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BRIEF REPORT

Encoding details: Positive emotion leads to memory broadening

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In the current experiment we tested the hypothesis that unlike negative arousal, which leads to memory narrowing effects whereby an increase in memory for the central details is accompanied by a decrease in memory for the peripheral details, positive arousing events might lead to a memory broadening effect such that positive arousal would increase memory for both central and peripheral details. This was assessed by testing recognition for central and peripheral details of pictures that were selected to vary in a continuous manner across a wide range of arousal for both positive and negative items. The results indicated that increases in both positive and negative stimulus arousal levels led to gradual increases in memory for the central aspects of the photos. In contrast, negative arousal first increased then decreased memory for peripheral detail as arousal levels increased, whereas positive arousal led to a continuous increase in memory for peripheral details. Thus, arousing negative materials lead to memory narrowing, whereas arousing positive materials can lead to memory broadening.

Keywords: Memory for detail; Positive emotion; Gun focus; Recognition; Encoding.

The emotional content of an event can have profound effects on our ability to remember the specific details that make up that event (Dolcos, LaBar, & Cabeza, 2006; Sharot & Phelps, 2004). For example, arousing negative events lead to a “memory narrowing” effect such that the central details of highly arousing negative events are typically better remembered than those of neutral events, but memory for the peripheral details of events are often poorer for negative than neutral events (Christianson & Loftus, 1991; Clifford & Hollin, 1981; Easterbrook, 1959; Kebeck & Lohaus, 1986; Libkuman, Stabler, & Otani, 2004; Loftus & Burns, 1982; but see Deffenbacher, Bornstein, Penrod, & McGorty, 2004; Laney, Campbell, Heuer, & Reisberg, 2004).

However, the effects of arousing positive events on memory are less clear. Prior studies have indicated that positive content is better remembered than neutral content, but it is less

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well remembered than negative content (see Kensinger, 2009; Reisberg & Heuer, 2004, for reviews). For example, negative items are often more likely to be vividly remembered with visual detail than positive items (e.g., Kensinger, Garoff-Eaton, & Schacter, 2007; Ochsner, 2000). However, as far as we are aware, no prior study has examined how memory for the peripheral details of positive events changes as the level of arousal of the portrayed events increases.

Positive and negative emotion may have very different effects on memory for detail. It has been suggested that emotion is best understood as an adaptive mechanism designed to support the organism in its survival efforts by facilitating cautious approach in the absence of imminent threat and fast withdrawal in the face of danger (Cacioppo & Gardner, 1999; Fredrickson, 2001). Thus, the function of positive affect may be to help the organism maintain its course and explore the environment, while the function of negative affect is to mobilise the organism to either avoid or directly respond to an aversive stimulus.

Evidence that positive and negative stimuli elicit different memory responses comes from recent fMRI studies that have shown that the encoding of negative pictures is associated with activity in sensory processing regions such as the visual cortex and fusiform gyrus whereas the encoding of positive pictures is related to activity in lateral prefrontal and temporal regions that are associated with the processing of semantic/conceptual information (Bernstein, Berg, Siegenthaler, & Grady, 2002; Garoff, Slotnick, & Schacter, 2005; Kirchhoff, Wagner, Maril, & Stern, 2000; Kuskowski & Pardo, 1999).

In addition, there is evidence that moderate increases in positive or negative emotion can increase attentional engagement, but that very high levels of positive arousal continue to increase attention, whereas high levels of negative arousal lead to a narrowing of attention (e.g., Fredrickson & Branigan, 2005). For example, a recent study by Bradley, Codispoti, Cuthbert, and Lang (2001) showed that processing moderately arousing positive and negative images led to physiological responses consistent with attentional engagement such as slowing of heart rate and an inhibition of the startle reflex. However, when presented with intense negative images, heart rate was accelerated and the startle reflex was potentiated—signs of attentional withdrawal (freezing) and preparedness for action. In contrast, when presented with highly arousing positive images the startle reflex was inhibited and heart rate remained slow. This evidence is broadly consistent with claims that positive affect should encourage attention to peripheral detail in order to enhance understanding and learning, whereas aversive states should translate into acute focus on central object in order to successfully track the source of danger and respond accordingly (Cacioppo & Gardner, 1999; Fredrickson, 2001).

Based on these results one would expect that memory encoding may be facilitated for moderately arousing positive and negative materials. In contrast, highly arousing negative content may lead to a memory narrowing such that memory for peripheral information is impaired, whereas highly arousing positive materials may lead to memory broadening such that peripheral details are further enhanced. The current study aimed to test these hypotheses by investigating memory for central and peripheral visual details of positive and negative photographs that varied continuously from low to highly arousing.

METHOD

Participants

Seventy-six participants were recruited from introductory telecommunications courses (44 females). Five additional subjects had been recruited but were not included in the peripheral data analysis because they chose to withdraw or because of equipment failure. Participants' age ranged from 18 to 25 with an average of 19.86 ($SD = 1.31$).

Materials

Emotional tone. Seventy-two pictures selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999) served as target items. Based on the published IAPS norms, pictures were selected such that there were an equal number of positive and negative pictures (positive pictures had scores ≥ 5.5 and negative pictures had scores ≤ 4.0, where 1 is *very negative* and 9 is *very positive*), and an equal number of items at each of 9 levels of arousal (1 is *extremely calm* and 9 is *highly arousing*). Images depicted positive and negative connotations across such topics as food, nature, sports, health, and sex. At the highest levels of arousing content positive items included high-risk sports events, thrilling amusement park rides, and mild erotica while negative items included natural disaster victims, assault, and mutilations.

Centrality and periphery. Pilot studies were conducted to ensure that: (i) the selected pictures depicted only one easily identifiable event (e.g., a man kissing a woman in a park; burn victim on a street); and (ii) the amount of peripheral detail was comparable across valence and arousal conditions. These were established based on judgements of 10 graduate student volunteers who observed the pre-selected pictures and formulated the gist of the event. The statements were then compared for each picture. Pictures were only included in the set if there was a 100% agreement about the gist of the event. Once these were selected the primary researcher and two volunteer research assistants examined the pictures in order to identify central and peripheral details. This was done in two stages. At the first stage the procedure described in Heuer and Reisberg (1990) was adapted. Using the gist of the event as a basic description judges identified any fact or item that if changed or eliminated would change the basic description of the event. These were considered central. Items or facts that would not have such an effect were considered peripheral. For each picture, about 2–4 central and peripheral items were identified that all judges agreed on. At the second stage judges examined the pictures one more time and ensured that these mutually agreed-on central items in each picture were primarily located in the visual centre and not in the periphery of the picture, and vice versa.

Due to a naturally occurring background–foreground overlap in photographs some features associated with central objects appeared in the periphery and some features associated with peripheral objects appeared in the central area. To control for this, only pictures captured in medium-long-shot camera format were selected to allow for equal background–foreground ratio across all pictures. This allowed for keeping the amount of leakage across all conditions about the same for all conditions. Moreover, an additional 72 IAPS pictures used as foils for the recognition test were selected to match one of the target items thematically and in terms of visual complexity (medium-long shots only), but not in terms of key central and peripheral details. As demonstrated in Figure 1 a target picture of a sports event (gymnast) was balanced by a lure sporting event (diver) thus, for central detail, participants had to remember that the athlete was a female gymnast not a male diver. And for peripheral condition participants had to remember that there was a room filled with audience members in the background, and not a pool filled with water.

Procedure

Participants were tested in groups of 5 or 6. During the study phase, 72 pictures were presented on a computer screen for 6 seconds each, and participants were instructed to study each picture for a later memory test. After the presentation of each picture, participants were asked to rate the arousal, positivity and negativity of each image on 9-point scales. After the study phase, participants were exposed to a 7-minute segment from the television sitcom *Friends* as a distracter task.

Recognition memory was then tested for a mixture of the studied pictures and an equal number of non-studied lures. Each recognition item was presented for 100 ms, after which participants were asked to respond as quickly as possible with a "yes" if they remembered the item or "no" if they did not. For half of the trials subjects were tested for the central details by presenting a mask over the peripheral details, whereas they were tested for the peripheral details by presenting a mask over

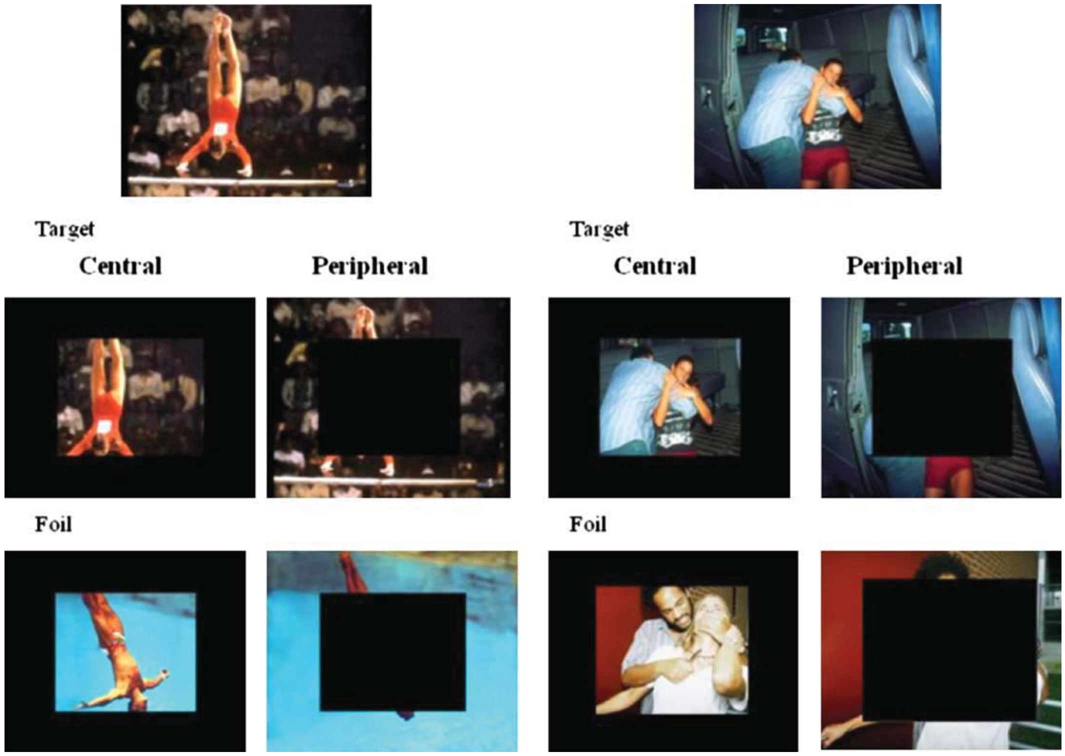

Figure 1. *Examples of the study and test materials, at arousing content level 8, used in the current experiment. [To view this figure in colour, please visit the online version of this Journal.]*

the central details (see Figure 1). Across the test, the central and peripheral aspects of each picture were tested. Central and peripheral items were tested in blocks, with the central items presented first followed by peripheral items to avoid ceiling effects for central details. The order of item presentation was randomised within each block.

RESULTS

Ratings during encoding

As expected, during encoding negative pictures were rated as significantly more negative ($M = 6.28$, $SE = 0.11$) than positive pictures ($M = 1.96$, $SE = 0.09$); $F(1, 80) = 1885.12$, $p < .001$, $\eta_p^2 = .95$, and, conversely, positive pictures were rated to be significantly more positive ($M = 5.61$, $SE = 0.12$) than the negative pictures ($M = 1.85$, $SE = 0.07$); $F(1, 80) = 1127.27$, $p < .001$, $\eta_p^2 = .93$. In addition, there was an effect of arousal on the ratings of arousal, $F(8, 640) = 129.16$, $p < .001$, $\eta_p^2 = .61$, which reflected the fact that the subjects' ratings of arousal increased with the published ratings of arousal.

Recognition memory

The average recognition scores are reported in Table 1. To assess recognition accuracy, the proportion of hits and false alarms were used to calculate d' values (Macmillan & Creelman, 1991). An Arousal × Valence × Detail analysis of variance (ANOVA) was conducted and revealed that there was a significant three-way interaction, $F(8, 600) = 15.33$, $p < .001$, $\eta_p^2 = .17$, indicating that the effect of Valence on central and peripheral Details was different for positive and negative materials. This was further quantified by subsequent ANOVAs.

Table 1. *Hit and false alarm rates for central and peripheral detail as a function of arousal (1 = low and 9 = high) for positive and negative images*

		Central detail		*Peripheral detail*	
	Arousal level	*Hit rate*	*False alarm rate*	*Hit rate*	*False alarm rate*
Positive	1	0.95	0.6	0.33	0.12
	2	0.95	0.61	0.58	0.2
	3	0.96	0.61	0.6	0.2
	4	0.97	0.6	0.62	0.21
	5	0.98	0.61	0.71	0.28
	6	0.97	0.59	0.69	0.21
	7	0.95	0.54	0.62	0.13
	8	0.98	0.57	0.64	0.17
	9	0.94	0.51	0.67	0.15
Negative	1	0.98	0.67	0.54	0.17
	2	0.97	0.63	0.55	0.09
	3	0.99	0.65	0.56	0.1
	4	0.92	0.48	0.7	0.18
	5	0.95	0.53	0.72	0.16
	6	0.95	0.55	0.6	0.18
	7	0.93	0.51	0.5	0.12
	8	0.94	0.51	0.52	0.17
	9	0.84	0.33	0.54	0.22

For the positive materials, Arousal had a main effect on recognition, $F(8, 608) = 7.43$, $p < .001$, $\eta_p^2 = .09$, such that memory improved as the content became more arousing (Figure 2A). The linear trend component of the Arousal main effect was significant, $F(1, 76) = 66.42$, $p < .001$, $\eta_p^2 = .47$. There was also an arousing content by Detail interaction, $F(8, 608) = 2.21$, $p = .02$, $\eta_p^2 = .03$. As one can see in Figure 2A this reflected the fact that arousal had a slightly more pronounced effect on the peripheral than the central details.

For negative content, however, the main effect of arousing content, $F(8, 608) = 3.63$, $p < .001$, $\eta_p^2 = .05$, had a significant quadratic trend component, $F(1, 76) = 18.02$, $p < .001$, $\eta_p^2 = .19$, and no linear component ($F < 1$). Further examination of the arousal by detail interaction, $F(8, 608) = 6.42$, $p < .001$, $\eta_p^2 = .09$, shown in Figure 2B, suggests that this was due to the fact that recognition for peripheral detail of negative images initially improved as arousing content increased and then dropped at highest levels of arousal.

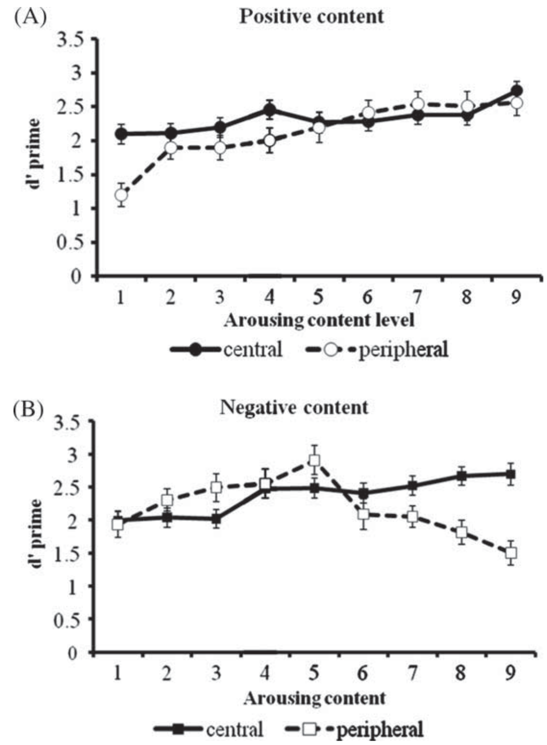

Figure 2. *Recognition accuracy (d′) plotted for central and peripheral detail as a function of arousal (1 = low and 9 = high) for positive (A) and negative images (B).*

DISCUSSION

The current results demonstrate that positive and negative emotion can have very different effects on recognition memory. In agreement with several previous studies, the results indicate that negative emotion leads to memory narrowing such that increasingly negative pictures lead to a constant increase in memory for the central information, but an increase followed by a decrease in memory for the peripheral information. In contrast, however, increasingly positive pictures lead to an increase in recognition for central and peripheral details across the range of arousal, indicating that positive emotion leads to a memory broadening rather than memory narrowing.

The dissociative effects of positive and negative emotion on memory are in agreement with prior studies showing that the encoding of positive and negative pictures engages different brain networks (Bernstein et al., 2002; Garoff et al., 2005; Kirchhoff et al., 2000; Kuskowski & Pardo, 1999), and with physiological studies indicating that high levels of negative emotion lead to attentional withdrawal whereas high levels of positive emotion lead to attentional engagement (Bradley et al., 2001). The current results are also consistent with several recent studies that have found that recall of items presented following a pleasantly arousing event are enhanced relative to those following a neutral event (Basso, Schefft, Ris, & Dember, 1996; Derryberry & Reed, 1998; Fredrickson & Branigan, 2005; Gasper & Clore, 2002). Whether the mechanisms underlying these temporal effects are the same as those underlying the memory broadening effects observed in the current experiment is not yet known.

One possible account of the dissociative effects of positive and negative emotion that were observed here is that the optimal arousal levels for positive and negative materials might be quite different. That is, the optimal level of arousal for the encoding of negative peripheral materials was at the midpoint of the materials examined in the current study. It is possible that a similar inverted U-shaped function might be observed for positive materials as well, but it is simply shifted farther to the right. It does seem quite plausible that extremely high levels of positive arousal might begin to have detrimental effects on memory for the peripheral materials, but what those positive stimuli might be is unclear. In any case, the important finding was that at the levels examined in the current study, where arousal levels were reasonably well matched between positive and negative items, the effects of positive and negative emotion were quite different.

The results suggest that positive compared to negative arousal leads to very different trade-offs between the encoding of central and peripheral information. Indeed, the quadratic function of peripheral detail encoding suggests that at moderate levels of arousing content encoding efforts were equally divided between central and peripheral detail, keeping the information intake at about the same rate. However, at the highest levels of arousal once the content became highly aversive, the cognitive system responded by shifting away from peripheral detail encoding. The reasons for this shift remain to be tested.

It is important to point out that in the current study the emotional intensity was carried primarily by the central detail of the images and the periphery was neutral. Thus, it is not known whether the pattern would hold under reverse conditions or when both centre and periphery of the images are equally emotionally salient. It is also important to keep in mind that positivity and negativity were elicited using an aggregate set of topics limited to the IAPS materials. Whether the broadening effect is replicable using more real-world emotional manipulations, or using more discrete emotional states, such as happiness, joy, or ecstasy alone remains to be tested.

Finally, in the current study, prior to the test phase we had subjects watch a short video of a television comedy, and this may have induced a positive mood. Because the same video was seen by all subjects, it is unlikely that this would have produced the interactions that we observed, but future studies examining the effects of mood on memory for central and peripheral materials will be informative. In fact, there is evidence that when expectancy of gain is used to manipulate arousal, positive emotional states can have different effects on central and peripheral detail memory (Gable & Harmon-Jones, 2010).

The finding that high levels of negative arousal lead to memory narrowing whereas positive arousal leads to memory broadening may have practical implications in a wide variety of contexts, such as studies of communication and the media. For example, in the context of political advertising it may be the case that highly negative content leads to effective encoding of central information while leaving peripheral information such as the source of the information or the funding organisation poorly remembered. In contrast, positive arousal may enhance memory for both the central content and the peripheral details. Although future studies will be necessary to test the generalisability of the current results, the results suggest that what is remembered and what is forgotten about a message can be impacted in complex ways by the emotional tone of that information.

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REFERENCES

Basso, M. R., Schefft, B. K., Ris, M. D., & Dember, W. N. (1996). Mood and global–local visual processing. *Journal of the International Neuropsychological Society*, *2*(3), 249–255.

Bernstein, L. J., Berg, S., Siegenthaler, A. L., & Grady, C. L. (2002). The effect of encoding strategy on the neural correlates of memory for faces. *Neuropsychologia*, *40*, 86–98.

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion*, *1*(3), 276–298.

Cacioppo, J. T., & Gardner, W. L. (1999). Emotion. *Annual Reviews: Psychology*, *50*, 191–214.

Christianson, S. A., & Loftus, E. (1991). Remembering emotional events: The fate of detailed information. *Cognition and Emotion*, *5*, 81–108.

Clifford, B. R., & Hollin, C. R. (1981). Effects of the type of incident and the number of perpetrators on eyewitness memory. *Journal of Applied Psychology*, *66*(3), 364–370.

Deffenbacher, K. A., Bornstein, B. H., Penrod, S. D., & McGorty, E. K. (2004). A meta-analytic review of the effects of high stress on eyewitness memory. *Law and Human Behavior*, *28*(6), 687–706.

Derryberry, D., & Reed, M. A. (1998). Anxiety and attentional focusing: Trait, state and hemispheric influences. *Personality and Individual Differences*, *25*(4), 745–761.

Dolcos, F., LaBar, K. S., & Cabeza, R. (2006). The memory enhancing effect of emotion: Functional neuroimaging evidence. In B. Uttl, N. Ohta, & A. L. Siegenthaler (Eds.), *Memory and emotion: Interdisciplinary perspectives* (pp. 107–133). Malden, MA: Blackwell Publishing.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review*, *66*, 183–201.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist*, *56*(3), 218–226.

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought–action repertoires. *Cognition and Emotion*, *19*, 313–332.

Gable, P. A., & Harmon-Jones, E. (2010). The effect of low versus high approach-motivated positive affect on memory for peripherally versus centrally presented information. *Emotion*, *10*(4), 599–603.

Garoff, R. J., Slotnick, S. D., & Schacter, D. L. (2005). The neural origins of specific and general memory: The role of the fusiform cortex. *Neuropsychologia*, *43*, 847–859.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global vs. local processing of visual information. *Psychological Science*, *13*, 34–40.

Heuer, F., & Reisberg, D. (1990). Vivid memories of emotional events: The accuracy of remembered minutiae. *Memory & Cognition*, *18*, 496–506.

Kebeck, G., & Lohaus, A. (1986). Effect of emotional arousal on free recall of complex material. *Perceptual and Motor Skills*, *63*(2, Pt. 1), 461–462.

Kensinger, E. A. (2009). Remembering the details: Effects of emotion. *Emotion Review*, *1*(2), 99–113.

Kensinger, E. A., Garoff-Eaton, R. J., & Schacter, D. L. (2007). Effects of emotion on memory specificity: Memory trade-offs elicited by negative visually arousing stimuli. *Journal of Memory and Language*, *56*, 575–591.

Kirchhoff, B. A., Wagner, A. D., Maril, A., & Stern, C. E. (2000). Prefrontal-temporal circuitry for episodic encoding and subsequent memory. *Journal of Neuroscience*, *20*, 6173–6180.

Kuskowski, M. A., & Pardo, J. V. (1999). The role of the fusiform gyrus in successful encoding of face stimuli. *NeuroImage*, *9*, 599–610.

Laney, C., Campbell, H. V., Heuer, F., & Reisberg, D. (2004). Memory for thematically arousing events. *Memory & Cognition*, *32*(7), 1149–1159.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). *International Affective Picture System (IAPS): Technical manual and affective ratings*. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Libkuman, T. M., Stabler, C. L., & Otani, H. (2004). Arousal, valence, and memory for detail. *Memory*, *12*(2), 237–247.

Loftus, E. F., & Burns, T. E. (1982). Mental shock can produce retrograde amnesia. *Memory & Cognition*, *10*(4), 318–323.

Macmillan, N., & Creelman, C. (1991). *Detection theory: A user's guide*. Cambridge, UK: Cambridge University Press.

Ochsner, K. N. (2000). Are affectivve events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General*, *129*(2), 242–261.

Reisberg, D., & Heuer, F. (2004). Memory for emotional events. In D. Reisberg & P. Hertel (Eds.), *Memory and emotion* (pp. 3–41). New York, NY: Oxford University Press.

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