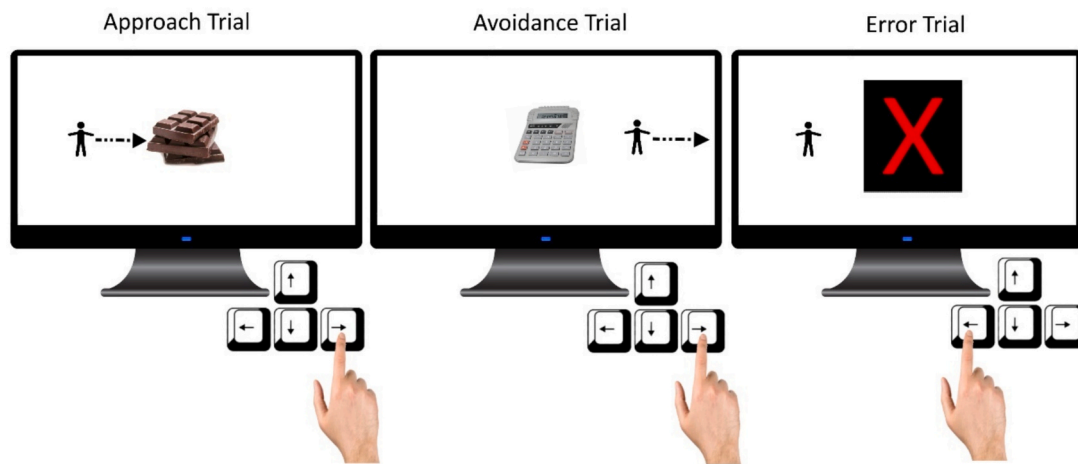


Fig. 1. Example of the manikin task: participants are instructed to approach chocolate.

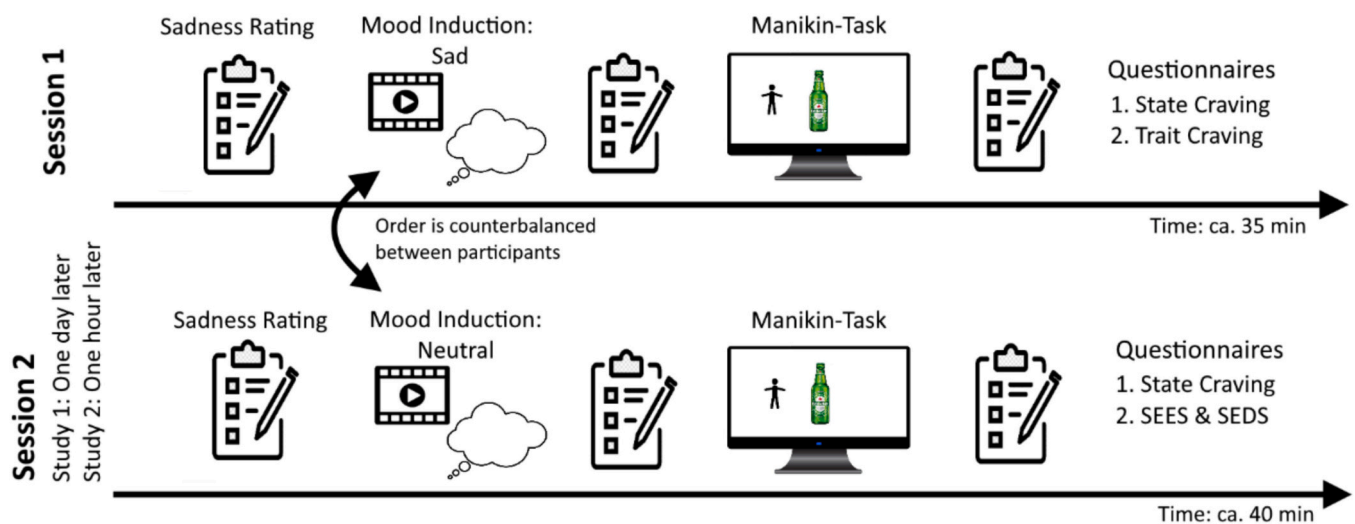


Fig. 2. Study procedure.

excluded. Task trials were excluded if the participant made an error, or if RTs were faster than 200 ms, or slower than 2000 ms; after these exclusions, remaining trials were excluded if the RT deviated >3 SDs from the individual mean. Three participants with $>35\%$ excluded trials were additionally removed from analyses involving bias scores. Subsequently, we calculated approach bias scores for each session and each stimulus type by computing the mean RT in each condition and subtracting them according to this formula: (avoid target – approach target) – (avoid reference – approach reference).

Categorical predictors were as effect-coded (target: object = -1 vs. chocolate/alcohol = 1 ; movement: avoidance = -1 vs. approach = 1 ; stimulus type: blocks with alcohol = -1 , blocks with chocolate = 1 ; affect induction: neutral = -1 vs. negative = 1) and continuous predictors were standardized. The best fitting random effect structure was included based on Akaike's Information Criterion as this protects against overfitting (Park et al., 2020) and does not inflate the type II error rate like maximal random effect models do (Matuschek et al., 2017). p -values for fixed effects were based on t -tests with Satterthwaite adjustments (Luke, 2017). Because trial-level RTs right skewed, we excluded trials with RTs below 370 ms and applied an inverse transformation (inv.RT). This transformation yielded the most normal-looking QQ-plots when

compared to other transformations (Online Supplement Fig. A.1) and it can be meaningfully interpreted as representing the number of reactions per second (i.e. Hertz). Significance of the results did not depend on the transformation and the procedure to achieve normally distributed RTs was pre-registered.

To address a reviewer's suggestion regarding interpretations of non-significant findings, the pre-registered frequentist multilevel models were also re-analyzed in a Bayesian framework using non-informative default priors from the R-package brms (Bürkner, 2017). To determine the practical equivalence of an effect, we defined a Region of Practical Equivalence (ROPE) around zero which represents an effect size considered negligible, namely between -0.1 and 0.1 of the standardized β parameter (i.e. half of a small effect size as defined by Cohen, 1988; Kruschke, 2018). The probability of direction (PD) indicates the proportion of the posterior distribution which exceeds zero and thus, a value around 50 % would suggest that positive and negative betas are equally likely (Makowski et al., 2019). Lastly, we computed Spearman-Brown corrected bootstrapped split-half reliability for the bias scores across both sessions (Kahveci, 2022). Biases in both studies were reliable for chocolate (Study 1: $r = 0.79$, 95 %-CI [0.72, 0.86]; Study 2: $r = 0.78$, 95 %-CI [0.72, 0.83]) and alcohol (Study 1: $r = 0.75$, 95 %-CI [0.65,

0.82]; Study 2: $r = 0.72$, 95 %-CI [0.65, 0.79]). Thus, approach bias measured using an online AAT was as reliable as approach bias measured using lab-based AATs (Kahveci et al., 2021; Van Alebeek et al., 2023).

1.2. Results

1.2.1. Manipulation check: Did the sad video induce higher sadness in study 1?

Due to negatively skewed sadness ratings, we used permutation t -tests stratified by subject to investigate whether self-reported sadness differed between the neutral and negative session across the three measurement time points (see Fig. 4: pre-video, post-video and post-manikin task). Sadness did not differ between sessions before the video ($Z = 0.26$, $p = 0.794$), but was higher in participants who just saw the sad video compared to those that just saw the neutral video ($Z = 3.78$, $p < 0.001$). This difference was not sustained until after the manikin task ($Z = -0.14$, $p = 0.889$). Descriptive analyses on a subject-level revealed that 40 % of participants reported higher sadness during the neutral session instead of the negative session (Online Supplement Fig. A.2).

1.2.2. Does sadness relate to increased approach bias and craving in study 1?

As the affect induction was not successful, its effect on appetitive responses was not analyzed. Thus, we deviated from the pre-registration of Study 1 and instead analyzed naturalistic within-subject changes in sadness from one session to the other. For this, the sadness ratings were averaged across the three measurement time points in a session and then centered within participants (WS). Centering within participants dissociates sadness (WS) from the between-subject (BS) variance in sadness (see Online Supplement Fig. A.2). This between-subject variance correlated with depressive symptoms of the CESD ($r(78) = 0.566$, $p < 0.001$) and can be considered a more stable sadness level that was not of interest to the within-subject research questions posed here. Yet, it was included as a covariate. Differences in sadness between sessions (i.e. within-subject sadness) stem from a mix of influences, encompassing not only the affect induction but also natural fluctuations in sadness from other sources (e.g., interpersonal conflicts or fatigue). Approach bias was operationalized as the interaction between movement (approach vs. avoid) and target (chocolate/alcohol vs. object) predicting trial-level inverse RT, as seen in Eq. (1). The effect of self-reported sadness on craving was tested using Eq. (2). The interaction with substance type was included exploratorily to detect potential differences, even though no specific hypotheses were made and similar mechanisms were assumed across substances. Fully formalized equations (e.g., with lower-level effects) are displayed in the Online Supplement D.

$$\begin{aligned} \text{inv.RTs} \sim & \text{Movement (avoid vs. approach)} \times \text{Target (object vs. chocolate} \\ & / \text{alcohol)} \times \text{Sadness (WS)} \times \text{SubstanceType} \\ & (\text{Blocks with alcohol vs Blocks with chocolate}) + \text{Sadness (BS)} \\ & + (\text{Movement} \times \text{Target} + \text{Sadness (WS)} \times \text{SubstanceType} \mid \text{Subject}) \\ & + (1 \mid \text{Stimulus}) \end{aligned} \tag{1}$$

$$\begin{aligned} \text{Craving} \sim & \text{Sadness (WS)} \times \text{SubstanceType} + \text{Sadness (BS)} + (\text{Sadness (WS)} \\ & + \text{SubstanceType} \mid \text{Subject}) \end{aligned} \tag{2}$$

For approach bias, we observed a non-significant 4-way interaction with substance type (see Online Supplement E.1). Together with a significant 3-way interaction between movement, target, and sadness (Table 2: Study 1), this indicated that approach biases to chocolate and alcohol increased with sadness, and no difference in this effect could be

Table 2

The approach bias (Movement \times Target) interacts with sadness to predict trial-level RTs.

Predictors	Trial-level reaction time					
	b	std. Beta	df	p	PD	ROPE
Study 1: Movement \times Target \times Sadness (ws)	0.010	0.01	37	0.010	99.53 %	80.11 %
Study 2: Movement \times Target \times Sadness (ws)	0.003	0.01	60	0.011	99.40 %	93.21 %
Study 2: Movement \times Target \times Affect Induction	0.005	0.01	60	<0.001	100 %	82.32 %
Integrative Data Analysis: Movement \times Target \times Sadness (ws)	0.003	0.01	97	<0.001	99.98 %	95.68 %

Note. Sadness (ws) = within-subject sadness.

demonstrated for the two substances (Fig. 3). Craving for chocolate and alcohol did not increase with sadness (Table 3: Study 1).

1.2.3. Inter-individual differences: Are sadness-related increases in approach bias and craving stronger in individuals with high self-reported emotional eating or drinking?

We used Eqs. (3) and (4) (see Online Supplement D for fully formalized equations) to test whether sadness-related changes in approach bias or craving were stronger in individuals with high self-reported emotional eating or drinking, respectively.³ In separate models, approach bias or craving for chocolate or alcohol were predicted with self-reported emotional eating or emotional drinking, within-subject change in sadness, and their interactions.

$$\begin{aligned} \text{Chocolate Bias/Craving} \sim & \text{Emotional Eating} \times \text{Sadness (WS)} \\ & + \text{Sadness (BS)} + (1 \mid \text{Subject}) \end{aligned} \tag{3}$$

$$\begin{aligned} \text{Alcohol Bias/Craving} \sim & \text{Emotional Drinking} \times \text{Sadness (WS)} \\ & + \text{Sadness (BS)} + (1 \mid \text{Subject}) \end{aligned} \tag{4}$$

For cravings and approach bias, the interactions between emotional intake and within-subject sadness did not attain significance (Tables 4 and 5: Study 1). Exploratory main effects of emotional drinking showed that individuals with self-reported emotional drinking had generally higher cravings ($b = 4.82$, $\beta = 0.24$, $t(77.73) = 2.51$, $p = 0.014$, 9.03 % in ROPE, PD = 99.22 %) but no significantly higher approach bias ($b = 13.12$, $\beta = 0.14$, $t(75) = 1.59$, $p = 0.116$, 44.34 % in ROPE, PD = 94.17 %) across both sessions. This main effect was not present for emotional eating (craving: $b = 3.07$, $\beta = 0.15$, $t(79.02) = 1.57$, $p = 0.120$, 32.73 % in ROPE, PD = 93.76 %; approach bias: $b = 13.717$, $\beta = 0.10$, $t(75) = 1.37$, $p = 0.173$, 42.63 % in ROPE, PD = 91.86 %).

1.3. Discussion

As the videos did not successfully induce sadness, the influence of the affect induction on appetitive responses was not analyzed. However, approach biases for chocolate and alcohol were stronger during the session in which participants incidentally felt more sad, providing some support for our hypothesis. For chocolate, this increase may have been driven by participants who reported high emotional eating in everyday life, based on a trend-level effect. However, these conclusions are limited because (1) few participants experienced large changes in sadness levels from one session to the other, which may have resulted in

³ As pre-registered, participant-level bias scores instead of trial-level reaction times were predicted to avoid overly complex 4-way interactions and reduce the risk for convergence issues. However, the exact model specification of the preregistration was vague and for the sake of consistency, the following models were specified as pre-registered for Study 2.

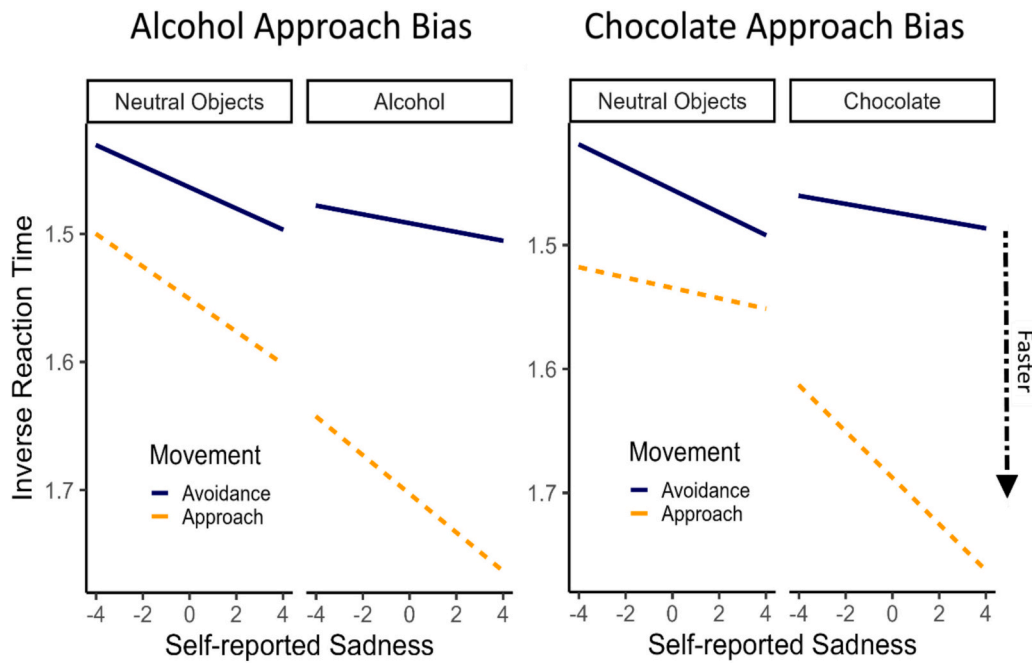


Fig. 3. Approach biases to chocolate and alcohol increased with sadness ratings in Study 1. Note. Given the inverse transformation, larger values indicate faster reaction times; The Y axis was reversed accordingly. Higher sadness was associated with stronger approach bias to target stimuli relative to neutral objects (left: blocks with alcohol; right: blocks with chocolate), where approach bias was quantified as faster approach than avoidance of the stimulus category.

Table 3
Craving increases with sadness in Study 2 and in the integrative analysis.

Predictors	Craving					
	b	std. Beta	df	p	PD	ROPE
Study 1: Sadness (ws)	2.05	0.08	16	0.083	96.59 %	57.65 %
Study 2: Sadness (ws)	2.11	0.10	72	0.003	99.86 %	55.42 %
Study 2: Affect Induction	2.14	0.09	131	<0.001	99.96 %	53.20 %
Integrative Data Analysis: Sadness (ws)	2.13	0.10	88	0.001	99.98 %	53.42 %

Note. Sadness (ws) = within-subject sadness.

underpowered analyses, and (2) these *correlational* findings with changes in self-reported sadness do not allow for conclusions about whether increases in bias and craving were specifically *caused* by sadness. These limitations were addressed in the follow-up study.

2. Study 2

In Study 2 we aimed to strengthen the affect induction by asking participants to either recall negative or neutral autobiographical events

Table 4
Inter-individual differences: Emotional eating interacts with sadness to predict chocolate approach bias.

Predictors	Chocolate approach bias						Alcohol approach bias					
	b	std. Beta	df	p	PD	ROPE	b	std. Beta	df	p	PD	ROPE
Study 1: Sadness (ws) × Emotional Eating/Drinking	12.74	0.10	76	0.182	90.69 %	47.24 %	-2.68	-0.02	76	0.778	61.01 %	75.30 %
Study 2: Sadness (ws) × Emotional Eating/Drinking	14.96	0.14	123	0.024	98.71 %	33.58 %	7.57	0.08	245	0.181	91.07 %	76.49 %
Integrative Data Analysis: Sadness (ws) × Emotional Eating/Drinking	14.70	0.13	201	0.005	99.71 %	31.69 %	4.93	0.05	201	0.300	84.99 %	91.91 %

Note. Sadness (ws) = within-subject sadness.

and by including reminders of these memories throughout the manikin task. The negative and neutral sessions occurred consecutively on the same day with a one-hour ‘wash-out’ period in between. This change from the design of Study 1 was employed to minimize naturally occurring fluctuations in sadness between both sessions, and thereby increase the variance in affect that can be attributed to the affect induction. To replicate the trend-level findings from Study 1 with more power (i.e., sadness-related increases in cravings and stronger bias changes in participants reporting emotional eating), the sample size was increased to 130 and the same hypotheses/analyses were pre-registered.

2.1. Methods

We only describe the differences with Study 1 in the following.

2.1.1. Participants

An a-priori simulation based on data from Study 1 (Online Supplement B) indicated that a sample size of 130 should be sufficient to replicate a significant 3-way interaction with a power of 80 %. However, it should be noted that this power analysis is limited because we unfortunately confounded sources of variances in sadness. We still followed through with our pre-registered sample size and recruited 132 participants (66 male, 66 female). Due to technical problems, the data was incomplete for one participant. In three participants, one of the two approach bias scores was additionally excluded because they had >35 %

Table 5
Inter-individual differences: emotional drinking interacts with sadness to predict alcohol craving.

Predictors	Chocolate craving						Alcohol craving					
	b	std. Beta	df	p	PD	ROPE	b	std. Beta	df	p	PD	ROPE
Study 1: Sadness (ws) × Emotional Eating/Drinking	0.32	0.01	79	0.817	59.39 %	86.11 %	1.04	0.04	77	0.372	81.38 %	83.78 %
Study 2: Sadness (ws) × Emotional Eating/Drinking	1.22	0.06	125	0.097	95.20 %	90.12 %	1.14	0.05	125	0.047	97.56 %	97.10 %
Integrative Data Analysis: Sadness (ws) × Emotional Eating/Drinking	0.88	0.04	206	0.179	90.72 %	97.32 %	1.15	0.05	205	0.026	98.59 %	98.22 %

Note. Sadness (ws) = within-subject sadness.

excluded trials in the respective manikin task. Sample characteristics did not differ between Studies 1 and 2 based on Welch's *t*-tests (Table 1). The number of participants with high level of alcohol problems (i.e., 9.52 %) did not significantly differ from the number of participants in Study 1 based on a chi-squared test ($\chi^2 = 0, p = 1$).

2.1.2. Affect induction

In the new affect induction procedure, participants were either asked to recall a situation from the last four weeks that made them sad (negative session), or to recall a non-emotional routine event such as everyday dental hygiene (neutral session). They were asked to mentally re-experience the sad situation with the following questions as guidance: where did the situation take place? What were your thoughts during the situation? Can you remember the bodily sensations during the situation? What did you do during the situation? There was no time limit, and after participants recalled a situation, they summarized it in one sentence, and answered two questions. Similar procedures have been termed 'idiosyncratic emotion induction' (Blechert et al., 2014) or 'autobiographical emotional memory tasks' (Mills & D'Mello, 2014). For the routine situation, participants reported where the situation took place and what they saw; and for the sad situation, they reported what was sad about the situation, and which thought was especially prominent. The answers to these questions were displayed in alternating order after each block of the manikin task, together with the request to mentally re-experience the situation.

2.2. Results

With one exception, data were analyzed as in Study 1.⁴

2.2.1. Manipulation check: Did the negative memory recall induce higher sadness in study 2?

Self-reported sadness was higher in the neutral than negative session before the memory recall ($Z = -2.25, p = 0.025$), but higher in the negative than neutral session directly after the memory recall ($Z = 7.32, p < 0.001$) and – in contrast to Study 1 – higher sadness was sustained after the manikin task ($Z = 5.07, p < 0.001$). Fig. 4 illustrates the higher effectiveness of the affect induction in Study 2 than in Study 1.

2.2.2. Does sadness increase approach bias and craving in study 2?

2.2.2.1. Approach bias. With the now successful affect induction, we found a significant 3-way interaction between approach bias (Movement × Target) and the affect induction (Table 2: Study 2). Together with a non-significant 4-way interaction with substance type (see Online Supplement E.1), this indicated that there was no demonstrable difference between both substances in the extent to which biases were sensitive to

⁴ Instead of averaging sadness across all three sadness ratings per session, sadness was calculated from the self-reports at the two measurement time points after the memory recall. This was done because the higher sadness ratings before the affect induction in the neutral session (as seen in Fig. 4) suggested that the negative memory recall was still inducing sadness at the beginning of the neutral session for the participants who received this session second.

the affect induction. Specifically, though approach biases were present during both affect inductions, they were stronger under negative than neutral affect (Fig. 5). When using within-subject sadness ratings instead of the session type as a predictor, consistent with the analysis in Study 1, we further replicated the finding that biases increased with self-reported sadness, and there was no demonstrable difference in this effect between chocolate and alcohol (Table 2: Study 2).

2.2.2.2. Craving. The affect induction also increased craving significantly (Fig. 6). Craving for chocolate and alcohol was stronger after the negative affect induction than after the neutral affect induction (Table 3: Study 2). The trend-level effect of within-subject sadness on chocolate and alcohol craving from Study 1 also became significant in Study 2 (Table 3: Study 2).

2.2.3. Inter-individual differences: Are sadness-related increases in approach bias and craving stronger in individuals with high self-reported emotional eating or drinking?

Regarding *biases*, the sadness-related increase in chocolate approach bias was significantly moderated by self-reported trait emotional eating (Table 4: Study 2). Follow-up Johnson-Neyman plots (Fig. 7) indicated that individuals reporting high emotional eating (scores higher than 15) had stronger biases to chocolate when feeling sadder, while those reporting lower emotional eating did not. For alcohol approach bias, the sadness-related increase was, like in Study 1, not significantly moderated by self-reported emotional drinking (Table 4: Study 2). Yet, participants reporting emotional drinking again had a stronger approach bias to alcohol in general ($b = 20.25, \beta = 0.19, t(122) = 2.93, p = 0.004, 11.11\%$ in ROPE, PD = 99.80 %). This exploratory main effect was not present for emotional eating ($b = -11.58, \beta = -0.09, t(122) = -1.38, p = 0.172, 53.62\%$ in ROPE, PD = 91.19 %).

Regarding *craving*, we replicated the null results of Study 1 for chocolate (Table 5: Study 2). However, the interaction between sadness and emotional drinking was now a significant predictor of alcohol craving (Table 5: Study 2). Additionally, participants reporting emotional drinking also had higher alcohol cravings in general ($b = 6.76, \beta = 0.29, t(124.98) = 3.76, p < 0.001, 0.56\%$ in ROPE, PD = 99.99 %). An exploratory main effect that was absent for emotional eating ($b = -0.85, \beta = -0.04, t(124.91) = -0.48, p = 0.633, 72.02\%$ in ROPE, PD = 70.61 %).

2.2.4. Power simulation

Given the limited a-priori power in Study 2 (see Participant Section), we conducted a post-hoc simulation to estimate the sample size needed to replicate observed effects with 80 % power - namely, increases in approach bias and craving based on self-reported sadness and affect induction, as well as interindividual differences in these effects. For each sample size from 70 to 300 in steps of five, we drew 100 random datasets and calculated the proportion yielding significant results, using the same model specifications as in the remainder of the manuscript.

As depicted in the Online Supplement (Fig. B.2), the sadness-related increase in approach bias reached statistical significance in 80 out of 100 simulated datasets (i.e., 80 % power) from sample sizes of 120 and above. The increase in approach bias by the affect induction reached

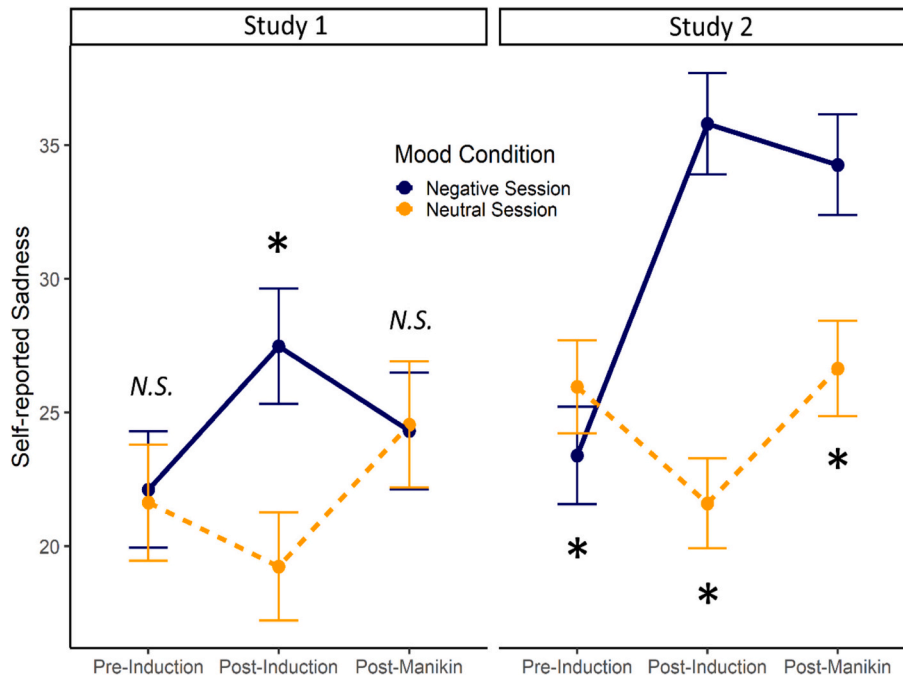


Fig. 4. Effects of the affect induction on self-reported sadness in Study 1 and 2. Note. Error bars depict standard errors.

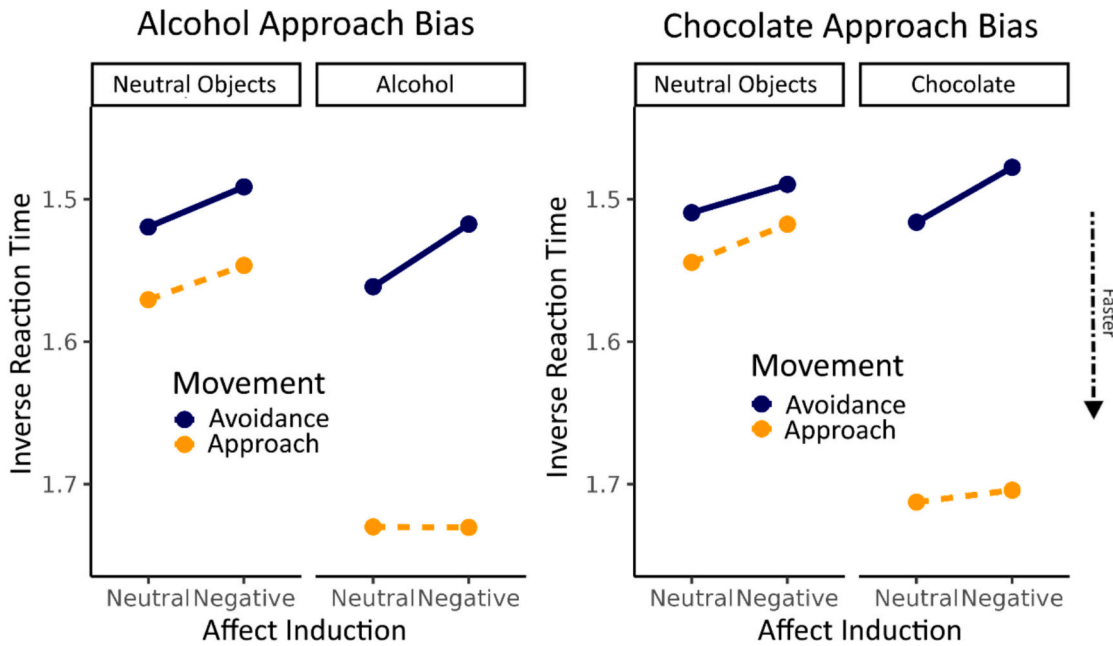


Fig. 5. Approach bias to chocolate and alcohol increased from the neutral to the negative session in Study 2. Note. Larger values indicate faster reaction times due to the inverse transformation. Approach biases are quantified as faster approach than avoidance for target stimuli (left: blocks with alcohol; right: blocks with chocolate) relative to neutral objects.

statistical significance in 80 % of simulations with sample sizes of 110 and above. For craving, 80 % power was reached at approximately 105 participants for sadness-related increases, and at 75 participants for increases due to the affect induction. In contrast, detecting interindividual differences in affect-related increases with sufficient power required larger sample sizes than those used in Study 1 and 2. The interaction between sadness-related increases in chocolate approach bias and emotional eating reached 80 % power at around 160 participants, whereas the interaction between sadness-related increases in

alcohol craving and emotional drinking required at least 280 participants.

2.3. Discussion

With the more successful experimental affect induction, Study 2 showed that negative affect causally increased cravings and approach bias to chocolate and alcohol. Further, we replicated the sadness-related increase in approach bias observed in Study 1 (based on within-subject

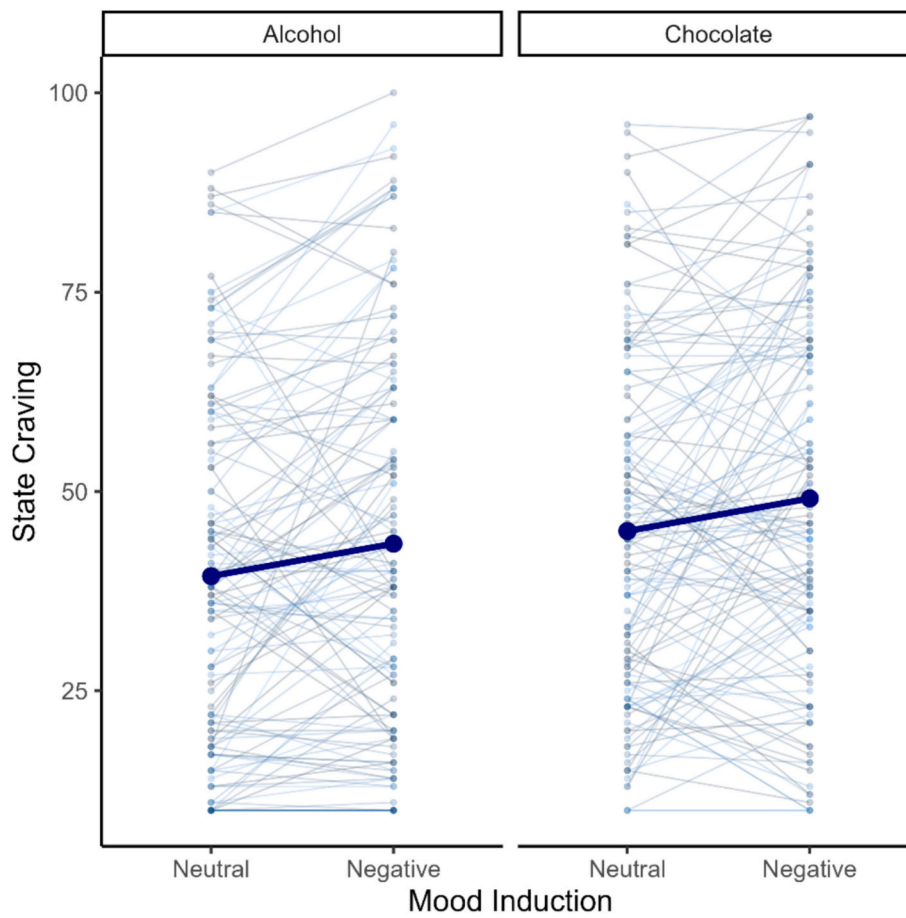


Fig. 6. Chocolate and alcohol craving was stronger after the negative affect induction in Study 2.

changes in sadness) and the previously trend-level effect of sadness-related increases in craving also reached statistical significance in Study 2. We additionally found stronger sadness-related increases in alcohol craving in individuals reporting emotional drinking and stronger sadness-related increases in chocolate approach bias for individuals reporting emotional eating – effects that were absent in Study 1. As our power simulation suggested sample sizes of above 130 for the sadness-related increase in food approach bias in emotional eaters and the sadness-related increase in alcohol craving in emotional drinkers, findings on interindividual differences are probably underpowered. To increase power and draw conclusions about analyses for which significance levels differed between Studies 1 and 2, we decided to conduct an integrative data analysis (Curran & Hussong, 2009).

3. Integrative data analysis

In the integrative data analysis, we re-ran the analyses applicable to both studies, namely those employing self-reported sadness as a predictor. Using same model specification as in Studies 1 and 2 (Eqs. (1) and (2)), we examined if approach bias or craving increase with higher within-subject sadness, and if this depends on respective self-reports of emotional eating or drinking (Eqs. (3) and (4)). Self-reported sadness was operationalized as in each study: the mean of all three ratings in Study 1, and the mean of pre- and post-AAT ratings in Study 2 (see rationale above).

In the combined dataset, we replicated the sadness-related increase in approach bias for chocolate and alcohol (see Table 2: Integrative Analysis). The sadness-related increase in chocolate approach bias was stronger in emotional eaters, whereas the sadness-related increase in alcohol approach bias was not significantly stronger in emotional

drinkers (see Table 4: Integrative Analysis). However, individuals reporting high emotional drinking had a stronger approach bias to alcohol across both sessions ($b = 16.39$, $\beta = 0.16$, $t(200) = 3.10$, $p = 0.002$, 18.26 % in ROPE, PD = 99.84 %), an effect that was not significant for emotional eating ($b = -3.73$, $\beta = -0.03$, $t(200) = -0.58$, $p = 0.564$, 89.58 % in ROPE, PD = 71.21 %). We further showed that craving was stronger in sessions in which participants reported higher sadness, with no significant difference between chocolate and alcohol (Table 3: Integrative Analysis). The sadness-related increase in chocolate craving was *not* significantly stronger in emotional eaters. The sadness-related increase in alcohol craving was however stronger in emotional drinkers (Table 5: Integrative Analysis).

In general, the combined analyses from Study 1 and 2 suggested that trend-level or non-significant effects observed in Study 1 probably stem from an insufficient sample size. Further, it should be noted that findings remained stable even after controlling for potentially confounding variables such as harmful alcohol consumption, depressive symptoms, chocolate consumption or gender by including them as covariates (see analyses in the Online Supplement B, point 4).

4. General discussion

We conducted two studies to investigate the mechanisms of emotional intake of food and alcohol. Table 6 shows an overview of the results for our pre-registered analyses. As hypothesized, approach biases and cravings were stronger when participants experienced more sadness. These findings were extended by the stronger experimental affect induction in Study 2, which demonstrated that the induced negative affect caused the increase in approach bias and cravings. These findings did not differ between chocolate and alcohol. In Study 2, we

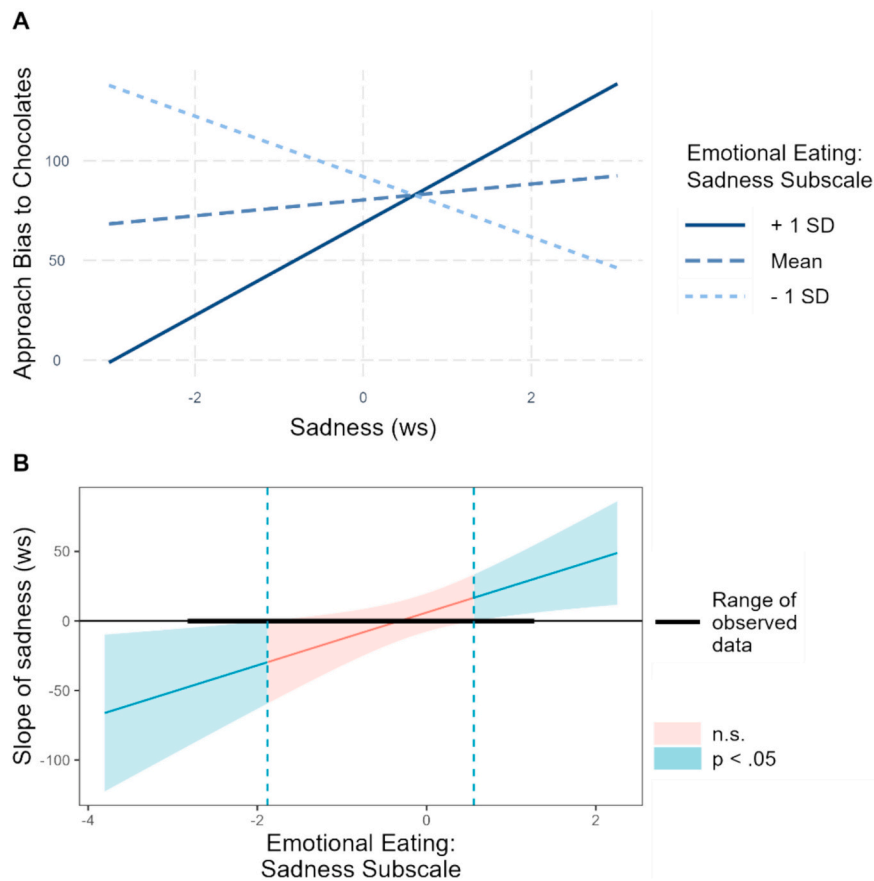


Fig. 7. The sadness-related increase in chocolate approach bias is specific for self-reported emotional eating. Note. Sub-fig. A displays the interaction between the within-subject changes in sadness and self-reported emotional eating. Sub-fig. B displays a Johnson-Neyman plot for which level of self-reported emotional eating sadness is significantly related to the approach bias to chocolate.

Table 6
Overview of results.

	Study 1		Study 2		Combined	
	Chocolate	Alcohol	Chocolate	Alcohol	Chocolate	Alcohol
Approach Bias	(✓)	(✓)	✓	✓	✓	✓
Craving	×	×	✓	✓	✓	✓
Bias × emotional intake	×	×	(✓)	×	✓	×
Craving × emotional intake	×	×	×	(✓)	×	(✓)

Note. Non-significant effects are indicated with a ×, significant effects with a ✓, and underpowered effects with a (✓).

additionally provided evidence for interindividual differences in affect-related cue-reactivity: individuals with high emotional eating had a stronger approach bias to chocolate during sadness. Individuals with high emotional drinking, by contrast, did not show an affect-related modulation of alcohol approach bias but had a *generally* higher approach bias. Additionally, we showed in Study 2 and in the integrative data analysis that individuals with high emotional drinking had stronger craving for alcohol during sadness. This last result may be less robust than the other ones since it was underpowered and it did not attain significance when we used the composite score across all three negative emotions (i.e., sadness, anxiety, and anger) instead of the sadness-specific emotional drinking score. Thus, we refrain from further interpretation. All other effects pertaining to emotional intake were also present when using the composite negative emotional intake score (see Online Supplement B, point 5), highlighting that these effects may also generalize to negative emotional states other than sadness.

4.1. Sadness and the affect induction increased approach bias and craving

For both substances, self-reported sadness and the negative affect induction did not only intensify cravings, but also facilitated rapid approach responses towards substance cues. According to the cue-reactivity literature, heightened craving and approach bias prepare the individual for intake. Thus, our findings challenge the idea that the non-significant effects of negative affect on actual intake across participants in recent meta-analyses stem from an actual disconnect between appetitive responses and negative affect. Instead, it is more likely that negative affect prepares appetitive responses (approach tendencies, craving) in many situations, but the transfer into overt consumption behavior may only happen under specific external situational/social circumstances, such as when the substance is directly available. Additionally, when it is judged inappropriate to consume the substance in a given context, self-regulation capacities may hinder the transfer from increased appetitive responses to actual consumption. Such disruptions may easily occur because the effect of sadness and the affect induction

on intake-related variables was small across participants in the current study.

Next to demonstrating that sadness and the affect induction generally increases appetitive responding, our findings elucidate the mechanisms through which negative affect may cause intake. Even though approach bias and cravings are related to each other (see the Online Supplement B, point 1 for correlations in the current sample) and should both facilitate intake, the circumstances under which both manifest may be contingent upon the *availability* of cognitive resources (Hammilton et al., 2013; Kakoschke et al., 2015). While appetitive substances should directly trigger both an approach bias and intrusive thoughts (e.g., about chocolate or alcohol), the progression from intrusive thoughts to actual cravings is theorized to require additional processing steps such as elaborative thoughts and mental imagery (Kakoschke et al., 2019; Kavanagh et al., 2005). Critically, such additional steps depend on cognitive resources (May et al., 2010; van Dillen & Andrade, 2016) and accordingly, when cognitive resources are low, intake may thus be more strongly facilitated by approach bias than by cravings. In turn, when cognitive resources are available, intake may be as well facilitated by cravings depending on whether cognitive resources are used to elaborate on the positive outcome of substance intake or not. Future studies should test if negative affect indeed increases craving specifically when cognitive resources are available, while it increases approach bias independently of cognitive resources.

4.2. Approach bias are dynamic states: Implications for emotional intake

While it is often assumed that approach bias is elicited by relatively stable stimulus-response associations, the affect-related increase in approach bias suggests that biases should be viewed as dynamically changing states rather than as stable traits. This state-view of approach bias constitutes a shift in the literature. However, it is supported by findings showing that (a) approach biases have low test-retest reliability, despite their high internal consistency at individual timepoints (Zech, Gable, et al., 2022) and that (b) food approach biases covary with hunger (Zech, van Dijk, & Dillen, 2022). This viewpoint is not unique to approach biases, and may generalize to a wider range of cognitive bias measures: attentional biases to substance cues have also been reconceptualized as co-varying with motivational states (Bollen et al., 2022), and craving has long been known to fluctuate over time in intensity and frequency (Reichenberger et al., 2018).

This changed perspective on biases bears notable implications on *when* biases facilitate intake. Rather than solely assuming that substance cues always trigger approach bias and that their influence on intake primarily depends on whether an individual can suppress this influence, negative emotions like sadness may actually increase bias. This momentary affect-related increase in bias may render self-regulation more difficult. However, this may not apply to everyone. First, it may be present in individuals experiencing a strong affect-related increase in bias, which might potentiate even minor baseline biases to the extent that they can no longer be suppressed. Second, it may be present in individuals who exhibit a strong baseline approach bias, since in those individuals, even a small bias increase (as observed in our study with small average effect sizes) might engender approach biases too strong to suppress.

The first scenario could apply to emotional eating. Here, the sadness-related increase in chocolate approach bias was especially large in participants reporting a history of emotional eating. These participants, however, did not exhibit a generally stronger (baseline) approach bias to chocolate compared to participants reporting lower level of emotional eating. The second scenario may be more plausible for emotional drinking. Participants reporting a history of emotional drinking had a stronger alcohol approach bias regardless of affective state. However, their sadness-related increase in approach bias did not surpass that of the average participant. This aligns with two previous studies in which coping-related drinking motives did not relate to affect-related changes

in approach bias (Cousijn et al., 2014; Ralston et al., 2013). Thus, larger affect-related increases in approach bias may play a role in emotional eating, whereas a generally higher approach bias may play a role in emotional drinking. This generally high approach bias may instead facilitate drinking when it is combined with a negative affect-related increase in alcohol approach bias that occurs in individuals regardless of whether they are emotional drinkers.

These findings have implications for clinical practice. Since strong approach bias is assumed to contribute to overconsumption, researchers and clinicians aim to retrain these biases by repeatedly pairing appetitive cues with avoidance-related actions (Kakoschke et al., 2017). Stronger baseline approach bias for alcohol in certain individuals may explain why approach bias modification is generally considered effective in the alcohol domain (Eberl et al., 2013; Mann et al., 2017; Wiers et al., 2011). In contrast, the affect-dependency of food-related approach bias could explain limited success of similar intervention in the food domain (Becker et al., 2018), particularly considering that they are usually delivered in emotionally neutral laboratory settings. Current findings suggest that, in the food domain, it may be more effective to intervene at moments when biases are high for example, by using so-called just-in-time adaptive interventions (Nahum-Shani et al., 2017). In turn, targeting emotional drinking may be successful through standard approach bias modification, due to the relatively affect-independent association between emotional drinking and approach bias magnitude.

4.3. Approach bias and cravings increased across substances: Joining segregated literatures?

Although foods and alcohol differ in their physiological effects as well as in the societal norms around their consumption (Ziauddeen & Fletcher, 2013), we found similarly strong affect-related increases in approach bias and craving across both chocolate and alcohol (not taking interindividual differences into account). Also irrespective of momentary affect, we observed a positive correlation between craving, approach bias and self-reported emotional intake for both substances (see analyses in Online Supplement Table B.1). Similar responses to food and alcohol call for a tighter integration of the literatures on emotional eating and drinking. These literatures may have segregated due to divergent terminologies and theories. For example, the concept of ‘coping motives’ is most common in the alcohol domain, whereas emotion-related consumption in the food domain is usually referred to as ‘emotional eating’. Assessment of the former uses wordings suggesting a conscious and goal-directed motive for drinking (e.g., to forget problems, feel better when in negative mood; Kuntsche & Kuntsche, 2009), whereas emotional eating is usually assessed by simply asking about the co-occurrence of the urge for eating and negative affect (Nagl et al., 2016). Both have however been criticized for their lack of predictive validity (Austin et al., 2020; Bongers & Jansen, 2016). Thus, in our effort to assess these two phenomena in a comparable manner, we used/developed parallel questionnaires for both appetitive substances which intentionally did not include items on theoretically proposed mechanisms such as coping motives. While it should be noted that these questionnaires have not been formally validated for actual affect-related intake, our results indicate that they are sensitive to interindividual differences in affect-related appetitive responses. Further validating these measures could serve two purposes. Firstly, parallel questionnaires could provide a basis to research the similarities and differences in emotional intake across substances as we did here. Secondly, valid questionnaires can identify *who* is at particular risk for emotional intake and to individualize dietary or abstinence interventions accordingly.

4.4. Limitations

A key limitation is that the affect induction in Study 1 failed, restricting causal interpretations to Study 2. Although the emotional

video had previously been validated (Joseph et al., 2020), and increased sadness immediately after watching it, this effect did not persist throughout the AAT in Study 1. As cognitively demanding tasks can serve as a distractor from negative affect (Van Dillen et al., 2009), it is likely that the AAT itself diminished the *induced* affect. Yet, participants varied in sadness between the neutral and negative video session, with some even reporting higher sadness in the neutral session. Since sessions occurred on separate days, these sadness differences were likely caused by incidentally occurring factors such as interpersonal conflicts or other stressors.

Although the personalized affect induction in Study 2 elicited more persistent negative affect, effect sizes remained small – likely due to uncontrolled variability from incidentally occurring factors, as Study 2 was also conducted outside the lab. Specifically, much of Bayesian evidence fell within negligible effect size ranges, despite high certainty for the presence of effects (e.g., 100 % probability of direction for approach bias). Such small effect sizes raise questions about the practical relevance of observed increases in bias and craving for actual substance intake.

As participants did not report on co-occurring emotional states, it remains unclear whether effects are specific to sadness or reflect responses to negative affect in general. That interindividual differences in sadness-related bias increases emerged regardless of whether trait emotional eating was reported for sadness or general negative affect (e.g., anxiety, anger, sadness) suggest that some findings may generalize across negative emotion, but further research need to investigate the emotion-specificity of current findings.

To align with theories emphasizing the reward value of substances in emotion-related intake, we selected chocolate, beer, and wine as commonly consumed stimuli in Europe (Alberts & Cidell, 2006; Silva et al., 2017), and we only recruited participants that consume chocolate and alcohol at least twice a week. Future studies would however benefit from individualized stimulus selection to ensure that employed stimuli are indeed personally rewarding for each participant.

4.5. Conclusion

The two studies revealed increased approach bias and craving as possible mechanisms of emotional intake for both food and alcohol. Effect sizes were small, however, when assessed across participants. This may explain why the transfer from increased appetitive responses to actual emotion-related intake may not occur across situations and is thus difficult to detect. As we additionally found inter-individual differences, respective trait questionnaires may identify who is at risk for emotional intake under which conditions, allowing for individually tailored interventions.

Declarations of competing interest

None.

CRediT authorship contribution statement

Hannah van Alebeek: Writing – original draft, Visualization, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Sercan Kahveci:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Reinout W. Wiers:** Writing – review & editing, Validation, Methodology, Conceptualization. **Jens Blechert:** Writing – review & editing, Supervision, Resources, Methodology, Funding acquisition, Conceptualization.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.paid.2025.113333>.

Data availability

Data is shared at <https://osf.io/n8u3t> (referenced in the manuscript)

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