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Letting Go of the Negative, Holding on to the Positive: Within-Individual Differences in Affective Habituation to Negative and Positive Stimuli

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Letting Go of the Negative, Holding on to the Positive:
Within-Individual Differences in Affective Habituation to Negative and Positive Stimuli

By

Elizabeth Yartsev

A dissertation submitted in partial satisfaction of the
requirements for the degree of

Doctor of Philosophy

in

Psychology

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Ozlem Ayduk, Chair
Professor Oliver John
Professor Anne Collins

Spring 2022

Abstract

by

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Doctor of Philosophy in Psychology

University of California, Berkeley

Professor Ozlem Ayduk, Chair

Do people habituate faster to positively than to negatively-valenced emotional triggers? We performed 2 studies to examine whether rate of affective habituation is moderated by stimuli valence (manipulated within-subjects) with the hypothesis that habituation would be faster for positive than for negative stimuli. Additionally, we tested whether the hypothesized effect of stimuli valence on habituation was stronger among people higher in anxiety. In the first study, participants ($N = 105$) were presented with negative and positive images from the International Affective Picture System (IAPS; Lang et al., 2008). Images were matched ideographically across subjects in their intensity and were presented in random order with 10 repetitions (trials) per image. In the second study which was pre-registered, participants performed a similar task after their state anxiety levels were experimentally manipulated (N experimental group = 103; N control group = 106). Results from both studies indicated that habituation was faster for positive than for negative stimuli and anxiety was positively associated with the magnitude of differences in positive vs. negative habituation rates. This effect was primarily due to differences in positive habituation as people who reported experiencing higher levels of anxiety (chronic and situational) habituated to positively-valenced elicitors significantly faster. Overall, these results suggest that positive habituation, both on its own and vis-à-vis negative habituation might be an important mechanism that underlies emotional functioning and enhancing our understanding of the building blocks of emotional disorders in non-clinical populations.

Keywords: Affective habituation, emotion, valence, anxiety, affective chronometry.

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“The most beautiful moments always seemed to accelerate and slip beyond one’s grasp just when you want to hold onto them for as long as possible.”

Bucchianeri, E.A. (2011), *Brushstrokes of a Gadfly*, Batalha Publishers

In everyday life we are exposed to countless mundane emotional triggers, both positive and negative in nature, some internally generated, while others initiated by external situations. These emotional triggers elicit a rich variety of emotional reactions that tend to linger with us for a certain period of time before they fade away and other emotions take the stage. However, emotions are unlikely to dissipate all at the same pace; whereas some (types of) emotions might fade away relatively quickly, others may linger on for much longer. Although there is already substantial research on how emotions elicited by major life events might change over extended periods of time (e.g., Brickman et al., 1978; Lyubomirsky, 2011), it is less well understood how immediate emotional reactions to mundane situational triggers change dynamically over short periods of time, and how such trajectories might differ as a function of stimulus valence. Therefore, one of the goals of the current study was to examine whether *affective habituation* – the process by which emotional reactions lose their intensity when eliciting stimulus is repeatedly presented, might be different for positive vs. negative emotional triggers. We did so by taking an experimental approach that varied stimulus valence within-subjects, providing a direct test of whether people habituate to positive stimuli faster than to negative stimuli.

Letting go of a negative emotional charge quickly on the one hand and holding on to positive experiences longer on the other hand, have been shown to be key predictors of healthy psychological functioning (e.g., Catalino & Fredrickson, 2011; Fredrickson & Losada, 2005; Gross & Jazaieri, 2014; Joormann et al., 2007; Kring & Bachorowski, 1999; Nolen-Hoeksema, 2000). Although these findings suggest that habituating too quickly to positive and/or too slowly to negative stimuli might be a cause and/or a marker of heightened vulnerability to emotional dysfunction, there is very little data in the existing literature that speaks directly to this possibility. Therefore, a second goal of the present study was to address whether positive and negative habituation rates are moderated by individual differences in anxious or depressive symptomatology. By taking a closer look at the individual differences in the processing of positive and negative emotional triggers in a non-selected sample, we aimed to broaden our understanding of basic affective processes that may play a role in the development and maintenance of emotional disorders.

Affective Habituation

Affective or emotional habituation refers to the process of experiencing a progressive decrease in physiological, emotional, and behavioral responses to a repeatedly presented stimuli over a relatively short period of time (Averill et al., 1972; Dijksterhuis & Smith, 2002; Leventhal et al., 2007; Mantua & Ready, 2019; Thompson & Spenser, 1966). The phenomenon of habituation has been described across a wide range of species, from simple organisms to humans (Averill et al., 1972; Grissom & Bhatnagar, 2009; Groves & Thompson, 1970; Pinsky et al., 1970; Thompson & Spenser, 1966), and is believed to serve as a prerequisite for more complex forms of learning, memory and cognition, due to its role in filtering out irrelevant information while processing a wide-range of stimuli in the environment (Rankin et al., 2009).

Affective habituation has been mostly studied in laboratory settings where emotional responses to a repeatedly presented, affectively-charged stimulus, are tracked over time. This is similar to but distinct from *affective chronometry* (Davidson, 1998; Hemenover, 2003), which

relates to temporal dynamics of emotions after elicitation (e.g., time it takes for emotion to reach its peak and to go back down to baseline). Therefore, whereas habituation focuses on changes in reactions to repeated stimuli presentation over time, affective chronometry focuses on the dynamics of affective responding following a single elicitor.

The extensive literature on affective habituation has mostly focused on habituation to negatively-valenced stimuli (negative habituation from here on), particularly within the context of exposure-based interventions in clinical populations, in which the central therapeutic component revolves around exposing patients repeatedly to the source of their anxiety to reduce the strength of their emotional reactions and maladaptive avoidance behaviors (Foa & Chambless, 1978; Foa & Kozak, 1986; Foa & McLean, 2016; McSweeney & Swindell, 2002).

The empirical literature on exposure therapy is largely consistent with these theoretical accounts, showing that people habituate to negative stimuli with prolonged exposure. Most notably, studies on systematic desensitization demonstrate significant reductions in fear arousal and extinction of phobic behavior when phobic individuals are repeatedly exposed to fear stimuli of progressively increasing intensity (Bandura et al., 1969; De Silva & Rachman, 1981; Foa & Chambless, 1978; Foa & McLean, 2016; Grayson et al., 1982; Wolpe, 1968).

Though studies that focus on positive stimuli are much further and fewer in between, preliminary evidence suggests that with repeated exposure, emotional responses to positively-valenced stimuli, too, lose their intensity (“positive habituation” onward). For example, prior subliminal exposure to extremely positive (and negative) words has been found to reduce their emotional impact during subsequent supraliminal exposure (Dijksterhuis & Smith, 2002). Similarly, emotional reactions to positive images have been shown to decay linearly over time with repeated exposure (Leventhal et al., 2007; Mantua & Ready, 2019).

Gaps in Knowledge

Taken together, there is considerable evidence demonstrating that our emotional reactions to affectively-charged experiences decline in their intensity with prolonged or repeated exposure to the eliciting stimuli. Yet, several notable gaps remain in our understanding of the habituation process, which described next, that the current study aimed to address.

Lack of Studies on Positive Stimuli. Vast majority of the extant research on habituation examines emotional reactions to negative stimuli. Despite the potential relevance of positive habituation for positive affectivity and psychological functioning more broadly (Bar-Haim et al., 2007; Catalino & Fredrickson, 2011; Werner-Seidler et al., 2013), there has been relatively little attention paid to positive habituation in the emotion literature outside of the few papers mentioned earlier (Dijksterhuis & Smith, 2002; Leventhal et al., 2007; Mantua & Ready, 2019). Therefore, there is a clear need for more research that focuses on emotional reactions to positive, in addition to negative, stimuli in order to develop a more complete understanding of affective habituation.

Furthermore, existing evidence on how valence might impact affective habituation is either inconclusive or comes from studies that have examined related constructs but not habituation per se. For example, studies on hedonic adaptation have demonstrated a “bad is stronger than good” bias (i.e., people adapt to positive life events faster than to negative ones), however, these data come predominantly from between-subject designs (e.g., comparing lottery winners to paralyzed accident victims), and do not address within-person habituation processes directly (e.g., Brickman et al., 1978; Lyubomirsky, 2011). Moreover, affective habituation is conceptually related but distinct from “hedonic adaptation” which tracks changes in people’s well-being to a single extreme life event (getting paralyzed) over extended periods of time, such

as months or years (e.g., Brickman et al., 1978; Lyubomirsky, 2011). Along similar lines, studies on affective chronometry which track temporal dynamics of affective responding following emotion induction (e.g., how quickly emotion peaks following stimulus onset, or how quickly it returns to baseline after the peak) also provide insights into habituation only indirectly (Hemenover, 2003; Lapate et al., 2014). Therefore, it is difficult to draw inferences about affective habituation directly from either the hedonic adaptation or the affective chronometry literatures.

Among the relatively small set of studies utilizing standard habituation paradigms, examining positive and negative stimuli separately or at the between-subjects level is also highly common (Dijksterhuis & Smith, 2002; Leventhal et al., 2007). To the best of our knowledge, only a few studies to-date have examined how valence might moderate rate of habituation within-subjects. In a standard lab-based habituation paradigm, Mantua & & Ready (2019) found that positive images were rated lower in intensity over repeated exposure, but negative images were not; in an fMRI study, Wright and colleagues (2001) showed that repeated exposure to happy (vs. angry) faces led to significantly greater reduction in prefrontal cortex activation. In contrast, Bradley et al. (1993) found that the habituation of the startle reflex to affectively-charged images did not differ significantly by valence (though the sample size was extremely low, $N = 19$). Hence, the current knowledge on the effect of valence on habituation comes from a relatively small number of studies which yielded mixed results. Therefore, one of the main aims of the present study was to contribute to this body of work by testing the moderation by valence hypothesis in a well-powered study using a within-subjects design.

Need to Examine How Individual Differences in Affective Habituation are Related to Psychological Functioning

The current literature is sparse on the issue of whether and how individual differences in the rate of negative and positive habituation might be related to psychological functioning in normative populations. Instead, the bulk of our current knowledge is based on studies conducted in clinical samples. Although the majority of the world's population does not meet criteria for clinically diagnosed anxiety and/or depression, many people deal with symptoms of depression and anxiety of varying severity in their daily lives (e.g., Brody et al., 2018). Therefore, there is a need to examine how affective habituation is related to indicators of psychological functioning in normative samples to establish continuities (and potentially discontinuities) between clinical and non-clinical populations.

The focus on anxiety and depression in the existing research on habituation is understandable given that the well-established cognitive mechanisms that underlie them implicate that valence-based cognitive biases in information processing relevant to affective habituation are involved in their etiology and maintenance (Bardeen & Daniel, 2018; Mathews & MacLeod, 2002, 2005; Watters & Williams, 2011). Specifically, anxious individuals exhibit cognitive biases towards threat-related stimuli at different stages of information processing, including hyper-vigilance for threat, inability to disengage from negative cues, and perseverance on negative content, which lead to worry (Bar-Haim et al., 2007; Fox, Russo, Bowles, & Dutton, 2001; Gross & Jazaieri, 2014; Kring & Bachorowski, 1999; Yiend & Mathews, 2001; Mathews, 1990). Similar to anxiety, depression is also characterized by perseverative thought on negative content and decades of research have shown that rumination - the act of passively and repetitively focusing on one's negative mood states, both precipitates and maintains depression as well as numerous other psychological emotional disorders (e.g., Nolen-Hoeksema, 2000; Nolen-Hoeksema et al., 2008; Ruscio et al., 2011).

Anxiety and depression have also been associated with a number of common mechanisms in the experience and processing of positive states. Briefly, deficits in the experience of positive affect (i.e., anhedonia) is a key feature of depression (American Psychiatric Association, 2013) and frequently occurs in social anxiety (Kashdan, 2007). Furthermore, attentional bias away of positive information, deficits in its encoding and recall, as well as hyposensitivity to reward have been reported for depression (Burt et al., 1995; Dillon, 2015; Eshel & Roiser, 2010; Gotlib et al., 2004; Henriques & Davidson, 2000; Schaefer et al., 2006; Winer & Salem, 2016), and for social anxiety (Chen et al., 2012; Glazier & Alden, 2017; Taylor et al., 2010, 2011).

Taken together, these findings suggest that higher levels of anxiety and/or depression may be characterized by a tendency to habituate more slowly to negative information and faster to positive information. Whereas habituation studies to date have not revealed a consistent pattern to support the former (Eckman et al., 1997; Houtveen et al., 2001; Mauss et al., 2003; Mantua & Ready, 2019), we know even less about the latter (Mantua & Ready, 2019). Therefore, we aimed to address this gap in knowledge by further probing the role of anxiety and depression in positive and negative habituation in the context of the methodological improvements discussed above.

Overview of present studies

To address these gaps in knowledge, we conducted two studies. In Study 1, we presented participants with positively and negatively valenced images, which were ideographically selected to elicit the most intense positive and negative reactions, respectively for each individual. We examined whether the intensity of emotional reactions declined with repeated exposure as a function of stimuli valence as well as anxiety symptomatology.

The main goal of Study 2 was to replicate the findings from Study 1. Methods and hypotheses were preregistered (<https://aspredicted.org/nh4f7.pdf>, [3qa57.pdf \(aspredicted.org\)](https://aspredicted.org/3qa57.pdf), <https://aspredicted.org/38yr4.pdf>). Study 2 also aimed to improve the generalizability of Study 1 findings by exposing subjects to a fixed set of stimuli, selected on the basis of preestablished normative ratings. Additionally, state anxiety was manipulated as we were interested to explore the causal effects of anxiety on habituation trajectories by valence. Lastly, affective theme within each valence was manipulated (love vs. excitement for positive, fear vs sadness for negative) to examine whether habituation was impacted by thematic differences in the eliciting stimuli.

Study 1

In Study 1 we exposed an unselected sample of participants to separate blocks of 2 positive and 2 negative images (randomly presented) with 10 repetitions in each block and measured their affective reactions immediately after each presentation. Our main questions and hypotheses were as follows:

1) Does the average rate of habituation differ by valence (e.g., is the average within-subject rate of habituation faster/slower for negative vs. positive triggers?). Based on the preliminary findings reviewed above (e.g., Mantua & Ready, 2019) our expectation was that positive habituation would be faster than negative habituation.

2) How is anxiety symptomatology related to positive and negative habituation? More specifically, do people with more pronounced anxiety symptoms take more time to habituate to negative but less time to habituate to positive stimuli? Relative scarcity of existing studies on habituation relevant to these questions precluded us from generating firm hypotheses. Nevertheless, based on prior evidence of attentional bias to negativity in anxious subjects (e.g., Bar-Haim et al., 2007), we speculated that higher anxiety symptomatology might be associated with slower habituation to negative stimuli (cf. Mantua & Ready, 2019). Because there is also

some evidence that anxious people tend to ignore positive information (Taylor et al., 2010, 2011), we also reasoned that higher anxiety symptomatology might be associated with faster habituation to positive triggers. Consequently, we speculated that the relatively faster rates of habituation to positive than negative stimuli might be even more pronounced in individuals with higher level of anxiety symptoms.

Although considered to describe distinct mood experiences, self-reported depression and anxiety constructs are known to be highly correlated (Clark & Watson, 1991; Feldman, 1993) and difficult to meaningfully differentiate when assessed by self-report measures in non-clinical samples (Feldman, 1993). Furthermore, preliminary analyses on the present data revealed that findings for anxiety and depression were highly similar; therefore, we focus the remaining of the paper on anxiety specifically and present the findings for depressive symptomatology in the Supplementary Online Materials (SOM)¹.

Method

Participants

The design of our study included one primary between-subjects variable, anxiety (continuous) and two within-subjects variables (valence and repetition). Rule-of-thumb recommendations suggest 30 (VanVoorhis & Morgan, 2007) to 50 (Simmons et al., 2013) subjects per cell to achieve power at 80% when testing between-subjects effects. Using these guidelines and treating anxiety as if it is a 2-level (low vs. high) between-subjects factor, we aimed to recruit approximately 50 subjects per each level of the between-subjects variable (high vs. low anxiety), totaling 100 participants for our target sample size (VanVoorhis & Morgan, 2007).

Accordingly, 105 members of the UC-Berkeley community, which included mostly students as well as several employees, participated in the study for monetary compensation of \$15. The participants were recruited with the help of Experimental Social Science Lab of UC Berkeley (Xlab). The sample was 63.5% female, with an average age of 21.5 (*Med* = 20, *SD* = 4.44). The demographic characteristics of the sample was as follows: 57.7% Asian American, 20.2% European-American/White, 6.7% Latino-American, 1.9% African-American, 1% Pacific Islander, 6.7 mixed race and 5.8% other.

Because of concerns that the negative images used as stimuli could trigger more than mild and transitory distress, the eligibility criterion included no self-reported past or current PTSD diagnosis. Additional eligibility criteria included being 18 years or older, and proficient in English. These criteria were advertised in advance; therefore, we had no participants who self-reported PTSD in the screening questionnaire at the beginning of the study session. One participant was eliminated from the analyses for failing 2 out of 3 attention check items embedded in self-report measures (Kung et al., 2018).

Procedure

Participants completed the study individually in computer cubicles. The experiment included three phases. In Phase 1, participants were presented with 26 affectively valenced images from the International Affective Picture System (IAPS; Lang et al., 2008), based on previously established norms in Ito et al., 1998: 6 neutral images (valence: *M* = 4.60, *SD* = 0.34; arousal: *M* = 3.43, *SD* = 0.9), 10 positive images (valence: *M* = 7.14, *SD* = 0.38; arousal: *M* = 6.49, *SD* = 0.77) and 10 negative images (valence: *M* = 2.33, *SD* = 0.41; arousal: *M* = 6.19, *SD* = 0.57). The images were chosen to present themes of human emotion and/or human interaction

¹ As reported in the SOM, analyses with depression yielded the same pattern of significant moderation results observed with anxiety.

and therefore, did not include any images without humans (e.g., nature scenes). These images corresponded to the following image numbers in the IAPS set (neutral: 2210, 9210, 2200, 9070, 2410, 2190; negative: 6212, 6831, 8230, 6312, 2800, 9050, 3530, 6550, 3550, 3220; positive: 5621, 8031, 4599, 8030, 5628, 8080, 5629, 8370, 4601, 4641).

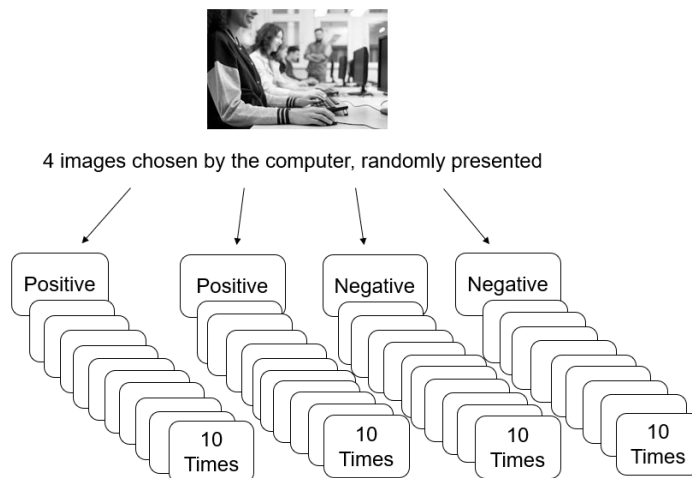
Pictures were presented randomly, and after each image presentation participants rated their emotional experience on the emotional intensity scale described below. Because the goal of Phase 1 was to generate ideographically negative and positive stimuli, the computer automatically selected the 2 most negative and the 2 most positively rated pictures for each individual, which were then used as stimuli for that person in the following habituation phase.

Phase 2 consisted of the habituation task that included 4 blocks of presentation, one for each of the 4 pictures selected in the previous phase (2 negative, 2 positive), presented in random order. Within a block, each picture was presented 10 times for 5 seconds. Participants were instructed to look at each image presentation for the full time it was presented. On the next screen they were instructed to rate their reactions to each presentation on the sliding scale described below during a 5 second period.

At the end of the study, participants completed a survey designed to assess individual differences in anxiety and depression among other constructs (see SOM, for additional measures included but not analyzed for this manuscript). All study materials can be requested directly from the first author. Data, and analyses syntax are reported in Yartsev & Ayduk (2021).

Figure 1.

Flowchart of Habituation Paradigm of Study 1



Notes. Following the practice rating task of 26 images, the computer selected the 4 images rated highest on emotional intensity (2 positive and 2 negative). The four images were presented in random order, in 4 blocks of 10 repetitions per block.

Measures

Emotional Intensity

Following each image presentation in Phases 1 and 2, participants were asked to rate their emotional response after each image presentation (“Please rate how this image makes you feel right now, at this moment”) on a sliding scale (from -3 = “extremely negative” to +3 =

“extremely positive”, with 0 = “neither positive nor negative”). They could rate their emotions anywhere on the scale with increments of 0.10 (which were not shown to the participants), and their ratings were recorded on a scale from -30 (extremely negative) to +30 (extremely positive) by the computer.

We subtracted emotion intensity ratings to negatively-valenced stimuli from zero, such that more positive ratings reflected more intense negative reactions to negative stimuli. This allowed us to compare positive and negative habituation patterns to each other because higher ratings indicated higher emotional intensity for both types of stimuli. The mean emotional intensity of the 26 images rated during Phase 1 was 16.76 ($SD = 10.78$; positive images: $M = 12.67$, $SD = 11.08$; negative images $M = 20.85$, $SD = 8.73$). As expected, images that were selected for Phase 2 had higher intensity ratings for both positive ($M = 22.67$; $SD = 6.25$) and negative ($M = 27.01$, $SD = 4.96$) images, where the latter was also significantly more intense than the former ($t(102) = 8.32$, $p < .001$).

Anxiety Symptomatology

Anxiety symptomatology was measured with multiple questionnaires: anxiety ($k = 7$) and stress ($k = 7$) subscales of the Depression Anxiety Stress Scale 21 (DASS 21; Lovibond & Lovibond 1995), and the Burns Anxiety Inventory (BAI; Burns, 1989). DASS-21 anxiety and stress scales include ratings of past weeks' negative emotional symptomology (Anxiety scale: symptoms related to autonomic arousal, situational and subjective experience of anxiety, e.g., “I felt I was close to panic”; Stress scale: symptoms of general chronic arousal, such as irritability and proneness to over react, e.g., “I found it hard to wind down”). BAI assesses the degree to which 33 symptoms of anxiety (anxious feelings, e.g., “Feeling tense, stressed, “uptight”, or on edge”; anxious thoughts, e.g., “Racing thoughts or having your mind jump from one thing to the next”; and physical symptoms, e.g., “Trembling or shaking”) were experienced over the previous week. Ratings for both scales were done on a 4-point rating scale (0=never to 3=always).

BAI total score was computed by summing ratings across all items ($\alpha = 0.91$, $M = 16.46$, $SD = 11.88$). Following standard scoring procedures (Lovibond & Lovibond 1995), DASS-21 anxiety and stress subscale scores were computed by summing ratings across items on each subscale and multiplying each sum by two (anxiety: $\alpha = 0.76$, $M = 6.58$, $SD = 6.22$; stress: $\alpha = 0.83$, $M = 11.19$, $SD = 8.11$). Although the DASS anxiety and stress subscales included fewer items than the BAI measure, the former two showed good internal reliability and all three correlated highly with each other ($.70 \leq rs \leq .66$). Therefore, a composite symptomatology score was computed by averaging standardized scores across the three scales ($\alpha = .87$, $M = 0$, $SD = .89$)². Anxiety symptomatology scores were not correlated with the emotional intensity of the images that served as stimuli for the habituation task (Negative: $r = .01$, $p = .95$; Positive: $r = .02$, $p = .83$)³.

² Analyses with each of the 3 anxiety scales separately yielded identical pattern of significant results with the composite measure of anxiety and are presented in the SOM.

³ Trait neuroticism is a higher-order construct that encompasses vulnerability to depression and anxiety. Evidence exists showing that higher neuroticism is associated with faster decay of positive but slower decay of negative affect after watching positive and negative film clips, respectively (Hemenover, 2003), which is consistent with the hypothesized impact of anxiety and depression on affective habituation outlined above. Nevertheless, we chose to focus the present study on anxiety and depression rather than neuroticism because bulk of the work delineating information processing biases potentially relevant to affective habituation has been conducted in the context of the former. However, results from parallel analyses with neuroticism can be found in the SOM, which indicated neuroticism was not a significant moderator of affective habituation (the effect was in the same direction as anxiety). This discrepancy could be due to the fact that that anxiety and depression scales measured current and recent

Results

To examine the effect of valence (positive/negative) on emotional reactions over time, we performed Multilevel Modeling, MLM, to account for the non-independence of the data points measured repeatedly within participants (R version 4.0.3; Pinheiro et al., 2020; R Core Team, 2020). Specifically, our data consisted of 40 data points of repeated emotional ratings nested within each individual, including two images per valence (Positive and Negative), and 10 repetitions per image. Our analyses indicated that a two-level model with fixed effects for valence and repetition time, as well as random effects for intercepts (e.g., allowing different emotional baselines per participant) and slopes (e.g., allowing different associations between any two variables per participant) best fitted our data and was used as the base model in testing study hypotheses. Because gender was not related to anxiety in this sample ($\beta = .02, p = .86$), and because we did not have a priori hypothesis about gender differences in habituation per se, gender was not included in the main analyses reported below (see the online supplemental materials for analyses with gender).

Does the Rate of Change in Emotional Intensity with Repeated Exposure Differ as a Function of Image Valence?

To address this question, we predicted emotion intensity from valence (2: positive vs. negative; fixed), repetition (continuous, 1-10; fixed), valence*repetition (fixed), with random intercepts and slopes. In omnibus tests, valence was effects-coded (negative = -1, positive = 1) and repetition (1-10) was person centered on time 1, to observe how emotional intensity elicited by the very first image presentation changed with repeated presentation of the same image for each individual.

MLM results indicated that positive images elicited less intense emotional reactions on average than negative images (valence: $t(4041) = 7.04, \beta = -5.07, p < .001$), and that emotional reactions lost their intensity with repeated exposure (repetition: $t(4041) = 5.84, \beta = -.45, p < .001$). As hypothesized, repetition*valence interaction was also significant ($t(4041) = 2.22, \beta = -.19, p = .03$), with habituation occurring significantly faster for positive images ($t(4041) = 7.43, \beta = -.63, p < .001$) negative ones ($t(4041) = 5.84, \beta = -.45, p < .001$).

Does Anxiety Symptomatology Moderate Habituation to Negative vs. Positive Images?

To explore whether the habituation findings reported above differed as a function of self-reported anxiety symptoms, we re-ran our base model, this time including a fixed effect for anxiety symptomatology (standardized) and all higher-level interaction terms among valence, repetition and anxiety symptomatology. Because we were mainly interested in whether the valence*repetition interaction is further moderated by individual differences in anxiety symptomatology, we focus our discussion in the main text on the 3-way interaction; main effects and all lower-level interaction terms from this analysis are presented below in Table 1.

This analysis yielded a significant 3-way interaction between valence, repetition, and anxiety symptomatology ($t(4038) = 2.53, \beta = -.23, p = .01$). To decompose this 3-way interaction, we examined the 2-way interaction between valence and repetition for people low (1 SD below the mean) vs. high (1 SD above the mean) in anxiety symptomatology. Among people with low reported anxiety symptoms, the results showed a significant main effect for valence (i.e., stronger reactions to negative than positive; $t(4038) = 5.18, \beta = -5.28, p < .001$) and repetition (i.e., lower

symptomatology whereas Neuroticism tapped into a stable personality trait. Consistently, Neuroticism was positively but moderately correlated with anxiety ($r = .45, p < .001$) and depression ($r = .54, p < .001$) symptoms in the current sample.

emotional intensity over time; $t(4038) = 4.51, \beta = -.49, p < .001$). However, the valence*repetition interaction was not significant ($t(4038) = 0.17, \beta = .02, p = 0.87$), indicating similar habituation rates to positive vs negative stimuli.

Table 1

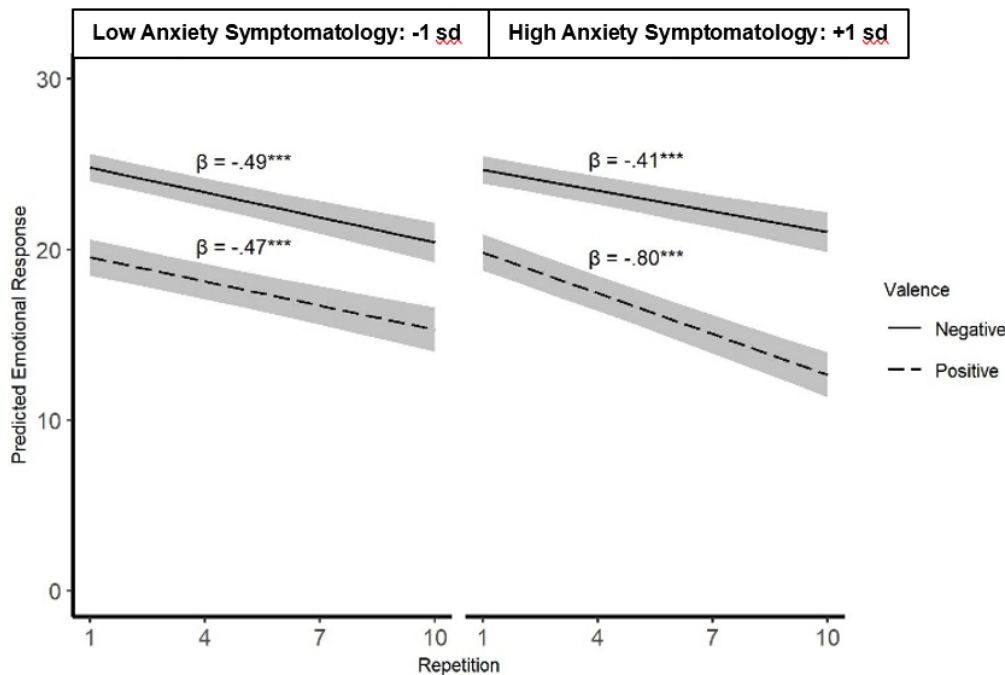
Parameter Estimates and Inferential Statistics from Analyses Testing Anxiety Symptomatology as a Moderator

Predictors	Estimates		Inferential Statistics		
	β	SE	df	t-value	p-value
Valence (effect coded)	-5.07	.72	4038	7.01	<.001
Repetition (1 st rep. centered)	-0.45	.08	4038	5.83	<.001
Anxiety	-0.07	.65	102	0.11	.92
Valence*Repetition	-0.19	.08	4038	2.28	.02
Valence*Anxiety	0.24	.82	4038	0.29	.77
Repetition*Anxiety	0.05	.09	4038	0.53	.60
Valence*Repetition*Anxiety	-0.23	.09	4038	2.53	.01

In contrast, among people reporting high levels of anxiety, both main effects (valence: $t(4038) = 4.76, \beta = -4.86, p < .001$; repetition: $t(4038) = 3.76, \beta = -.41, p < .001$) and the valence*repetition interaction were significant ($t(4038) = 3.40, \beta = -.39, p < .001$). The latter reflected the fact that habituation rate to positive stimuli in people with high level of anxiety symptoms ($t(4038) = 6.72, \beta = -.80, p < .001$) was faster than their habituation rate to negative stimuli ($t(4038) = 3.76, \beta = -.41, p < .001$).

To further unpack the 3-way interaction among valence, repetition, and the rate of anxiety symptomatology, we also run simple slope analyses where we probed the repetition*anxiety symptomatology interaction separately for negative vs. positive stimuli.

These analyses showed that repetition*anxiety symptomatology interaction for negative images was not significant ($t(1964) = 0.55, \beta = 0.05, p = .58$), reflecting the fact that people with high and low levels of anxiety symptoms habituated to negative stimuli similarly. In contrast, the 2-way interaction between repetition and anxiety symptomatology was significant for positively-valenced stimuli ($t(1972) = 1.96, \beta = -.19, p = .05$), demonstrating that individuals with high rate of anxiety symptoms habituate ($t(1972) = 6.72, \beta = -.80, p < .001$) significantly faster than individuals with low anxiety levels ($t(1972) = 3.96, \beta = -.47, p < .001$). These findings are illustrated below in Figure 2.

Figure 2*Habituation Trajectories as a Function of Stimuli Valence and Anxiety*

Notes. *** $p < .001$, ** $p < .01$, * $p < .05$. Rate of habituation to positive and negative stimuli for individuals low (-1 SD below) and high (+1 SD above) the mean on anxiety symptomatology. The bands around predicted lines represent 1 SE above and below the regression line.

Secondary Analyses

We conducted secondary analyses to rule out alternative explanations and potential confounds that might have impacted the main findings. First, because people habituate faster to more familiar stimuli than to novel stimuli (Leventhal et al., 2007) we wanted to rule out that valence differences were not explained solely by potential differences in the novelty vs. familiarity of the events depicted in positive (e.g., romance, sports) vs. negative (e.g., plane crash, murder) images.

Second, the 4 images (2 positive, 2 negative) presented during the habituation phase of the study were selected based on participants' idiographic ratings of valence on a larger set of 10 positive and 10 negative images completed during a preceding pilot phase. Taking an idiographic approach to image selection process ensured that the experimental stimuli were subjectively equivalent across participants during the following habituation task. However, the fact that images differed between participants raised the question of whether there were thematic differences in the stimuli based on individual differences in anxiety. In what follows, we summarize our methodological approach to addressing these issues and report the results from relevant analyses.

Ruling Out Novelty as an Alternative Explanation. The pool of 10 positive and 10 negative images participants rated in the pilot phase of the study were rated by 6 independent judges (UC Berkeley students and staff unfamiliar with the study) on the following three dimensions: a) perceived likelihood (i.e., *How likely is the event/scene depicted to happen in*

everyday life; ”1 = extremely likely, 4 = neither likely nor unlikely, 7 = extremely unlikely; ICC = .82; b) perceived frequency (i.e., “How often might this or a similar event happen to someone like yourself?”, 1 = daily, 4 = every few months, 8 = never; ICC = .92); and c) event exposure (i.e., “To what degree do you encounter information about this event (or others very similar) in your daily life through witnessing them occur around you, encountering them in the news/social media or hearing about them from other people?”, 1 = daily, 4 = every few months, 8 = never; ICC = .82). The three dimensions correlated highly with each other ($.53 \leq r_s \leq .80$), therefore, a composite *novelty* score was computed by averaging the standardized scores across the three dimensions ($\alpha = .87$, $M = 0$, $SD = .89$), such that higher scores indexed higher novelty.

To address whether valence effects were accounted by differences in novelty, we first compared average ratings across the 10 positive and 10 negative images rated by the independent judges. We found no significant differences between positive ($M = -0.22$, $SD = 1.17$) and negative ($M = 0.22$, $SD = 0.45$) images although descriptively the latter was rated as more novel ($t(11.63) = 1.09$, $p = .30$). Second, we ran our original MLM model of emotional intensity (continuous, fixed) predicted by valence (2: positive vs. negative; fixed), repetition (continuous; 1-10; fixed), and valence*repetition interaction with the addition of novelty (continuous; fixed) and novelty*repetition interaction with random intercept and slopes for repetition and valence. Pitting the valence*repetition and novelty*repetition interaction terms against each other allowed us to examine whether the differences in habituation rates in positive and negative valence are due to novelty or not.

The results revealed a significant novelty*repetition interaction term ($t(4039) = 2.84$, $b = -0.12$, $p = 0.005$) which indicated that participants habituated faster to themes high (+1 SD) in novelty (repetition: $t(4039) = 6.48$, $b = -0.53$, $p < .001$) than those low (-1 SD) in novelty (repetition: $t(4039) = 3.35$, $b = -0.31$, $p < 0.001$). However, the valence*repetition interaction remained significant as well ($t(4039) = 2.86$, $b = -0.24$, $p = 0.004$) indicating that valence differences reported in the main results section cannot be explained by differences in the familiarity of the events depicted in positive vs. negative images.

Potential Thematic Differences in the Experimental Stimuli as a Function of Anxiety Symptomatology. The first and second authors first rationally identified key themes that were present in the images, which yielded 12 possible (overlapping) themes: Excitement/Enthusiasm, Competition/Ambition, Romance/Love/Sensuality, Disgust/Revulsion, Loneliness/Isolation, Human Suffering (illness, pain), Death/Injury/Threat of physical harm, Male to Female Aggression, War/Terrorism, Outdoor activity/Sports, Sadness/Crying, Sensation seeking/adventure, Other. In the next step, 6 independent judges rated each theme with respect to their centrality for the scene depicted in each image (1 = not central at all, 4 = moderately central, 7 = absolutely central). All ICC ratings fell within the range of 0.77 and 1.00, except the theme of “loneliness” which had an ICC of 0.60.

For each participant, theme ratings for the 2 positive images and the 2 negative images viewed during the habituation were averaged. We kept positive and negative image scores separate (instead of averaging across 4 images) to provide a more granular examination of the relationship between anxiety symptomatology and image theme. Analyses showed that anxiety symptomatology was not significantly associated with any of the theme ratings (negative images: $-.17 \geq r_s \geq .14$, $p_s > .08$; positive images: $-.11 \geq r_s \geq .10$, $p_s > .26$; see SOM for details). Additionally, we examined if anxiety symptomatology was associated with image novelty and found that it was not ($r_{pos} = -.1$, $p_{pos} = .35$; $r_{neg} = -.11$, $p_{neg} = .26$). In short, results showed that anxiety symptomatology was not related to viewing qualitatively different images during

habituation (see SOM for exploratory factor analyses of theme ratings and the relationship of anxiety to latent theme factors).

Summary of Study 1

Results from study 1 confirmed our main hypothesis on faster habituation to positive versus negative stimuli. Anxiety symptomatology strengthened the association between positive and negative habituation rates with emotional intensity, mainly due to faster positive habituation in people with higher reported anxiety levels. Alternative explanations to the described effects, such as previous familiarity with the emotional theme depicted in the presented images, as well as people with more anxiety symptoms choosing a set of qualitatively different experimental stimuli were not supported and thus ruled out.

Study 2

The overarching goal of Study 2 was to replicate and extend findings from Study 1. First, Study 2 aimed to replicate the effect of valence on habituation, testing the hypothesis that habituation occurs faster for positive than for negative stimuli. Second, we were interested in a deeper understanding of the role of anxiety in habituation. In Study 1, anxiety symptomatology was measured as an individual difference variable, therefore, whether it had a causal effect on habituation was unclear. Therefore, in Study 2, we manipulated state anxiety to further examine how anxiety modulates habituation trajectories to positive and negative emotional elicitors.

Third, we aimed to make a methodological improvement in Study 2 to better control for the stimuli used in the habituation task. In Study 1, the images presented during habituation were pre-selected ideographically based on the highest emotional rating given by each participant during the pilot phase of the study. Although this approach allowed for customized elicitation of emotion - accounting for individual differences in response to stimuli, having different images for each subject decreased the generalizability of the findings beyond ideographic stimuli. Therefore, to have a better control for stimuli in study 2, we preselected two sets of stimuli that were shown to all participants.

Finally, we were interested in examining whether habituation depended on specific thematic elicitors within the same valence category. In Study 1, we coded for such themes post-hoc and did not find thematic differences in the elicitors to moderate the valence effect. In study 2, we aimed to rule out this possibility in a more systematic way by manipulating themes in the images viewed during the habituation task. We specifically focused on fear vs. sadness themes for negative stimuli and on love vs. excitement themes for positive stimuli because these themes came up frequently in Study 1, and because images for some of these themes were developed and well validated in previous research (Mikels et al., 2005).

The following hypotheses were preregistered for Study 2:

1) Does the average rate of affective habituation differ by valence (e.g., is the average within-subject rate of habituation faster/slower for negative vs. positive triggers?). We hypothesize that the rate of positive habituation would be faster than the rate of negative habituation overall.

2) Does state anxiety cause faster habituation to positive and/or slower habituation to negative stimuli? We expected the pattern of findings under the first hypothesis to be moderated by experimental condition such that positive-negative habituation differences would be more pronounced in the anxiety than in the control condition.

3) Do people higher in anxious symptomatology take more time to habituate to negative but less time to habituate to positive stimuli? We speculated that the relatively faster rates of

habituation to positive than negative stimuli might be even more pronounced in individuals reporting higher levels of anxiety symptoms in the control condition.

Method

Participants

To achieve power of 80% we followed the more stringent convention of 50 subjects per each of the 4 between-subjects cells, since valence was manipulated within-subjects and there were 2 primary between-subjects variables, experimental condition and gender (Simmons et al., 2013; VanVoorhis & Morgan, 2007). Accordingly, we recruited 249 members of the UC-Berkeley community between 18-40 years old English proficient adults, which included mostly students and a few employees.

Participants were recruited online from the subject pool of the Experimental Social Science Lab of UC Berkeley (Xlab). As previously [preregistered](#), 11 participants were excluded due to failing attention check criteria (error rates exceeding 66% in embedded attention check items within session 1, and/or error rates exceed 25% in stimuli recognition task post habituation paradigm within session 2). Additionally, we excluded 27 participants in the experimental group for whom the stress manipulation paradigm was ineffective (had lower state anxiety scores post manipulation compared to their [baseline](#)). The final sample included a total of 211 subjects (experimental group: 51 men and 52 women; control group: 54 men and 52 women). The average age of the sample was 20.93 ($Med = 20$, $SD = 2.96$), with the following demographic characteristics: 59% Asian or Pacific Islander, 26% White or Caucasian, 1% African-American, 4% mixed race and 9% other.

Procedure

Data were collected in two sessions completed 1 to 4 days apart. The first online session was administered to all study participants on the Qualtrics survey platform, and consisted of signing a consent form, filling out a demographic questionnaire and answering a set of questionnaires, including questionnaires which were used to measure individual differences in anxiety in Study 1.

The following morning, participants received an email invitation to complete the second study session. For increased believability of experimental manipulation of stress, the second study session was administered during working days and hours. At the onset of the second session, participants were randomly assigned to experimental vs. control conditions (within each gender separately) and were forwarded to the *Inquisit by Millisecond* survey platform in order to complete the major part of the study including the stress manipulation and the habituation task.

The *Inquisit* session started with questions measuring state emotions (anxiety, excitement, sadness, calmness, and attentiveness) at baseline followed by a practice image rating task. The practice task consisted of 8 images (2 of love, excitement, fear, and sadness each) that had been selected as the habituation stimuli on an a priori bases and 4 neutral images⁴ (IAPS; Lang et al. 2008; Mikels et al., 2005). This practice task was designed to parallel the procedure of the first experiment where idiographic rating phase of the study allowed participants to not only view images but to also calibrate their use of the rating scale before the beginning of the habituation task. Images were presented in random order and participants were instructed to look at each image for 5 seconds and then to rate the emotional intensity of their reactions. They also

⁴ The following images were selected from the IAPS set of stimuli and were rated during the training phase - 4 neutral (2200, 2410, 9210, 9070), 4 positive (Love: 4599, 4601; Excitement: 5628, 5621) and 4 negative (Fear: 6212, 3530; Sadness: 2800, 3220). The positive and negative sets were also used as part of the habituation paradigm.

rated each image on 4 specific *Emotional themes* (love, excitement, sadness, fear) and chose from a dropdown menu which of the 4 themes described the most *Dominant emotion theme* for each image.

Next, participants completed “My Dream Job” task that manipulated state anxiety. In the experimental (anxiety) group, participants were told to imagine that they got an interview for their dream job and asked to deliver a speech about their strengths and weaknesses for the position to a panel of 2 public speaking experts trained in speech evaluation via a live Zoom meeting. This step was necessary to elicit moderate stress during experimental conditions and was adapted from the Trier Social Stress Test (Kirschbaum et al., 1993). Participants were given 1.5 minutes to mentally prepare delivering a 5-minute speech describing why they would be a good candidate for their ideal job. The control group too was asked to imagine that they got an interview for their dream job and but unlike the experimental group were told they would write an essay about the qualities that would make them well suited for this job and that their essay will be reviewed by a computer algorithm for content and style (modified from Birkett, 2011; Kirschbaum et al., 1993). Like the experimental group, they were given 1.5 minutes to mentally prepare for writing the essay. Both groups were told that the Dream Job Task was going to take place as the last task of the session, following the image rating task. Right after the preparation period, participants in both groups rated their state anxiety (i.e., post-manipulation anxiety) on the same item used to measure baseline anxiety.

Subsequently, participants completed the habituation task where they rated the emotional intensity of their reactions to 8 images selected from the International Affective Picture System (IAPS; Lang et al. 2008; see Habituation Stimuli section below for details). Images were randomized into 2 sets such that each set included one image from each theme category (i.e., love, excitement, fear, and sadness). Images within a set were presented in randomized blocks with 10 repetitions of 5 seconds per image. Participants were instructed to look at each image for the full time it was presented and to rate their intensity of their emotions after each presentation. Additionally, after tenth repetition of each image they were asked to rate their current level of interest and engagement. We used interest ratings to rule out the possibility that habituation effects were simply due to disengagement from the task (See Figure 3 below for study design). Lastly, participants were forwarded back to the Qualtrics software where they completed a short attention check task, probed for suspicion about the goals of the study and were debriefed for deception since none of them actually made a 5-minute speech or wrote an essay.

Measures

Session 1

Anxiety Symptomatology. Individual differences in anxiety were computed using the same measures as in Study 1: BAI ($\alpha = 0.95$, $M = 19.47$, $SD = 15.9$); DASS-21 anxiety ($\alpha = 0.81$, $M = 6.13$, $SD = 6.80$) and DASS-21 stress ($\alpha = 0.86$, $M = 10.59$, $SD = 8.79$). All three scales showed high inter-correlations ($0.76 \leq r \leq 0.79$) and following Study 1, scores were averaged after ratings on each scale were standardized ($\alpha = 0.91$, $M = 0$, $SD = 0.92$).

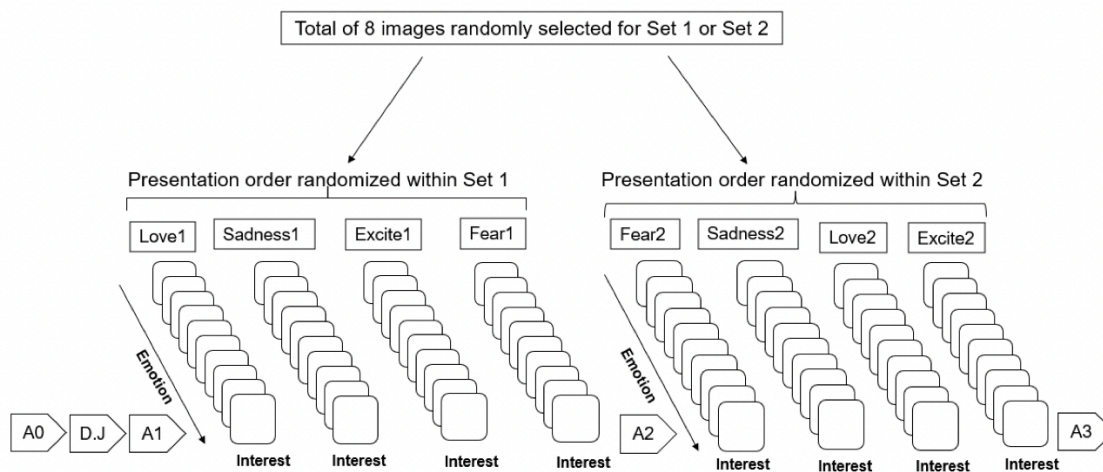
Session 2

Habituation Stimuli. Participants were presented with 4 positive and 4 negative IAPS images. Based on previously established norms and on findings of study 1, we chose images representing each of the emotional categories as following: Love: 4599, 4601; Excitement: 5628, 5621; Fear: 6212 ($M_{fear} = 3.57$, $SD = 2.19$), 3530 ($M_{fear} = 4$, $SD = 2.06$); Sadness: 2800 ($M_{sadness} = 5.4$, $SD = 1.62$), 3220 ($M_{sadness} = 4.23$, $SD = 1.66$; Mikels et al., 2005).

Baseline state emotions. Baseline emotions were measured on a sliding scale from 1(not at all) to 7 (very much so) by answering the following 5 questions: a. Right now, how tense, on edge, anxious do you feel at this moment? b. How excited, enthusiastic, energized do you feel at this moment? c. How interested, engaged & attentive do you feel at this moment? d. How calm, relaxed or at ease do you feel right now? e. How sad, downhearted or unhappy do you feel at this moment? Ratings on the first item were used as baseline state anxiety scores in subsequent analyses.

Emotional Intensity. Emotional intensity during the habituation task was measured similarly to Study 1. Participants were given 5 seconds following each image presentation, and they were asked to rate the emotional intensity of their reactions (“How does this image make you feel right now, at this moment?”) on a sliding scale from -3 (extremely negative) to 3 (extremely positive) with increments of 0.1. The mean emotional intensity of the 12 images rated at the practice rating task was 10.21 ($SD = 14.23$; positive images: $M = 13.94$, $SD = 10.78$; negative images $M = 20.14$, $SD = 9.84$; neutral images $M = -3.44$, $SD = 9.79$).

Figure 3
Flowchart of experimental Study 2 design.



Notes. Study 2 flowchart of the second study session, in which state anxiety (A) was measured at baseline (A0) and at several timepoints throughout the habituation paradigm (A1, A2, A3). D.J represents the My Dream Job task.

State Anxiety. State anxiety was measured by asking “Right now, how tense, on edge or anxious do you feel?”. Participants chose a rating on a sliding scale from 1 (not at all), 4 (moderately so) to 7 (very much so) with increments of 0.1. This question was presented a total of 4 times throughout the second study session (as illustrated in Figure 3 above), as the following: i) *baseline anxiety* presented at the very beginning of Session 2 ($M = 2.38$, $SD = 1.33$; experimental: $M = 2.49$, $SD = 1.36$; control: $M = 2.28$, $SD = 1.29$); ii) *post-manipulation anxiety*, presented after the “My Dream Job” task and immediately before the habituation task ($M = 4.38$, $SD = 1.76$; experimental: $M = 5.07$, $SD = 1.62$; control: $M = 3.71$, $SD = 1.64$); iii) *mid-habituation anxiety* which was assessed mid-way during the habituation task, after the first set of images were rated ($M = 3.82$, $SD = 1.84$; experimental: $M = 4.47$, $SD = 1.79$; control: $M = 3.27$,

$SD = 1.64$); and iv) *post-habituatation anxiety* assessed right after the habituation task ($M = 3.56$, $SD = 2.01$; experimental: $M = 4.16$, $SD = 2.02$; control: $M = 3.03$, $SD = 1.82$).

Interest. Interest was measured at baseline and throughout the habituation task, following the 10th presentation of each image. Participants were asked “How interested, engaged or attentive do you feel at this moment?”. The responses were rated on a sliding scale ranging from 1 (not at all) to 7 (very much so) with increments of 0.1 (Baseline interest: $M = 4.09$, $SD = 1.3$; experimental: $M = 4.11$, $SD = 1.3$; control: $M = 4.07$, $SD = 1.3$; Habituation interest: $M = 2.52$, $SD = 1.53$; experimental: $M = 2.5$, $SD = 1.43$; control: $M = 2.54$, $SD = 1.62$; Additional analyses in Appendices).

Image themes. During the practice task of the second session, participants rated the 8 practice images on *Emotional theme* (How much does this image makes you feel each of the following specific emotions, right now, at this moment?). They were presented with the following emotional triplets: a. Inspired, uplifted (excited), or elevated; b. Love, closeness, or trust; c. Sad, downhearted, or unhappy; d. Scared, fearful, or afraid; e. Other. Each emotional triplet was rated on a scale from 1 (not at all) to 7 (very much so). Next, participants selected one *Dominant emotion theme* (“if you were to choose only one emotion this image made you feel the most, which one would you choose?”) from the following dropdown menu: a. Inspired, uplifted (excited), or elevated; b. Love, closeness, or trust; c. Sad, downhearted, or unhappy; d. Scared, fearful, or afraid (See table 2 for descriptive statistics).

Table 2.

Emotion Theme Ratings and Dominant Emotion Frequencies by Image Category.

Image Category	Emotion theme ratings							
	Love, closeness, or trust		Inspired, uplifted (excited), or elevated		Sad, downhearted, or unhappy		Scared, fearful, or afraid	
	<i>Mrating</i> (<i>SD</i>)	Freq.(%)	<i>Mrating</i> (<i>SD</i>)	Freq%	<i>Mrating</i> (<i>SD</i>)	Freq%	<i>Mrating</i> (<i>SD</i>)	Freq%
Love	5.16 (1.74)	86.97%	3.57 (1.8)	4.98%	1.62 (1.04)	6.16%	1.39 (0.94)	1.9%
Excitement	3.33 (1.9)	10.43%	5.32 (1.42)	82.46%	1.37 (0.88)	1.42%	2.46 (1.49)	5.69%
Sadness	1.43 (1.01)	16.88%	1.3 (0.78)	18.87%	5.52 (1.51)	39.62%	4.45 (1.91)	24.64%
Fear	1.21 (0.69)	18.4%	1.33 (0.9)	17.16%	4.62 (1.94)	34.74%	5.34 (1.8)	29.70%

Mean emotion theme ratings for each of the following IAPS images' categories: love (IAPS; 4599, 4601), excitement (IAPS; 5628, 5621), sadness (IAPS; 2800, 3220) and fear (IAPS; 6212, 3530). Frequency percentage of emotion theme ratings refers to most dominant emotional triplet chosen for each category of images.

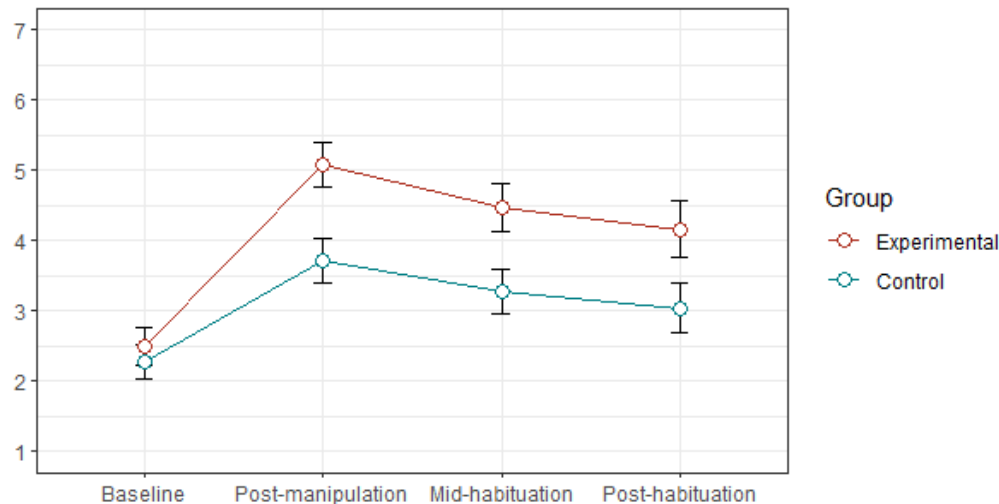
Results

Manipulation Checks

Anxiety. Although experimental ($M = 2.49$, $SD = 1.36$) and control ($M = 2.28$, $SD = 1.29$) groups were similar in their levels of baseline anxiety ($t(205.52) = 1.13$, $p = .26$), they differed significantly in post-manipulation anxiety levels they reported ($t = 6.07$, $df = 208.73$, $p < .001$), with higher anxiety scores in the experimental group ($M = 5.07$, $SD = 1.62$) than in the control group ($M = 3.71$, $SD = 1.64$). Furthermore, although anxiety showed a significant increase from baseline to post-manipulation both in the experimental ($t(197.77) = 12.37$, $p < .001$) and control ($t(202.88) = 7.11$, $p < .001$) groups, the increase in the former was significantly greater than the latter ($t(205.34) = 4.95$, $p < .001$). Overall, these findings indicated that our anxiety manipulation was successful.

Additionally, we examined how long the effect of the manipulation lasts by looking at state emotion ratings throughout the habituation task. Results indicated that group differences in post-manipulation anxiety were maintained throughout the habituation task (experimental vs control group mid-habituation anxiety: $t(206.4) = 5.23, p < .001$; experimental vs control group post-habituation anxiety: $t(205.4) = 4.42, p < .001$). Furthermore, state anxiety levels declined significantly from post-manipulation to mid-habituation for both groups (control: $M = 3.27, SD = 1.64$; experimental: $M = 4.47, SD = 1.79$), but the decline from mid-habituation to post-habituation was not significant (control: $M = 3.03, SD = 1.82$; experimental: $M = 4.16, SD = 2.02$). Within the experimental group, mid-habituation anxiety was significantly lower than post-manipulation anxiety ($t(201.97) = -2.56, p = 0.01$), but was not significantly different from post-habituation anxiety ($t(201.12) = -1.14, p = .26$). Similarly, within the control group, mid-habituation anxiety was significantly lower than post-manipulation anxiety ($t(211.92) = -1.96, p = .05$), and did not differ from post-habituation anxiety ($t(207.74) = -0.99, p = .32$; See Figure 4).

Figure 4
State Anxiety Levels Over Time



Images Themes: To confirm our a priori categorization of the images to 4 emotion themes, we examined participants' ratings of excitement, love, sadness and fear for each image category (see Table 2). Excitement images were rated significantly higher on excitement than on love ($t(796.75) = 17.38, p < .001$), sadness ($t(717.15) = 48.97, p < .001$) and fear ($t(858.12) = 28.83, p < .001$). Love images were rated significantly higher on love than on excitement ($t(860.79) = 13.16, p < .001$), fear ($t(663.5) = 39.61, p < .001$) and sadness ($t(705.28) = 36.23, p < .001$). Similarly, sadness images were higher on sadness ratings than on fear ($t(831.05) = 9.21, p < .001$), excitement ($t(656.62) = 51.99, p < .001$) and love ($t(762.77) = 47.20, p < .001$) ratings. Lastly, fear images were rated higher on fear compared to sadness ($t(851.12) = 5.56, p < .001$), excitement ($t(630.56) = 41.23, p < .001$) and love ($t(552.33) = 44.3, p < .001$).

Analyses of responses to the dominant emotional theme confirmed that "love, closeness or trust" triplet was the most frequent theme chosen for love images, "inspired, uplifted, or elevated" for excitement images, "sad, downhearted, or unhappy" for sadness images, and "scared, fearful, or afraid" for fear images. Although fear and sadness images were less well-differentiated from each other than love vs. excitement images, fear and sadness triplets were

nevertheless chosen significantly more as the dominant theme for fear and sadness images, respectively.

Table 2.

Emotion Theme Ratings and Dominant Emotion Theme Frequencies by Image Category.

Image Category	Emotion triplets							
	Love, closeness, or trust		Inspired, uplifted (excited), or elevated		Sad, downhearted, or unhappy		Scared, fearful, or afraid	
	Ratings <i>M</i> (<i>SD</i>)	Dominant theme Freq (%)	Ratings <i>M</i> (<i>SD</i>)	Dominant theme Freq (%)	Ratings <i>M</i> (<i>SD</i>)	Dominant theme Freq (%)	Ratings <i>M</i> (<i>SD</i>)	Dominant theme Freq (%)
Love	5.16 (1.74) _a	86.97 _e	3.57 (1.8) _b	4.98 _f	1.62 (1.04) _c	6.16 _g	1.39 (0.94) _d	1.9 _g
Excitement	3.33 (1.9) _a	10.43 _e	5.32 (1.42) _b	82.46 _f	1.37 (0.88) _c	1.42 _g	2.46 (1.49) _d	5.69 _h
Sadness	1.43 (1.01) _a	0.95 _e	1.3 (0.78) _b	1.18 _e	5.52 (1.51) _c	70.38 _f	4.45 (1.91) _d	27.49 _g
Fear	1.21 (0.69) _a	0.47 _e	1.33 (0.9) _b	2.37 _f	4.62 (1.94) _c	29.38 _g	5.34 (1.8) _d	67.77 _h

Mean emotion theme ratings for each of the following IAPS images' categories: love (IAPS; 4599, 4601), excitement (IAPS; 5628, 5621), sadness (IAPS; 2800, 3220) and fear (IAPS; 6212, 3530). Frequency percentage of emotion theme ratings refers to most dominant emotional triplet chosen for each category of images. Within each image category, numbers with different subscripts are statistically different from one another at $p < .05$ for ratings (subscripts a-d) and for dominant theme frequencies (subscripts e-h).

Main Analyses

Similar to Study 1, we performed Multilevel Modeling to account for repeated measures of 10 emotional ratings nested within 4 emotional elicitors within each individual to account for the effect of valence on emotional intensity over time. In particular, our data consisted of 80 data points of repeated emotional ratings nested within each individual, including four images per valence (Positive and Negative) which consisted of 2 images per emotional theme (love, excitement, fear, sadness) and 10 repetitions per image. Our analyses indicated that a multi-level model with fixed effects for valence and repetition time, as well as random effects for intercepts (e.g., allowing different emotional baselines per participant) and slopes (e.g., allowing different associations between any two variables per participant) best fitted our data and was used as the base model in testing study hypotheses.

Does the Rate of Change in Emotional Intensity with Repeated Exposure Differ as a Function of Image Valence?

To replicate the effect of valence on habituation found in Study 1, emotion intensity was predicted from valence (2: positive vs. negative; fixed), repetition (continuous, 1-10; fixed), valence*repetition (fixed), with random intercepts and slopes. Once again, valence was effects-coded (negative = -1, positive = 1) and repetition (1-10) was person centered on time 1, to observe changes in emotional intensity with repeated exposure to images within individual.

As in the previous study, positive images elicited weaker emotional reactions on average than negative images (valence: $t(16666) = 13.38$, $\beta = -8.80$, $p < .001$), and emotional reactions lost their intensity over exposure time (repetition: $t(16666) = 4.86$, $\beta = -.26$, $p < .001$). The 2-way repetition*valence interaction was replicated in the current study as well ($t(16666) = 2.21$, $\beta = -.14$, $p = .03$), with habituation occurring significantly faster for positive images ($t(16666) = 7.42$, $\beta = -.40$, $p < .001$) compared to negative ones ($t(16666) = 4.86$, $\beta = -.26$, $p < .001$).

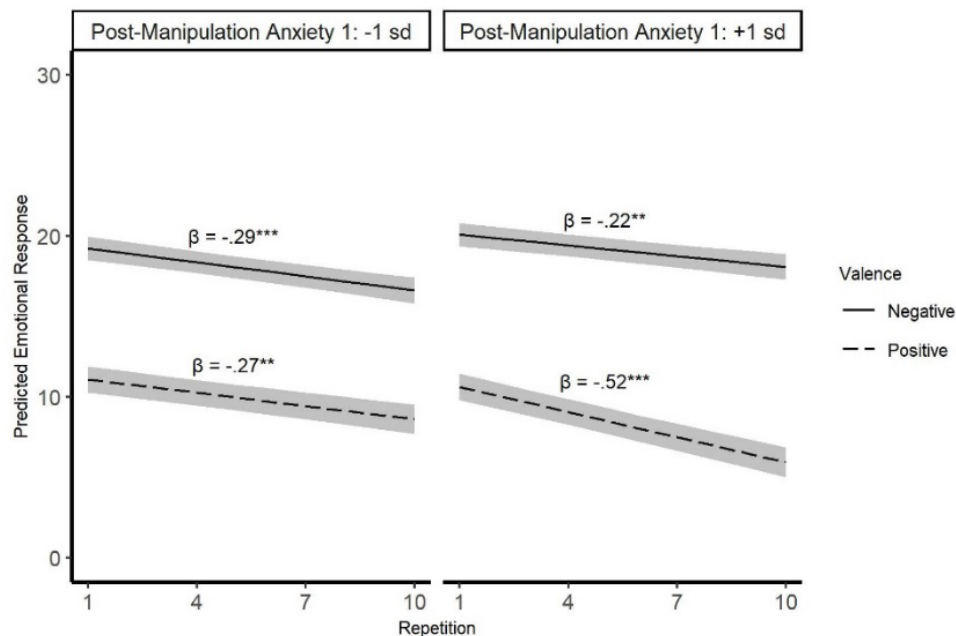
Does State Anxiety Moderate Habituation to Negative vs. Positive Images?

To test hypothesis 2, we first added experimental condition (2: anxiety vs. control) and its interactions with valence and time as predictors of emotional intensity to the analysis described above. The 3-way interaction between valence*time*condition was not significant ($t(16663) = .86, b = -.11, p = .39$). This could partly be due to the fact that state anxiety also increased in the control condition from baseline to post-manipulation albeit to a lesser extent than in the experimental condition. Since post-manipulation anxiety was the psychological mechanism the experimental condition aimed to manipulate in the first place, in the next step we replaced experimental condition in the above analysis with post-manipulation state anxiety scores (an analytic approach that was preregistered, see <https://aspredicted.org/3qa57.pdf>).

As presented in Figure 5 below, results indicated a significant 3-way interaction between valence, repetition and post-manipulation anxiety ($t(16663) = 2.49, \beta = -.009, p = .01$; see Figure 2). This interaction held while we controlled for baseline anxiety ($t(16584) = 2.50, b = -.009, p < .01$), and when controlling for both baseline anxiety and interest levels ($t(16153) = 2.54, b = -.009, p = .01$).

Figure 5

Habituation Trajectories as a Function of Stimuli Valence and Anxiety



Notes. *** $p < .001$, ** $p < .01$, * $p < .05$. Rate of habituation to positive and negative stimuli for individuals low (-1 SD below) and high (+1 SD above) the mean on state anxiety 1. The bands around predicted lines represent 1 SE above and below the regression line.

Further analyses showed that the 2-way interaction between valence and repetition was significant only for individuals high (1 SD above the mean) in post-manipulation anxiety ($t(16663) = 3.34, b = 0.3, p = 0.001$), with faster habituation to positive ($t(16663) = -6.94, b = -0.52, p < .001$) than negative ($t(16663) = 2.98, b = -0.22, p < .003$) images. Among individuals low in post-manipulation anxiety (1 SD below the mean), results indicated significant effects for

valence (i.e., higher intensity for negative vs positive images; $t(16663) = 8.75, b = -8.14, p < .001$) and for repetition (i.e., decreased emotional intensity over time; $t(16663) = 3.88, b = -0.29, p = .0001$). However, the 2-way interaction between valence*repetition was not significant ($t(16663) = 0.17, b = 0.02, p = 0.86$), indicating similar habituation trajectories for negative and positive stimuli.

In additional simple slope analyses, we examined the 2-way interaction of repetition*post manipulation anxiety separately for negative and positive stimuli. Repetition*post manipulation anxiety interaction was not significant for negative images ($t(16663) = 0.64, \beta = 0.02, p = .52$), indicating that participants habituated to negative stimuli similarly regardless of anxiety. In contrast, the 2-way interaction between repetition and post-manipulation anxiety was significant for positively-valenced stimuli ($t(16663) = 2.32, \beta = -.007, p = .002$), demonstrating that individuals with high (+1 SD) anxiety levels habituated ($t(16663) = 6.94, \beta = -0.52, p < .001$) significantly faster than individuals with low (-1 SD) anxiety levels ($t(16663) = 3.66, \beta = -0.27, p < .001$). This pattern of results was identical to findings from study 1.

Do Individual Differences in Anxious Symptomatology Moderate Habituation to Negative vs. Positive Images?

To examine whether anxiety findings on individual differences in anxious symptomatology from study 1 could be replicated in study 2, we tested the 3-way interaction between repetition (continuous, 1-10; fixed), valence (2: positive vs. negative; fixed), and individual differences in anxiety symptoms of the control group, since the control group was more analogous to the design of Study 1 where state anxiety was not experimentally manipulated.

We ran our base model of valence and repetition with anxious symptomatology, as well as all higher-level interaction terms and random effects for effect coded valence and repetition. Replicating Study 1, results showed a significant 3-way interaction effect ($t(8526) = 1.74, b = -0.16, p = .04$, one-tailed). Furthermore, among those higher in anxious symptomatology there was a significant two-way valence*repetition interaction ($t(8526) = 2.04, b = -0.24, p = .04$) indicating that faster habituation to positive than to negative stimuli ($t(8526) = 5.21, \beta = -.55, p < .001$). The two-way interaction was not significant for individuals with lower levels of anxious symptomatology ($t(8526) = 0.33, \beta = 0.04, p = 0.74$), indicating comparable habituation rates to positive versus negative stimuli. Although anxious symptomatology showed a weaker moderation effect in the current study compared to the first experiment, it is important to note that the second study was not completely equivalent to the first study, since post-manipulation anxiety in the control group was significantly higher compared to their baseline anxiety ($t(202.88) = 7.11, p < .001$).

Do Thematic Differences in the Experimental Stimuli Moderate Habituation Rates?

Differently from the first study, the current study included fixed stimuli by emotional theme (sadness vs fear; love vs excitement). Having fixed stimuli between participants allowed us to systematically examine whether thematic differences in emotion elicitors resulted in different habituation trajectories.

Among negative stimuli, we predicted emotion intensity from repetition (continuous, 1-10; fixed and person centered on time 1), emotion elicitor (effect coded: fear = 1, sadness = -1), repetition*emotion elicitor, with random intercepts and slopes. Consistent with previous findings, results showed a main effect for time ($t(8226) = 4.74, b = -0.28, p < .001$) with decreasing emotional intensity over time, however the two-way interaction between repetition

and emotion elicitor type was not significant ($t(8226) = 0.62, b = 0.04, p = 0.54$), indicating no substantial differences between sadness and fear in habituation rates over time.

We observed similar pattern for the positive elicitors, while predicting emotion intensity from repetition (continuous, 1-10; fixed and person centered on time 1), emotion elicitor (effect coded: love = 1, excitement = -1), repetition*emotion elicitor, with random intercepts and slopes. We found a main effect for time ($t(8226) = 5.43, b = -0.36, p < .001$) with decreasing emotional intensity over time, and again the two-way interaction between repetition and emotion elicitor type was not significant ($t(8226) = 0.96, b = -0.07, p = 0.34$), indicating no substantial differences in habituation rates between love and excitement.

General Discussion

The present research included two studies which examined whether and how affective habituation might differ for positive vs. negative stimuli in normative samples. In Study 1 stimuli was selected based on idiographic ratings of positivity and negativity. To increase experimental control and examine generalizability of valence effects to normative stimuli, Study 2 used fixed stimuli across participants selected based on preestablished norms. Finally, Study 2 was a preregistered study aimed to replicate and extend Study 1 findings by manipulating rather than assessing state anxiety, and by further exploring potential habituation differences within each valence category based on thematic differences in the images used to elicit negative and positive emotions.

Findings were consistent across studies as well as with previous research in demonstrating a significant linear decline in the intensity of people's emotional reactions following repeated exposure to both positive and negative stimuli. As hypothesized, however, rate of affective habituation differed by valence and was faster for positive than negative emotional triggers – a pattern congruent with hedonic adaptation theorists' argument that "bad is stronger than good" (Baumeister et al., 2001; Lyubomirsky, 2011; Mantua & Ready, 2019; Pratto & John, 2001). Using different emotion elicitors within each valence did not result in different habituation trends, indicating that the observed effect is due to general valence differences.

Importantly, differences in the rate of habituation to positive vs. negative stimuli was moderated by both chronic and situationally induced anxiety, although the findings were only partially consistent with our initial hypotheses. On the one hand, people showed similar rates of habituation to negative stimuli regardless of level of anxiety – a finding inconsistent with a priori expectations (cf. Houtveen et al., 2001; Mantua & Ready, 2019; Mauss et al., 2003). Initially we considered that this finding might be due to the specific study paradigm applied in Study 1, where negative stimuli were ideographically equated in their negative intensity, creating a *strong situation*, and potentially decreasing response variance between groups (Lissek et al., 2006; Mischel, 1977). However, Study 2 showed the same effect even in response to normative stimuli, strengthening our conclusion that anxiety does not significantly impact habituation to negative elicitors. It is possible that the tendency of individuals higher in anxiety to habitually expect negative outcomes (e.g., Cabeleira et al., 2014) lead to a compensatory dampening of negative affect during repeated exposure to negative stimuli, thus, minimizing group differences in negative habituation. Other moderators could be in play as well, and due to limitations of the current study scope, it should be addressed in future research.

On the other hand, and consistent with expectations, people experiencing higher levels of anxiety (due to individual differences or situational inductions) habituated to positive stimuli significantly faster than those with low levels of anxiety, leading to even greater differences

between negative and positive habituation rates among the former compared to the latter. In other words, the “bad is stronger than good” bias observed at the group level was even stronger when individuals experienced higher (vs. lower) levels of anxiety. Because habituation occurred more slowly to positive (than negative) images at lower levels of anxiety and because experiencing prolonged positive emotion is known to enhance physical, social and intellectual resources (Fredrickson, 1998; Hofmann et al., 2012), findings from the current research suggest that positive habituation processes may be among the underpinnings of anxiety disorders, with slower habituation to positive stimuli (hence, more savoring of positive emotions) serving as a protective factor.

The role that positive emotions might play in vulnerability to mood and anxiety disorders is a topic relatively neglected compared to the emphasis placed on the role of negative emotions in psychopathology (Gross & Jazaieri, 2014; Joormann et al., 2007; Kring & Bachorowski, 1999). For example, heightened negative affect is emphasized to play a central role in the possible mechanisms of a wide range of psychological disorders (Kring & Bachorowski, 1999, Merriman et al., 2007; Nolen-Hoeksema, 2000). Additionally, common psychotherapy methods, such as cognitive therapy components of the CBT, emphasize negatively biased cognition as a core element in the treatment of mood and anxiety disorders, concentrating on patients’ daily negative affect and related automatic thoughts (Beck et al., 1979; Young et al., 2014). In contrast, although savoring positive emotions has been found to benefit psychological health (Bar-Haim et al., 2007; Catalino & Fredrickson, 2011; Eisner et al., 2009), positive habituation has not been examined in clinical populations and might be of importance in future work. However, more research is needed to replicate our preliminary findings and to test the possibility that faster positive habituation may be significantly and causally linked to anxiety.

Ruling out alternative mechanisms

It is also noteworthy that Study 1 ruled out novelty as an alternative explanation for valence differences in habituation. That is, because the kinds of events depicted in negative stimuli (e.g., plane crash) tend to be less common and more unfamiliar than those in positive images (e.g., sports), it was plausible that faster habituation to positive (vs. negative images) could be an artifact of differences in novelty. In secondary analyses of Study 1, we coded all images for novelty and pitted the effect of image valence on habituation over time against the effect of image novelty. Contrary to our expectation, we found that people habituated faster to themes that were rated as more novel. One plausible explanation that needs to be explored in future research is that themes people are most familiar with resonate as more self-relevant, which in turn, elicit higher emotional intensity (N'diaye et al., 2009; Sander et al., 2007). Yet, differences as a function of image valence also held, indicating that valence impacts habituation above and beyond novelty.

Secondary analyses of the first experiment also addressed an unanticipated consequence of using an idiographic approach to experimental stimuli selection, namely, whether the specific images participants viewed during habituation differed thematically between low and anxious individuals (e.g., was anxiety correlated with viewing more positive images depicting romance themes less?) To rule out this potential confound, stimuli were rated along 12 dimensions that corresponded to the most common themes depicted in the images, but the analyses yielded no significant associations between anxiety and thematic differences either for positive or negative images. This issue was addressed in the second experiment, by presenting normative stimuli to all participants, which exposed participants to comparable stimuli. Results from study 2

confirmed that the reported anxiety effect was not related to thematic differences during habituation.

Limitations & Future Research

We would like to point to a number of limitations of the presented research. First, although we successfully manipulated anxiety in Study 2, individual differences in post-manipulation anxiety, rather than experimental condition per se, was a significant moderator of valence X time effect on emotional intensity. It is possible that experimental condition proved to be weak predictor because the stress manipulation increased anxiety in the control condition as well as the experimental condition, albeit to a lesser extent. Therefore, although the pattern of findings with post-manipulation anxiety was consistent with our preregistered hypotheses and replicated Study 1 findings, we are limited in the causal inferences we can make about the role of anxiety. Tackling the causality question should be a priority in future work because just as it is important to know if anxiety leads people to habituate faster to positive stimuli, it's just as important to know if faster habituation to positive elicitors is a precursor to anxiety. Knowing the answers to these questions could both directly inform interventions and treatment in clinical settings.

Second, the current research utilized a self-reported measure to assess the trajectories of emotional experience over time. Although the multilevel analyses accounted for individual differences in reporting, it still might have some reliability and validity issues such as people misreporting their experiences, understating or exaggerating habituation trends. Therefore, the results should be replicated with additional objective measures of habituation (e.g., skin conductance) in future studies.

Lastly, the images that were presented during the repetition part in our first study were selected ideographically based on the highest emotional rating given by each participant. In the second study the images were specifically selected based on previously established norms of moderate to high arousal rates and polar valence ratings (Ito et al., 1998). This may have led to a ceiling effect preventing us from being able to detect potential sensitization – a process where affective intensity increases with repeated exposure (Groves & Thompson, 1970). Setting a lower range of affective intensity in the stimuli selection process in future research might allow us to examine sensitization processes alongside habituation.

Conclusions

Temporal dynamics of affective responding is a topic that is receiving growing empirical attention (Davidson, 2015; Hamaker et al., 2015; Kuppens, 2015; Kuppens et al., 2007; Larsen et al., 2009; Trull et al., 2015; Verduyn et al., 2019), being examined in multiple, differing frameworks, including that of hedonic adaptation, affective chronometry, and affective habituation. The current research contributes to this broader aim of understanding the time course of emotional responding by focusing on the moment-by-moment affective habituation to repeated emotion elicitation. Specifically, by showing that a) people habituate to positive stimuli faster than negative stimuli and b) this is specifically true for people higher in anxiety, the current results suggest that the way people respond to positive stimuli is of importance as it might serve as an additional marker for vulnerability to emotional dysfunction.

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Appendices

Study 1

Overview

Part I describes additional measures which were administered for exploratory purposes. Part II includes analyses on additional moderators, including depression, neuroticism, baseline intensity, gender, and order of presentation. Part III reports additional analyses conducted on the thematic ratings of the experimental stimuli.

Part I – Additional Measures

Depression

Depression was evaluated on the following questionnaires: i) the Center for Epidemiologic Studies Depression Scale (CES-D, Radloff, 1977) which assesses the degree to which 20 symptoms of depression were experienced over the past week (0 = rarely or none of the time, 3 = Most of the time; $\alpha = .87$, $M = 13.25$, $SD = 8.43$), ii) Depression items ($k = 7$) from the depression sub-scale of the DASS 21 (Lovibond & Lovibond 1995), were rated on a 4 point rating scale (0=never, 3=always; $\alpha = .88$, $M = 9.6$, $SD = 8.29$) and iii) the Rumination Response Scale (RRS, Treynor et al., 2003) which includes 22 items assessing ruminative responses when facing depressed mood (1 = almost never, 4 = almost always; $\alpha = .91$, $M = 49.49$, $SD = 12.04$). A composite depression score was computed by averaging standardized scores across the three scales ($\alpha = .85$, $M = 0$, $SD = .88$).

Personality Factors

Big 5 personality factors were evaluated by the Big Five Inventory (BFI, John, Donahue, & Kentle, 1991). BFI contains 44 items measuring extraversion ($k = 8$; $M = 3.11$, $SD = 0.82$, $\alpha = 0.85$), agreeableness ($k = 9$, $M = 3.73$, $SD = 0.55$, $\alpha = 0.67$), conscientiousness ($k = 9$; $M = 3.45$, $SD = 0.71$, $\alpha = 0.81$), neuroticism ($k = 8$; $M = 2.98$, $SD = 0.81$, $\alpha = 0.84$), and openness to experience ($k = 10$, $M = 3.67$, $SD = 0.76$, $\alpha = 0.86$). The items were rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Emotion Regulation

The Emotion Regulation Questionnaire (ERQ, Gross & John, 2003), assessed the habitual use of suppression ($k = 4$) and reappraisal ($k = 6$). Ratings were completed on a 7-point Likert scale (1 = “strongly disagree” to 7 = “strongly agree”) and averages were computed for each subscale (suppression: $\alpha = 0.71$, $M = 15.36$, $SD = 4.46$; reappraisal: $\alpha = 0.83$, $M = 30.35$, $SD = 5.64$).

Experiences in Close Relationships

Participants completed the Experiences in Close Relationships Scale – Short Form (ECR-S, Wei et al., 2007), which measured the levels of attachment avoidance ($k=6$) and anxiety ($k=6$). They were asked to rate their degree of agreement with statements describing their relationships with significant others (e.g., “It helps to turn to my significant others in times of need”). Ratings were made on a 7-point Likert scale (1= “strongly disagree” to 7 = “strongly agree”) and averaged within each subscale to indicate levels of avoidance ($\alpha = 0.76$, $M = 2.94$, $SD = 1.13$) and anxiety ($\alpha = 0.71$, $M = 3.89$, $SD = 1.18$).

Rejection Sensitivity

Rejection Sensitivity Questionnaire (RSQ; Downey & Feldman, 1996) was administered to assess rejection expectations. The questionnaire presents 18 statements describing possible scenarios of possible rejection by a significant other. Participants indicated their levels of concern (1= very unconcerned to 6 = very concerned), and the likelihood of others responding with acceptance for each scenario, on a six-point-scale (1 = very unlikely, to 6 = very likely). The score for each item is a product of the concern and likelihood of rejection. The total rejection sensitivity score was calculated by dividing the products' sum by the number of test items ($\alpha = 0.79$, $M = 10.39$, $SD = 3.35$).

Behavioral Inhibition and Behavioral Activation Scales (BIS:BAS)

The 20-item BIS-BAS questionnaire (Carver & White, 1994) was administered to assess BIS-BAS behavioral motivational systems and included 4 subscales; 1 measuring behavioral inhibition ($k=7$; $\alpha = 0.76$, $M = 20.04$, $SD = 4.03$), and three subscales of behavioral activation; reward responsiveness ($k=5$; $\alpha = 0.84$, $M = 16.58$, $SD = 2.87$), drive ($k=4$; $\alpha = 0.78$, $M = 10.24$, $SD = 2.54$), and fun seeking ($k=4$; $\alpha = 0.77$, $M = 11.18$, $SD = 2.7$). The items were rated on a 4-point scale ranging from 1 (strongly disagree) to 4 (strongly agree).

Distinct Emotions Elicited During Habituation

In Phase 3 of the experiment, we presented participants with the 4 images they were exposed to in the habituation task they had previously completed. Participants were asked to choose from a drop-down menu the most dominant emotion they felt when they saw each of the 4 images for the first and the last time. Emotion options included: fear, sadness, disgust, anger, awe, excitement, contentment, amusement, anxiety, empathy, horror, interest, joy, nostalgia, satisfaction, romance, and other (see Frequencies Table A1a for the negative images and Table A1b for the positive images).

Part II – Additional Moderator Analyses

Moderation by Individual Anxiety Scales

Analyses with the anxiety composite reported in the manuscript were rerun with each of the individual anxiety scales that comprised the composite. Specifically, in 3 separate models, we predicted emotional intensity from standardized anxiety scores using the DASS 21 anxiety, DASS 21 stress and BAI, with repetition (continuous, 1-10; fixed) and valence (2: positive vs. negative; fixed). Results presented in Table A2 show that the anxiety*repetition*valence interaction which was our theoretical focus was statistically significant in all 3 cases. These results suggest that the 3-way interaction reported in the main manuscript was not primarily driven by any one scale that made up the composite and anxiety moderated habituation regardless of the scale used to operationalize it.

Moderation by Depression

We explored whether emotional habituation rates differ as a function of depression symptoms. We repeated the key multilevel model of predicting emotional intensity from repetition (continuous, 1-10; fixed), valence (2: positive vs. negative; fixed) and depression (standardized, fixed) including all higher interaction terms among valence, repetition and depression, with random intercepts and slopes. Main effects and all lower-level interaction terms from this analysis are presented in Table A3. As shown in Table A3, the pattern of findings was identical to those reported in the main text for anxiety.

Moderation by Neuroticism

We were interested to test the influence of neuroticism on habituation rates. We added neuroticism (standard, fixed) to the multilevel model predicting emotional intensity from repetition (continuous, 1-10; fixed) and valence (2: positive vs. negative; fixed) as well as all higher interaction terms among valence, repetition and neuroticism, with random intercepts and slopes. The results showed no significant interaction effect of repetition and valence with neuroticism ($t(4038) = 1.57, \beta = -.16, p = .12$), signifying that the habituation trends were not influenced by differences in neuroticism levels in the current sample.

Moderation by Baseline Intensity

One question we wished to address was whether the intensity of affect at the very first presentation of each image (baseline intensity from hereon) moderated subsequent rates of habituation. We reasoned for example that people may show slower habituation to images that were not high in intensity to start with; the opposite possibility, namely that people might habituate more slowly to higher intensity images was also conceivable. Furthermore, these patterns could be different depending on stimuli valence; for example, the rate of habituation to positive stimuli might be faster than to negative one, when baseline intensity is high. In low baseline intensity, there might not be as much need to habituate, and therefore the habituation rates for both negative and positive stimuli could be similarly low.

To explore these possibilities, baseline intensity was grand mean centered and was added as a fixed effect to our base model of valence and repetition predicting emotional responses⁵. This analysis yielded a significant 3-way interaction ($t(4000) = 5.51, \beta = -.05, p < .001$),

⁵ A single outlier as identified by R was excluded from models of baseline intensity.

indicating that people show different habituation rates for positive vs. negative images depending on baseline image intensity (see Figure A1).

In subsequent simple slope analyses conducted to unpack this interaction, we examined valence*repetition interaction for images high (+1 SD) vs. low (-1 SD) in baseline intensity. For high intensity (+1 SD) images, there was significant 2-way interaction between valence*repetition ($t(4000) = 6.55, \beta = -.78, p < .001$) such that rate of habituation, although significant for both positive ($t(4000) = 12.42, \beta = -1.33, p < .001$) and negative ($t(4039) = 6.32, \beta = -0.54, p < .001$) stimuli, was much faster for the former than for the latter. In contrast, for images low (-1 SD) in baseline intensity valence*repetition interaction was not significant ($t(4000) = 0.05, \beta = -0.01, p = .96$). There was however, a significant main effect of time such that people's emotional responses lost their intensity with repeated exposure ($t(4000) = 2.73, \beta = -.28, p = 0.006$) and did so at a similar rate for positive and negative images. The main effect of valence was not significant ($t(4000) = 1.69, \beta = -.77, p = .09$).

Unique Effects of Anxiety and Baseline Intensity. Even though anxiety and baseline intensity were not correlated (Negative images: $r = -.05, p = .64$; Positive images: $r = 0, p = 1.00$), in subsequent analyses, we pitted the 3-way interaction with anxiety (valence*time*anxiety) against the 3-way interaction with baseline intensity (valence*time*baseline intensity). The rationale for running this model was to assess whether anxiety and image intensity had unique effects above and beyond the effect of each other. In this analysis both interaction terms remained significant ($t(3997) = 2.13, \beta = -.23, p = .03$, and $t(3997) = 5.47, \beta = -.05, p < .001$, respectively) indicating that anxiety and baseline intensity impact habituation rates for positive vs. negative stimuli above and beyond the effect of each other. Footnote: the 4-way interaction among valence*time*anxiety*baseline intensity was not significant, $t < 1$.

In summary, exploratory analyses revealed an interesting finding regarding how habituation rates are moderated by the intensity with which an image elicited emotion in its first presentation. The pattern was such that participants showed faster rate of habituation to both negative and positive images that were higher in intensity to start with (though this effect was more pronounced for positive images). These results cannot be explained by a floor effect, since images (even the lower intensity ones) were preselected for the experiment based on the high negativity ratings they received in the pilot phase. This pattern of findings -- that habituation failed to occur for stimuli that did not elicit intense emotions, is in line with the exposure therapy framework's assumption that without a substantial elicitation of the fear response, emotional processing cannot occur (Foa & Kozak, 1986).

Moderation by Gender

Due to considerably higher prevalence of anxiety disorders during lifetime in women compared to men (e.g., Bandelow & Michaelis, 2015; McLean et al., 2011), we examined whether habituation might vary as function of individual differences in anxiety and gender jointly. To address this question, we tested gender as an additional moderator in a mixed effect model, predicting emotional intensity from valence (2: negative vs. positive, fixed and random effects), repetition (continuous, fixed and random effects), anxiety (continuous, fixed effects), and gender (2: male vs. female, fixed effects). We found a significant 4-way interaction between valence*repetition*anxiety*gender ($t(4032) = 2.27, \beta = -.42, p = .02$). To further unpack this 4-way interaction, we performed a series of simple slopes analyses, estimating the slope of

repetition on emotional intensity for each combination of valence, gender, and high/low anxiety (see Figure A2a and Figure A2b for men and women, respectively).

As can be seen in Figure S2.1, men showed different habituation patterns over time depending on stimulus valence and anxiety (repetition*valence*anxiety in men: $t(4032) = 3.39$, $\beta = -.50$, $p = .0007$). When data were analyzed separately for high (1 SD above) vs. low anxious men (1 SD below), results yielded a significant repetition*valence interaction among high anxious men ($t(4032) = 3.26$, $\beta = -.59$, $p = .001$) such that they showed significant habituation to positive stimuli ($t(4032) = 4.40$, $\beta = -.84$, $p < .001$), but not to negative stimuli ($t(4032) = 1.47$, $\beta = -.25$, $p = .14$). In contrast, low anxious men showed significant habituation to both positive ($t(4032) = 2.42$, $\beta = -.47$, $p = .02$) and negative stimuli ($t(4032) = 4.32$, $\beta = -.76$, $p < .001$), which were not significantly different from each other (repetition*valence: $t(4032) = 1.52$, $\beta = .28$, $p = .13$).

In further analyses of the 3-way interaction between repetition*valence*anxiety among men, we performed simple slope analyses where we looked at the repetition*anxiety interaction for negative vs. positive stimuli. The two-way repetition*anxiety interaction was significant for negatively-valenced ($t(4032) = 2.09$, $\beta = 0.29$, $p = .04$), but not for positively-valenced ($t(4032) = 1.36$, $\beta = -0.21$, $p = .18$) images. These results indicate that whereas habituation to negative stimuli depended on men's anxiety, habituation to positive images did not.

For women (see Figure A2b), in contrast to men, habituation to positive and negative stimuli was not moderated by anxiety (repetition*valence*anxiety: $t(4032) = .67$, $\beta = -.08$, $p = .50$). However, the 2-way interaction between repetition and valence was significant ($t(4032) = 2.00$, $\beta = -.20$, $p = .05$) such that women habituated faster to positive ($t(4032) = 5.91$, $\beta = -.62$, $p < .001$) than to negative ($t(4032) = 4.50$, $\beta = -.42$, $p < .001$) stimuli regardless of anxiety levels.

Moderation by Order of Presentation

Although the valence of the 4 images (2 positive and 2 negative) was randomly presented for each participant, one of the questions we addressed was whether habituation rates were impacted by the order with which Ps viewed positive and negative images. More specifically, two questions were posed: a) Do people habituate to negative images faster after having seen a different negative image or a positive image? b) Do people habituate to positive images faster after having seen a different positive image or a negative image?

To address the issue of whether habituation rates depended on the valence of the image presented in a preceding trial, we ran our original analysis with the addition of previous trial's valence as a moderator. That is, we predicted emotion intensity from repetition (continuous; 1-10; fixed), valence (2: positive vs. negative; fixed) and previous trial (2: positive vs. negative) and all 2- and 3-way interaction terms (continuous, fixed). For random effects we were able to include repetition, valence and their interaction; however, the model did not run when we tried to add the valence of the previous trial in the random effects. The 3-way interaction between the valence*repetition*previous trial ($t(2968) = 0.51$, $b = -.08$, $p = .61$) was not significant indicating that order did not moderate positive and negative habituation rates.

Part III. Additional Analyses on Image Themes

As reported in the main text, images were coded on the following themes: Excitement/Enthusiasm, Competition/Ambition, Romance/Love/Sensuality, Disgust/Revulsion, Loneliness/Isolation, Human Suffering (illness, pain), Death/Injury/Threat of physical harm,

Male to Female Aggression, War/Terrorism, Outdoor activity/Sports, Sadness/Crying, Sensation seeking/adventure, Other. Due to possible overlap between the various themes, we examined the factorability between the themes, and observed many correlations above 0.3. Bartlett's test of sphericity was significant ($\chi^2(66) = 231.93, p < .001$) and confirmed the need for reduction of themes to more basic factors. We performed Exploratory Factor Analysis (EFA) using varimax rotation to capture orthogonal latent variables (see Table S4a for details).

Examination of eigen-values and the scree plot indicated an optimal number of 3 components, which explained 77% of the total variance (See Table S4a). Factor 1 (40%) -- *excitement* (vs. aggression), included themes of excitement, competition, disgust (reversed), male-female aggression (reversed), war (reversed), outdoor activity and sensation seeking; Factor 2 (21%) -- *death* (vs. love), included themes of death and romance (reversed); Factor 3 (16%) -- *loneliness*, included themes of loneliness, and sadness. Sadness (Factor 3) and Suffering (Factor 1) ratings loaded on more than one factor, and were thus, not included in creating factor scores.

We created average factor scores for the 2 positive and 2 negative images each participant viewed during the habituation phase of the study. We chose to calculate factor scores for positive and negative images separately (instead of averaging across 4 images) to provide a more granular examination of the relationship between anxiety and image theme. We then computed Pearson correlations between anxiety and factor ratings. Table S4b shows that we observed no significant correlations between any of the EFA themes and anxiety.

Event Type (Interpersonal vs. Individual). In addition to thematic coding, images were also coded for whether or not they depicted scenes that were interpersonal/social. Any image that included more than one person were coded as interpersonal; images that included only a single person was coded as individual. For example, a scene describing a soldier pointing a gun at a child, or a scene of a romantic couple were coded as interpersonal, while images of a crying child or a lone skier were coded as individual. There were 11 interpersonal images (6 negative, 5 positive) and 9 individual images (4 negative, 5 positive). Because this coding simply required a count of people in each image, the first author did this coding on her own.

We ran logistic regression on event type (Interpersonal = 1, Individual = 0), with anxiety as the predictor. The results revealed no significant log ratio of anxiety scores in predicting interpersonal vs. individual events included in the images ($z = -0.05, b = -.01, p = .96$). Thus, the probability of viewing interpersonal vs. individual images during habituation was not dependent on anxiety scores.

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Tables and Figures for Study 1

Table A1a

Study 1 - Frequency Table of Distinct Emotions to Negative Images before and after repeated exposure (self-reported at the end of the exposure phase)

Emotions	Negative # 1: before exposure	Negative # 1: after exposure	Negative # 2: before exposure	Negative # 2: after exposure
anger	12	10	8	13
anxiety	10	13	7	6
disgust	16	16	13	23
empathy	3	3	0	9
fear	23	14	23	8
horror	26	13	37	0
sadness	14	31	17	0
contentment	0	0	0	1

Table A1b

Study 1 - Frequency Table of Distinct Emotions to Positive Images before and after repeated exposure (self-reported at the end of the exposure phase)

Emotions	Positive # 1: before exposure	Positive # 1: after exposure	Positive # 2: before exposure	Positive # 2: after exposure
amusement	3	2	6	10
awe	23	8	12	4
contentment	7	13	6	11
empathy		2		
excitement	33	15	36	9
interest	2	9	6	15
joy	5	9	6	14
nostalgia	5	5	4	4
romance	21	17	23	11
satisfaction	4	8	4	10
anxiety	1	0		1
sadness	1	1		
disgust		1	1	
fear		1	1	1

Table A2

*Study 1 - Comparing the 3-way Interaction Among Valence*Time*Anxiety in Using Different Anxiety Measures (anxiety construct, DASS 21 anxiety subscale, DASS 21 stress subscale, BAI).*

	β	SE	DF	t-value	p-value
Valence*Repetition*anxiety composite	-0.23	.09	4038	-2.53	.01
Valence*Repetition*anxiety.BAI	-0.19	.08	4038	-2.27	.02
Valence*Repetition*anxiety.DASS21	-0.17	.08	4038	-2.01	.04
Valence*Repetition*stress.DASS21	-0.18	.08	4038	-2.23	.025

Table A3.*Study 1 - The 3-way Interaction Among Valence*Time*Depression*

	β	SE	DF	t-value	p-value
Valence (effect coded)	-5.07	.72	4038	7.01	<.001
Repetition (1 st repetition centered)	-0.45	.08	4038	5.90	<.001
Depression	-0.82	.65	102	1.26	.21
Valence*Repetition	-0.19	.08	4038	2.29	.02
Valence*Depression	0.12	.83	4038	0.15	.88
Repetition*Depression	0.14	.08	4038	1.62	.10
Valence*Repetition*Depression	-0.25	.09	4038	2.69	.01

Table A4a*Study 1 - Exploratory Factor Analyses of Coded Themes.*

		Factors		
		1	2	3
		Excitement (vs. Aggression)	Death (vs. Love)	Loneliness
Themes	Excitement	.81		
	Competition	.90		
	Outdoor activity	.98		
	Sensation seeking	.85		
	Disgust	-.52		
	War	-.45		
	Male-Female Aggression	-.35		
	Romance		-.91	
	Death		.88	
	Loneliness			.97
	Sadness	-.57		.57
	Suffering	-.70	.56	
	<i>% Variance Explained</i>	40	21	16
Factor Correlations	Factor 1	--	-.64	-.72
	Factor 2	-.29	--	.67
	Factor 3	-.34	.42	--

Notes. Factor correlations above the diagonal include all themes in their respective factors whereas those below the diagonal exclude suffering (from Factor 1) and sadness (from Factor 3). In all factor correlations the negative items within factors 1 and 2 were reversed scored.

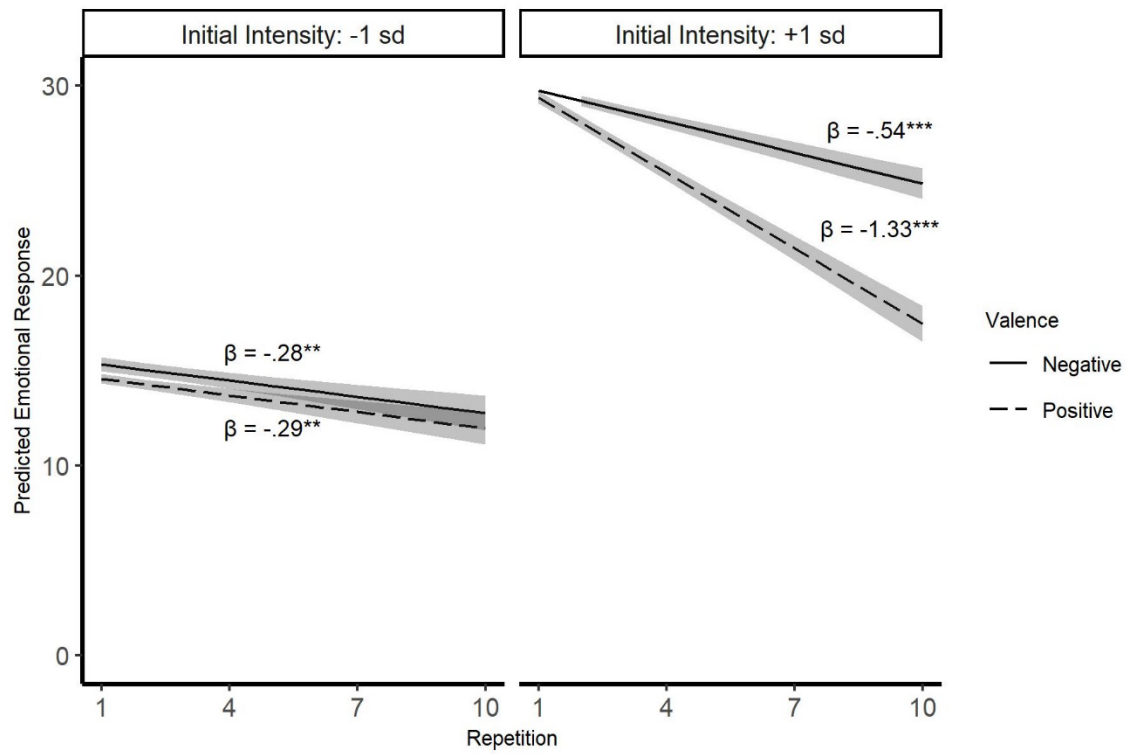
Table A4b*Study 1 - Pearson correlations between anxiety and image themes.*

Individual themes	Image Valence	
	Positive	Negative
<i>Excitement</i>	-.09	NA
<i>Competition</i>	-.09	-.04
<i>Outdoor activity</i>	-.09	-.03
<i>Sensation seeking</i>	-.08	-.02
<i>Disgust</i>	NA	.14
<i>War</i>	.09	.00
<i>Male-Female Aggression</i>	.10	-.06
<i>Romance</i>	.09	-.17
<i>Death</i>	-.11	-.14
<i>Loneliness</i>	-.01	.09
<i>Sadness</i>	NA	.05
<i>Suffering</i>	-.03	.13
Factors based on EFA		
<i>Excitement (vs. aggression)</i>	-.10	-.01
<i>Death (vs. love)</i>	-.10	-.09
<i>Loneliness</i>	-.01	.09

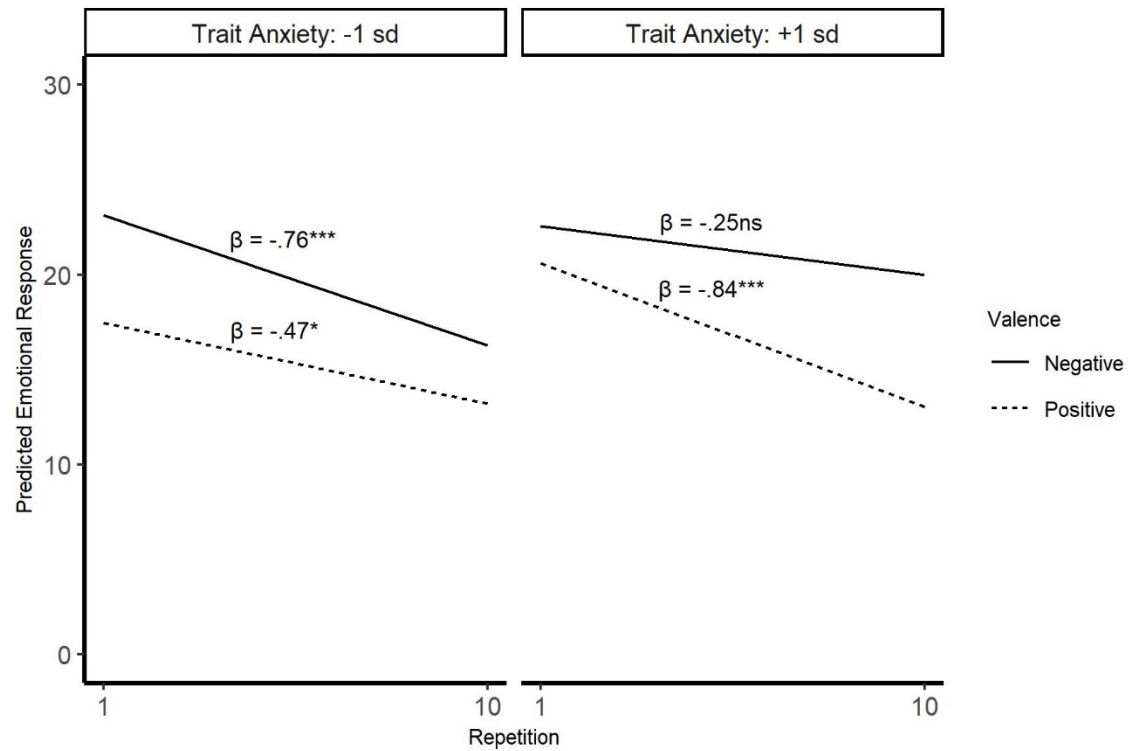
Notes. In cells with NA, correlations could not be computed because there was no variability in theme ratings. None of the correlation coefficients were significant at $p < .05$.

Figure A1

Study 1 - Rate of Habituation to Positive and Negative Stimuli for Individuals Low and High on Initial Emotional Intensity of the First Image Repetition Time



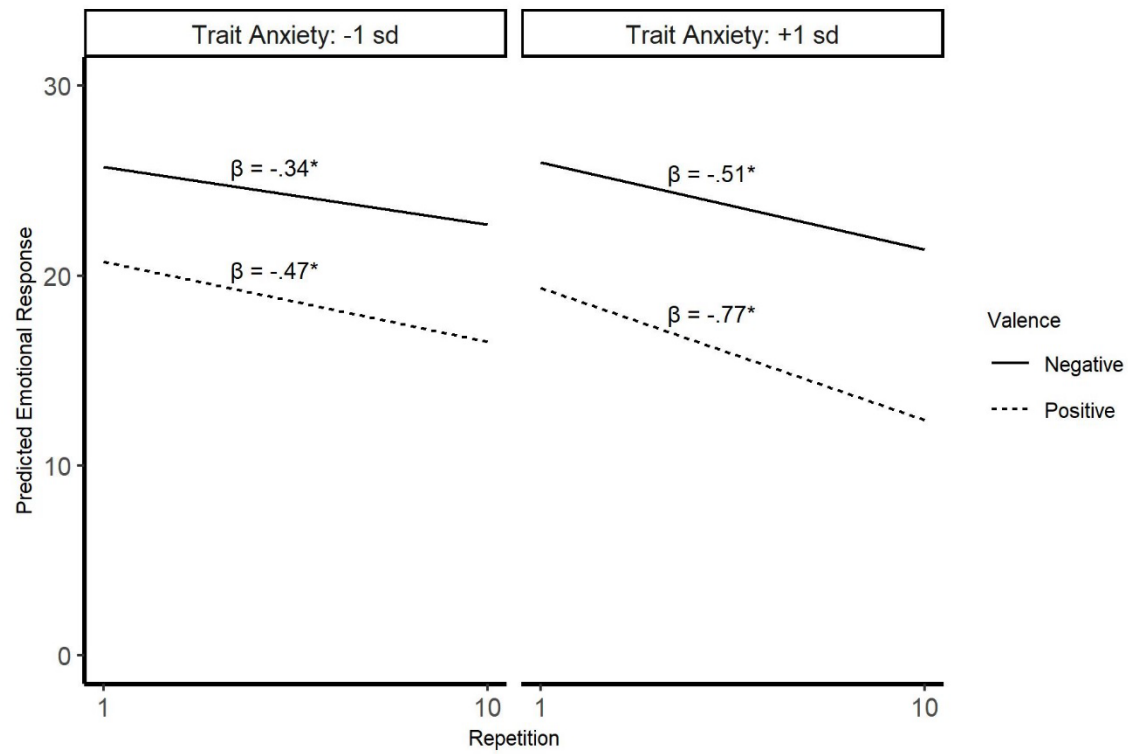
Note. *** $p < .001$, ** $p < .01$, * $p < .05$. The bands around predicted lines represent 95% CIs.

Figure A2a*Study 1 - Simple Slope of Repetition on Emotional Intensity Among High vs. Low Anxious Men*

Note. *** $p < .001$, ** $p < .01$, * $p < .05$

Figure A2b

Study 1 - Simple Slope of Repetition on Emotional Intensity Among High vs. Low Anxious Women



Note. *** $p < .001$, ** $p < .01$, * $p < .05$

Study 2

Overview

Part I describes additional measures which were administered for exploratory purposes. Part II includes analyses on additional moderators, including, neuroticism and gender.

Part 1 - Additional Measures

Personality Factors

Big 5 personality factors were evaluated by the Big Five Inventory-2 (BFI2, Soto & John, 2017). BFI-2 contains 60 items measuring extraversion ($k = 12$; $M = 3.23$, $SD = 0.78$, $\alpha = 0.87$), agreeableness ($k = 12$, $M = 3.67$, $SD = 0.55$, $\alpha = 0.73$), conscientiousness ($k = 12$; $M = 3.48$, $SD = 0.73$, $\alpha = 0.86$), negative emotionality ($k = 12$; $M = 2.91$, $SD = 0.82$, $\alpha = 0.89$), and open-mindedness ($k = 12$, $M = 3.82$, $SD = 0.67$, $\alpha = 0.83$). The items were rated on a five-point Likert scale (1 = disagree strongly, 5 = agree strongly).

Emotion Regulation

The Emotion Regulation Questionnaire (ERQ, Gross & John, 2003), assessed the habitual use of suppression ($k = 4$) and reappraisal ($k = 6$). Ratings were completed on a 7-point Likert scale (1 = “strongly disagree” to 7 = “strongly agree”) and averages were computed for each subscale (suppression: $\alpha = 0.78$, $M = 3.95$, $SD = 1.28$; reappraisal: $\alpha = 0.86$, $M = 4.89$, $SD = 1.05$).

Experiences in Close Relationships

Participants completed the Experiences in Close Relationships Scale – Short Form (ECR-S, Wei et al., 2007), which measured the levels of attachment avoidance ($k=6$) and anxiety ($k=6$). They were asked to rate their degree of agreement with statements describing their relationships with significant others (e.g., “It helps to turn to my significant others in times of need”). Ratings were made on a 7-point Likert scale (1= “strongly disagree” to 7 = “strongly agree”) and averaged within each subscale to indicate levels of avoidance ($\alpha = 0.8$, $M = 2.87$, $SD = 1.2$) and anxiety ($\alpha = 0.81$, $M = 3.81$, $SD = 1.42$).

Temporal Distancing

The Temporal Distancing Questionnaire (Bruehlman-Senecal, Ayduk & John, 2016), assessed participants’ habitual response while facing negative or unpleasant life events. Participants rated their agreement with the items on a 5-point scale (1 = “strongly disagree” to 5 = “strongly agree”) and averaged to indicate levels of temporal distancing ($\alpha = 0.79$, $M = 3.55$, $SD = 0.7$).

Emotional Reactivity

The Emotion Reactivity Scale (PERS; Beccera et al., 2019), was modified to address the specific emotions in the current study (sadness, fear, love, excitement). Participants rated different aspects of their habitual reaction to experiencing emotional events on a 5-point scale (1 = “very unlike me” to 5 = “very like me”). The scale consisted of 18 statements categorized into 3 factor domains: Ease of Activation (e.g., “I tend to get unhappy/sad very easily”; $\alpha = 0.44$, $M = 3.26$,

$SD = 0.65$), Duration (e.g., “It’s hard for me to recover from being unhappy/sad”; $\alpha = 0.56$, $M = 3.39$, $SD = 0.67$), and Intensity (e.g., “I tend to feel affection and love very strongly”; $\alpha = 0.65$, $M = 3.58$, $SD = 0.68$).

Savoring/Dampening

13 items were extracted from 3 instruments (RPA; Feldman, Joorman, & Johnson, 2008, IRPAS; Wright & Armstrong, 2016, SBI; Bryant, 2003) together with one original item to create a Savoring/Dampening Combined questionnaire. Participants were presented with a statement “When I feel happy, excited, or good, I...”, and rated 13 items (e.g., Dampening: “Think about things that could go wrong”; Savoring: “Can prolong enjoyment”), “on a scale of 1 (Never) to 5 (Always). Scores were averaged within each subscale to indicate levels of savoring ($\alpha = 0.8$, $M = 3.73$, $SD = 0.72$) and dampening ($\alpha = 0.87$, $M = 2.22$, $SD = 0.92$).

Social Avoidance and Distress

Participants were administered with the Social Avoidance and Distress Scale (SADS; Watson & Friend, 1969), which included 28 items describing aspects of social anxiety including distress, discomfort, avoidance and fear. The items were rated on a scale of true/false, and the total score was computed by summing the ratings across items ($\alpha = 0.92$, $M = 10.61$, $SD = 7.5$), with higher scores indicating greater social anxiety.

State Anxiety. State anxiety was measured by asking “Right now, how tense, on edge or anxious do you feel?”. Participants chose a rating on a sliding scale from 1 (not at all), 4 (moderately so) to 7 (very much so) with increments of 0.1. This question was presented a total of 4 times throughout the second study session, as the following: i) *baseline anxiety* presented at the very beginning of Session 2 ($M = 2.38$, $SD = 1.33$; experimental: $M = 2.49$, $SD = 1.36$; control: $M = 2.28$, $SD = 1.29$); ii) *post-manipulation anxiety*, presented after the “My Dream Job” task and immediately before the habituation task ($M = 4.38$, $SD = 1.76$; experimental: $M = 5.07$, $SD = 1.62$; control: $M = 3.71$, $SD = 1.64$); iii) *mid-habituation anxiety* which was assessed mid-way during the habituation task, after the first set of images were rated ($M = 3.82$, $SD = 1.84$; experimental: $M = 4.47$, $SD = 1.79$; control: $M = 3.27$, $SD = 1.64$); and iv) *post-habituation anxiety* assessed right after the habituation task ($M = 3.56$, $SD = 2.01$; experimental: $M = 4.16$, $SD = 2.02$; control: $M = 3.03$, $SD = 1.82$).

Interest. Interest was measured at baseline and at 8 timepoints during the habituation task, following the 10th presentation of each image. Participants were asked “How interested, engaged or attentive do you feel at this moment?”. The responses were rated on a sliding scale ranging from 1 (not at all) to 7 (very much so) with increments of 0.1. Interest declined across time during the habituation task as presented in Figure A3. However, interest levels were not significantly different between groups at baseline ($t(417.8) = 0.06$, $p = .95$) nor the mean ratings during the habituation phase were different between groups ($t(12.99) = -0.37$, $p = .72$).

Part II – Additional Moderator Analyses

Interest

To examine the change in interest ratings during the habituation task, we predicted interest ratings from the interest rating order within the habituation task (1-8, fixed and random effects).

Results indicated that interest ratings declined significantly across images during habituation task ($t(16238) = 6.79, \beta = -0.08, p < .001$). However, this decline in interest over time was not moderated by valence, since adding valence (2: negative vs. positive, fixed and random effects) to the above described model did not result in a 2 way interaction between image order*valence ($t(16236) = 1.05, \beta = -0.02, p = .3$).

Moderation by Gender

We examined whether habituation might vary as function of individual differences in anxiety and gender. We included gender as an additional moderator in a mixed effect model, predicting emotional intensity from valence (2: negative vs. positive, fixed and random effects), repetition (continuous, fixed and random effects), post-manipulation anxiety (continuous, fixed effects), and gender (2: male vs. female, fixed effects). The 4-way interaction between valence*repetition*post-manipulation anxiety*gender was not significant ($t(16657) = 0.22, \beta = 0.02, p = .83$). We also examined the 3-way interaction of valence*repetition*post manipulation anxiety separately within male and women samples. Results showed a marginal 3-way interaction in women only ($t(8368) = -1.92, \beta = -.01, p = .06$), while in the male sample anxiety post-manipulation did not moderate the habituation rates ($t(8289) = -1.51, \beta = -.008, p = .13$). To further unpack this 3-way marginal interaction in women, we completed simple slopes analyses estimating the slope of repetition on emotional intensity for high/low post manipulation anxiety.

When data were analyzed separately for high (1 SD above) vs. low anxious women (1 SD below), results yielded a significant repetition*valence interaction among high anxious women ($t(8368) = 2.74, \beta = -.34, p = .006$). The two-way repetition*valence interaction was marginal (repetition*valence: $t(8368) = -1.9, \beta = -0.09, p = .06$). Simple slopes analyses showed significant habituation to positive and negative stimuli, but positive habituation was higher ($t(8368) = 5.53, \beta = -.55, p < .001$) than negative habituation ($t(8368) = 2.07, \beta = -.21, p = .04$). Low anxious women habituated at a similar pace to both positive ($t(8368) = 3.06, \beta = -.33, p = .002$) and negative stimuli ($t(8368) = 3.12, \beta = -.33, p = .002$).

In further analyses of the 3-way interaction between repetition*valence*anxiety among women, the simple slope analyses of the repetition*anxiety interaction for negative vs. positive stimuli were not significant for both negatively valenced ($t(8368) = 0.87, \beta = -.003, p = .38$) and positively valenced ($t(8368) = 1.52, \beta = -.006, p = .13$) images. These results indicate that habituation of both types of images did not depend on anxiety.

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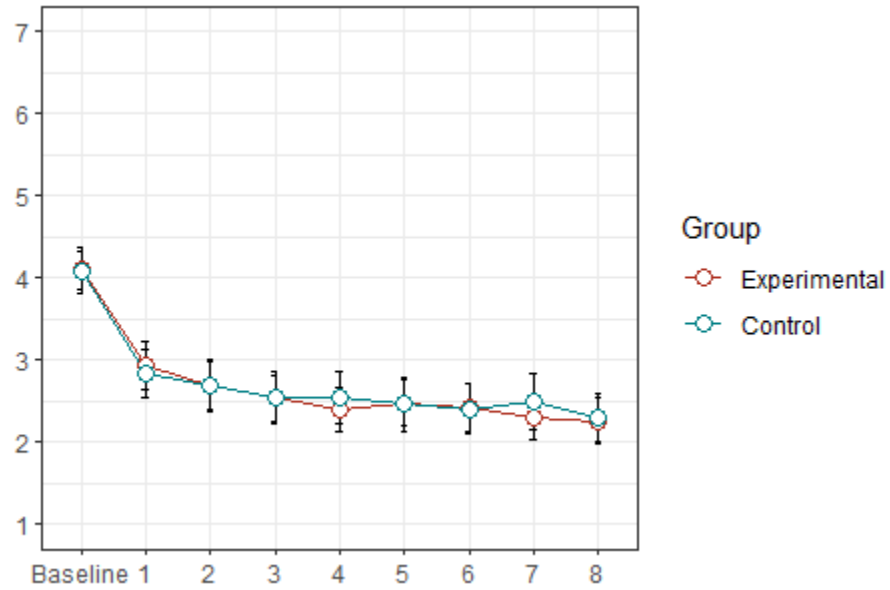
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Figures for Study 2**Figure A3***Interest Levels Over Time*

Note. The X axis represents the order of the interest ratings measured at baseline and 8 additional times after 10th image presentation during the habituation task.