Avoidance: From threat encounter to action execution
Arnaudova, I.B.

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Chapter 6

The Bridget Jones effect: How negative mood shapes conditioned appetitive responses

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Abstract

Mood affects how individuals process information and behave. Some theories predict emotional congruency effects (e.g., preferential processing of negative information in negative mood), while others propose mood-repair tendencies (e.g., focusing on positive information when in negative mood). Emotional congruency effects should theoretically obstruct the learning of positive associations (appetitive learning) and their ability to guide behavior under negative mood, whereas mood repair tendencies might lead to enhanced appetitive learning in negative mood. Two studies tested the effects of negative mood on appetitive learning with chocolate (Experiment 1) and alcohol (Experiment 2). Following a negative or positive mood induction procedure, participants underwent an appetitive learning procedure. Automatic and controlled conditioned responses were measured. In both experiments, participants showed increased approach tendencies towards predictors of reward (stimuli associated with consumption) after negative mood induction. This increase seemed to be related to a reduction in positive affect (Experiment 1). No effects of mood induction on conditioned reward expectancies, craving, or consumption were observed. Overall, support was found for mood-repair tendencies. Negative mood might serve as a vulnerability factor for addiction, through increasing conditioned approach tendencies.
6.1 Introduction

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 mood on appetitive behavior and consumption have been documented not only in literature, but have also attracted theoretical attention in the behavioral sciences (e.g., Herman & Polivy, 1983). Of prime importance is how mood affects the learning and expression of appetitive responses.

Appetitive 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 appetitive outcomes (e.g., a piece of chocolate or a puff of smoke; unconditioned stimuli or USs) through repeated pairing (appetitive conditioning). In human appetitive learning experiments, a variety of USs have been used, including chocolate (e.g., Van Gucht, Vansteenwegen, Van den Bergh, & Beckers, 2008), nicotine (e.g., Hogarth, Mogg, Bradley, Duka, & Dickinson, 2003) and alcohol (e.g., Field & Duka, 2002). Following appetitive learning, confrontation with the CS is sufficient to trigger preparation of the organism for the consumption of the expected appetitive US (Stewart, de Wit, Eikelboom, Wit, & Eikelboom, 1984). Appetitive learning is assumed to play a vital role in consumption and addictive behaviors, whether related to food, drugs or other substances. Through such learning, CSs acquire incentive salience (Stewart et al., 1984), which can guide consumption by eliciting conditioned craving for the US (conditioned response, CR; Van Gucht et al., 2008).

From an evolutionary perspective, suppression of appetitive behavior is expected when strong negative emotions are experienced, because such behavior would interfere with the operation of the defensive motivational network (Herman & Polivy, 1983). Defensive behavior is believed to have control precedence over appetitive behavior (e.g., Frijda, 1996). Put simply, when under threat, resources would be devoted to dealing with the object of concern rather than to the indulgence of appetitive motives. Negative mood may result in a similar reduction of appetitive responses (Macht, 2008). Yet evidence suggests individual variability in the effects of mood on the appetitive behavior of eating (Macht, 2008). Some individuals report an increase and others a decrease in food consumption and appetite under conditions of stress. Differences in attitudes towards eating (emotional vs. normal vs. restrained) seem to modulate these mood effects (Macht, 2008). Emotional congruency is suggested to occur for normal eaters (Macht, 2008).

Emotional congruency refers to the idea that processing of information congruent with the current mood should occur more easily than processing of mood-incongruent information (associative network theory of affect; Bower, 1981). Thus, while in negative mood, processing of positive information and appetitive behavior should be hampered. Similarly, the learning and/or expression of positive or appetitive associations might be reduced. That is, negative mood might inhibit (learning of) conditioned appetitive responses (e.g., attention to or approach of positive stimuli), because they would be incongruent to the current emotional state (Vrijssen et al., 2013).

In line with the associative network theory of affect (Bower, 1981), disturbed
appetitive learning is hypothesized 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). Physiological indices of affective processing also seem to be affected by clinical status. Individuals with depression are reported to be less sensitive to stimulus valence (Dichter & Tomarken, 2008). Last, but not least, recent studies have shown reduction of reward learning associated with depression and anhedonia (Liverant et al., 2014; Pergadia et al., 2014). Taken together, this evidence would further suggest that appetitive learning in depression might be impaired.

To our knowledge, only one study to date has examined the effect of negative mood on appetitive learning specifically (Bongers, van den Akker, Havermans, & Jansen, 2015). No clear evidence was found for modulation of appetitive CRs, be it craving, US expectancies, salivation or cue-modulated intake (Bongers et al., 2015). One reason for the lack of any effect of mood on appetitive 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 the activation of two independent response systems: a fast impulsive one, which operates automatically, and a slower reflective system, which is under volitional control (Strack & Deutsch, 2004; Wiers & Stacy, 2006). Responses towards appetitive CSs span across those response systems (e.g., Van Gucht et al., 2008). Bongers et al. (2015) assessed mostly controlled indices of conditioning (verbal reports of craving and expectancy, voluntary consumption behavior in a lab setting), rather than more implicit responses.

Implicit responses to appetitive conditioned stimuli play an important role in appetitive learning (Van Gucht et al., 2008). In particular, action tendencies might be crucial for instigating appetitive behavior (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 coincide (e.g., Cunningham, Preacher, & Banaji, 2001). For example, drug users have difficulty inhibiting their approach action tendencies towards drugs, despite having knowledge about the negative consequences of continued use (Wiers & Stacy, 2006). Thus, it is important to include measures of implicit responses and particularly action tendencies, when examining the effects of mood on appetitive learning.

The emotional congruency account would suggest that negative mood should obstruct the acquisition or expression of such approach tendencies. In line with this idea, approach deficits have been proposed as a factor in depression (Trew, 2011). Radke, Gütls, André, Müller, and de Bruijn (2014) found no approach tendency towards positive social stimuli in individuals with depression, although an experimental study that examined the effects of a negative mood induction procedure (MIP), which serves as an experimental model for depression (Good-
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More empirical evidence from experimental studies is needed to determine the effects of negative mood on approach tendencies. Studying it within an appetitive learning paradigm, might be particularly important (Martin-Soelch et al., 2007), because this paradigm allows the examination of how basic reward associations are formed. In two experiments, we tested the effect of negative mood induction on appetitive learning with either chocolate or alcohol as US in order to clarify the impact of negative mood on appetitive learning.

6.2 Experiment 1

We used a well-established appetitive conditioning procedure, known to result in the acquisition of US expectancies, craving, and approach tendencies toward the CS+ in comparison to the CS- (e.g., Van Gucht et al., 2008). We compared the effect of a negative (failure) versus positive (success) MIP on appetitive learning, in order to test the hypothesis derived from the associative network theory of affect that negative mood would impair such learning. In particular, we hypothesized that conditioned craving might be reduced for the CS+ as a result of a deficit in the formation of positive associations under negative mood. We did not expect any influence of mood on US expectancy ratings, due to the simplicity of the paradigm (Lissek et al., 2006). We also hypothesized that negative mood induction would reduce the acquisition of conditioned approach tendencies towards the CS+ as measured in a symbolic approach-avoidance task (AAT). At the end of the experiment, we tested whether mood induction would affect cue-elicited consumption of the chocolate US (expression of learned association).

6.2.1 Methods

Participants

Sixty-one participants were recruited through online advertisements and posters. Exclusion criteria were 1) diabetes, 2) intolerance to glucose, 3) currently following a diet, 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 hours before participation in the experiment. One participant was excluded for refusing to eat chocolate during the experiment and one for reporting to not have eaten anything in the last 24 hours. Data from a third participant were lost due to a technical malfunction and another two participants were excluded because they reported to have used drugs in the last 24 hours before participation. The final sample for the study therefore consisted of 56 participants (19 male, $M_{AGE} = 23.05$, $SD_{AGE} = 5.57$), randomly assigned to either the fail ($n = 27$) or success ($n = 29$) MIP conditions. 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 counterbalanced across participants. Through e-mail, participants indicated their favorite brand of chocolate, which was prepared in advance and wrapped in aluminum foil in pieces of approximately two cm$^2$, as in Van Gucht et al. (e.g. 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 use as target pictures during the AAT.

Questionnaires

Baseline hunger was assessed using a visual analogue scale (VAS) ranging from absolutely not hungry (0) to extremely hungry (10). Participants also reported the last time they consumed chocolate or other sweets as well as the last time they had eaten anything.

Online craving/expectancy ratings were given on a trial-by-trial basis during the appetitive conditioning procedure. Participants rated their chocolate craving and expectancy to receive chocolate on the current trial on a 100-mm computerized VAS ranging from “no craving”/“certainly not expecting chocolate” to “a lot of craving”/“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”. 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; D. Watson, Clark, & Tellegen, 1988; Dutch translation by Peeters, Ponds, & Vermeeren, 1996) measures the experience of 20 emotions 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. Internal consistency of the PANAS is good (Cronbach’s alphas of .87 for NA and .77 for PA; Engelen, De Peuter, Viciot, Van Diest, & Van den Bergh, 2006).

The Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995; Dutch translation by (de Beurs et al., 2001) is a 42-item questionnaire, which assesses depression (DASS-D), anxiety (DASS-A) and stress (DASS-S) symptoms over the past week on a 4-point scale. Subscale scores are obtained by summing the scores for each subscale item. The reliability of the Dutch translation of these scales is excellent (Cronbach’s alphas of .95, .90, and .93 for DASS-D, DASS-A and DASS-S, respectively; de Beurs et al., 2001).

The Snaith-Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995; Dutch translation by Franken, Rassin, & Muris, 2007) contains 14 statements about the experience of pleasure and measures current anhedonia. Participants rate the items on a 4-point scale. Higher total scores on the questionnaire indicate higher levels of anhedonia. Chronbach’s alpha for this scale is .91, which indicates high internal consistency Franken et al., 2007.
The Barratt Impulsiveness Scale (BIS-11; Patton, Stanford, & Barratt, 1995; Dutch translation by Lijffijt and Barratt, unpublished manuscript) assesses trait impulsivity with 30 items rated on a four-point scale. The original version of the questionnaire shows high internal consistency for undergraduate students (Cronbach’s alpha = .82; Patton et al., 1995); no validation data are available for the Dutch translation.

The Dutch Eating Behavior Questionnaire (DEBQ; van Strien, Frijters, Bergers, & Defares, 1986) is a 33-item questionnaire, rated on a 5-point scale, which measures eating habits. Reliability coefficients are high for the three subscales of emotional eating (DEBQ-EE, Cronbach’s alpha = .94), external eating (DEBQ-EX, Cronbach’s alpha = .80) and dietary restraint (DEBQ-R, Cronbach’s alpha = .95). Higher mean scores on each subscale indicate higher endorsement of the given behavior.

**Procedure**

After learning about the experimental procedure and providing their informed consent, participants reported their baseline hunger and filled in the baseline computerized PANAS (pre-assessment).

The success/fail MIP 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, in which participants familiarized themselves with the task, 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 had to provide 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 in the test block and were requested to make a prediction of their own performance. Participants were randomly assigned to a success or fail condition, where they would either succeed or fail 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 verbalized within the seven-second time frame of anagram presentation. Participants then filled in the post-test computerized PANAS (post-assessment), to record possible mood changes.

The appetitive conditioning procedure consisted of four CS+ and four CS- trials and was modeled after Van Gucht et al. (e.g., 2008). 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/expectancy ratings on a scale that appeared centered at the bottom of the computer screen in front of them. 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 then placed on top of the serving tray and participants were asked to unwrap and eat the chocolate, before moving to the next trial. 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 immediately after completion of the appetitive conditioning procedure, consisted of two blocks with four practice trials and 16 test trials each (Krypotos et al., 2014). On each trial, a small stick-figure manikin appeared in the center of the top or bottom half of the screen. After 1500 ms, the manikin was supplemented by a target picture, which appeared centered either above or below the manikin. Participants responded by pressing one of two response buttons (B, marked with \(\downarrow\) or Y, marked with \(\uparrow\)), upon which the manikin moved in the appropriate direction for 2000 ms. Computerized and verbal 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, randomized 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 computerized PANAS (follow-up assessment), DASS, SHAPS, BIS-11 and DEBQ. These questionnaires were used to assess baseline differences between the participants in the two experimental conditions in factors, which might have influenced the results if any baseline differences were present. A consumption test followed. The experimenter presented participants with the CS+ tray and eight allegedly left-over 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. The number of pieces that they consumed was recorded. At the end of the experiment, participants were verbally debriefed about the purpose of the study.

Data analysis

Differences between conditions were examined with independent sample t-tests with questionnaire scores 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 versus Fail) was always entered as a between-subject variable. For the MIP, Time (Pre-, Post- and Follow-up Assessment) was entered as within-subject variables and for the appetitive 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 mood change and conditioned responding, Pearson’s correlations were used.

### 6.2.2 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. Differences between conditions were not observed on any of the questionnaires either (see Table 6.1, all $p > .10$). A chi-square test suggested a similar gender distribution across conditions ($p > .50$).

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Success</td>
<td>Fail</td>
</tr>
<tr>
<td>BMI</td>
<td>21.45 (2.40)</td>
<td>21.88 (2.94)</td>
</tr>
<tr>
<td>DASS-D</td>
<td>4.10 (4.26)</td>
<td>5.07 (5.72)</td>
</tr>
<tr>
<td>DASS-A</td>
<td>3.97 (3.96)</td>
<td>3.11 (3.30)</td>
</tr>
<tr>
<td>DASS-S</td>
<td>9.03 (6.72)</td>
<td>9.48 (7.47)</td>
</tr>
<tr>
<td>BIS-11</td>
<td>61.38 (10.76)</td>
<td>63.74 (9.33)</td>
</tr>
<tr>
<td>SHAPS</td>
<td>24.17 (10.85)</td>
<td>26.93 (14.65)</td>
</tr>
<tr>
<td>DEBQ-EE</td>
<td>2.42 (0.73)</td>
<td>2.54 (0.64)</td>
</tr>
<tr>
<td>DEBQ-EX</td>
<td>3.44 (0.48)</td>
<td>3.26 (0.53)</td>
</tr>
<tr>
<td>DEBQ-R</td>
<td>2.46 (1.03)</td>
<td>2.73 (0.87)</td>
</tr>
<tr>
<td>AUDIT</td>
<td>8.63 (2.37)</td>
<td>8.83 (2.48)</td>
</tr>
<tr>
<td>DMQ-CP</td>
<td>2.19 (0.78)</td>
<td>1.94 (0.69)</td>
</tr>
<tr>
<td>DMQ-E</td>
<td>3.59 (0.75)</td>
<td>3.13 (0.75)*</td>
</tr>
<tr>
<td>DMQ-SR</td>
<td>3.87 (0.72)</td>
<td>3.69 (0.83)</td>
</tr>
<tr>
<td>DMQ-CN</td>
<td>1.71 (0.62)</td>
<td>1.47 (0.51)</td>
</tr>
</tbody>
</table>

**Note:** *p ≤ .05

#### Mood induction

Participants’ predictions about their performance on the anagram task before the MIP did not differ 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.
Participants in the two conditions did not differ in baseline PA or NA (ps > .50), but for both types of affect a differential pattern emerged during the experiment (PA: $F(2, 108) = 8.82, p < .001, \eta^2 = .14$; NA: $F(2, 108) = 6.79, p = .002, \eta^2 = .11$; see Figure 6.1A). The difference was most pronounced for PA ($p = .003$) and NA ($p = .03$) at post-test and PA ($p = .05$) at follow-up. Taken together, those 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 mood induction procedure was effective.

**Appetitive 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, $F(2.50, 135.09) = 13.31, p < .001, \eta^2 = .20$)
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and $F(3, 162) = 46.23, \ p < .001, \ p\eta^2 = .46$, respectively; see Figure 6.2A). Mood induction did not have an effect on conditioning, as evidenced by non-significant Cue × Trial × Condition interactions for craving and US expectancies (both ps > .40). Thus, results show that mood did not affect US expectancies or self-reported craving.

**Figure 6.2:** Self-reported online US expectancy and craving across trials for Experiment 1 (A) and Experiment 2 (B)

At the end of the experiment, participants rated the CS+ ($M = 70.14, \ SD = 20.58$) higher on valence than the CS- ($M = 41.04, \ SD = 20.11; \ F(1, 54) = 40.86, \ p < .001, \ p\eta^2 = .43$), with no effect of MIP on the ratings (Cue × Condition, $p = .29$). This suggest that evaluative learning took place and was largely unaffected by induced mood.

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AAT

Analysis of the AAT data yielded a non-significant Cue × Response interaction \((p = .53)\), but a significant Cue × Response × Condition interaction, \(F(1, 54) = 11.99, p = .001, \eta^2 = .18\) (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, \(F(1, 26) = 9.42, p = .005, \eta^2 = .27\), whereas the pattern in the success condition showed a non-significant trend in the opposite direction, \(F(1, 28) = 3.68, p = .07, \eta^2 = .12\). Thus, in contrast to our hypotheses, we found evidence for enhanced rather than reduced conditioned approach tendencies following negative mood induction.

**Figure 6.3:** Mean RTmd for approach and avoid responses towards the CS+ and CS- pictures during the AAT for Experiment 1 (A) and Experiment 2 (B).

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**Consumption test**

Participants consumed on average 2.35 pieces \((SD = 2.49)\) of chocolate during the consumption test, with no difference between conditions, \(t(53) = -.22, p = .83\). This shows that mood induction did not influence chocolate intake.

**Exploratory analyses**

In order to further understand what influence mood has 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 and the RTmd on CS- avoid trials minus the RTmd on CS+ avoid and the RTmd CS- approach trials). 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 basis of the mood-congruency hypothesis. This shows that enhanced approach tendencies are
related specifically to decreases in positive affect and not to changes in negative affect.

6.2.3 Discussion

In line with expectations, we did not find any evidence for an influence of negative mood on the learning of CS-US contingencies, as evidenced by self-reported US expectancies. Contrary to our hypothesis, however, learning of conditioned craving and chocolate consumption were also unaffected by mood induction. Surprisingly, participants in the fail group exhibited an enhanced approach tendency towards 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.

Counter to the associative network theory of affect, Isen (1985) has argued that individuals would attempt to repair their negative mood and mood-incongruent responses would be primed in negative mood. The US in Experiment 1, chocolate, is considered to have mood-repairing abilities (Macht & Mueller, 2007). Thus, enhanced approach tendencies towards cues associated with chocolate consumption under negative mood might represent an automatic tendency towards mood repair.

Similarly to Isen (1985), Khantzian (1997) proposed in his self-medication hypothesis of addiction, that individuals in negative mood might try to alleviate their negative mood through the use of substances with psychoactive ingredients (e.g., opiates). Building upon this idea, Baker et al. (2004) further suggested in their negative reinforcement theory of addiction that negative mood increases the reinforcement value of a drug and as a result might become a direct cue, which can elicit appetitive behavior automatically. These accounts would have predicted the observation of increased approach tendencies towards appetitive CSs following negative mood in our experiment. This increase 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).

In Experiment 2, we set out to replicate and extend the findings of Experiment 1, using a small dosage of alcohol as US. Alcohol is a common substance abused in addiction, 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).

6.3 Experiment 2

Using alcohol as the US during appetitive conditioning, we did not expect any differences in US expectancies or conditioned craving between the two mood induction conditions, as observed in Experiment 1 and in line with the findings of Bongers et al. (2015). Further, in replication of Experiment 1, we hypothesized that individuals in the fail condition would show stronger approach tendencies towards the CS+ compared to the success condition. We expected also that negative mood induction would enhance overall liking of the US, because negative mood would increase its reinforcement value (Baker et al., 2004).

In Experiment 1, we found differences between participants in the success and
fail conditions only on the automatic level of conditioned responding (automatic 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) have previously been found in normal drinkers (Field & Duka, 2002). Furthermore, heavy alcohol users show both increased automatic action tendencies (Field & Cox, 2008) and attentional biases (Field & Cox, 2008). Thus, negative mood might enhance attentional bias towards CSs associated with alcohol even in social drinkers, similarly to action tendencies, and serve as a maintaining factor for continued use (Field & Cox, 2008).

6.3.1 Methods

Participants

A total of 63 participants participated in Experiment 2. 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). Participants were also requested to not drink anything in the last two hours and not consume any alcohol in the last 24 hours 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 hours 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 P.M. and 9 P.M. 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). CS assignment was counterbalanced across participants.

A small dose (10 ml) of chilled Heineken beer (5% alc/vol) in a shot glass was used as US in this study. 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 breathalyzer (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. 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; Kokotaïlo et al., 2004).

A *thirst questionnaire* was used to assess baseline thirst on a VAS ranging from absolutely not thirsty (0) to extremely thirsty (10). Participants also reported the last time they consumed beer or other alcoholic drinks as well as the last time they had drunk anything.

The *Drinking Motives Questionnaire* (DMQ; Cooper, 1994; Dutch translation by Wiers and van Empelen, unpublished manuscript) assesses with 20 self-report items the different motives for alcohol consumption: coping (DMQ-CP), enhancement (DMQ-E), social rewards (DMQ-SR) and conformity (DMQ-CN). Higher mean ratings suggest stronger endorsement of that particular motive. Reliability coefficients for all four scales in the original questionnaire are high (Cronbach’s alphas are .84, .88, .85, and .85 for DMQ-CP, DMQ-E, DMQ-SR and DMQ-CN, respectively; Cooper, 1994).

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

**Procedure**

Experiment 2 closely resembled Experiment 1. Only the differences in the methodology between the two experiments are outlined here.

Participants were first screened by telephone and returned a filled-in AUDIT via e-mail. Upon arrival in the lab, participants received information about the experiment and gave their informed consent. Their BAC was measured to assure that participants had not consumed alcohol prior to participation. Afterwards, participants filled out the thirst questionnaire and the baseline computerized PANAS (pre-assessment). They then underwent the same MIP and appetitive learning procedure as in Experiment 1, but with the alcohol US instead of the chocolate US. The AAT with pictures of the new CSs followed as in Experiment 1.

Participants then competed a dot-probe task (DPT) to measure attentional bias, modeled 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, centered on the left and right side of the screen, for either 200 or 500 ms. At picture offset, a visual probe (↑ or ↓) was presented centered 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 as ↓). 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 randomized, 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 centered on the screen. Participants were instructed to concentrate on the fixation cross during ITIs.

After completion of this task, participants underwent an instrumental training phase and a transfer test as part of a Pavlovian-to- Instrumental Transfer task (PIT; P. Watson, Wiers, Hommel, & de Wit, 2014), which is not reported here. It is important to note that in the first stage of this task, 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.

Participants then rated the valence of both trays as in Experiment 1, filled in the computerized 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 during the time when participants were filling in the demographic questionnaire and some manipulation checks. A debriefing about the purpose of the research concluded the experiment.

Participants’ BAC was measured again after conclusion of the experiment and they were requested to stay in the lab until the BAC level dropped to below half of the legal limit (.25 mg/ml).

## Data analysis

Data were analyzed as in 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, 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.

### 6.3.2 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 6.1, all $p$s > .10). The two conditions differed, however, on their scores on the DMQ-AE 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, χ²(1) = 4.93, p = .03, with more participants in the success condition reporting that they had not had enough sleep (n = 8). 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). To evaluate the effects of significant baseline differences between conditions, we included these factors as covariates (DMQ-AE and BMI; both of these variables were grand-mean centered as suggested by Schneider, Avivi-Reich, & Mozuraitis, 2015) or as a between-subject variable (Sleep) in all analyses. Only when the findings changed as a result, those analyses are reported. Otherwise, the analyses reported are without these baseline variables included in the model.

**Mood Induction**

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, despite having predicted the same performance, t(54) = -.91, p = .37. 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, η² = .06, and NA, F(2, 108) = 8.15, p = .001, η² = .13 (see Figure 1B). The difference between conditions was only significant for NA (p = .04) at post-test. These 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 this difference did not persist until the end, as evidenced by the non-significant difference at follow-up. 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 mood induction was successful.

**Appetitive Conditioning**

Over the conditioning trials, differential craving, F(2.41, 130.20) = 20.15, p < .001, η² = .27, and US expectancies, F(2.37, 127.72) = 68.86, p < .001, η² = .56, emerged, in replication of Experiment 1 (see Figure 2B). Again, mood 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 did observe a significant interaction of Cue × Condition for self-reported craving, F(1, 54) = 4.80, p = .03, η² = .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, η² = .26), with a near-significant Cue × Condition interaction, F(1, 54) = 3.94, p = .05, η² = .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).  

1Sleep was not assessed in Experiment 1.
AAT

In replication of Experiment 1, no significant Cue × Response interaction was observed overall, $F(1, 52) < 1$, $p\eta^2 = .009$. The Cue × Response × Condition interaction approached significance, $F(1, 52) = 3.74$, $p = .06$, $p\eta^2 = .07$ (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, $F(1, 26) = 3.45$, $p = .07$, $p\eta^2 = .12$, in the expected direction. As a whole, the results of Experiment 2 mirrored the findings of Experiment 1 in suggesting that negative mood enhanced conditioned approach tendencies.

DPT

In the analysis of RTmnds for the DPT, the main effect of congruency was not significant, $F(1, 51) = 2.44$, $p = .13$, $p\eta^2 = .05$. However, there was a significant Congruency × Condition interaction, $F(1, 51) = 4.78$, $p = .03$, $p\eta^2 = .09$. The congruency pattern was significant in the success condition, $F(1, 24) = 4.53$, $p = .04$, $p\eta^2 = .16$, with shorter RTs on congruent trials than incongruent trials, but not in the fail condition, $F(1, 27) = .36$, $p = .56$, $p\eta^2 = .01$.

When we examined the baseline differences in sleep, we found that the interaction between Congruency and Sleep was borderline significant, $F(1, 49) = 3.93$, $p = .05$, $p\eta^2 = .07$, 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, $F(1, 50) = 4.71$, $p = .04$, $p\eta^2 = .09$. 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 difference in reported craving for beer ($p = .39$) or water ($p = .20$) between conditions.

Participants found the beer tasty overall ($M = 6.89$, $SD = 1.72$) and no significant difference was observed between the conditions in terms of 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 behavioral 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 mood induction did not 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.

6.3.3 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. However, we found a difference between the conditions in the differentiation between the CS+ and CS- on craving. Even though the MIP seemed to be less effective and stable in Experiment 2 than in Experiment 1, participants in the fail condition showed enhanced approach tendencies towards the CS+ as compared to the CS-, as in Experiment 1. 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 MIP 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, which was stronger for participants in the success condition, likely due to differences in the degree of sleep deprivation between conditions.

6.4 General discussion

We presented data from two experiments that tested the effect of negative mood on appetitive learning. Following a negative or positive mood induction procedure, 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 mood did not result in different US expectancy ratings or conditioned craving responses, regardless of US type. However, conditioned approach tendencies seemed to be enhanced for participants in the fail condition relative to participants in the success condition. Data from Experiment 1 suggested that this enhancement might be related to a reduction of positive affect. 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 experienced better mood, but 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 observed increase of approach tendencies for participants in the fail condition and the absence of such tendencies in the success condition. These results are at odds with the emotional congruency account proposed on the basis of the associative network theory of affect (Bower, 1981) and with empirical data to date (Radke et al., 2014; Vrijse, et al., 2013). According to the mood-repair hypothesis (Isen, 1985), however, desires to cope with negative emotions can motivate approach to positive
information. Further, theories of drug addiction (Baker et al., 2004; Khantzian, 1997) propose that negative mood might directly and automatically motivate drug use and this might also hold for 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 mood might act as a vulnerability factor for addictive behaviors (Kassel, Stroud, & Paronis, 2003) through increasing approach tendencies. It is possible that individuals experiencing negative mood readily learn 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 use (e.g., Magid, Colder, Stroud, Nichter, & Nichter, 2009) and desires for alcohol use (Cooney, Litt, Morse, Bauer, & Gaupp, 1997) and individuals have also been shown to consume more unhealthy snack foods when they believed that those could affect their negative mood (Tice, Bratslavsky, & Baumeister, 2001).

The correlation observed in Experiment 1 between the decrease of positive affect and approach-avoidance tendencies, questions the use of substances to regulate negative affect. It is possible that drug use is motivated by its effect on positive affect regulation, as some researchers have already proposed (Audrain-McGovern, Wileyto, Ashare, Cuevas, & Strasser, 2014) and thus, positive affect might protect individuals from learning strong 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 MIP was not as strong as in Experiment 1 (M = 4.41, SD = 4.56), which might have obstructed the observation of the relationship.

Since the findings of increased approach-avoidance tendencies in negative mood might have been due to the fact that individuals with negative mood 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\(^2\). No differences in the ratings of the US were observed between the groups, so this cannot explain the present findings. 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 the emotional responses of individuals towards the US in detail.

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). The increase of attentional bias towards predictors of reward observed in the success condition 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 et

\(^2\)In Experiment 1, we gave participants pieces of their favorite kind of chocolate, which they had indicated during the screening procedure; we did not measure their subjective liking of the chocolate.
It is still unclear how mood influences attention. Evidence has so far been inconclusive (Rusting, 1998; Sanchez, Vazquez, Gomez, & Joormann, 2014) with some studies suggesting attentional biases to mood-congruent and other to mood-incongruent information. Attention seems to be guided more by the salience of a stimulus, rather than its valence, while approach tendencies seem to be guided primarily by stimulus valence (Phaf et al., 2014). In support, attention towards the CS+ has been found following both appetitive (e.g., Field & Cox, 2008; Pool, Brosch, Delplanque, & Sander, 2014) and aversive conditioning (Koster, Crombez, Verschuere, & De Houwer, 2004; Koster, Verschuere, et al., 2005) and recent research suggests that attentional bias is stronger for consistent predictors of reward than for stimuli that predict reward only sometimes (Austin & Duka, 2012; Field et al., 2011; Hardman, Scott, Field, & Jones, 2014). If negative mood indeed reduces attentional bias towards appetitive cues, the findings of Experiment 2 might be interpreted as a decreased reactivity to salience in negative mood. Further research should examine this possible reduction of reactivity to salient cues in negative mood.

In accordance with our hypotheses, 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 mood does not result in deficits of the formation of CS-US associations and that the salience of the CS+ remains unaffected by mood in such a simple conditioning task.

Conditioned craving also remained largely unaffected by mood 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). Using a laboratory analogue of depression (Goodwin & Williams, 1982), we did not find support for this proposition either, in line with Willner et al. (1998). On the contrary, in Experiment 2 participants in the fail condition reported more differentiation in craving between the CS+ and CS- and rated the CS+ as more pleasant than participants in the success condition. Since we used an experimental model 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 such deficits might occur more readily in conditioning with secondary reinforcers such as monetary gain or social interactions. Indeed, recent research suggests differential responding to primary and secondary reinforcers in both appetitive (Valentin & O’Doherty, 2009) and aversive learning (Delgado, Jou, & Phelps, 2011).

In conclusion, we have shown that mood affects the strength of appetitive responses at an automatic level only, namely by enhancing approach tendencies. Thus, the failure of Bongers et al. (2015) to find any effects of mood in their experiment might have been due to not examining such automatic responses and focusing on controlled responses. Studying mood effects on controlled behavior in the laboratory might be challenging, since participants might be apprehensive to act freely under experimental scrutiny. Increased automatic approach tendencies
might be difficult to inhibit in more naturalistic settings and might prompt appetitive behavior towards the substance even when an individual is aware of the negative consequences of its use. Thus, Bridget Jones might have had a difficulty keeping up with her resolutions to reduce eating, smoking and drinking following negative events, because of her strong approach tendencies under negative mood.