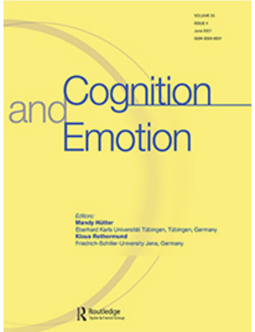

Cognition and Emotion

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/pcem20

Emotional context effects on memory accuracy for neutral information

Melody M. Moore, Emily J. Urban-Wojcik & Elizabeth A. Martin

COGNITION AND EMOTION
2021, VOL. 35, NO. 4, 774–789
https://doi.org/10.1080/02699931.2021.1874880

REGISTERED REPORT

Emotional context effects on memory accuracy for neutral information*

Melody M. Moore [a], Emily J. Urban-Wojcik[a] and Elizabeth A. Martin [b]

[a]Department of Psychological Science, University of California Irvine, Irvine, CA, USA; [b]Center for Healthy Minds, University of Wisconsin-Madison, Madison, WI, USA

ABSTRACT

Despite decades of study, it remains unclear how emotional contexts influence memory for non-emotional information. In two studies, we previously found memory accuracy for neutral information encoded in an emotional context differed by valence. Specifically, neutral images encoded in a negative context were remembered with similar accuracy as those encoded in a non-emotional context, and neutral images encoded in a positive context were remembered with less accuracy than a non-emotional context. This Registered Report contains a third study to replicate our original results and allow for direct comparison between the negative and positive encoding conditions. People in the positive condition showed decreased memory accuracy, but this effect was very small in size and only significant when compared to the neutral condition. Given the lack of difference between negative and neutral conditions, effects of emotion on memory are not only a function of emotional arousal. At the same time, given the nonsignificant, small difference between positive and negative conditions, effects of emotion on memory are also not solely attributable to valence. This series of studies represents a step towards re-examining the tenet that emotion enhances memory unless the experience elicits sufficiently high arousal levels such that memory is impaired.

ARTICLE HISTORY
Received 2 October 2018
Revised 5 January 2021
Accepted 7 January 2021

KEYWORDS
Gist memory; detail memory; valence effects; arousal

It is widely accepted that emotional stimuli and events are remembered with greater accuracy than non-emotional events (e.g. Choi et al., 2013; LaBar & Cabeza, 2006; Levine & Edelstein, 2009). However, researchers disagree over which dimensions of emotion are responsible for memory enhancement. This ongoing debate is principally divided between researchers who suggest nonspecific emotional arousal accounts for the influence of emotion on memory (see Buchanan & Adolphs, 2002), and researchers who argue that in conjunction with arousal, emotional valence drives distinct patterns of memory accuracy (e.g. Kensinger, 2009). To address this debate, we varied levels of both valence and arousal during encoding while holding constant the information being encoded across three studies. That is, the current group of studies aims to disentangle the effects of arousal and valence on memory by examining whether encoding the same neutral information in various emotional contexts (negative arousing, positive arousing, or neutral non-arousing) results in differences in memory accuracy 24-hours later.

It is well documented that arousal, a continuum ranging from calm/bored to excited/anxious (Bradley et al., 1992), modulates memory (for review, see Kensinger, 2009; Mather & Sutherland, 2009). Not only are arousing events better remembered than non-arousing events (e.g. Bradley et al., 1992), arousal typically leads to better memory for the source of arousal and worse memory for non-arousing information (for review, see Buchanan & Adolphs, 2002; Kensinger, 2009). However, research indicates

CONTACT Elizabeth A. Martin emartin8@uci.edu Center for Healthy Minds, University of Wisconsin-Madison, Madison, WI, USA
Supplemental data for this article can be accessed at https://doi.org/10.1080/02699931.2021.1874880.
*A portion of this research was previously presented as part of a colloquium at the University of California, Irvine, 8 May 2017.

not all emotions influence memory in the same way, and arousal alone appears ill-equipped to distinguish when memory will be enhanced or impaired (e.g. Kensinger & Schacter, 2006; Levine & Bluck, 2004). This has led to investigations of the influence of other dimensions of emotion on memory, and findings indicate valence, a continuum ranging from pleasant to unpleasant (Bradley et al., 1992) can help clarify the type of information emotion enhances in memory.

Research suggests positive and negative mood states are associated with unique patterns of memory accuracy whereby positive moods lead to increased errors in memory (Kensinger & Schacter, 2006; Levine & Bluck, 2004). That positive and negative experiences are associated with distinct patterns of memory accuracy is not surprising given that negative and positive mood states elicit distinct information processing strategies, which in turn guide attention and result in downstream consequences for memory accuracy. Negatively valenced moods signal people to search for information and focus on identifying what might be wrong in the current environment (Schwarz & Clore, 1983). Correspondingly, negative mood is associated with effortful cognitive processing strategies characterised by greater focus on the information directly at hand, such as resistance to the influence of scripts (Bless et al., 1996).

By contrast, positive mood is associated with a host of alterations to cognitive processes which are summarised as cognitive broadening (e.g. Fredrickson, 2004). For example, positive mood has been shown to increase relational processing (Fiedler, 2001) and results in a broader scope of attention (Fredrickson & Branigan, 2005). Despite increasing flexibility and creativity (Isen et al., 1987), cognitive broadening is also associated with undesirable outcomes such as impaired cognitive control on the Tower of London task (Oaksford et al., 1996), Stroop task (Phillips et al., 2002) and a working memory task (Martin & Kerns, 2011).

At the same time, not all variants of positive affect result in cognitive broadening, and research has shown the relationship between the current positive mood and people's goals or motivation has downstream consequences on attention. For example, when people have achieved their goals, low-approach motivated positive mood arises signalling the environment is safe and comfortable (Carver, 2003; Fredrickson, 2001). By contrast, when an individual is excitedly engaged in goal-pursuit, high-approach motivated mood arises, and research has shown that low- and high-approach motivated mood differentially modulate attentional focus such that low-approach positive mood is associated with increases in attentional breadth while high-approach positive affect is associated with decreased breadth of attention, thus increasing focus on goal attainment (Gable & Harmon-Jones, 2008). Therefore, in studies that elicit changes in mood, theory would predict a low-approach positive encoding context to elicit concurrent increases in breadth of attention, resulting in increased errors in memory relative to neutral and negative contexts.

Emotional contexts have been used to examine the influence of emotion on memory for decades (e.g. Bower et al., 1978; Isen, 1985; Laird et al., 1982), and yet findings remain mixed. For example, in studies which elicit brief changes in affect and test memory accuracy for neutral details at short intervals, some studies show no differences in memory accuracy between emotional and neutral contexts (e.g. Jaeger et al., 2009; Smith et al., 2004) or between positive and negative encoding trials (e.g. Erk et al., 2005). At the same time, other researchers have found decreased memory for neutral details encoded in negatively arousing contexts relative to neutral (e.g. Rimmele et al., 2011; Touryan et al., 2007), and similarly, that memory for neutral background images is worse for those previously presented with a negative object, relative to those presented with neutral objects (Kensinger et al., 2007).

On the other hand, in a study which elicited changes in mood and tested memory accuracy for neutral details at a short interval, recognition of neutral objects "central" to an image did not differ between neutral and negative contexts, while recognition of neutral objects located in the periphery was impaired in the negative encoding context relative to neutral (Kim et al., 2013). However, this study used a picture story paradigm in which emotional and non-emotional contexts were composed of four images containing central and peripheral objects. Because each image was inherently emotional or neutral, the set of images differed between conditions, and later, participant memory was tested for different objects depending on which set of images the participant viewed. Thus, whether the emotional or experimental context is responsible for differences in memory accuracy remains an unanswered question.

One reason for these discrepant findings regarding the effects of emotional contexts on memory may be that some studies elicit fleeting bursts of affect by briefly presenting affective stimuli (e.g. 200 ms) while others elicit longer lasting and conscious changes in mood through mood induction procedures (e.g. watching several minutes of a video). Thus, participants briefly exposed to affective stimuli would not likely experience cognitive and attentional changes associated with positive and negative mood because their mood state is not altered (see Dreisbach, 2006). In the current group of studies, we manipulated mood and thus expect attentional changes to occur in the emotional (positive and negative arousing) conditions.

Another reason for discrepancies in the literature regarding the effect of emotional contexts might be the result of using different sets of stimuli and memory questions between emotional and non-emotional contexts. When memory is assessed for emotional items or even neutral items within an emotional scene (e.g. Kim et al., 2013), emotional and non-emotional conditions differ in two important ways. First, the stimuli used differ between emotional and non-emotional contexts, and matching stimuli is a notoriously challenging task as stimuli may have intrinsic properties which confer a mnemonic advantage to one set of stimuli over another. Second, when conditions are composed of different sets of stimuli, the memory task itself will also differ such that between conditions participants will be asked different questions or shown different items. Therefore, it is difficult to conclude the emotional context is driving differences in memory between emotional and non-emotional conditions.

One group of researchers overcame this limitation by showing all participants the same set of neutral images flanked by either emotional or non-emotional images (Adolphs et al., 2005). As a result, emotional and non-emotional conditions differed only in the context in which images were presented, while the neutral information encoded was held constant. At a short interval memory test, participants in the emotional encoding context exhibited better memory for broad, essential information from neutral images ("gist") but no similar enhancement of background, irrelevant information ("detail") relative to a neutral encoding context. The emotional condition was higher in arousal than neutral and participants exhibited corresponding changes in physiological arousal, so the authors concluded emotional encoding results in an enhancement of gist memory driven by arousal. However, the emotional context of this study was composed only of negative images, thus the emotional context differed from neutral not only in arousal, but also in valence. Consequently, it remains unclear whether arousal drives the influence of emotion on memory or whether differences in valence contributed to the observed mnemonic difference. Thus, the current group of studies used a similar design but extends current research by including a positive encoding condition to better control for the effect of arousal.

In spite of the well-documented valence-specific modulation of memory, many studies examining emotional contexts only include negative valence in their design (e.g. Adolphs et al., 2005; Jaeger et al., 2009; Kim et al., 2013; Rimmele et al., 2011; Touryan et al., 2007). Of the studies which include a positive context, researchers often find valence-specific effects or an interaction between valence and arousal (e.g. Erk et al., 2005; Smith et al., 2004; Zhang et al., 2015). For example, researchers have found differential brain activation during encoding and recognition of neutral items encoded in positive and negatively valenced contexts (Erk et al., 2005). This line of work suggests that comparing positive and negative emotional contexts within a single study is a fruitful avenue towards advancing our understanding of the influence of emotion on memory.

Given the importance of studying positive emotional contexts, the current group of studies was modelled after Adolphs et al. (2005) and was designed to examine whether encoding neutral information in an emotional context results in distinct patterns of memory accuracy 24-hours later. In the proposed studies, participants encoded neutral target images in one of three emotional contexts: positive arousing, negative arousing, and neutral non-arousing. Memory for neutral target images was assessed using a fixed set of gist and detail questions 24-hours later, an interval selected in accordance with previous literature that has found that behavioural and neural consequences of post-encoding consolidation can be seen after 24 h (e.g. Jaeger et al., 2009; Sharot & Phelps, 2004). Our design builds upon existing literature by varying the valence associated with emotional context in which stimuli are encoded while keeping mnemonic targets constant across contexts and by examining the long-term consequences of emotional encoding.

The current manuscript contains three studies, the third of which was a pre-registered replication of

Studies 1 and 2. In Study 1, participants encoded neutral target images in either a negative arousing context or neutral non-arousing context. We hypothesised that gist memory would be enhanced for participants in the negative encoding condition, relative to neutral, based on previous research which found a negatively arousing encoding context was associated with in increased accuracy for gist information. To test the effects of a positive valence encoding condition, participants encoded neutral target images in either a positive arousing context or neutral non-arousing context in Study 2. Based on evidence that prolonged exposure to positive stimuli results in positive mood, which has been found to impair working memory and increase memory inconsistencies, we hypothesised that a positive encoding context would result in impairment of both gist and detail accuracy for neutral information, relative to a neutral encoding context. Last, to directly compare memory between negative and positive encoding conditions, participants in Study 3 encoded neutral target images in one of three emotional contexts: positive arousing, negative arousing, and neutral non-arousing. We expected to replicate our findings from Studies 1 and 2 and pre-registered these hypotheses. In Study 3, we also introduced a potential mechanism through which emotional encoding contexts influence memory: attentional breadth. We hypothesised the positive context would result in increased breadth of attention, evidenced by a global bias in attention on the local-global visual processing task (Kimchi & Palmer, 1982) relative to participants in the neutral and negative encoding contexts. Further, we hypothesised that breadth of attention would be associated with memory accuracy such that greater breadth of attention would be associated with greater memory impairment.

Study 1: negative v. neutral encoding

Participants

In total, 206 participants were recruited from a large coastal university to participate in the present study. The study included a one-hour session in the laboratory and a follow-up survey emailed to participants 24 hours after leaving the lab, which was completed online via Qualtrics (Provo, UT, 2015). Of the total 206 participants, 191 participants completed the memory survey emailed the day following participation in the lab session (i.e. the questionnaire completed online approximately 24 h later). While in the lab, participants also completed the Chapman Infrequency Scale (Chapman & Chapman, 1983). This scale consists of 13 items (e.g. "I find that I often walk with a limp, which is the result of a skydiving accident") designed to screen for careless or invalid responses and was embedded amongst other survey items. As is common practice, participants who endorsed three or more of these items ($n = 15$) were excluded from analyses (e.g. Brown et al., 2007; Chmielewski et al., 1995; Cicero et al., 2019; Kwapil et al., 2017; Martin & Kerns, 2010). On average, participants completed the follow-up memory questionnaire within 8 minutes of opening it ($M = 8.12$ minutes), with 96.9% of participants completing the survey in less than 32 minutes. The next closest participant completed the questionnaire in 92 minutes, which was 20 times greater than the standard deviation ($SD = 4.12$ minutes) of the preceding 96.9% of participants. Thus, participants were excluded if they spent 32 minutes or more completing the questionnaire as we reasoned this indicated careless responding ($n = 2$, 147 and 152 minutes). After these exclusions, our sample included 176 participants, with 94 participants in the neutral condition and 82 participants in the negative condition. Individuals in negative and neutral condition did not differ on any demographic variables, including age ($\chi^2(4) = .74$, $p = .94$), sex ($\chi^2(2) = 1.48$, $p = .47$), and ethnicity ($\chi^2(4) = 3.40$, $p = .49$) (Table 1).

Measures and materials

Encoding task

Subjects in each condition (neutral, negative) viewed a series of images accompanied by a voice recording narrating the images. Following previous research by Adolphs et al. (2005), participants viewed five neutral images (i.e. target images) that were embedded in either a neutral or negative context using six encoding images. In total, participants viewed 11 images that were each presented for 20 s. While each image was on the screen, participants listened to a narrative linking the images (see Appendix for the narratives). Images were either selected from the International Affective Picture System (IAPS; Lang et al., 2008; Neutral = 8; Negative = 6) or from an Internet search (Neutral = 3; available from the author upon request).[1]

Both conditions shared the same five target stimuli, which were the subject of a subsequent memory task. The remaining six images, hereby

Table 1. Descriptive statistics [means (standard deviations)] for demographics.

		Study 1 ($n = 176$)		Study 2 ($n = 143$)		Study 3 ($n = 210$)		
Sex [*n* (%)]	Female	147 (83.5%)			118 (82.5%)		176 (83.8%)	
Age [*n* (%)]							20.40 (3.03)	
	17 and under	2 (1.1%)			1 (0.6%)			
	18–21	154 (87.5%)			113 (79.7%)			
	22–25	14 (7.9%)			21 (14.68%)			
	26–30	4 (2.2%)			1 (0.6%)			
	31 and over	2 (1.1%)			5 (3.4%)			
Race [*n* (%)]								
	Asian	76 (43.1%)			79 (55.2%)		90 (42.85%)	
	African American	5 (%)			1 (0.6%)		9 (4.28%)	
	Caucasian	22 (12.5%)			17 (11.8%)		28 (13.33%)	
	Latino/Latina	55 (31.2%)			35 (24.4%)		67 (31.90%)	
	Other/Decline	18 (9.6%)			9 (4.1%)		16 (7.61%)	
	Mood Condition	Negative ($n = 82$)	Neutral ($n = 94$)	Positive ($n = 70$)	Neutral ($n = 73$)	Positive ($n = 70$)	Negative ($n = 71$)	Neutral ($n = 69$)
Sex [*n* (%)]	Female	67 (81.7%)	80 (85%)	58 (82.8%)	60 (84.9%)	61 (87.14%)	57 (80.2%)	58 (84.05%)
Age [*n* (%)]						20.01 (3.03)	20.46 (4.01)	20.72 (2.77)
	17 and under	1 (1%)	1 (1%)	1 (1.3%)	0 (0.0%)			
	18–21	73 (89%)	81 (87%)	56 (63%)	57 (81.4)			
	22–25	5 (6.1%)	9 (9.6%)	9 (12%)	12 (17.1%)			
	26–30	2 (2.4%)	2 (2.1%)	1 (1%)	0 (0.0%)			
	31 and over	1 (1%)	1 (1%)	1 (1%)	4 (5.7%)			
Race [*n* (%)]								
	Asian	36 (38%)	40 (48%)	41 (1%)	38 (54.2%)	90 (42.85%)	90 (42.85%)	90 (42.85%)
	African American	1 (1.2%)	4 (4.8%)	0 (0.0%)	1 (1.4%)	9 (4.28%)	9 (4.28%)	9 (4.28%)
	Caucasian	13 (13%)	9 (10.9%)	5 (6.8%)	12 (17.1%)	28 (13.33%)	28 (13.33%)	28 (13.33%)
	Latino/Latina	23 (24%)	32 (39%)	17 (23.2%)	18 (25.7%)	67 (31.90%)	67 (31.90%)	67 (31.90%)
	Other/Decline	9 (9.6%)	9 (11.25%)	4 (%)	5 (%)	16 (7.61%)	16 (7.61%)	16 (7.61%)

referred to as encoding images, differed by condition to create an emotional or non-emotional context for the target stimuli. Thus, the series of images consisted of alternating target and encoding images such that each target image was flanked by encoding images. IAPS images were chosen based on their normative ratings of valence (1 = *extremely pleasant*, 9 = *extremely unpleasant*) and arousal (1 = *no bodily reaction*, 9 = *extreme bodily reaction*). Target stimuli were the same in both conditions and were neutral in valence ($M = 5.06$, SD = 2.00) and arousal ($M = 3.28$, SD = .53). Encoding images were neutral or negative, corresponding to condition. Encoding stimuli differed in valence and arousal such that negative encoding images ($M = 2.26$, SD = .27) were significantly lower in valence (i.e. more negative) than neutral encoding images ($M = 4.82$, SD = .70), $t(10) = 6.19$, $p = .04$, and negative encoding images ($M = 5.60$, SD = .98) were significantly higher in arousal than neutral encoding images ($M = 3.83$, SD = .48), $t(10) = 7.59$, $p < .001$.

While viewing the images, participants listened to an audio recording corresponding to the encoding images. In the neutral encoding condition, participants listened to a story about a mother completing various errands and tasks, such as filling the car with gasoline and taking her daughter to a dentist appointment. In the negative encoding condition, participants listened to a story about a mother who must go to the scene of a car accident to find her daughter, where she learns her daughter is deceased. Before viewing and listening to the slideshow, participants were told this study was interested in measuring their creativity. Participants believed they would be asked to view a series of images and write a story connecting the images, and that this slideshow was an example. Participants then viewed and listened to the slideshow, and upon completion, participants viewed two neutral images then wrote a story to connect them. Participants did not know this study was interested in their memory for images from what they believed to be an example of how to write a narrative, and participants were not aware the follow-up survey would include memory questions.

Before viewing and listening to the narrative slideshow, participants rated a series of emotion terms to measure positive affect (joy, love, amusement, interest, happiness) and negative affect (unhappiness, disgust, fear, anxiety, sadness, contempt) on a 9 point scale (1 = *not at all/ none*, 9 = *extremely/ a great deal*). Participants rated these same emotion terms again upon completing the slideshow.

Memory task

Participants were emailed a follow-up survey 24-hours after leaving the laboratory. On average, participants completed the follow-up survey in 8 minutes ($M = 8.16$, SD = 4.20) and finished the survey 36 h after the laboratory session ($M = 36.5$ SD = 31.5). The purpose of this survey was to test memory accuracy for gist and detail of the neutral target images. As a validity check of the emotional properties of the stimuli, this survey also asked participants to rate the valence and arousal of the images viewed in the laboratory. We asked participants to rate these images at the 24-hour follow-up so they would not be re-exposed to the images before completing the memory test because this could alter their memory accuracy. Gist and detail were defined in accordance with previous literature as general information essential to the meaning of the image, and background information or irrelevant visual details, respectively (Adolphs et al., 2001). Accordingly, memory questions were based solely on visual information contained in the neutral target images. In total, participants were asked 15 multiple choice questions about gist information and 10 questions about detail information, with four alternatives per question. Participants were not asked about any encoding images, or the audio narrative. After completing the memory questions, participants rated valence (1= *extremely pleasant*, 9 = *extremely unpleasant*) and arousal (1 = *extreme bodily reaction*, 9 = *no bodily reaction*) for images previously seen in the lab.

Procedures

Before arriving, participants were randomly assigned to either a negative or neutral encoding condition. After obtaining consent, participants began the encoding task. After completing the encoding task, participants completed an unrelated task containing no emotional stimuli and several computer-based questionnaires. Participants were thanked, debriefed, and informed a follow-up survey would be sent to them via email on the following day.

Statistical approach

Because participants were asked a different number of gist vs. detail questions (15 vs. 10 questions), detail memory scores were weighted by a factor of 3/2 before hypothesis testing. Then, a mixed ANOVA was conducted to examine whether a negative encoding condition differentially affected memory compared to a neutral encoding condition. Next, we performed a series of validity checks, reported in full in the supplementary materials, to ensure our encoding conditions were properly designed across studies (i.e. each condition was comprised of images of the desired valence). When violations of the assumption of equal variances occurred, degrees of freedom have been adjusted. Effect sizes were calculated using partial η^2 and *d* values. According to Cohen (1969, pp. 278–280; for a recent review, please see Richardson, 2011) partial η^2 values of .0099, .0588, and .1379, ought to be interpreted as small, medium, and large in size, respectively. Similarly, according to Cohen (1988, pp. 24–26), *d* values of .2, .5, and .8 ought to be interpreted as small, medium, and large, respectively.

Study 1 results

Negative encoding condition does not enhance gist memory

We conducted a 2 (memory type: gist vs. detail) x 2 (encoding condition: negative vs. neutral) mixed ANOVA with memory type as the within-subjects variable and encoding condition as the between-subjects variable. We found a main effect of memory type, $F(1,174) = 493.0$, $p < .001$, *partial* $\eta^2 = .73$, such that gist accuracy was greater than detail accuracy in both the negative and neutral encoding conditions, and this effect was very large in magnitude. There was no main effect of condition, $F(1,174) = .12$, $p = .72$, *partial* $\eta^2 = .001$, and no interaction between memory score and condition, $F(1,174) = .47$, $p = .49$, *partial* $\eta^2 = .003$. Thus, encoding information in a negative or neutral context had similar effects on memory.

Post-mood ratings consistent with encoding condition

Participants in the negative and neutral conditions showed no differences in baseline positive or negative emotion (*ps* > .09). As expected, participants in the negative condition showed increased negative affect post-task relative to those in the neutral encoding condition (*ps* < .001, for the full analyses, please see our supplementary materials).

Valence and arousal of stimuli consistent with encoding conditions

Neutral target images were rated neutral in valence and arousal by both conditions (*ps* > .15). As expected, encoding images used in the negative condition were rated more negative in valence than encoding images used in the neutral condition and negative encoding images were significantly higher in arousal than neutral encoding images emotion (*ps* < .001, see supplementary materials).

Results replicated when participants who reported closing their eyes were excluded

We conducted the same series of the analyses after removing people who reported closing their eyes in response to the stimuli and all findings were replicated (main effect of memory type, $F(1,104) = 259.78$, $p < .001$, partial $\eta^2 = .71$, no main effect of condition, $F(1,104) = .37$, $p = .54$, partial $\eta^2 = .004$; see supplementary materials).

Study 1 discussion

Despite successfully creating an emotional context during encoding (see Table 2 for pre- and post-encoding affect ratings), we found no evidence that a negatively arousing context at encoding enhances gist memory (see Figure 1 for proportion of gist and detail questions correctly answered at follow-up). Further, we found no differences in memory accuracy for either gist or detail scores between conditions. At face value, these results appear to suggest encoding information in an emotional context may not be sufficient to alter memory accuracy for neutral information. However, Study 1 was limited to examining the effects of negative valence, and previous research suggests positive valence can influence memory accuracy (Kensinger & Schacter, 2006; Levine & Bluck, 2004; Martin & Kerns, 2011). Many studies examining the effects of an emotional context on memory have failed to include a positive condition (e.g. Adolphs et al., 2005; Jaeger et al., 2009; Kim et al., 2013; Rimmele et al., 2011; Touryan et al., 2007), therefore, we designed Study 2 to extend the literature and examine whether a positively arousing context at encoding produces a different outcome on memory accuracy, relative to neutral.

Table 2. Means and standard deviations of affect ratings.

Condition	Study 1				Study 2				Study 3					
	Neutral		Negative		Neutral		Positive		Neutral		Negative		Positive	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Positive Affect														
Baseline	5.16	1.43	4.77	1.66	4.90	1.46	4.90	1.33	4.32	1.68	4.33	1.55	4.51	1.53
Post-task	3.08	1.04	3.51	1.67	3.30	1.48	4.54	1.74	3.04	1.95	2.04	0.97	4.55	1.99
Negative Affect														
Baseline	2.76	2.69	1.20	1.17	2.71	1.46	2.70	1.22	2.83	1.18	2.56	1.17	2.61	1.08
Post-task	1.79	0.79	4.72	1.54	1.76	0.85	1.75	0.73	1.76	0.88	4.67	1.57	1.83	0.85

Study 2: positive v. neutral encoding

Participants

Inclusion criteria were identical to Study 1, for detailed information regarding participant inclusion criteria, please see the supplemental analysis. After all exclusions, our sample included 143 participants, with 73 participants in the neutral condition and 70 participants in the positive condition. Individuals in positive and neutral condition did not differ on any demographic variables, including age ($\chi^2(4) = 4.06$, $p = .39$), sex ($\chi^2(2) = 2.36$, $p = .30$), and race/ethnicity ($\chi^2(4) = 3.96$, $p = .41$).

Measures and materials

Encoding task

The encoding task used in Study 2 was identical in design to the task used in study one. Again, images were selected from the International Affective Picture System (IAPS).[2] For Study 2, we modified the emotional encoding condition by replacing negative images with positive images to create a positively valenced encoding condition. The accompanying narrative was altered to a story in which a mother has an exciting daytrip to the beach and spends time with her family. The neutral condition remained the same. Target stimuli were the same in both conditions and were the same as Study 1. Encoding images differed in valence and arousal between conditions such that positive encoding images ($M = 7.57$, SD = .37) were significantly higher in valence (i.e. more positive) than neutral encoding images ($M = 4.82$, SD = .70), $t(10) = 8.23$, $p < .001$, and positive encoding images ($M = 5.39$, SD = 1.39) were significantly higher in arousal than neutral encoding images ($M = 3.83$, SD = .48), $t(10) = 3.93$, $p < .003$. Critically, positive encoding images ($M = 5.39$, SD = 1.39) and negative encoding images used in Study 1 ($M = 5.60$, SD

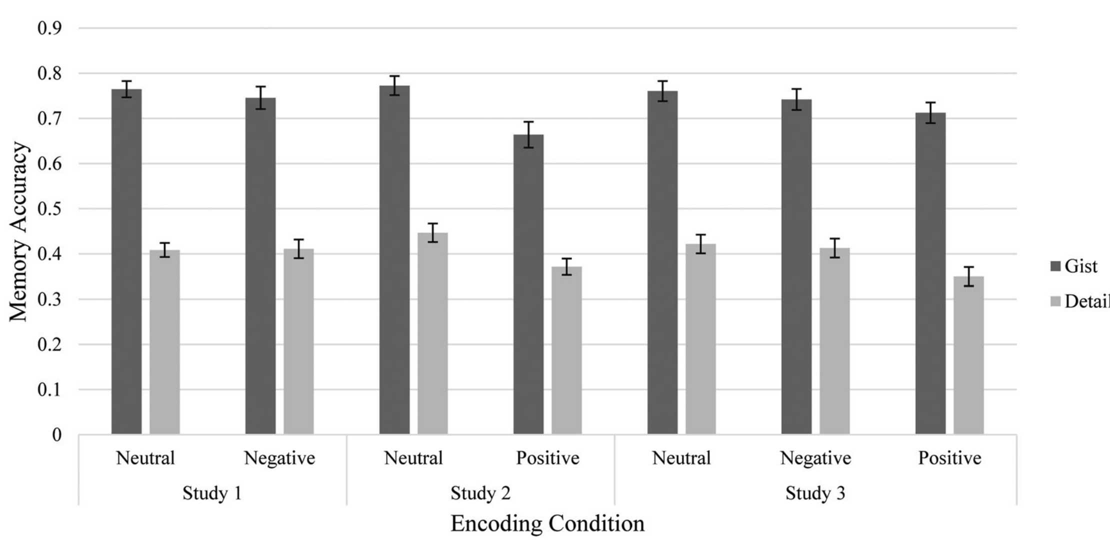

Figure 1. Proportion of gist and detail questions correctly answered at a 24-hour follow-up.

= .98) did not differ in arousal, $t(10) = .301$, $p = .76$. Positive encoding images were higher in valence than negative encoding images ($M = 2.26$, SD = .27), $t(10) = 27.90$, $p < .001$.

Memory task

The memory task was identical to Study 1. On average, participants completed the follow-up survey in approximately 9 minutes ($M = 9.6$, SD = 6.2) and finished the survey 32 hours after the laboratory session ($M = 32.2$, SD = 10.98).

Procedures

All procedures were identical to Study 1.

Statistical approach

The statistical approach for Study 2 was identical to Study 1.

Study 2 results

Positive encoding condition impairs gist and detail memory

We tested whether participants in the positive encoding condition displayed decreased memory accuracy relative to participants in the neutral encoding condition by conducting a 2 (memory type: gist vs. detail) x 2 (encoding condition: positive vs. neutral) mixed ANOVA. We found a main effect of memory type, $F(1,141) = 274.44$, $p < .001$, *partial* $\eta^2 = .66$, such that gist accuracy was greater than detail accuracy in both the positive and neutral encoding conditions, and this effect was very large in magnitude. We also found a main effect of condition, $F(1,141) = 12.9$, $p < .001$, *partial* $\eta^2 = .084$, such that participants in the positive condition correctly answered fewer gist and detail questions correctly than participants in the neutral condition, and this effect was medium in magnitude. There was no interaction between memory type and condition, $F(1,141) = .812$, $p = .36$, *partial* $\eta^2 = .006$. Thus, in contrast to Study 1 where there were no memory differences between the negative and neutral encoding conditions, memory of those in the positive encoding condition was significantly worse than the memory of those in the neutral encoding condition for both gist and detail information.

Post-mood ratings consistent with encoding condition

We found no difference in baseline negative or baseline positive emotion (*ps* > .93). As expected, participants in the positive condition reported increased positive affect at post-task ($p < .001$), relative to participants in the neutral condition. We found no differences in post-task negative affect ($p = .89$, see supplementary materials).

Valence and arousal of stimuli consistent with encoding conditions

As expected, we found no differences in ratings of valence or arousal for target images between conditions (*ps* > .40). Images used in the positive condition were rated more positive in valence than encoding images used in the neutral condition ($p < .001$), and arousal did not differ between positive and neutral encoding images ($p = .06$, see supplementary materials).

Results replicated when participants who reported closing their eyes were excluded

We conducted the same series of the analyses after removing people who reported closing their eyes in response to the stimuli and all findings were replicated (main effect of memory type, $F(1,119) = 275.55$, $p < .001$, partial $\eta^2 = .69$; main effect of condition, $F(1,119) = 14.15$, $p < .001$, partial $\eta^2 = .10$; see supplementary materials).

Study 2 discussion

Studies 1 and 2 aimed to examine the effects of an emotional encoding context on memory by varying levels of valence and arousal while holding constant the information being encoded. In Study 1, we found a negatively arousing encoding context did not alter memory for neutral gist or detail information, relative to a neutral non-arousing encoding context. In Study 2, we found a positively arousing encoding context broadly impaired memory, resulting in worse gist and detail accuracy relative to a neutral non-arousing encoding context. However, the effect of valence independent of arousal has yet to be examined. That is, Studies 1 and 2 do not address how a negatively arousing encoding context influences memory relative to a positively arousing context.

Therefore, Study 3 was designed to directly test this comparison; all aspects of the study were pre-registered with *Cognition and Emotion*.

Study 3: positive v. negative v. neutral encoding

In Study 3, we included all encoding conditions (positively arousing, negatively arousing, neutral non-arousing). In line with our findings from Studies 1 and 2, we hypothesised that gist and detail memory for neutral information would not differ between a negatively arousing and neutral non-arousing context, while a positively arousing encoding context would result in worse memory for both gist and detail information.

Methods

Pre-registered hypotheses, stimulus materials, and data can be accessed here: osf.io/ytq4c.

Participants

Our power analysis, conducted using the pwr package (Champely, 2018) for R (R Core Team, 2016), found we needed 69 participants in each group to detect a medium effect (Cohen's $f = .60$) with 90% power. This calculation was conducted using Cohen's *f*, a statistic which can be used to estimate effect size for one-way ANOVAs (Cohen, 1988). We expected to exclude 10% of our total sample for failure to complete the follow-up memory test, and 10% of our total samples for careless and invalid responding using the Chapman Infrequency Scale, thus, we aimed to recruit 85 participants per condition. Therefore, in total, we aimed to recruit 255 participants. Inclusion criteria were identical to Studies 1 and 2; for detailed information regarding participant inclusion criteria, please see the supplemental analysis. After all exclusions, our sample included 210 participants, with 70 participants in the positive condition, 71 participants in the negative condition, and 69 participants in the neutral condition. Individuals in positive, negative, and neutral conditions did not differ on any demographic variables including age, $F(2,207) = .97$, $p = .38$, sex ($\chi^2(4) = 9.26$, $p = .05$), and race/ethnicity, ($\chi^2(8) = 6.97$, $p = .53$).

Measures and materials

In Study 3, we combined materials from Study 1 and 2 to compare all three emotional encoding conditions within one study. The materials, procedures, and statistical analysis plan for Study 3 were identical to those of Study 1 and Study 2 with the exception that participants completed a new, additional task, the local-global task, immediately following the encoding task. Last, Study 3 used the same validity checks as Studies 1 and 2.

Local-global task

After completing the positive, negative, or neutral audiovisual narrative, participants completed Kimchi and Palmer's (1982) local-global visual processing task. In this task, participants are presented with a standard figure, which has one global element made up of smaller local elements, and two comparison figures. One comparison figure contains the same local elements as the standard figure, while the other has the same global element. Participants were asked to indicate which comparison figure is most similar to the standard figure, and the task is scored by counting the number of times participants select the comparison figure which shares a global element with the standard figure. Thus, this task serves to measure participant's breadth of attention, whereby higher scores indicate broader attention while lower scores indicate a focus on local elements.

Procedures

All study procedures were identical to Studies 1 and 2.

Statistical approach

As in Studies 1 and 2, detail memory scores were weighted by a factor of 3/2 before hypothesis testing. To test the hypothesis that encoding contexts differentially affected memory accuracy, a mixed ANOVA was conducted. Levene's test indicated that group variances were approximately even, thus Tukey's HSD post-hoc tests were reported to determine differences between conditions following a significant main effect. Effect sizes were calculated using partial η^2 or *d* values as appropriate. Please see page 13 for interpretations of effect size. To test the hypothesis that encoding context differentially affected attentional breadth, a one-way ANOVA was conducted. To follow-up significant main effects of encoding context, group differences was determined using the same series of post hoc analyses described above. Last, we completed similar validity checks as in Studies 1 and 2, reported in full in the supplementary materials.

Study 3 results

Positive encoding condition impairs gist and detail memory

We tested whether participants in the positive encoding condition showed decreased memory accuracy relative to participants in the neutral and negative encoding conditions by conducting a 2 (memory type: gist vs. detail) x 3 (encoding condition: positive vs. neutral vs. negative) mixed ANOVA. We found a main effect of memory type, $F(1,207) = 44.19$, $p < .001$, *partial* $\eta^2 = .68$, such that gist accuracy was greater than detail accuracy in all encoding conditions, and this effect was very large in magnitude. We also found a main effect of condition, $F(2,207) = 3.49$, $p = .03$, *partial* $\eta^2 = .033$, small in magnitude. There was no interaction between memory type and condition, $F(2,207) = .37$, $p = .68$, *partial* $\eta^2 = .004$. To follow-up the significant main effect of condition, we conducted Tukey's HSD post-hoc tests. Neutral and negative encoding conditions did not differ in memory accuracy, $p = .829$, $d = .09$. At the same time, participants in the positive condition exhibited decreased accuracy relative to participants in the neutral condition, $p = .03$, $d = .25$. Last, the negative and positive encoding conditions did not differ in accuracy, $p = .12$, $d = .15$, although there was a trend towards decreased accuracy in the positive encoding condition. Based on the results of the validity checks reported below, we ran the same ANOVA with neutral target valence ratings as a covariate. The addition of the covariate did not change the pattern of results (e.g. the effect of condition remained significant $F(2,206) = 3.34$, $p = .03$, *partial* $\eta^2 = .031$).

Attentional breadth did not differ by condition

We ran a one-way ANOVA comparing attentional breadth between the conditions. We found no difference in attentional breadth, $F(2,207) = 0.68$, $p = .50$. Thus, contrary to our hypothesis, the positive mood condition did not elicit greater cognitive broadening relative to neutral and negative conditions.

Post-mood ratings consistent with encoding condition

We found no difference in baseline negative or baseline positive emotion ($ps > .30$). Participants in the positive condition reported increased positive affect post-task, relative to participants in the negative and neutral conditions ($ps < .001$). Further, participants in the negative condition reported increased negative affect post-task relative to participants in the positive and neutral conditions ($ps < .001$). Participants in the neutral and positive conditions did not differ on post-task negative emotion ($p = .93$; see supplementary materials).

Valence and arousal of stimuli consistent with encoding conditions

Although we found no group differences in arousal ratings ($p = .77$) for neutral target images, participants in the negative encoding condition rated neutral targets as less negative/more positive than participants in the neutral and positive conditions ($p < .001$). The bipolar valence scale used in the current study denotes "5" as the neutral midpoint, thus all conditions deviated small amounts around the neutral midpoint in rating neutral targets, suggesting participants viewed the images as neutral as intended. However, these results suggest target image ratings were influenced by a negative emotional encoding context.

Last, participants rated positive, negative, and neutral encoding images consistent with the intended valence. These ratings did not differ by condition ($ps > .21$); for the full analyses, see our supplementary materials.

Study 3 discussion

Study 3 aimed to replicate our findings from Studies 1 and 2 while allowing for a direct comparison between the previous positive and negative conditions. Consistent with Study 1, there were no memory differences between the negative and neutral encoding conditions. Consistent with Study 2, participants in the positive condition exhibited worse memory relative to the neutral condition. Last, Study 3 allowed for a direct comparison of memory accuracy between differently valenced emotional encoding conditions, and we found no significant difference in memory between those in the positive and negative encoding. In other words, we found that positive and negative valence at encoding, independent of arousal, did not result in different patterns of memory accuracy 24 hours later.

General discussion

Decades of research suggests that emotion tends to enhance memory, and further, that when emotion fails to enhance memory, it is due to the detrimental effects of high arousal. Yet these general principles do not paint a complete picture of the complex influence of emotion on memory. To avoid perpetuating reductive accounts, researchers have called for a more nuanced approach to the study of emotional memory (Bennion et al., 2013). To that end, we systematically examined the influence of valence and arousal on memory and identified important boundary conditions of these general principles.

Across three studies we varied valence and arousal levels at encoding to examine whether memory for neutral information would differ when encoding occurred during various emotional contexts (negative arousing, positive arousing, or neutral non-arousing). In Studies 1 and 3, negative emotion did not enhance gist accuracy as expected (e.g. Adolphs et al., 2005). Instead we found that encoding neutral information in a negatively arousing context did not affect memory. In Studies 2 and 3, we found that encoding neutral information in a positively arousing context resulted in significantly decreased memory accuracy. In Study 2, this effect was medium in size, however, the magnitude of this effect in Study 3 was small. Negative and positive conditions were carefully matched in level of arousal, suggesting memory impairment associated with the positive condition was not purely a function of arousal. At the same time, in Study 3 memory did not significantly differ between positive and negative conditions, suggesting the impairment associated with positive emotion was also not purely a function of valence.

The current findings are problematic if we believe emotion always enhances memory unless there is sufficiently high arousal to impair memory. We contend these results fit into a larger pattern within the literature whereby emotion during encoding does not indiscriminately enhance all types of information in memory. Sedikides and Skowronski (2020) recently noted the common refrain "bad is stronger than good" does not, and indeed was not intended to, apply to memory (Baumeister et al., 2001, pp. 343–344). Instead, they argue certain contexts foster better memory for positive or negative information and "this variability [in memory] is sensible" (Sedikides & Skowronski, 2020, p. 89). Stimulus factors, namely valence of the information and relevance/centrality of the information to the self, are a sensible way to predict how well people will remember certain information. In other words, to the extent that information can be used for self-regulatory processes, especially those promoting self-enhancement, that information tends to be enhanced in memory.

Sedikides and Skowronski's view (2020) is consistent with a wealth of literature suggesting emotion enhances memory by directing cognitive resources towards the encoding of goal-relevant information (Arnold, 1960; Levine & Edelstein, 2009; Oatley & Johnson-Laird, 2014; Scherer, 2019). People are strongly motivated to achieve their goals and become frustrated when these attempts are blocked, thus goal-relevant information is typically considered relevant and central to the self (Levine & Pizarro, 2004). In the current studies, participant memory was tested for neutral information that was not directly relevant to the participant's view of themselves or their goals. Thus, our finding that negative encoding did not enhance memory for neutral information is consistent with theory that suggests information enhanced by emotion in memory is characterised by self-centrality and goal-relevance. Given that participants were tested on the same neutral information in all conditions, our finding that a positive encoding context did not enhance memory is also consistent with this theory.

Although there was a numerical trend for participants in the positive condition to show decreased memory accuracy, this effect was very small in size and only significant when compared to the neutral condition. These results are suggestive a pattern whereby memory is not altered solely by emotional arousal. At the same time, given the nonsignificant difference between positive and negative conditions, effects of emotion on memory are also not solely attributable to valence. Instead, it is possible that valence and arousal interact to influence memory. To clarify how valence and arousal interact to influence memory, future research could vary not only valence but also arousal levels within each valence condition to tease this possible interaction apart.

At the same time, previous research suggests mechanisms other than emotional arousal alter memory (Kaplan et al., 2012). Research and theory suggest that emotion can alter information processing styles by altering breadth of attention, with downstream effects on memory accuracy. To examine this mechanism, the current research administered a local-global processing task (Kimchi & Palmer, 1982) after the emotional encoding task and found no differences between any of the mood conditions. Theory suggests that regardless of valence only "post-goal" emotion elicits cognitive broadening because the function of broadening is to assist in seeking new goals (Kaplan et al., 2012). In other words, cognitive broadening is expected to occur with positive valence when positive affect is elicited in response to goal achievement. At the same time, cognitive broadening is expected to occur with negative valence when negative emotion is elicited in response to irrevocably lost goals or goal failure to aid in disengagement from an unattainable goal.

The current results found all three emotional contexts were associated with a similar breadth of attention. In other words, the positive condition did not elicit cognitive broadening when compared to negative and neutral. This lack of influence on information processing style may explain the small effect sizes of emotion on differences in memory accuracy. None of the emotional contexts in this study induced affect associated with goal-pursuit, which would narrow attentional breadth. Instead, emotional contexts in the current study elicited "post-goal" emotion that either signalled the environment was safe and predictable (positive and neutral contexts) or that current goals were unattainable (negative context). Despite subjective differences in these emotional experiences, all promote seeking of new goals and broad attentional focus. A next step in understanding the relationship between mood, information processing style, and memory, would be to administer the local-global processing task before and after mood manipulations to assess whether within-subject changes in processing style are associated with different patterns of memory accuracy. Future research could also compare discrete emotional states that are matched in valence but differ in motivation (Kaplan et al., 2012). For example, two positive conditions may be excitement (high-approach, narrow attentional focus) and amusement (low-approach, broad attention).

Overall, our pattern of results is consistent with theory suggesting that valence and arousal intersect to influence patterns of memory accuracy (e.g. Kensinger, 2009). When stimuli are neutral in valence, and are therefore by definition irrelevant to a participant's goals and self, negative mood did not have an enhancing effect on memory. Instead, positive mood was uniquely associated with decreases in memory accuracy, but only when compared to a neutral encoding context. Given that positive and negative contexts differed in valence but were matched on arousal, this small effect was not solely attributable to increased emotional arousal and the current results cannot conclude it is specific to positive valence. Broadly, the current series of studies are part of a movement to challenge commonly and closely held beliefs about emotion and memory (Bennion et al., 2013; Sedikides & Skowronski, 2020).

Notes

1. Target images (IAPS; 2032, 2383, 2377, 2411, 2480). Neutral encoding images (IAPS; 2026, 2279, 2745.1). Negative encoding images (IAPS; 9905, 9920, 3400, 3225, 3181, 9220). Because normative ratings for the images selected from the Internet search were not available, we used participant ratings in the following analyses.
2. Target images (IAPS; 2032, 2383, 2377, 2411, 2480). Neutral encoding images (IAPS; 2026, 2279, 2745.1), Positive encoding images (IAPS; 2360, 2091, 8492, 2388, 2070, 7325).

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Melody M. Moore http://orcid.org/0000-0003-3050-1538
Elizabeth A. Martin http://orcid.org/0000-0001-8893-1667

References

Adolphs, R., Denburg, N. L., & Tranel, D. (2001). The amygdala's role in long-term declarative memory for gist and detail. *Behavioral Neuroscience*, *115*(5), 983–992. https://doi.org/10.1037/0735-7044.115.5.983

Adolphs, R., Tranel, D., & Buchanan, T. W. (2005). Amygdala damage impairs emotional memory for gist but not details of complex stimuli. *Nature Neuroscience*, *8*(4), 512–518. https://doi.org/10.1038/nn1413

Arnold, M. B. (1960). *Emotion and personality*. Columbia University Press.

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology*, *5*(4), 323–370. https://doi.org/10.1037/1089-2680.5.4.323

Bennion, K. A., Ford, J. H., Murray, B. D., & Kensinger, E. A. (2013). Oversimplification in the study of emotional memory. *Journal of the International Neuropsychological Society: JINS*, *19*(9), 953–961. https://doi.org/10.1017/S1355617713000945

Bless, H., Clore, G. L., Schwarz, N., Golisano, V., Rabe, C., & Wölk, M. (1996). Mood and the use of scripts: Does a happy mood really lead to mindlessness? *Journal of Personality and Social Psychology*, *71*(4), 665–679. https://doi.org/10.1037/0022-3514.71.4.665

Bower, G. H., Monteiro, K. P., & Gilligan, S. G. (1978). Emotional mood as a context for learning and recall. *Journal of Verbal Learning and Verbal Behavior*, *17*(5), 573–585. https://doi.org/10.1016/S0022-5371(78)90348-1

Bradley, M. M., Greenwald, M. K., Petry, M. C., & Lang, P. J. (1992). Remembering pictures: Pleasure and arousal in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *18*(2), 379–390. https://doi.org/10.1037/0278-7393.18.2.379

Brown, L. H., Silvia, P. J., Myin-Germeys, I., & Kwapil, T. R. (2007). When the need to belong goes wrong. *Psychological Science*, *18*(9), 778–782. https://doi.org/10.1111/j.1467-9280.2007.01978.x

Buchanan, T. W., & Adolphs, R. (2002). The role of the human amygdala in emotional modulation of long-term declarative memory. In *Emotional cognition: From brain to behavior* (pp. 1–45). https://doi.org/10.1075/aicr.44.02buc

Carver, C. (2003). Pleasure as a sign you can attend to something else: Placing positive feelings within a general model of affect. *Cognition & Emotion*, *17*(2), 241–261. https://doi.org/10.1080/02699930302294

Champely, S. (2018). *pwr: Basic functions for power analysis. R package version 1.2-2*.

Chapman, J. P., & Chapman, L. J. (1983). Reliability and the discrimination of normal and pathological groups. *The Journal of Nervous and Mental Disease*, *171*(11), 658–661. https://doi.org/10.1097/00005053-198311000-00003

Chmielewski, P. M., Fernandes, L. O., Yee, C. M., & Miller, G. A. (1995). Ethnicity and gender in scales of psychosis proneness and mood disorders. *Journal of Abnormal Psychology*, *104*(3), 464–470. https://doi.org/10.1037/0021-843X.104.3.464

Choi, H.-Y., Kensinger, E. A., & Rajaram, S. (2013). Emotional content enhances true but not false memory for categorized stimuli. *Memory & Cognition*, *41*(3), 403–415. https://doi.org/10.3758/s13421-012-0269-2

Cicero, D. C., Krieg, A., & Martin, E. A. (2019). Measurement invariance of the prodromal questionnaire – brief among White, Asian, Hispanic, and multiracial populations. *Assessment*, *26*(2), 294–304. https://doi.org/10.1177/1073191116687391

Cohen, J. (1969). *Statistical power analysis for the behavioural sciences*. Academic Press.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. L. Erlbaum Associates.

Dreisbach, G. (2006). How positive affect modulates cognitive control: The costs and benefits of reduced maintenance capability. *Brain and Cognition*, *60*(1), 11–19. https://doi.org/10.1016/j.bandc.2005.08.003

Erk, S., Martin, S., & Walter, H. (2005). Emotional context during encoding of neutral items modulates brain activation not only during encoding but also during recognition. *NeuroImage*, *26*(3), 829–838. https://doi.org/10.1016/j.neuroimage.2005.02.045

Fiedler, K. (2001). Affective states trigger processes of assimilation and accommodation. In L. L. Martin & G. L. Clore (Eds.), *Theories of mood and cognition: A user's guidebook* (pp. 85–98). Lawrence Erlbaum.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology. The broaden-and-build theory of positive emotions. *The American Psychologist*, *56*(3), 218–226. https://doi.org/10.1037/0003-066X.56.3.218

Fredrickson, B. L. (2004). The broaden-and-build theory of positive emotions Barbara. *Philosophical Transactions of the Royal Society of London: Series B*, *125*, 1808–1814. https://doi.org/10.1098/rstb.2004.1512

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition & Emotion*, *19*(3), 313–332. https://doi.org/10.1080/02699930441000238

Gable, P. A., & Harmon-Jones, E. (2008). Approach-motivated positive affect reduces breadth of attention. *Psychological Science*, *19*(5), 476–482. https://doi.org/10.1111/j.1467-9280.2008.02112.x

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

Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology*, *52*(6), 1122–1131. https://doi.org/10.1037/0022-3514.52.6.1122

Jaeger, A., Johnson, J. D., Corona, M., & Rugg, M. D. (2009). ERP correlates of the incidental retrieval of emotional information: Effects of study-test delay. *Brain Research*, *1269*, 105–113. https://doi.org/10.1016/j.brainres.2009.02.082

Kaplan, R. L., Van Damme, I., & Levine, L. J. (2012). Motivation matters: Differing effects of pre-goal and post-goal emotions on attention and memory. *Frontiers in Psychology*, *3*, 404. https://doi.org/10.3389/fpsyg.2012.00404

Kensinger, E. A. (2009). Remembering the details: Effects of emotion. *Emotion Review*, *1*(2), 99–113. https://doi.org/10.1177/1754073908100432

Kensinger, E. A., Garoff-Eaton, R. J., & Schacter, D. L. (2007). Effects of emotion on memory specificity in young and older adults. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *62*(4), 208–215. https://doi.org/10.1093/geronb/62.4.p208

Kensinger, E. A., & Schacter, D. L. (2006). When the Red Sox shocked the Yankees: Comparing negative and positive memories. *Psychonomic Bulletin and Review*, *13*, 757–763. https://doi.org/10.3758/BF03193993

Kim, J. S.-C., Vossel, G., & Gamer, M. (2013). Effects of emotional context on memory for details: The role of attention. *PLoS ONE*, *8*(10), e77405. https://doi.org/10.1371/journal.pone.0077405

Kimchi, R., & Palmer, S. E. (1982). Form and texture in hierarchically constructed patterns. *Journal of Experimental Psychology: Human Perception and Performance*, *8*(4), 521–535. https://doi.org/10.1037/0096-1523.8.4.521

Kwapil, T. R., Gross, G. M., Silvia, P. J., Raulin, M. L., & Barrantes-Vidal, N. (2017). Development and psychometric properties of the Multidimensional Schizotypy Scale: A new measure for assessing positive, negative, and disorganized schizotypy.

Schizophrenia Research. https://doi.org/10.1016/j.schres.2017.07.001

LaBar, K. S., & Cabeza, R. (2006). Cognitive neuroscience of emotional memory. *Nature Reviews*, *7*, 54–64. https://doi.org/10.1038/nrn1825

Laird, J. D., Wagener, J. J., Halal, M., & Szegda, M. (1982). Remembering what you feel: Effects of emotion on memory. *Journal of Personality and Social Psychology*, *42*(4), 646–657. https://doi.org/10.1037/0022-3514.42.4.646

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International affective picture system (IAPS): Instruction manual and affective ratings* (Technical Report A-8). https://doi.org/1010.1016/j.epsr.2006.03.016

Levine, L., & Bluck, S. (2004). Painting with broad strokes: Happiness and the malleability of event memory. *Cognition & Emotion*, *18*(4), 559–574. https://doi.org/10.1080/02699930341000446

Levine, L. J., & Edelstein, R. S. (2009). Emotion and memory narrowing: A review and goal-relevance approach. *Cognition & Emotion*, *23*(5), 833–875. https://doi.org/10.1080/02699930902738863

Levine, L. J., & Pizarro, D. A. (2004). Emotion and memory research: A grumpy overview. *Social Cognition*, *22*(5), 530–554. https://doi.org/10.1521/soco.22.5.530.50767

Martin, E. A., & Kerns, J. G. (2010). Social anhedonia associated with poor evaluative processing but not with poor cognitive control. *Psychiatry Research*, *178*(2), 419–424. https://doi.org/10.1016/j.psychres.2009.08.018

Martin, E. A., & Kerns, J. G. (2011). The influence of positive mood on different aspects of cognitive control. *Cognition & Emotion*, *25*(2), 265–279. https://doi.org/10.1080/02699931.2010.491652

Mather, M., & Sutherland, M. (2009). Disentangling the effects of arousal and valence on memory for intrinsic details. *Emotion Review*, *1*(2), 118–119. https://doi.org/10.1177/1754073908100435

Oaksford, M., Morris, F., Grainger, B., & Williams, J. M. G. (1996). Mood, reasoning, and central executive processes. *Journal of Experimental Psychology*, *22*(2), 476–492. https://doi.org/10.1037/0278-7393.22.2.476

Oatley, K., & Johnson-Laird, P. N. (2014). Cognitive approaches to emotions. *Trends in Cognitive Sciences*, *18*(3), 134–140. https://doi.org/10.1016/j.tics.2013.12.004

Phillips, L. H., Bull, R., Adams, E., & Fraser, L. (2002). Positive mood and executive function: Evidence from stroop and fluency tasks. *Emotion*, *2*(1), 12–22. https://doi.org/10.1037/1528-3542.2.1.12

R Core Team. (2016). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Richardson, J. T. E. (2011). Eta squared and partial eta squared as measures of effect size in educational research. *Educational Research Review*. https://doi.org/10.1016/j.edurev.2010.12.001

Rimmele, U., Davachi, L., Petrov, R., Dougal, S., & Phelps, E. A. (2011). Emotion enhances the subjective feeling of remembering, despite lower accuracy for contextual details. *Emotion*, *11*(3), 553–562. https://doi.org/10.1037/a0024246

Scherer, K. R. (2019). Studying appraisal-driven emotion processes: Taking stock and moving to the future. *Cognition and Emotion*, *33*(1), 31–40. https://doi.org/10.1080/02699931.2018.1510380

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology*, *45*(3), 513–523. https://doi.org/10.1037/0022-3514.45.3.513

Sedikides, C., & Skowronski, J. J. (2020). In human memory, good can be stronger than bad. *Current Directions in Psychological Science*, *29*(1), 86–91. https://doi.org/10.1177/0963721419896363

Sharot, T., & Phelps, E. A. (2004). How arousal modulates memory: Disentangling the effects of attention and retention. *Cognitive, Affective and Behavioral Neuroscience*, *4*(3), 294–306. https://doi.org/10.3758/CABN.4.3.294

Smith, A. P., Henson, R. N., Dolan, R., & Rugg, M. (2004). fMRI correlates of the episodic retrieval of emotional contexts. *NeuroImage*, *22*(2), 868–878. https://doi.org/10.1016/j.neuroimage.2004.01.049

Touryan, S. R., Marian, D. E., & Shimamura, A. P. (2007). Effect of negative emotional pictures on associative memory for peripheral information. *Memory*, *15*(2), 154–166. https://doi.org/10.1080/09658210601151310

Zhang, Q., Liu, X., An, W., Yang, Y., & Wang, Y. (2015). Recognition memory of neutral words can be impaired by task-irrelevant emotional encoding contexts: Behavioral and electrophysiological evidence. *Frontiers in Human Neuroscience*, *9*, 1–12. https://doi.org/10.3389/fnhum.2015.00073

Appendix

Neutral and negative narratives.

	Neutral and negative narratives	
	Neutral	Negative
Image 1	A normal day for one family starts at seven so the father can get to work and the mother can get their kids to school.	The local morning news is broadcasting breaking coverage of a multi-car crash that occurred this morning.
Image 2	Early in the morning, the mother is getting ready for the day.	As she listens to the news, a mother is getting ready for the day.
Image 3	Following her routine, the mother has coffee with breakfast.	The crash occurred just outside a high school, multiple cars and many victims were involved. Many victims were high school students.
Image 4	The mother receives a call from the dentist's office reminding her that her younger daughter has an appointment later this afternoon.	A phone call from school tells the mother her older daughter did not arrive to school this morning, she may have been in the crash.
Image 5	On her way to pick up her younger daughter from school, the mother stops to put gasoline into her car.	A detached hand is found at the scene and carefully saved in hopes of being reattached later at the hospital.
Image 6	The mother thinks of her older daughter and hopes she made it to class on time because she is always running late.	On her way to the scene of the crash, the mother pictures her older daughter in her mind, trying to remember exactly what she looks like.
Image 7	The mother and younger daughter make it to the appointment on time, where her daughter has her braces adjusted.	After searching for a while, the mother identifies a body as her older daughter and is told she died upon impact.
Image 8	After her appointment at the dentist, the mother drops off her younger daughter to finish her school day.	the mother thinks of her younger daughter, currently at school, and dreads telling her about her sister's death.
Image 9	The mother stops by the store to pick up last minute items for dinner at their grandfather's house.	The mother notices her daughter's best friend, who was also in the crash and survived. She goes to talk to her.
Image 10	The grandfather looks out the window as he hears his family arrive.	The grandfather looks out the window as he hears his family arrive, they are going to visit his granddaughter's grave today.
Image 11	The whole family helps clean up dishes at their grandfather's house before returning home.	The family spends a quiet moment visiting the deceased girl's grave

Neutral and positive narratives.

	Neutral and positive narratives	
	Neutral	Positive
Image 1	A normal day for one family starts at seven so the father can get to work and the mother can get their kids to school.	On her day off, the mother wakes up to find that her husband has made her favorite breakfast to surprise her.
Image 2	Early in the morning, the mother is getting ready for the day.	After eating, she gets ready for the day.
Image 3	Following her routine, the mother has coffee with breakfast.	The mother and two of her youngest children play with the family's new kittens before the children leave for school.
Image 4	The mother receives a call from the dentist's office reminding her that her younger daughter has an appointment later this afternoon.	The mother receives a call from the doctors office with results from a routine check-up. She is very healthy and has no medical issues.
Image 5	On her way to pick up her younger daughter from school, the mother stops to put gasoline into her car.	The mother packs some snacks and treats for tomorrow, the family is going to an amusement park together.
Image 6	The mother thinks of her older daughter and hopes she made it to class on time because she is always running late.	The mother pictures her older daughter, who is away at college but will be coming home later today to spend the weekend with the family.
Image 7	The mother and younger daughter make it to the appointment on time, where her daughter has her braces adjusted.	The mother uses a skydiving voucher her family gave her for her birthday. She has always wanted to try skydiving and finds that she loves it.
Image 8	After her appointment at the dentist, the mother drops off her younger daughter to finish her school day.	At school, the middle daughter looks up new recipes for the family barbeque that night.
Image 9	The mother stops by the store to pick up last minute items for dinner at their grandfather's house.	While getting ready for dinner, the mother comes across an old picture of one of her daughters and feels happy the whole family will be together this weekend.
Image 10	The grandfather looks out the window as he hears his family arrive.	The grandfather looks out the window as he hears his family arrive for the barbeque
Image 11	The whole family helps clean up dishes at their grandfather's house before returning home.	The family enjoys swimming, barbequing, and laughing together for the evening.