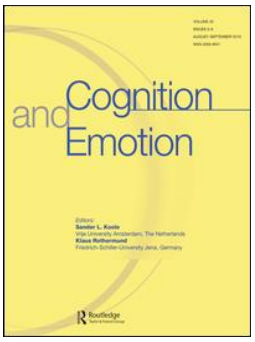

Cognition and Emotion

ISSN: 0269-9931 (Print) 1464-0600 (Online) Journal homepage: https://www.tandfonline.com/loi/pcem20

Manipulating affective state influences conditioned appetitive responses

Inna Arnaudova, Angelos-Miltiadis Krypotos, Marieke Effting, Merel Kindt & Tom Beckers

COGNITION AND EMOTION
2018, VOL. 32, NO. 5, 1062–1081
https://doi.org/10.1080/02699931.2017.1386624

Manipulating affective state influences conditioned appetitive responses

Inna Arnaudova[a,b], Angelos-Miltiadis Krypotos[a,c], Marieke Effting[a], Merel Kindt[a] and Tom Beckers[a,d]

[a]Department of Clinical Psychology and Amsterdam Brain & Cognition, University of Amsterdam, Amsterdam, the Netherlands; [b]Department of Psychology, University of Southern California, Los Angeles, CA, USA; [c]Department of Psychology, Utrecht University, Utrecht, the Netherlands; [d]Department of Psychology, KU Leuven, Leuven, Belgium

ABSTRACT

Affective states influence how individuals process information and behave. Some theories predict emotional congruency effects (e.g. preferential processing of negative information in negative affective states). Emotional congruency should theoretically obstruct the learning of reward associations (appetitive learning) and their ability to guide behaviour under negative mood. Two studies tested the effects of the induction of a negative affective state on appetitive Pavlovian learning, in which neutral stimuli were associated with chocolate (Experiment 1) or alcohol (Experiment 2) rewards. In both experiments, participants showed enhanced approach tendencies towards predictors of reward after a negative relative to a positive performance feedback manipulation. This increase was related to a reduction in positive affect in Experiment 1 only. No effects of the manipulation on conditioned reward expectancies, craving, or consumption were observed. Overall, our findings support the idea of counter-regulation, rather than emotional congruency effects. Negative affective states might therefore serve as a vulnerability factor for addiction, through increasing conditioned approach tendencies.

ARTICLE HISTORY
Received 10 June 2016
Revised 28 August 2017
Accepted 29 August 2017

KEYWORDS
Appetitive learning; reward; mood; approach tendencies; attentional bias

In the novel Bridget Jones's Diary (Fielding, 1999), the protagonist records her responses to emotional events in terms of number of drinks consumed, cigarettes smoked, and pounds gained. The effects of affective states on appetitive behaviour and consumption have been documented not only in literature, but have also attracted attention in the behavioural sciences (Herman & Polivy, 1984). Of prime importance is how affective states influence the learning and expression of appetitive responses.

Appetitive Pavlovian learning refers to the formation of associations between neutral cues (e.g. an abstract picture or a pack of cigarettes; conditioned stimuli or CSs) and reward outcomes (e.g. a piece of chocolate or a puff of smoke; unconditioned stimuli or USs) through repeated pairing (conditioning). In human appetitive Pavlovian conditioning experiments, a variety of USs have been used, including chocolate (e.g. van den Akker, Havermans, & Jansen, 2015), nicotine (e.g. Hogarth, Dickinson, & Duka, 2003) and alcohol (e.g. Field & Duka, 2002). Following appetitive Pavlovian learning, the CS is sufficient to trigger preparation for the expected US (Stewart, de Wit, Eikelboom, Wit, & Eikelboom, 1984). Thus, CSs acquire incentive salience (Stewart et al., 1984), which can guide consumption by eliciting conditioned craving for the US (conditioned response, CR; Van Gucht, Vansteenwegen, Van den Bergh, & Beckers, 2008). Appetitive Pavlovian learning is assumed to play a key role in consumption and addictive behaviours.

From an evolutionary perspective, suppression of appetitive behaviour might be expected when strong negative emotions are experienced, because such behaviour would interfere with the operation of the defensive motivational network (Herman & Polivy, 1984). Defensive behaviour is believed to have control precedence over appetitive behaviour

CONTACT Tom Beckers tom.beckers@kuleuven.be

(e.g. Frijda, 1996). Put simply, when under threat, resources would be devoted to dealing with the threat rather than to the indulgence of appetitive motives. Negative affective states may thus result in a reduction of appetitive responses due to emotional congruency (Macht, 2008).

Emotional congruency refers to the idea that processing of information congruent with the current affective state should occur more easily than processing of incongruent information (in line with the associative network theory of affect; Bower, 1981). Thus, while experiencing negative affect, processing of reward information and appetitive behaviour should be hampered. Similarly, the learning and expression of positive or appetitive associations might be reduced. That is, negative affective states might inhibit learning of appetitive responses (e.g. attention to or approach of reward stimuli), because they would be incongruent to the current emotional state (Vrijsen, Van Oostrom, Speckens, Becker, & Rinck, 2013).

In line with the associative network theory of affect (Bower, 1981), disturbed appetitive Pavlovian learning is hypothesised to play a role in depression (Martin-Soelch, Linthicum, & Ernst, 2007), where negative mood is a prominent symptom. In particular, deficits in the formation and maintenance of appetitive CS-US associations are assumed to be related to depression (Martin-Soelch et al., 2007). Brain imaging research has shown that individuals suffering from depression have a hypoactive dopaminergic system, which might contribute to decreased reward responsiveness (Martin-Soelch, 2009). Individuals with depression are reported to be in general less sensitive to stimulus valence (Dichter & Tomarken, 2008). Last, but not least, recent studies have shown reduction of reward learning to be associated with depression and anhedonia (Liverant et al., 2014; Pergadia et al., 2014). Taken together, this evidence would suggest that appetitive Pavlovian learning might be impaired under negative mood.

To our knowledge, only one study to date has examined the effect of negative affective states on appetitive Pavlovian learning (Bongers, van den Akker, Havermans, & Jansen, 2015). No clear evidence was found for modulation of different appetitive CRs (Bongers et al., 2015). One reason for the lack of strong effects of the affective state manipulation on appetitive Pavlovian learning in the study by Bongers et al. (2015) might relate to how appetitive conditioned responding was measured. Dual-process models propose that appetitive responses are determined by two independent response systems: a reflexive one, which operates rather automatically, and a reflective system, which is under volitional control (Strack & Deutsch, 2004; Wiers, Stacy, & Alan, 2006). Responding towards appetitive CSs span across those response systems (e.g. Van Gucht et al., 2008). Bongers et al. (2015) assessed mostly controlled indices (verbal reports of craving and expectancy, voluntary consumption behaviour in a lab setting). Even though they measured salivation, other implicit measures were not included.

Implicit responses to appetitive CSs arguably are of major importance for the control of appetitive behaviour (Van Gucht et al., 2008). In particular, action tendencies might be crucial for instigating appetitive behaviour (Stacy & Wiers, 2010). Action tendencies refer to the automatic preparation of the organism for action in response to a stimulus encounter (Krieglmeyer & Deutsch, 2010). In the case of confrontation with appetitive CSs, approach tendencies, i.e. a tendency to react with approach rather than avoidance responses, have been observed (Van Gucht et al., 2008). Implicit (e.g. action tendencies) and explicit responses (e.g. verbal responses) do not always converge (e.g. Cunningham, Preacher, & Banaji, 2001). For example, drug users have difficulty inhibiting their approach action tendencies towards drugs, despite knowing about the negative consequences of continued use (Wiers et al., 2006). The documented discordance between implicit and explicit responses suggests that affective states might not influence all responses similarly. In laboratory research, specifically, explicit response indices might be more susceptible to demand characteristics than implicit measures. Therefore, examining approach tendencies might be of relevance.

The emotional congruency account would suggest that negative affective states should obstruct the acquisition or expression of such approach tendencies. In line with this idea, approach deficits have been proposed in depression (Trew, 2011). Likewise, Radke, Güths, André, Müller, and de Bruijn (2014) found no approach tendency towards positive social stimuli in depressed individuals. However, a study that examined the effects of a negative mood induction procedure on approach tendencies found no reduction (Vrijsen et al., 2013).

Given these limited and mixed findings, more empirical evidence is needed to determine the effects of affective states on approach tendencies.

Studying such effects on appetitive Pavlovian learning might be particularly important (Martin-Soelch et al., 2007), as it allows for testing not only the effect of negative affective states on the expression of different appetitive responses, but also their acquisition.

Experiment 1

We used an appetitive Pavlovian conditioning procedure, known to result in the acquisition of US expectancies, craving, and approach tendencies toward a neutral stimulus repeatedly paired with an appetitive US (CS+) in comparison to a neutral stimulus never paired with that US (CS−; e.g. Van Gucht et al., 2008). We examined the effects of a negative (failure) versus positive (success) performance feedback manipulation, which were used to influence affective state, and tested the hypothesis derived from the associative network theory of affect that negative affective state would impair appetitive Pavlovian learning. We hypothesised that conditioned craving might be reduced for the CS+ as a result of a deficit in the formation of positive associations under negative affective states. We did not expect any influence of the manipulation on US expectancy ratings, due to the simplicity of the paradigm (Lissek, Pine, & Grillon, 2006). We also hypothesised that the affective consequences of the negative feedback would reduce the acquisition of conditioned approach tendencies towards the CS+ as measured in a symbolic approach-avoidance task (AAT). In addition, we tested whether the manipulation of affective states would reduce cue-elicited consumption of the chocolate US as an index of the expression of learned associations. Lastly, we explored whether any differences in conditioned responses between conditions were related to changes in positive or negative affect.

Methods

Participants

Sixty-one participants were recruited through advertisements. A-priori exclusion criteria were (1) diabetes, (2) intolerance to glucose, (3) currently dieting, (4) self-reported history of psychiatric disorders, (5) not being a native Dutch speaker, and (6) dyslexia. Participants were requested to not eat in the last two hours and not consume any chocolate in the last 24 h before participation. One participant was excluded for refusing to eat chocolate and one for reporting to not have eaten anything in the last 24 h. Data from a third participant were lost due to a technical malfunction and another two participants were excluded for having used drugs in the 24 h before participation. The final sample therefore consisted of 56 participants (19 male, $M_{age} = 23.05$, $SD_{age} = 5.57$), randomly assigned to either fail ($n = 27$) or success ($n = 29$) performance conditions, which yielded a power of well over .90 to observe a between-groups difference in conditioned appetitive responding of the size obtained by Van Gucht et al. (2008).[1] The Ethical Committee of the University of Amsterdam approved the experimental procedure.

Materials

Two serving trays (one white and rectangular, the other green and round) were used as CSs, with CS assignment fully counterbalanced across participants. Through e-mail, participants indicated their favourite chocolate, which was in advance wrapped in aluminum foil in pieces of approximately two cm^2, as in Van Gucht et al. (2008). Those chocolate pieces were used as US in the conditioning phase (4 pieces) and for the consumption test (8 pieces) at the end of the experiment.

Photographs of the trays, taken from four different angles, were superimposed upon horizontal (105 mm × 57 mm) or vertical (57 mm × 105 mm) white frames for the AAT.

Questionnaires

Baseline hunger was assessed using a visual analogue scale (VAS) ranging from absolutely not hungry (0) to extremely hungry (10).

Online craving/expectancy ratings were given on a trial-by-trial basis during the appetitive Pavlovian conditioning procedure. Participants rated their chocolate craving and expectancy to receive chocolate on the current trial on 100-mm computerised VAS. The craving scale ranged from "no craving" to "a lot of craving" and the expectancy scale ranged from "certainly not expecting chocolate" to "certainly expecting chocolate". The order of the craving and expectancy scales was counterbalanced across participants.

CS valence was measured on a similar 100-ms VAS ranging from "unpleasant" to "pleasant". Participants received written instructions to rate both the white and green trays. Upon presentation of the scales, a cursor was presented in the middle of the scale. Responses were confirmed by a mouse click and participants had the opportunity to correct their responses after confirmation.

The *Positive Affect Negative Affect Scale* (PANAS; Watson, Clark, & Tellegan, 1988; Dutch translation by Peeters, Ponds, & Vermeeren, 1996) measures the experience of 10 positive and 10 negative emotions at the moment of administration on a scale from 1 (slightly or not at all) to 5 (extremely). The two subscales of this questionnaire assess negative (NA) and positive affect (PA), with higher sum scores representing stronger experience of each, and have shown good internal consistency (Engelen, De Peuter, Victoir, Van Diest, & Van den Bergh, 2006).

Finally, the following questionnaires were included to rule out baseline differences between conditions that could influence the results. The Depression Anxiety Stress Scales (DASS; Dutch translation by de Beurs, Van Dyck, Marquenie, Lange, & Blonk, 2001; Lovibond & Lovibond, 1995) assess depression (DASS-D), anxiety (DASS-A) and stress (DASS-S) symptoms over the past week. They were used to evaluate whether the samples differed a-priori on negative affect. The Snaith-Hamilton Pleasure Scale (SHAPS; Dutch translation by Franken, Rassin, & Muris, 2007; Snaith et al., 1995) measures current anhedonia, which might obstruct the experience of the rewarding value of the US (Martin-Soelch, 2009). The Barratt Impulsiveness Scale (BIS-11; Patton, Stanford, & Barratt, 1995) assesses trait impulsivity, which might affect food cue reactivity (van den Akker, Stewart, Antoniou, Palmberg, & Jansen, 2014). The Dutch Eating Behavior Questionnaire (DEBQ; van Strien, Frijters, Bergers, & Defares, 1986) measures eating habits through three subscales: emotional eating (DEBQ-EE), external eating (DEBQ-EX) and dietary restraint (DEBQ-R). Eating habits might influence responding towards the US and the DEBQ is a common measure used to control for baseline differences in experiments using chocolate (e.g. Macht & Dettmer, 2006).

Procedure

After providing their informed consent, participants reported their baseline hunger and filled in the baseline computerised PANAS (pre-assessment).

An anagram task was then introduced to participants as an intelligence test, in which they had to form Dutch nouns from anagrams. The task, developed by Nelis (2014), consisted of one practice block of four trials, followed by a test block containing 20 trials. Between trials, a fixation point was presented on screen for three seconds. On each trial, a five-letter anagram was presented on the screen for seven seconds, during which the participant provided a verbal solution, followed by a beep and the correct solution, presented for five seconds.

Following the practice block, participants were informed that the average performance on this test was to solve 10 of the 20 presented anagrams and were requested to make a prediction of their own performance. Participants were a-priori randomly assigned to a success or fail performance feedback condition. Depending on the condition, they either succeeded or failed to reach average performance due to the experimentally pre-determined difficulty of the task (e.g. ALAMR for *alarm* in the easy version and ASNJE for *jeans* in the hard version). The experimenter recorded all correct answers and gave the number of correct solutions as feedback. An answer was scored as correct only if the exact solution was verbalised within the seven-second time frame of anagram presentation. Participants then filled in the post-test computerised PANAS (post-assessment), to record changes in affective states.

The appetitive Pavlovian conditioning procedure consisted of four CS+ and four CS− trials and was modelled after Van Gucht et al. (2008). Before the procedure began, participants were introduced to both trays and informed that one tray might be followed by the US, while the other one would never be paired with the US. Each trial started with the presentation of a serving tray, after which participants were asked to concentrate on their thoughts and feelings. After 30 s, participants reported their online craving and expectancy ratings. In case of a CS+ trial, after participants reported their online ratings, the US (i.e. a piece of chocolate wrapped in aluminum foil) was placed on top of the serving tray and participants were asked to eat the chocolate, before continuing. The order of the trials was pre-determined for each participant, with the limitation that at most two consecutive trials were of the same type. Trials were separated by a 30-s inter-trial interval (ITI).

The AAT task, which followed after completion of the appetitive Pavlovian conditioning procedure, consisted of two blocks with four practice trials and 16 test trials each (Krypotos, Effting, Arnaudova, Kindt, & Beckers, 2014). On each trial, a small manikin (stick figure) appeared in the centre of the top or bottom half of the screen. After 1500 ms, the manikin was supplemented by a target picture, which appeared centred either above or below the manikin. Participants responded by pressing one of two response buttons (B, marked with ↓ or Y, marked with ↑), upon which the manikin moved in the appropriate direction for 2000 ms. Instructions before each block informed participants that they were to move the manikin as fast and accurately as possible toward or away from the target picture, based on the orientation of its frame (toward horizontal and away from vertical or vice versa, with instructions switched between blocks; order of blocks was counterbalanced across participants). Inaccurate responses were followed by the presentation of a red cross for 500 ms at the manikin's starting position, whereas after accurate responses the manikin remained in its final position for 500 ms. The ITI was 2000 ms. Per block, during test trials, four horizontal and four vertical target pictures of the CS+ and of the CS− were presented twice each, randomised with the restriction that no more than two consecutive trials could be of the same type (CS+ or CS−). The reaction time (RT) between picture onset and response was recorded.

Participants then rated the valence of both trays and filled in the computerised PANAS (follow-up assessment), DASS, SHAPS, BIS-11 and the complete DEBQ. A consumption test followed. The experimenter presented participants with the CS+ tray and eight allegedly leftover pieces of chocolate. Participants were informed that they could eat as many chocolate pieces as they wanted, while filling in the last questionnaires about their demographic information and some manipulation checks (e.g. their belief of the MIP as an intelligence test and their motivation for the experiment on 10-point Likert scales). The number of pieces that they consumed was recorded.

Participants were then verbally debriefed about the study. They were informed that the anagram task was not an intelligence test and that it was pre-determined whether a participant would be able to solve more or less than half of the anagrams presented. Participants were informed this was done so that they could either experience "success" and positive affect or "failure" and negative affect.

Data analysis

Differences between conditions were examined with independent sample t-tests with questionnaire scores or final chocolate consumption as dependent variables. When Levene's test for equality of variances was significant, corrected t-test values are reported.

Repeated measures analyses of variance (ANOVAs) were used to compare differences in response pattern between conditions. Condition (Success and Fail) was always entered as a between-subject variable. For the manipulation of affective states, Time (Pre-, Post- and Follow-up PANAS Assessment) was entered as a within-subject variable. For the appetitive Pavlovian conditioning procedure, Trials (1 to 4) and Cue (CS+ and CS−) were entered as within-subject variables. If Mauchly's test of sphericity was significant, Greenhouse-Geisser correction was applied.

For the AAT data, all error trials and trials with RTs longer than 3000 ms were excluded from the analyses (Krypotos et al., 2014). Median RTs (RTmd) were then calculated per participant for each combination of cue and response. Cue (CS+ and CS−) and Response (Approach and Avoidance) were entered as within-subject variables and Condition was entered as a between-subject variable.

For exploratory analyses of the relation between changes in affective states and conditioned responding, Pearson's correlations were used.

Results

Demographic comparisons

Participants in both conditions were comparable in baseline hunger, age, motivation for the experiment, belief in the cover story for the MIP being an intelligence test, and body mass index (BMI) as calculated from participants' self-reported height and weight (see Table 1). Differences between conditions were not observed on any of the questionnaires either (all $ps > .10$). A chi-square test suggested a similar gender distribution across conditions ($p > .50$).

Manipulation of affective states

Participants' predictions about their performance did not differ significantly between conditions, $t(44.34) = -.15$, $p = .88$, but participants in the fail condition solved significantly fewer anagrams ($M = 4.74$, $SD = 1.06$) than those in the success condition ($M = 14.17$, $SD = 1.77$), $t(24.34) = 46.25$, $p < .001$, as intended. Four participants in the fail condition and one participant in the success condition solved exactly as many anagrams as they had predicted; they were nonetheless included in the analyses.

Participants in the two conditions did not differ significantly in baseline PA or NA ($ps > .50$), but for both types of affect a differential pattern emerged during the experiment (PA: $F(2, 108) = 8.82$, $p < .001$, $\eta_p^2 = .14$; NA: $F(2, 108) = 6.79$, $p = .002$, $\eta_p^2 = .11$; see Figure 1A). The difference was most pronounced for PA ($p = .003$) and NA ($p = .03$) at post-test and PA (p

Table 1. Demographic comparisons for Experiment 1 and Experiment 2.

	Experiment 1		Experiment 2	
Questionnaire	Success Mean (*SD*)	Fail Mean (*SD*)	Success Mean (*SD*)	Fail Mean (*SD*)
n	29	27	27	29
Age	22.55 (*4.62*)	23.59 (*6.48*)	21.67 (*2.72*)	21.52 (*2.68*)
Base hunger/thirst	5.55 (*2.33*)	6.39 (*1.94*)	6.87 (*1.67*)	6.92 (*1.67*)
Motivation Q	8.53 (*1.19*)	8.50 (*.68*)	8.62 (*1.04*)	8.44 (*1.06*)
Motivation T	8.29 (*1.05*)	8.42 (*.83*)	8.62 (*.93*)	8.17 (*1.08*)
Test belief	4.13 (*2.42*)	3.67 (*2.28*)	3.64 (*2.50*)	2.74 (*1.96*)
BMI	21.45 (*2.40*)	21.88 (*2.94*)	22.23 (*2.36*)	20.78 (*2.53*)*
DASS-D	4.10 (*4.26*)	5.07 (*5.72*)	5.96 (*5.47*)	5.17 (*6.50*)
DASS-A	3.97 (*3.96*)	3.11 (*3.30*)	4.52 (*4.69*)	3.79 (*4.53*)
DASS-S	9.03 (*6.72*)	9.48 (*7.47*)	9.81 (*7.77*)	8.17 (*8.79*)
BIS-11	61.38 (*10.76*)	63.74 (*9.33*)	64.30 (*11.83*)	69.10 (*10.88*)
SHAPS	24.17 (*10.85*)	26.93 (*14.65*)		
DEBQ-EE	2.42 (*.73*)	2.54 (*.64*)		
DEBQ-EX	3.44 (*.48*)	3.26 (*.53*)		
DEBQ-R	2.46 (*1.03*)	2.73 (*.87*)		
AUDIT			8.63 (*2.37*)	8.83 (*2.48*)
DMQ-CP			2.19 (*.78*)	1.94 (*.69*)
DMQ-E			3.59 (*.75*)	3.13 (*.75*)*
DMQ-SR			3.87 (*.72*)	3.69 (*.83*)
DMQ-CN			1.71 (*.62*)	1.47 (*.51*)

Notes: Motivation-Q = Motivation for filling in the questionnaires; Motivation-T = Motivation for the tasks; Test belief = Belief that the anagram task was an intelligence test; BMI = Body Mass Index, DASS-D = Depression Anxiety Stress Scales, Depression subscale; DASS-A = Depression Anxiety Stress Scales, Anxiety subscale, DASS-S = Depression Anxiety Stress Scales, Stress subscale; BISS-11 = Barratt Impulsiveness Scale; SHAPS = Snaith-Hamilton Pleasure Scale; DEBQ-EE = Dutch Eating Behavioral Questionnaire, Emotional Eating subscale; DEBQ-EX = Dutch Eating Behavioral Questionnaire, External Eating subscale; DEBQ-R = Dutch Eating Behavioral Questionnaire, Dietary Restraint subscale; AUDIT = Alcohol Use Disorders Identification Test; DMQ-CP = Drinking Motives Questionnaire, Coping subscale; DMQ-E = Drinking Motives Questionnaire, Enhancement subscale; DMQ-SR = Drinking Motives Questionnaire, Social Rewards subscale; DMQ-CN = Drinking Motives Questionnaire, Conformity Subscale.
*$p \leq .05$.

= .05) at follow-up. No significant differences were observed for NA at follow up. If participants who solved the same number of anagrams as predicted were removed from the analysis, significant differences were found for PA ($p = .003$) and NA ($p = .02$) only at post-test. These results show that participants in the fail condition experienced an increase in negative affect and a decrease in positive affect relative to participants in the success condition at post-test, which suggests that our manipulation of affective states was effective, be it that the effects were somewhat short-lived.

Appetitive Pavlovian conditioning

Conditioning was also successful, as indicated by increased differentiation in craving and US expectancies between the CS+ and the CS− over the four trials, in the expected direction (Cue × Trial, $F(2.50, 135.09) = 13.31$, $p < .001$, $\eta_p^2 = .20$, and $F(3, 162) = 46.23$, $p < .001$, $\eta_p^2 = .46$, respectively; see Figure 2A). An effect of condition on conditioning was not observed, as evidenced by non-significant Cue × Trial × Condition interactions for craving and US expectancies (both *p*s > .40). Thus, results show that there were no significant differences in US expectancies or self-reported craving between the conditions.

At the end of the experiment, participants rated the CS+ ($M = 70.14$, $SD = 20.58$) higher on valence than the CS− ($M = 41.04$, $SD = 20.11$; $F(1, 54) = 40.86$, $p < .001$, $\eta_p^2 = .43$), with a non-significant effect of condition on the ratings (Cue × Condition, $p = .29$). This suggests that evaluative learning took place and was largely unaffected by induced affective states.

AAT

Analysis of the AAT data yielded a significant Cue × Response × Condition interaction, $F(1, 54) = 11.99$, $p = .001$, $\eta_p^2 = .18$ (see Figure 3A). In the fail condition, participants showed a relative tendency to approach CS+ pictures faster than CS− pictures and avoid CS− pictures faster than CS+ pictures, $F(1, 26) = 9.42$, $p = .005$, $\eta_p^2 = .27$, whereas the pattern in the success condition showed a non-significant trend in the opposite direction, $F(1, 28) = 3.68$, $p = .07$, $\eta_p^2 = .12$. Thus, in contrast to our hypotheses, we found evidence for

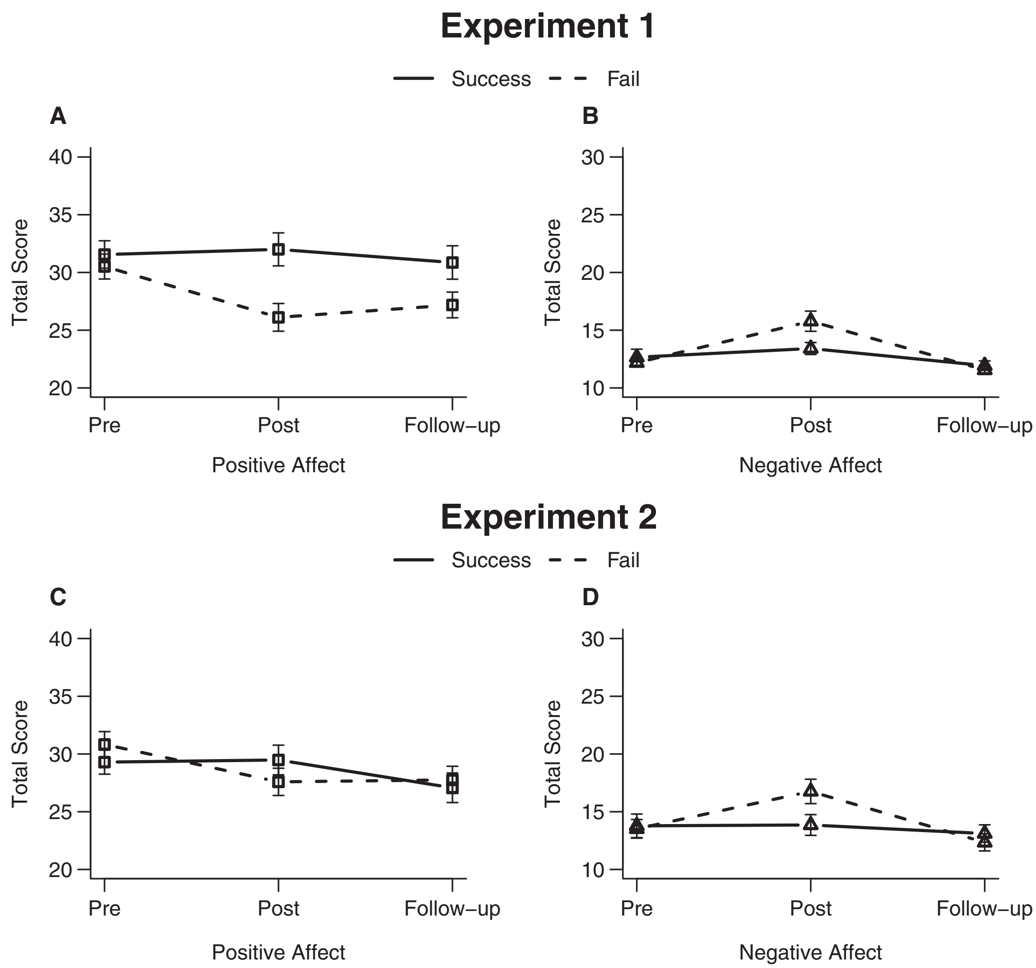

Figure 1. Positive and negative affect for the success and fail conditions in Experiment 1 (A, B) and Experiment 2 (C, D). Error bars indicate standard errors of the mean.

enhanced rather than reduced conditioned approach tendencies following the induction of a negative affective state.

Consumption test

Participants consumed on average 2.35 pieces (SD = 2.49) of chocolate during the consumption test, with no significant difference between conditions, $t(53) = -.22$, $p = .83$. As such, no evidence was found for an effect of the affective state manipulation on chocolate intake.

Exploratory analyses

In order to further understand what influence affective states have on approach-avoidance tendencies, we calculated difference scores for PA and NA between pre- and post-assessment and explored their correlations with an approach-avoidance index (per participant, defined as the RTmd on CS+ approach trials plus the RTmd on CS− avoid trials minus the sum of the RTmd on CS+ avoid and the RTmd on CS− approach trials). Negative scores on this index suggest relatively stronger conditioned approach tendencies. The results showed that only the decrease in PA from baseline to post-assessment overall predicted conditioned approach tendencies, Pearson's $r(56) = -.34$, $p = .01$, which is again in the opposite direction from what we predicted on the basis of the emotional congruency hypothesis. This suggests that enhanced approach tendencies are related specifically to decreases in positive affect and not to changes in negative affect.

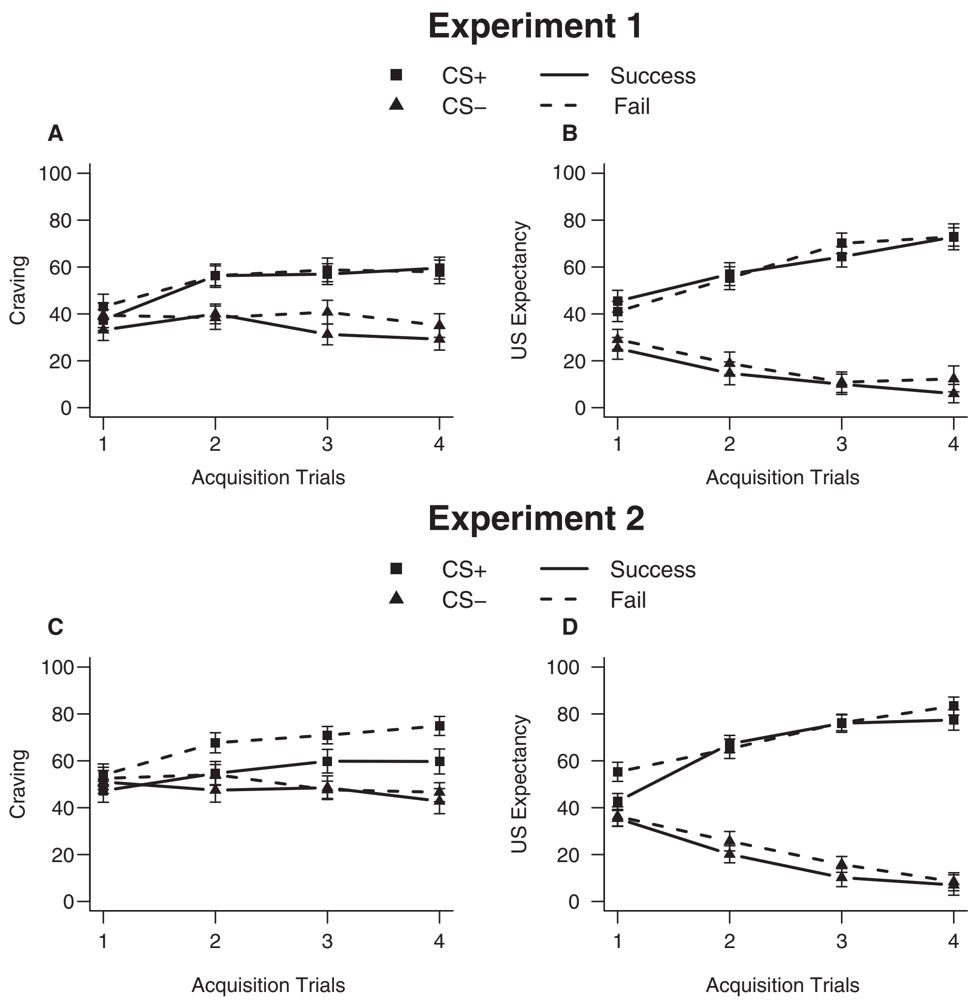

Figure 2. Self-reported online craving (left column) and US expectancy (right column) across acquisition trials for both conditions during Experiment 1 (A, B) and Experiment 2 (C, D). Error bars represent standard errors of the mean.

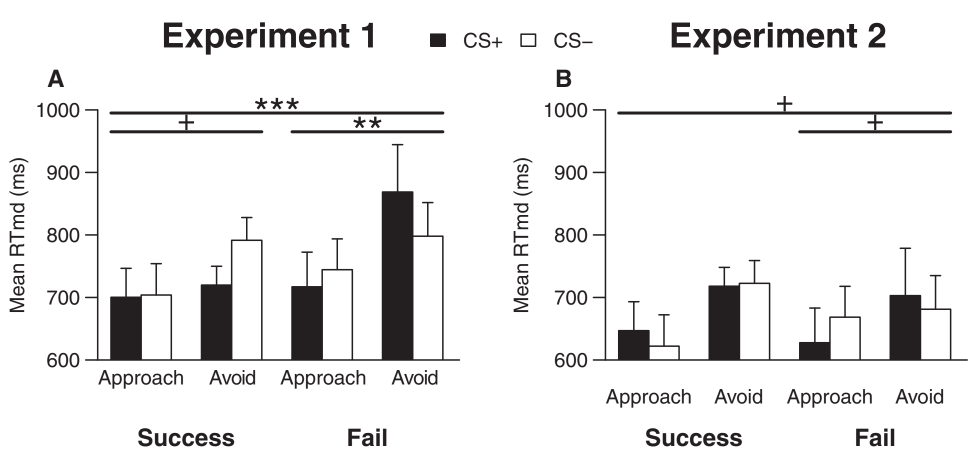

Figure 3. Mean RTmd for approach and avoid responses towards the CS+ and CS− pictures during the AAT for Experiment 1 (A) and Experiment 2 (B). Error bars show standard errors of the mean. Note: $^{+}p \leq .10$, $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$.

Discussion

In line with expectations, we found no evidence for an influence of negative mood on self-reported US expectancies. Contrary to our hypothesis, however, learning of conditioned craving and chocolate consumption also remained unaffected. Surprisingly, participants in the fail condition exhibited an enhanced approach tendency towards the CS+ as compared to the CS−, which squarely contradicted our hypothesis. Exploratory analyses showed that the strength of the approach tendencies was positively related to the reduction of positive affect.

An explanation for these surprising findings might be found in the literature on cognitive processing. Counter to the associative network theory, Isen (1985) has argued that individuals will attempt to repair their negative mood and that mood-incongruent responses will be primed in negative mood. Similarly, in a series of studies, Rothermund and colleagues (Rothermund, 2003; Rothermund, Voss, & Wentura, 2008; Schwager & Rothermund, 2013, 2014) have found specific counter-regulation tendencies following negative performance feedback, after which attention to incongruent rather than congruent information is enhanced. Such incongruency is indicative of the flexibility of information processing in healthy individuals (Rothermund et al., 2008). In cases of extreme negative affect, counter-regulation can alleviate the experience by increasing access to positive information, while in cases of extreme positive affect, counter-regulation can ground the individual and protect from risky decision-making, by increasing access to negative information (Schwager & Rothermund, 2014). The results of Experiment 1 might reflect such counter-regulation, through enhanced approach of conditioned cues for an appetitive US like chocolate that is known to positively influence affective states (Macht & Mueller, 2007). This might also explain the trend towards an avoidance tendency in the success condition.

Relatedly, Khantzian (1997) in his self-medication hypothesis of addiction proposed that individuals in negative affective states might try to alleviate their negative affect through the use of psychoactive substances (e.g. opiates), which can be seen as an extreme form of counter-regulation. Building upon this idea, Baker, Piper, McCarthy, Majeskie, and Fiore (2004) suggested that negative affect increases the reinforcement value of a drug and that negative affect might as a result become a direct cue that can elicit appetitive behaviour automatically. This idea was recently experimentally validated in a study by Bongers and Jansen (Bongers & Jansen, 2017). Taken together, all these accounts would have predicted the observation of increased approach tendencies towards appetitive CSs in negative affective states in a counter-regulatory fashion, as observed here. A maladaptive increase in counter-regulatory mechanisms might actually serve as a pathway through which recreational drug use becomes an addiction, since strong approach tendencies might be difficult to inhibit through volitional control (Stacy & Wiers, 2010). This account would have also predicted increased final consumption, which was not observed, potentially because the differences in affect between both conditions had largely dissipated by the final consumption test.

In Experiment 2, we set out to replicate and extend the findings of Experiment 1, using alcohol as US. Alcohol is a commonly abused substance, to which some of the above-mentioned theories apply (e.g. Baker et al., 2004), and often used for coping with negative experiences (Cooper, 1994).

Experiment 2

In this experiment, we did not expect any differences in US expectancies or conditioned craving between the two mood induction conditions. Further, in replication of Experiment 1, we hypothesised that individuals in the fail condition would show stronger approach tendencies towards the CS+ than the CS− compared to the success condition. We expected also that negative affective states would enhance overall liking of the US, because negative affective states should increase its reinforcement value (Baker et al., 2004). We also expected to replicate the exploratory finding of a correlation between the decline in positive affect and strength of the conditioned approach tendency of Experiment 1.

In Experiment 1, we found differences between the success and fail conditions only on a rather automatic level of conditioned responding (action tendencies). Thus, in Experiment 2, we aimed to extend our findings by including another automatic measure of conditioned responding. Automatic preferential attention towards CSs associated with alcohol (attentional bias) has previously been found in normal drinkers (Field & Duka, 2002) and counter-regulation effects have been found on a number of attention measures (Rothermund, 2003; Rothermund et al., 2008; Schwager & Rothermund, 2013, 2014). Thus, we hypothesised that negative affective states might enhance attentional bias towards CSs associated with alcohol even in social drinkers, similarly to action tendencies, which might serve as a maintaining factor for continued use (Field & Cox, 2008). Otherwise, Experiment 2 closely resembled Experiment 1. Only the differences in the methodology between the two experiments are outlined here.

Methods

Participants

A total of 63 participants took part in Experiment 2. A-priori exclusion criteria were (1) use of medication that counter-indicates alcohol consumption, (2) self-reported history of psychiatric problems, (3) pregnancy or breast-feeding, (4) not being a Dutch native speaker, and (5) dyslexia. Further, in order to limit our sample to social drinkers without alcohol use disorders, we excluded participants who reported drinking fewer than two to four times a month and those who scored higher than 11 on the Alcohol Use Disorders Identification Test (AUDIT; Babor, de la Fuente, Saunders, & Grant, 1992), as recommended by Kokotailo et al. (2004). We also assured that no participants who participated in Experiment 1 took part in Experiment 2. Participants were requested to not drink anything in the last two hours and not consume any alcohol in the last 24 h before participation in the experiment. Two participants were excluded for reporting no general craving for beer, one participant due to technical problems and four participants for having used drugs in the last 24 h prior to the experiment. Our final sample consisted of 56 participants (17 male, $M_{age} = 21.59$, $SD_{age} = 2.68$), randomly assigned to either the success ($n = 27$) or fail conditions. All participants were tested between 2 and 9 pm. The Ethical Committee of the University of Amsterdam approved the experiment.

Materials

CSs for this experiment were two rectangular serving trays (white and blue). We replaced the green round serving tray from Experiment 1 because our pilot studies revealed that participants already had strong associations between the green round tray and alcohol (we blame Heineken).

A small dose (10 ml) of chilled Heineken beer (5% alc/vol) in a shot glass was used as US in this study. We did not use the favourite beer of the participant for this experiment, because beers can vary widely in their alcohol percentage. For the consumption test, one 330 ml tin of chilled Heineken beer and one 330 ml bottle of chilled Spa Reine still mineral water were used. Participants' breath alcohol concentration (BAC) was measured at the beginning and at the end of the experiment with a digital breathalyser (DA-7100, Alcofind, Incheon, Korea).

Photographs of the trays, taken from four different vantage points, were superimposed upon the same frames as in Experiment 1 for use during the AAT. The same tray pictures were also superimposed upon white frames (97 mm × 121 mm) for use during target trials in the DPT.

Questionnaires

The *Alcohol Use Disorders Identification Test* (AUDIT; Babor et al., 1992; Dutch translation by Schippers & Broekman, 2010) is a ten-item screening tool for alcohol use problems (range 0–40). The psychometric properties of AUDIT have been examined in numerous populations. It shows good reliability, construct and criterion validity (Reinert & Allen, 2002); its sensitivity and specificity are also high for use with undergraduate populations (e.g. Aertgeerts et al., 2000; Kokotailo et al., 2004).

A *thirst questionnaire* was used at the beginning of the experiment to assess baseline thirst on a VAS ranging from absolutely not thirsty (0) to extremely thirsty (10).

We included the *Drinking Motives Questionnaire* (DMQ; Cooper, 1994; Dutch translation by Wiers and van Empelen, unpublished manuscript) to measure potentially confounding baseline differences in the motives for alcohol consumption: coping (DMQ-CP), enhancement (DMQ-E), social rewards (DMQ-SR) and conformity (DMQ-CN). This was administered because particular drinking motives might be related to implicit responses to predictors of alcohol following a manipulation of affect (Birch et al., 2008).

A *bogus taste test* was used to encourage consumption during the behavioural test. Participants rated both the beer and the water on six taste characteristics (e.g. sweet, salty) on a ten-point Likert scale. We did not actually analyze those ratings.

Procedure

Participants were first screened by telephone and returned a filled-in AUDIT via e-mail. Upon arrival in the lab, participants gave their informed consent and their BAC was measured. Afterwards, participants filled out the thirst questionnaire and the baseline computerised PANAS (pre-assessment). They then underwent the same affective state manipulation and appetitive Pavlovian learning procedure as in Experiment 1, but with the alcohol US instead of the chocolate US. The AAT with pictures of the CSs (the serving trays) followed as in Experiment 1.

Participants then completed a dot-probe task (DPT) to measure attentional bias, modelled after the procedure used in Schoenmakers, Wiers, and Field (2008). This task consisted of a practice block of 12 trials and a test block of 2 buffer trials and 56 target trials. On each trial, two pictures appeared simultaneously, centred on the left and right side of the screen, for either 200 or 500 ms. Two different trial durations were included, because divergent results have been obtained using different presentation durations in attentional bias paradigms in the literature (Mogg & Bradley, 2016; Mogg, Bradley, Field, & De Houwer, 2003). At picture offset, a visual probe (↓ or ↑) was presented centred to the location of one of the two pictures. Participants were required to identify the probe with a button press (B, marked as ↓ or Y, marked with ↑). Reaction time was recorded. Empty white frames were presented during practice and buffer trials and CS pictures were presented during target trials. Target trials were randomised, so that no more than three consecutive trials appeared with the same position (left or right) of CS+ and CS− and probe or duration. Trials were separated by 500 ms ITIs, during which a fixation cross was presented centred on the screen. Participants were instructed to concentrate on the fixation cross during ITIs.

After completion of this task, participants in both conditions underwent the same instrumental training phase and transfer test as part of a Pavlovian-to-Instrumental Transfer task (PIT; P. Watson, Wiers, Hommel, & de Wit, 2014), which is not reported here. The PIT task included in this experiment is similar to the one used in the study reported by Watson et al. (2014), including similar instrumental training and testing stages, but with only two reinforcers (beer and water) and two stimuli (pictures of the CS+ and CS− used during the appetitive Pavlovian conditioning in this experiment). There was no between-participant manipulation during the PIT task. Upon response reinforcement in the instrumental training stage, participants consumed four small shots of beer and water (each 5 ml). After this, participants were also asked to rate their craving for water and beer as well as their overall thirst on a VAS. The PIT procedure lasted about 13 min.

Participants then rated the valence of both trays as in Experiment 1, and filled in the computerised follow-up PANAS, DMQ, DASS, and BIS-11.

At the beginning of the consumption test, participants were asked to taste the drinks in the presence of the experimenter and answer the first two questions on the bogus taste test. The drinks were left in the lab together with the CS+ tray during the time when participants were filling in the demographic questionnaire and some manipulation checks (e.g. belief in the intelligence test). We also examined whether participants found that they had had sufficient sleep the night before the experiment, and participants rated how tasty they found the US on a 10-point Likert scale. Participants' BAC was measured again and a debriefing about the research concluded the experiment.

Data analysis

Data were analyzed as for Experiment 1. Two participants were excluded from the analyses of the AAT due to having a number of excluded target trials that was higher than 2.5 SD above the mean number for the whole sample.

For the analysis of the DPT, trials with incorrect responses and those with reaction times exceeding 1000 ms were excluded (Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004). Three participants were further excluded from the DPT analysis because they had a number of excluded trials higher than 2.5 SD above the mean number for all participants. Median RTs were calculated for CS+ congruent (when the probe replaced the CS+) and incongruent (when the probe replaced the CS−) trials. Congruency was entered as a within-subject variable and Condition was entered as a between-subject variable. Since no significant interaction of trial duration (200 or 500 ms) and congruency (CS+ congruent vs. CS+ incongruent) was observed (Congruency × Duration interaction, $p = .42$; Congruency × Duration × Condition, $p = .48$), we collapsed the data across trial duration.

Results

Demographic comparisons

No differences between conditions were found for baseline thirst, age, motivation for the experiment, belief in the anagram test cover story, or most of the questionnaire scores (see Table 1, all $ps > .10$). The two conditions differed, however, on their scores on the DMQ-E scale, $t(54) = 2.30$, $p = .03$ and on BMI, $t(53) = 2.19$, $p = .03$.

A chi-square test showed that gender was evenly distributed across the two conditions ($p = .64$). There was a significant difference in self-reported sleep, $\chi^2(1) = 4.93$, $p = .03$, with more participants ($n = 8$) in the success condition than in the fail condition ($n = 2$) reporting that they had not had enough sleep. This is important to take into consideration when analyzing RT data, because sleep deprivation has been shown to negatively affect speed of responding (Ratcliff & Van Dongen, 2011).[2]

To evaluate the effects of the significant baseline differences between conditions, we performed additional analyses with DMQ-E and BMI added as covariates and Sleep added as a between-subject variable in the models. Both DMQ-E and BMI were grand mean centred before being entered in these additional analyses, as suggested by Schneider, Avivi-Reich, and Mozuraitis (2015). The analyses reported here are without those additional baseline variables included in the models. Only when the findings changed as a result of including these variables in the models, the follow-up analyses are reported as well.

Manipulation of affective states

Participants in the fail condition performed worse on the anagram task, solving fewer anagrams ($M = 4.83$, $SD = 1.37$) than those in the success condition ($M = 14.63$, $SD = 1.21$), $t(54) = 28.32$, $p < .001$, while having predicted similar performance, $t(54) = -.91$, $p = .37$. Four participants in the fail condition solved as many anagrams as they had predicted and one solved one more than predicted. Those participants were retained in the analysis. When these participants were excluded, there was a significant difference in the baseline prediction between the conditions ($p = .02$), with participants in the success condition predicting to solve fewer anagrams than the participants in the fail condition.

Baseline PA or NA did not differ between the conditions (smallest $p = .32$), but there was a significant interaction between Time and Condition for both PA, $F(2, 108) = 3.57$, $p = .03$, $\eta_p^2 = .06$, and NA, $F(2, 108) = 8.15$, $p = .001$, $\eta_p^2 = .13$ (see Figure 1B). The difference between conditions was only significant for NA ($p = .04$) at post-test. Those results show that participants in the fail condition experienced an increase in negative affect as compared to participants in the success condition at post-test, but that difference did not persist until the end, as evidenced by the non-significant difference at follow-up. When participants who solved the same number of anagrams as they had predicted were excluded, the Time by Condition interaction became non-significant for PA ($p = .07$), as did the results of all t-tests (lowest $p = .10$). We further observed that individuals who reported not having had enough sleep the night before the experiment showed a steady decline in PA over time, regardless of condition, which might explain why the two conditions did not differ significantly at post-test or follow up. Overall, results support the conclusion that the procedure changed affective states, but the effects were weaker than what was observed in Experiment 1, despite the use of an identical procedure.

Appetitive Pavlovian conditioning

Over the conditioning trials, differential craving, $F(2.41, 130.20) = 20.15$, $p < .001$, $\eta_p^2 = .27$, and US expectancies, $F(2.37, 127.72) = 68.86$, $p < .001$, $\eta_p^2 = .56$, emerged, in replication of Experiment 1 (see Figure 2B). Again, affective state induction did not influence these ratings as evidenced by a non-significant Cue × Trial × Condition interaction for both craving and US expectancies (both $ps > .10$). We observed a significant Cue × Condition interaction for self-reported craving, $F(1, 54) = 4.80$, $p = .03$, $\eta_p^2 = .08$, with the fail condition showing stronger differentiation between the cues overall.

Participants rated the CS+ ($M = 70.77$, $SD = 19.07$) significantly higher on valence than the CS− ($M = 51.79$, $SD = 22.93$; $F(1, 54) = 19.09$, $p < .001$, $\eta_p^2 = .26$), with a near-significant Cue × Condition interaction, $F(1, 54) = 3.94$, $p = .05$, $\eta_p^2 = .07$. There was a trend for a difference in ratings between the two conditions for the CS+, $t(54) = -1.86$, $p = .07$, with participants in the fail condition rating the CS+ higher ($M = 75.24$, $SD = 17.11$) than those in the success condition ($M = 65.98$, $SD = 20.20$).

AAT

In replication of Experiment 1, no significant Cue × Response interaction was observed overall, $F(1, 52) < 1$, $\eta_p^2 = .009$. The Cue × Response × Condition interaction approached significance, $F(1, 52) = 3.74$, $p = .06$, $\eta_p^2 = .07$[3] (Figure 3B). The Cue × Response interaction was not significant in the success condition ($p > .30$), whereas there was a trend for significance in the fail condition, $F(1, 26) = 3.45$, $p = .07$, $\eta_p^2 = .12$.

A difference in thirst emerged between the conditions at the end of the experiment. We added this as a covariate in the repeated-measures ANOVA and we found an even more pronounced Cue × Response × Condition interaction for the AAT, $F(1,51) = 4.57$, $p = .04$, $\eta_p^2 = .08$, which suggests that differences in thirst cannot explain the findings observed here. As a whole, the results of Experiment 2 mirrored the findings of Experiment 1.

DPT

In the analysis of the DPT, the main effect of congruency was not significant, $F(1, 51) = 2.44$, $p = .13$, $\eta_p^2 = .05$. However, there was a significant Congruency × Condition interaction, $F(1, 51) = 4.78$, $p = .03$, $\eta_p^2 = .09$ (Figure 4). The congruency pattern was significant in the success condition, $F(1, 24) = 4.53$, $p = .04$, $\eta_p^2 = .16$, with shorter RTs on congruent trials than incongruent trials, but not in the fail condition, $F(1, 27) = .36$, $p = .56$, $\eta_p^2 = .01$. This suggests that negative affective states eliminated the attentional bias towards the CS+, contrary to our hypothesis.

When we examined the baseline differences in sleep, we found that the interaction between Congruency and Sleep was borderline significant, $F(1, 49) = 3.93$, $p = .05$, $\eta_p^2 = .07$, with participants who reported not having had enough sleep the night before the experiment showing stronger congruency effects. Notably, the interaction of Congruency and Condition became non-significant ($p = .24$) when Sleep was added to the model, whereas the main effect of congruency reached significance, $F(1, 50) = 4.71$, $p = .04$, $\eta_p^2 = .09$. This suggests that the observed difference between conditions on attention might be explained in part by the greater number of sleep-deprived individuals in the success condition.

US ratings

There was a significant difference in general thirst ratings following the PIT instrumental training stage, with participants in the fail condition ($M = 62.93$, $SD = 14.68$) reporting more thirst than participants in the success condition ($M = 51.90$, $SD = 21.76$), $t(45.16) = -2.21$, $p = .03$. There was no significant difference in reported craving for beer ($p = .39$) or water ($p = .20$) between conditions.

At the end of the experiment, participants found the beer tasty overall ($M = 6.89$, $SD = 1.72$). No significant difference was observed between the conditions in US taste evaluation, $t(54) = -.32$, $p = .75$, contrary to the hypothesis.

Consumption test

Participants consumed on average 97.05 ml of beer and 111.27 ml of water during the behavioural test. There was no overall preference for one drink ($p = .37$) and there was no difference in preference between conditions ($p = .53$). This suggests that the mood induction did not significantly affect voluntary consumption at the end of testing.

Exploratory analyses

In order to explore the effects of mood on conditioned approach-avoidance tendencies, we calculated similar pre–post change scores for positive and negative affect as in Experiment 1. In Experiment 2, the approach-avoidance index (calculated as in Experiment 1) did not correlate significantly with either change score.

Discussion

Experiment 2 largely replicated the results of Experiment 1, with participants in the success and fail conditions showing no differences in conditioned US expectancies or craving. Even though the manipulation of affective states seemed to be less effective and stable in Experiment 2 than in Experiment 1, participants in the fail condition again showed enhanced approach tendencies towards the CS+ as compared to the CS−. Yet, we failed to replicate the relationship between mood change and approach-avoidance tendencies found in Experiment 1, possibly due to the reduced effect of the manipulation on PA in Experiment 2.

Contrary to predictions, participants in the fail condition did not rate the US as more pleasant, but they did give slightly higher valence ratings for the CS+, at odds with Experiment 1. In the DPT, an overall congruency effect appeared, with attention being captured by the CS+ more than the CS−. This congruency effect was stronger for participants in the success condition, likely due to differences in the degree of sleep deprivation between conditions. Of note, our overall sample size of 53 for the DPT was likely sufficient to find an overall DPT effect (e.g. for a typical DTP effect of about $d = .50$ [e.g. see Schoenmakers et al., 2008], which corresponds to a medium effect size according to the conventions of Cohen (1988), power to find an effect at $\alpha = .05$ equals .95)

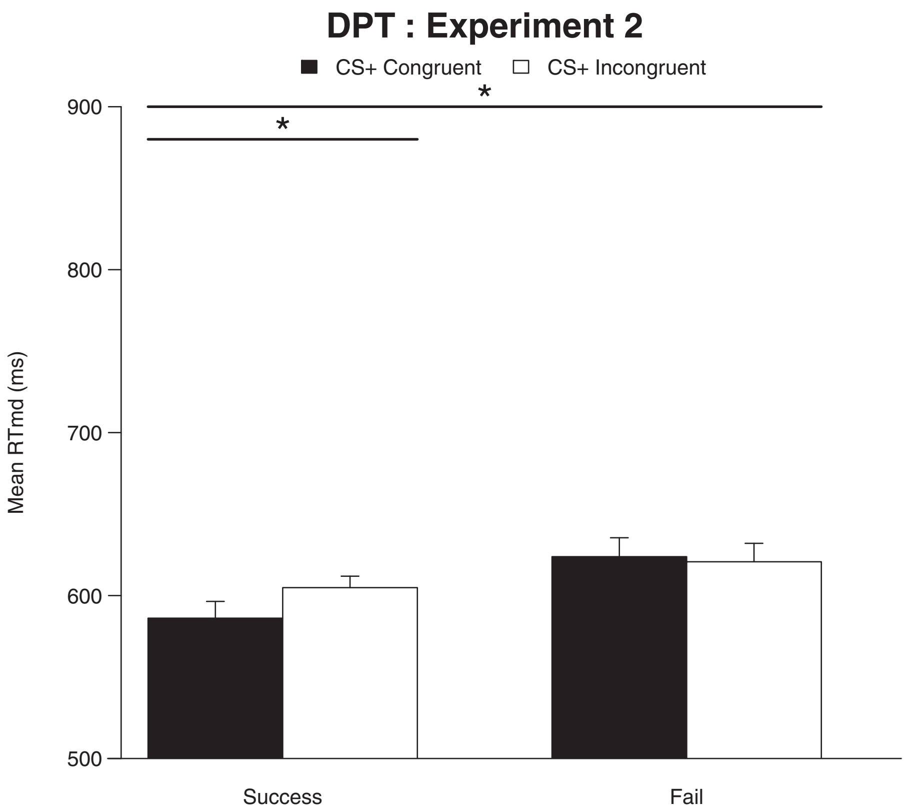

Figure 4. Experiment 2: Mean RTmd for CS+ congruent and CS+ incongruent trials during the DPT. Error bars indicate standard errors of the mean. Note: **p* ≤ .05.

but our sample size may have been insufficient to find a between-groups difference in the DTP effect (for an intervention effect on the DTP of similar size, i.e. a medium-size effect, the power to find it at $\alpha = .05$ with the present sample size would be just .43).

General discussion

We presented two experiments that tested the effect of experimentally manipulated affective states on appetitive Pavlovian learning and expression of appetitive responses. Following a manipulation of affective states, participants learned that a CS+ was always followed by consumption of chocolate (Experiment 1) or alcohol (Experiment 2), while the CS− was not. Results revealed that negative affective state did not result in different US expectancy ratings or conditioned craving responses, regardless of US type. However, participants in the fail condition exhibited stronger conditioned approach tendencies than participants in the success condition. Data from Experiment 1 suggested that this enhancement might be related to a reduction of positive affect, but this finding was not replicated in Experiment 2. Further, Experiment 2 showed that participants had an attentional bias towards the predictor of reward (CS+) and that this congruency effect was increased for participants in the success condition, who reported higher positive affect, but incidentally also reported more sleep deprivation. Finally, in Experiment 2, participants in the fail condition evaluated the CS+ as more positive than those in the success condition, even though they did not rate the US as more positive.

The most notable finding in the present experiments was the observation of approach tendencies to appetitive conditioned stimuli for participants in the fail conditions, but not for those in the success conditions. These results are at odds with the emotional congruency account (Bower, 1981) and with empirical data to date (Radke et al., 2014; Vrijsen et al., 2013). According to the counter regulation hypothesis (e.g. Rothermund, 2003), however, the information processing system is attuned such that under certain conditions stimuli and responses incompatible with the current affective state will dominate. This framework provides a theoretically sound interpretation of the findings observed here. Further, theories of drug addiction (Baker et al., 2004; Khantzian, 1997) propose that negative affective states might directly and automatically motivate drug use and this might also hold for the eating of chocolate, which some theorists propose resembles an addiction (Hebebrand et al., 2014) and has been shown to affect mood (Macht & Mueller, 2007).

Thus, negative affective states might act as a vulnerability factor for addictive behaviours (e.g. Kassel, Stroud, & Paronis, 2003) through increasing approach tendencies and other counter-regulatory mechanisms. It is possible that individuals experiencing negative affect readily learn and express approach tendencies towards predictors of psychoactive substances and as a result, consumption might be more difficult to inhibit (Stacy & Wiers, 2010). Negative affect has indeed been linked to cigarette (e.g. Magid, Colder, Stroud, Nichter, & Nichter, 2009) and alcohol use (Cooney, Litt, Morse, Bauer, & Gaupp, 1997) and individuals have also been shown to consume more unhealthy foods when they believed that those could affect their negative mood (Tice, Bratslavsky, & Baumeister, 2001). Interestingly, we did not observe any effect of our manipulation on actual US consumption. This might be related to the fact that effects of the affective state manipulation seemed to have largely dissipated by the end of the experiments. Also, our procedure allowed for variability in the duration of the consumption test, with slower participants having the opportunity for US consumption during a longer period. Future research might want to control the duration of such tests more strictly. However, ceiling effects might be present with such procedures, since participants might only be able to consume a particular amount of chocolate or drink within a given time frame, while in our procedure they could have prolonged the consumption test and consumed as much as they wanted.

Whether a change in negative or positive affect guides counter regulation is another important question. The correlation observed in Experiment 1 between the decrease of positive affect and approach-avoidance tendencies suggests that reductions in positive affect might underlie the increase of approach tendencies. It is possible that drug use is motivated by its effect on positive affect regulation, as some researchers have proposed (Audrain-McGovern, Wileyto, Ashare, Cuevas, & Strasser, 2014), such that positive affect might protect individuals from excessive reward approach tendencies. These findings, however, should be interpreted with caution since they resulted from an exploratory analysis and we did not manage to replicate the correlation between changes in positive affect and approach tendencies in Experiment 2. In Experiment 2, the decrease of positive affect ($M = 3.24$, $SD = 3.52$) following our manipulation of affective states was not as large as in Experiment 1 ($M = 4.41$, $SD = 4.56$), which might have obstructed the observation of a relationship.

Because increased approach-avoidance tendencies under negative affective states might have been due to the fact that individuals with increased negative affect perceived the reward as more positive (Baker et al., 2004), we examined the valence ratings of the US in Experiment 2, where all individuals received exactly the same type of substance.[4] No differences in the ratings of the US were observed between the groups. However, since affective differences were no longer present at the end of the experiment, we cannot exclude that the US would had been rated differently by the participants in the two conditions had the rating been administered earlier in the experimental procedure, when affect did differ between the conditions. It is important to note that despite their mood-repairing qualities (Fairbairn & Sayette, 2013; Macht & Mueller, 2007), chocolate and alcohol consumption might result in negative feelings, such as guilt, in some individuals (Macht & Dettmer, 2006). One limitation of the studies presented here is that we did not examine emotional responses towards the US per se.

In order to extend our findings on approach-avoidance tendencies to another automatic measure, we examined attentional bias in Experiment 2. We observed an overall attentional bias towards predictors of reward, in replication of previous results (e.g. Hogarth, Dickinson, & Duka, 2005), but only when the between-subject factor of sleep deprivation was added in the model. The increase of attentional bias towards predictors of reward observed in the success condition, when this factor was not entered in the model, might have resulted from the increased fatigue of certain participants as a result of sleep deprivation and their relatively reduced ability to control automatic responding (Hagger, Wood, Stiff, & Chatzisarantis, 2010). It is in fact unclear how affect modulates attention. Evidence has so far been inconclusive (e.g. Rusting, 1998; Sanchez, Vazquez, Gomez, & Joormann, 2014) with some studies suggesting congruent and other incongruent attentional biases. This might result from the fact that a number of different paradigms have been used to test attention, from visual search tasks (e.g. Rothermund, 2003) to dot probe tasks. Different tasks might measure different aspects of attention. Further, it is important to note that the results of the DPT, if anything, contradict the result of the AAT. Desynchony of responding (Hodgson & Rachman, 1974; Rachman, 1974) has been discussed as an important factor in psychological functioning and the results here might be seen as evidence for this phenomenon. An alternative explanation is that the effects of our manipulation were different during the AAT and the DPT. Since we did not observe any differences in affect at follow up, it is possible that affect differences had dissipated before the DPT and other processes took centre stage. The experimental procedure was rather long, thus fatigue might have also influenced performance on the DPT.

In accordance with our hypothesis, US expectancies were not affected by mood induction in either Experiment 1 or Experiment 2 (see also Bongers et al., 2015). We believe that this provides sufficient evidence to conclude that negative affective states does not greatly affect the formation of CS-US associations and that the salience of the CS+ remains unaffected by mood in a simple conditioning task.

Conditioned craving also remained largely unaffected by our manipulation, in accordance with Bongers et al. (2015). Across conditions, increased craving was reported to the CS+ in comparison to the CS–, which is in accordance with previous experiments (Van Gucht et al., 2008). In the view of Martin-Soelch et al. (2007), depression should result in reduced craving, due to diminished reward responsiveness, even though one study has found exactly the opposite (Willner et al., 1998). Failure feedback manipulations are commonly referred to as laboratory models for depression (Goodwin & Williams, 1982). However, the results of our study showed only small changes in negative affect following the manipulation. We also did not find decreased craving following our failure feedback manipulation, in line with Willner et al. (1998). On the contrary, in Experiment 2 participants in the fail condition showed more craving differentiation between the CS+ and the CS– and rated the CS+ as somewhat more pleasant than participants in the success condition. Because we used an experimental model, which only resulted in short-term affective changes in contrast to the long-lasting mood effects of depression, it is unclear whether similar results would be obtained with depressed individuals. In addition, it can be argued that our choice of USs represented primary reinforcers and that reduction of desire under conditions of negative affect might occur more readily in conditioning with secondary reinforcers such as monetary gain. Indeed, recent research suggests differential neural conditioned responding in particular brain regions with primary and secondary reinforcers in both appetitive (ventral striatum, Valentin & O'Doherty, 2009) and aversive learning (amygdala; Delgado, Jou, & Phelps, 2011).

A few limitations of the studies reported here should be noted. One significant limitation is that the affect manipulation was somewhat weak and its effects did not last until the end of the experiment, which might have obstructed the emergence of further differences between conditions, especially on controlled measures of responding such as craving and consumption. We chose a success/failure feedback manipulation, because we hypothesised that its effects might be longer lasting than those of other procedures (Chartier & Ranieri, 1989) and wanted to reduce demand effects, which are considered an issue in this type of research (Westermann, Spies, Stahl, & Hesse, 1996). Future research should examine the effects of other manipulations, which might be delivered closer in time to the testing of appetitive responses. Second, despite our efforts to achieve enough power for the studies presented here (see Footnote 1), it is possible that the current sample sizes were not large enough to detect some effects, especially in the DPT. This should be considered when interpreting the null-findings reported here.

In conclusion, we have shown that negative affective states enhance the strength of conditioned appetitive approach tendencies, as proposed by the counter-regulation framework. Further research should study the effects of affective states on more controlled appetitive approach behaviour as well. Studying the influence of affective states on controlled behaviour in the laboratory might be challenging, since participants might be apprehensive to act freely under experimental scrutiny. Increased automatic approach tendencies might be translated in voluntary approach behaviour more readily in naturalistic settings, where individuals may be inclined to express approach behaviour towards appetitive cues even when they are aware of potential negative consequences.

Notes

1. Calculations on the raw data of Van Gucht et al. (2008, Experiment 1) yield an effect size of $\eta_p^2 = .21$ for the difference in the AAT effect between a group tested in the acquisition context, which exhibited a significant AAT effect, and a group that was tested in an extinction context and exhibited an attenuated, non-significant AAT effect. With the present sample size, the power to obtain a between-groups difference in AAT effect of a similar size (which is statistically equivalent to a Cue x Response x Condition interaction in the current design), using $\alpha = .05$, equals .97 (This power calculation and others reported in the present manuscript were conducted using G*Power 3.1, see Faul, Erdfelder, Lang, & Buchner, 2007).
2. Sleep was not assessed in Experiment 1, but was assessed in Experiment 2, since testing sessions occurred in the late afternoons and early evenings.
3. This interaction became significant when the individuals with excessive error rates were included in the sample.
4. In Experiment 1, we gave participants pieces of their favourite kind of chocolate, which they had indicated during the screening procedure; we did not measure their subjective liking of the chocolate.

Acknowledgements

We thank Johanna Furch and Sophie van der Spek for collecting the data for these experiments, Bert Molenkamp for technical assistance and Dinska Van Gucht for providing us with her experimental protocol.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The research reported here was supported by Innovation Scheme (Vidi) [grant number 452-09-001] from the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO) awarded to Tom Beckers. The funding source had no involvement in the study design, the collection, analysis or interpretation of the data, the writing of the report, nor in the decision to submit the article for publication.

ORCID

Tom Beckers http://orcid.org/0000-0002-9581-1505

References

Aertgeerts, B., Buntinx, F., Bande-Knops, J., Vandermeulen, C., Roelants, M., Ansoms, S., & Fevery, J. (2000). The value of CAGE, CUGE, and AUDIT in screening for alcohol abuse and dependence among college freshmen. *Alcoholism: Clinical and Experimental Research*, *24*(1), 53–57.

Audrain-McGovern, J., Wileyto, E. P., Ashare, R., Cuevas, J., & Strasser, A. A. (2014). Reward and affective regulation in depression-prone smokers. *Biological Psychiatry*, *76*(9), 689–697. doi:10.1016/j.biopsych.2014.04.018

Babor, T., de la Fuente, J., Saunders, J., & Grant, M. (1992). *The alcohol use disorders identification test: Guidelines for use in primary health care*. Geneva, Switzerland: World Health Organization.

Baker, T. B., Piper, M. E., McCarthy, D. E., Majeskie, M. R., & Fiore, M. C. (2004). Addiction motivation reformulated: An affective processing model of negative reinforcement. *Psychological Review*, *111*(1), 33–51. doi:10.1037/0033-295X.111.1.33

Birch, C. D., Stewart, S. H., Wiers, R. W., Klein, R. M., MacLean, A. D., & Berish, M. J. (2008). The mood-induced activation of implicit alcohol cognition in enhancement and coping motivated drinkers. *Addictive Behaviors*, *33*(4), 565–581. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0306460307003061

Bongers, P., & Jansen, A. (2017). Emotional eating and Pavlovian learning: Evidence for conditioned appetitive responding to negative emotional states. *Cognition and Emotion*, *31*(2), 284–297. doi:10.1080/02699931.2015.1108903

Bongers, P., van den Akker, K., Havermans, R., & Jansen, A. (2015). Emotional eating and Pavlovian learning: Does negative mood facilitate appetitive conditioning? *Appetite*, *89*, 226–236. doi:10.1016/j.appet.2015.02.018

Bower, G. H. (1981). Mood and memory. *American Psychologist*, *36*(2), 129–148.

Chartier, G. M., & Ranieri, D. J. (1989). Comparison of two mood induction procedures. *Cognitive Therapy and Research*, *13*(3), 275–282. Retrieved from papers3://publication/uuid/54B7D553-3832-4B77-8427-2D8F6EAB3645.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. New York: Routledge Academic.

Cooney, N. L., Litt, M. D., Morse, P. A., Bauer, L. O., & Gaupp, L. (1997). Alcohol cue reactivity, negative-mood reactivity, and relapse in treated alcoholic men. *Journal of Abnormal Psychology*, *106*(2), 243–250. doi:10.1037/0021-843X.106.2.243

Cooper, M. L. (1994). Motivations for alcohol use among adolescents: Development and validation of a four-factor model. *Psychological Assessment*, *6*(2), 117–128. doi:10.1037/1040-3590.6.2.117

Cunningham, W. A., Preacher, K. J., & Banaji, M. R. (2001). Implicit attitude measures: Consistency, stability, and convergent validity. *Psychological Science*, *12*(2), 163–170. doi:10.1111/1467-9280.00328

de Beurs, E., Van Dyck, R., Marquenie, L. A., Lange, A., & Blonk, R. W. B. (2001). De DASS: een vragenlijst voor het meten van depressie, angst en stress. *Gedragstherapie*, *34*, 35–53. Retrieved from http://www2.psy.unsw.edu.au/dass/Dutch/DASS-manuscriptdeBeurs.pdf

Delgado, M. R., Jou, R. L., & Phelps, E. A. (2011). Neural systems underlying aversive conditioning in humans with primary and secondary reinforcers. *Frontiers in Neuroscience*, *5*, 1–10. doi:10.3389/fnins.2011.00071

Dichter, G. S., & Tomarken, A. J. (2008). The chronometry of affective startle modulation in unipolar depression. *Journal of Abnormal Psychology*, *117*(1), 1–15. doi:10.1037/0021-843X.117.1.1

Engelen, U., De Peuter, S., Victoir, A., Van Diest, I., & Van den Bergh, O. (2006). Verdere validering van de Positive and Negative Affect Schedule (PANAS) en vergelijking van twee Nederlandstalige versies. *Gedrag En Gezondheid*, *34*, 61–70.

Fairbairn, C. E., & Sayette, M. A. (2013). The effect of alcohol on emotional inertia: A test of alcohol myopia. *Journal of Abnormal Psychology*, *122*(3), 770–781. doi:10.1037/a0032980

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175–191. doi:10.3758/BF03193146

Field, M., & Cox, W. (2008). Attentional bias in addictive behaviors: A review of its development, causes, and consequences. *Drug and Alcohol Dependence*, *97*(1–2), 1–20. doi:10.1016/j.drugalcdep.2008.03.030

Field, M., & Duka, T. (2002). Cues paired with a low dose of alcohol acquire conditioned incentive properties in social drinkers. *Psychopharmacology*, *159*(3), 325–334. doi:10.1007/s00213-001-0923-z

Fielding, H. (1999). *Bridget Jones's Diary*. London, UK: Penguin Publishing Group.

Franken, I. H. A., Rassin, E., & Muris, P. (2007). The assessment of anhedonia in clinical and non-clinical populations: Further validation of the Snaith–Hamilton Pleasure Scale (SHAPS). *Journal of Affective Disorders*, *99*(1–3), 83–89. doi:10.1016/j.jad.2006.08.020

Frijda, N. H. (1996). Passions: Emotion and socially consequential behavior. In R. D. Kavanaugh, B. Zimmerberg, & S. Fein (Eds.), *Emotion: Interdisciplinary perspectives* (pp. 1–27). Mahwah, NJ: Erlbaum.

Goodwin, A. M., & Williams, J. M. G. (1982). Mood-induction research—its implications for clinical depression. *Behaviour Research and Therapy*, *20*(4), 373–382. doi:10.1016/0005-7967(82)90097-3

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: A meta-analysis. *Psychological Bulletin*, *136*(4), 495–525. doi:10.1037/a0019486

Hebebrand, J., Albayrak, Ö, Adan, R., Antel, J., Dieguez, C., de Jong, J., … Dickson, S. L. (2014). "Eating addiction", rather than "food addiction", better captures addictive-like eating behavior. *Neuroscience & Biobehavioral Reviews*, *47*, 295–306. doi:10.1016/j.neubiorev.2014.08.016

Herman, C. P., & Polivy, J. (1984). A boundary model for the regulation of eating. *Research Publications - Association for Research in Nervous and Mental Disease*, *62*(12), 141–156. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/6695111

Hodgson, R., & Rachman, S. (1974). II. Desynchrony in measures of fear. *Behaviour Research and Therapy*, *12*, 319–326. doi:10.1016/0005-7967(74)90006-0

Hogarth, L., Dickinson, A., & Duka, T. (2003). Discriminative stimuli that control instrumental tobacco-seeking by human smokers also command selective attention. *Psychopharmacology*, *168*(4), 435–445. doi:10.1007/s00213-003-1456-4

Hogarth, L., Dickinson, A., & Duka, T. (2005). Explicit knowledge of stimulus? Outcome contingencies and stimulus control of selective attention and instrumental action in human smoking behaviour. *Psychopharmacology*, *177*(4), 428–437. doi:10.1007/s00213-004-1973-9

Isen, A. M. (1985). Asymmetry of happiness and sadness in effects on memory in normal college students: Comment on Hasher, Rose, Zacks, Sanft, and Doren. *Journal of Experimental Psychology: General*, *114*(3), 388–391. doi:10.1037/0096-3445.114.3.388

Kassel, J. D., Stroud, L. R., & Paronis, C. A. (2003). Smoking, stress, and negative affect: Correlation, causation, and context across stages of smoking. *Psychological Bulletin*, *129*(2), 270–304. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12696841

Khantzian, E. J. (1997). The self-medication hypothesis of substance use disorders: A reconsideration and recent applications. *Harvard Review of Psychiatry*, *4*(5), 231–244. doi:10.3109/10673229709030550

Kokotailo, P. K., Egan, J., Gangnon, R., Brown, D., Mundt, M., & Fleming, M. (2004). Validity of the alcohol use disorders identification test in college students. *Alcoholism: Clinical and Experimental Research*, *28*(6), 914–920. doi:10.1097/01.ALC.0000128239.87611.F5

Koster, E. H. W., Crombez, G., Van Damme, S., Verschuere, B., & De Houwer, J. (2004). Does imminent threat capture and hold attention? *Emotion*, *4*(3), 312–317. doi:10.1037/1528-3542.4.3.312

Krieglmeyer, R., & Deutsch, R. (2010). Comparing measures of approach–avoidance behaviour: The manikin task vs. two versions of the joystick task. *Cognition & Emotion*, *24*(5), 810–828. doi:10.1080/02699930903047298

Krypotos, A.-M., Effting, M., Arnaudova, I., Kindt, M., & Beckers, T. (2014). Avoided by association: Acquisition, extinction, and renewal of avoidance tendencies toward conditioned fear stimuli. *Clinical Psychological Science*, *2*(3), 336–343. doi:10.1177/2167702613503139

Lissek, S., Pine, D. S., & Grillon, C. (2006). The strong situation: A potential impediment to studying the psychobiology and pharmacology of anxiety disorders. *Biological Psychology*, *72*(3), 265–270. doi:10.1016/j.biopsycho.2005.11.004

Liverant, G. I., Sloan, D. M., Pizzagalli, D. A., Harte, C. B., Kamholz, B. W., Rosebrock, L. E., … Kaplan, G. B. (2014). Associations among smoking, anhedonia, and reward learning in depression. *Behavior Therapy*, *45*(5), 651–663. doi:10.1016/j.beth.2014.02.004

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the depression anxiety stress scales (DASS) with the beck depression and anxiety inventories. *Behaviour Research and Therapy*, *33*(3), 335–343. doi:10.1016/0005-7967(94)00075-U

Macht, M. (2008). How emotions affect eating: A five-way model. *Appetite*, *50*(1), 1–11. doi:10.1016/j.appet.2007.07.002

Macht, M., & Dettmer, D. (2006). Everyday mood and emotions after eating a chocolate bar or an apple. *Appetite*, *46*(3), 332–336. doi:10.1016/j.appet.2006.01.014

Macht, M., & Mueller, J. (2007). Immediate effects of chocolate on experimentally induced mood states. *Appetite*, *49*(3), 667–674. doi:10.1016/j.appet.2007.05.004

Magid, V., Colder, C. R., Stroud, L. R., Nichter, M., & Nichter, M. (2009). Negative affect, stress, and smoking in college students: Unique associations independent of alcohol and marijuana use. *Addictive Behaviors*, *34*(11), 973–975. doi:10.1016/j.addbeh.2009.05.007

Martin-Soelch, C. (2009). Is depression associated with dysfunction of the central reward system? *Biochemical Society Transactions*. Retrieved from http://www-06.all-portland.net/bst/037/0313/0370313.pdf

Martin-Soelch, C., Linthicum, J., & Ernst, M. (2007). Appetitive conditioning: Neural bases and implications for psychopathology. *Neuroscience & Biobehavioral Reviews*, *31*(3), 426–440. doi:10.1016/j.neubiorev.2006.11.002

Mogg, K., & Bradley, B. P. (2016). Anxiety and attention to threat: Cognitive mechanisms and treatment with attention bias modification. *Behaviour Research and Therapy*. doi:10.1016/j.brat.2016.08.001

Mogg, K., Bradley, B. P., Field, M., & De Houwer, J. (2003). Eye movements to smoking-related pictures in smokers: Relationship between attentional biases and implicit and explicit measures of stimulus valence. *Addiction (Abingdon, England)*, *98*(6), 825–836. doi:10.1046/j.1360-0443.2003.00392.x

Nelis, S. (2014). *When even a full glass looks half empty: A study of processes that dampen positivity in the context of depression* (Unpublished doctoral dissertation). KU Leuven, Belgium.

Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the barratt impulsiveness scale. *Journal of Clinical Psychology*, *51*(6), 768–774. doi:10.1002/1097-4679(199511)51:6<768::AID-JCLP2270510607>3.0.CO;2-1

Peeters, F. P. M. L., Ponds, R. W. H. M., & Vermeeren, M. T. G. (1996). Tijdschrift voor Psychiatrie - Affectiviteit en zelfbeoordeling van depressie en angst. *Tijdschrift Voor Psychiatrie*, *3*, 240–250. Retrieved from http://www.tijdschriftvoorpsychiatrie.nl/zoeken/artikelen/1157

Pergadia, M. L., Der-Avakian, A., D'Souza, M. S., Madden, P. A. F., Heath, A. C., Shiffman, S., … Pizzagalli, D. A. (2014). Association between nicotine withdrawal and reward responsiveness in humans and rats. *JAMA Psychiatry*, *71*(11), 1238–1245. doi:10.1001/jamapsychiatry.2014.1016

Rachman, S. (1974). I. Synchrony and desynchrony in fear and avoidance. *Behaviour Research and Therapy*, *12*(3), 311–318.

Radke, S., Güths, F., André, J. A., Müller, B. W., & de Bruijn, E. R. A. (2014). In action or inaction? Social approach–avoidance tendencies in major depression. *Psychiatry Research*, *219*(3), 513–517. doi:10.1016/j.psychres.2014.07.011

Ratcliff, R., & Van Dongen, H. P. A. (2011). Diffusion model for one-choice reaction-time tasks and the cognitive effects of sleep deprivation. *Proceedings of the National Academy of Sciences*, *108*(27), 11285–11290. doi:10.1073/pnas.1100483108

Reinert, D. F., & Allen, J. P. (2002). The alcohol use disorders identification test (AUDIT): A review of recent research. *Alcoholism: Clinical and Experimental Research*, *26*(2), 272–279.

Rothermund, K. (2003). Motivation and attention: Incongruent effects of feedback on the processing of valence. *Emotion*, *3*(3), 223–238. doi:10.1037/1528-3542.3.3.223

Rothermund, K., Voss, A., & Wentura, D. (2008). Counter-regulation in affective attentional biases: A basic mechanism that warrants flexibility in emotion and motivation. *Emotion*, *8*(1), 34–46. doi:10.1037/1528-3542.8.1.34

Rusting, C. L. (1998). Personality, mood, and cognitive processing of emotional information: Three conceptual frameworks. *Psychological Bulletin*, *124*(2), 165–196. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9747185

Sanchez, A., Vazquez, C., Gomez, D., & Joormann, J. (2014). Gaze-fixation to happy faces predicts mood repair after a negative mood induction. *Emotion*, *14*(1), 85–94. doi:10.1037/a0034500

Schippers, G. M., & Broekman, T. G. (2010). De AUDIT. Nederlandse vertaling van de alcohol use disorders identification test. Babor, T., Higgins-Biddle, J.C., Saunders, J., & Monteiro, M.G. (2001). Retrieved July 26, 2015, from http://www.mateinfo.nl/audit/audit-nl.pdf

Schneider, B. A., Avivi-Reich, M., & Mozuraitis, M. (2015). A cautionary note on the use of the analysis of covariance (ANCOVA) in classification designs with and without within-subject factors. *Frontiers in Psychology*, *6*, 1–12. doi:10.3389/fpsyg.2015.00474

Schoenmakers, T., Wiers, R. W., & Field, M. (2008). Effects of a low dose of alcohol on cognitive biases and craving in heavy drinkers. *Psychopharmacology*, *197*(1), 169–178. doi:10.1007/s00213-007-1023-5

Schwager, S., & Rothermund, K. (2013). Counter-regulation triggered by emotions: Positive/negative affective states elicit opposite valence biases in affective processing. *Cognition & Emotion*, *27*(5), 839–855. doi:10.1080/02699931.2012.750599

Schwager, S., & Rothermund, K. (2014). On the dynamics of implicit emotion regulation: Counter-regulation after remembering events of high but not of low emotional intensity. *Cognition & Emotion*, *28*(6), 971–992. doi:10.1080/02699931.2013.866074

Snaith, R. P., Hamilton, M., Morley, S., Humayan, A., Hargreaves, D., & Trigwell, P. (1995). A scale for the assessment of hedonic tone the snaith-hamilton pleasure scale. *The British Journal of Psychiatry*, *167*(1), 99–103. doi:10.1192/bjp.167.1.99

Stacy, A. W., & Wiers, R. W. (2010). Implicit cognition and addiction: A tool for explaining paradoxical behavior. *Annual Review of Clinical Psychology*, *6*(1), 551–575. doi:10.1146/annurev.clinpsy.121208.131444

Stewart, J., de Wit, H., Eikelboom, R., Wit, H. D., & Eikelboom, R. (1984). Role of unconditioned and conditioned drug effects in the self-administration of opiates and stimulants. *Psychological Review*, *91*(2), 251–268. doi:10.1037/0033-295X.91.2.251

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review*, *8*(3), 220–247. doi:10.1207/s15327957pspr0803_1

Tice, D. M., Bratslavsky, E., & Baumeister, R. F. (2001). Emotional distress regulation takes precedence over impulse control: If you feel bad, do it! *Journal of Personality and Social Psychology*, *80*(1), 53–67. doi:10.1037/0022-3514.80.1.53

Trew, J. L. (2011). Exploring the roles of approach and avoidance in depression: An integrative model. *Clinical Psychology Review*, *31*(7), 1156–1168. doi:10.1016/j.cpr.2011.07.007

Valentin, V. V., & O'Doherty, J. P. (2009). Overlapping prediction errors in dorsal striatum during instrumental learning with juice and money reward in the human brain. *Journal of Neurophysiology*, *102*(6), 3384–3391. doi:10.1152/jn.91195.2008

van den Akker, K., Havermans, R. C., & Jansen, A. (2015). Effects of occasional reinforced trials during extinction on the reacquisition of conditioned responses to food cues. *Journal of Behavior Therapy and Experimental Psychiatry*, *48*, 50–58. doi:10.1016/j.jbtep.2015.02.001

van den Akker, K., Stewart, K., Antoniou, E. E., Palmberg, A., & Jansen, A. (2014). Food cue reactivity, obesity, and impulsivity: Are they associated? *Current Addiction Reports*, *1*(4), 301–308. Retrieved from http://link.springer.com/10.1007/s40429-014-0038-3

Van Gucht, D., Vansteenwegen, D., Van den Bergh, O., & Beckers, T. (2008). Conditioned craving cues elicit an automatic approach tendency. *Behaviour Research and Therapy*, *46*(10), 1160–1169. doi:10.1016/j.brat.2008.05.010

van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *International Journal of Eating Disorders*, *5*(2), 295–315. doi:10.1002/1098-108X(198602)5:2<295::AID-EAT2260050209>3.0.CO;2-T

Vrijsen, J. N., Van Oostrom, I., Speckens, A., Becker, E. S., & Rinck, M. (2013). Approach and avoidance of emotional faces in happy and sad mood. *Cognitive Therapy and Research*, *37*(1), 1–6. doi:10.1007/s10608-012-9436-9

Watson, D., Clark, L. A., & Tellegan, A. (1988). Worksheet 3.1 the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) PANAS questionnaire. *Journal of Personality and Social Psychology*, *54*(6), 1063–1070.

Watson, P., Wiers, R. W., Hommel, B., & de Wit, S. (2014). Working for food you don't desire. Cues interfere with goal-directed food-seeking. *Appetite*, *79*, 139–148. doi:10.1016/j.appet.2014.04.005

Westermann, R., Spies, K., Stahl, G., & Hesse, F. W. (1996). Relative effectiveness and validity of mood induction procedures: A meta-analysis. *European Journal of Social Psychology*, *26*, 557–580.

Wiers, R. W., Stacy, A. W., & Alan, W. (2006). Implicit cognition and addiction. *Current Directions in Psychological Science*, *15*(6), 292–296. doi:10.1111/j.1467-8721.2006.00455.x

Willner, P., Benton, D., Brown, E., Cheeta, S., Davies, G., Morgan, J., & Morgan, M. (1998). "Depression" increases "craving" for sweet rewards in animal and human models of depression and craving. *Psychopharmacology*, *136*(3), 272–283. doi:10.1007/s002130050566