

Positive emotions enhance recall of peripheral details

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Emotional arousal and negative affect enhance recall of central aspects of an event. However, the role of discrete emotions in selective memory processing is understudied. Undergraduates were asked to recall and rate autobiographical memories of eight emotional events. Details of each memory were rated as central or peripheral to the event. Significance of the event, vividness, reliving and other aspects of remembering were also rated for each memory. Positive affect enhanced recall of peripheral details. Furthermore, the impairment of peripheral recall was greatest in memories of anger, not of fear. Reliving the experience at retrieval was negatively correlated with recall of peripheral details for some emotions (e.g., anger) but not others (e.g., fear), irrespective of similarities in affect and intensity. Within individuals, recall of peripheral details was correlated with less belief in the memory's accuracy and more likelihood to recall the memory from one's own eyes (i.e., a field perspective).

As will be reviewed, there is considerable support for the claim that emotional intensity enhances memory for central details at the expense of memory for peripheral details. This phenomenon is usually referred to as tunnel memory (see Christianson, 1992, for a review). However, with a handful of exceptions, this claim is based on studies that use only intensely negative events, not intensely positive events. For the few studies that have

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compared positive to negative memories, some have found that tunnel memories are only found for negative not for intensely positive events (e.g., Berntsen, 2002). However, in studies like this, only one negative and one positive event is usually recalled. Here we test the generality of the claim by having participants recall events that represent eight distinct emotions chosen to vary in affect and intensity. One might expect that memories for different emotional events will show different patterns regarding the relative amount of central versus peripheral details under the assumption that they reflect different patterns of appraisal (Lazarus, 1991).

High arousal and negative affect enhance recall of central aspects of events. This statement has been supported by research in autobiographical memory (Berntsen, 2002; Christianson & Loftus, 1990; Strube & Neubauer, 1988; Wessel & Merckelbach, 1994), eyewitness memory (Stebly, 1992; Yuille & Cutshall, 1986), event memory (Christianson & Loftus, 1991; Reisberg & Heuer, 2004), episodic memory (Kensinger & Corkin, 2003; MacKay et al., 2004), animal learning (Easterbrook, 1959) and perception (Öhman, Flykt, & Esteves, 2001; Safer, Christianson, Autry, & Österlund, 1998). Some, but not all, researchers (see McNally, 2003, for a review) argue that trauma memories are an exception to this rule and that they are subject to global impairment (Terr, 1991; Williams, 1994) or selective impairment of central information (van der Kolk & Fisler, 1995). Moreover, the DSM-IV-TR – C3 criteria for posttraumatic stress disorder (and all PTSD scales and evaluations that are based on it) include selective impairment of central information in the form of “an inability to recall an important aspect of the trauma” (American Psychiatric Association, 2000, p. 468; see Rubin, Berntsen, & Johansen, *in press*, for a critical review).

However, a number of laboratory episodic, as opposed to autobiographical, memory studies have recently shown that contextual information, including colour (Doerksen & Shimamura, 2001; Kensinger & Corkin, 2003; MacKay et al., 2004), spatial location (MacKay & Ahmetzanov, 2005), and temporal context (D’Argembeau & van der Linden, 2005), is enhanced for negative emotional stimuli relative to neutral. Thus, emotional arousal and negative affect were confounded and the effects of one could offset the effects of the other. In addition, in each of these examples, there was only one object and that object’s colour, spatial location, or temporal order was tested in conjunction with the identity of the object. In other words, two different but salient aspects of the same object were investigated. In more complex, real-world events, it is reasonable to assume that when, where, and what something looked like would all be attributed to one detail, either central or peripheral, depending on its physical or conceptual relationship to the overarching experience.

In addition to changes in peripheral detail recall, boundary extension (misremembering a scene as being more distant or including more of the

surrounding area than was originally presented; Intraub & Richardson, 1989) is *not* found for negative emotional stimuli; instead participants tend to recall images as being more “close up” than they actually were (Safer et al., 1998). The weapon-focus effect in eyewitness memory also argues for a perceptual narrowing of attention towards the most salient aspect of an emotional event to the detriment of other elements of the scene (Burt, Watt, Mitchell, & Conway, 1998; Pickel, 1999; Shaw & Skolnick, 1999). Finally, a number of studies have found that increasing affect is correlated with self-rated recall of central details (Christianson & Hubinette, 1993; Christianson & Loftus, 1990; Wessel & Merckelbach, 1994).

The primary explanations for differential recall of details have centred on the emotional dimensions of arousal and affect. Arousal is an insufficient explanation of these effects because the type of arousal matters. Physiological arousal alone—e.g., as induced by physical exercise (Dutton & Carroll, 2001; Libkuman, Nichols-Whitehead, Griffith, & Thomas, 1999) or arousal-inducing drugs such as adrenaline (epinephrine; Christianson & Mjörndal, 1985)—fail to produce memory effects. Emotional intensity may be a better construct as it has been shown to be predictive of memory experience (Talarico, LaBar, & Rubin, 2004) even for situations where physiological arousal is low but depth of feeling is high, such as in loneliness or depression.

One may predict that at sufficient intensity, negative affect draws attention to the most salient features, narrowing attention to enhance their perception at the expense of peripheral details (Loewenstein, Weber, Hsee, & Welch, 2001; Öhman et al., 2001; Reisberg & Heuer, 2004). Conversely, Fredrickson’s (1998, 2001; Fredrickson & Branigan, 2005) *broaden-and-build* theory of positive emotions argues that enhanced attention to peripheral features can enhance positive experience at the time and enhance the utility of recalling that experience in the future. *Broaden-and-build* is one example of appraisal theory that predicts differential encoding and retrieval depending on the functional relevance of each stimulus in an emotional situation (Ellsworth & Scherer, 2003). Negative affect is of particular interest due to the desire to generalise to populations suffering from depression, posttraumatic stress disorder, and other disorders whose proximate cause can be emotional distress. The evolutionary benefit of attending to salient negative information is obvious, as is the need to remain vigilant even in positive situations for the appearance of a threatening stimulus. However, it may be just as beneficial to attend to as much of a positive experience as possible (to enhance current positive mood, to enhance generalisability of positive experiences to future situations, and to undo lingering negative affect; Fredrickson, 2001). Furthermore, happy mood seems to enhance cognitive flexibility, creativity and open-minded processing (Estrada, Isen, & Young, 1997; Isen & Daubman, 1984; Isen, Daubman, & Nowicki, 1987), which should allow for enhanced encoding of peripheral details during real-world

events. All of this is consistent with cognitive appraisal theories of emotion (Lazarus, 1991; Simon, 1967).

The observed effects do not have to do only with processes at encoding. Another possibility is that they have to do with the way the memories are rehearsed and reconstructed. For example, Levine and Bluck (2004) argued that people employ less problem-oriented processing strategies for happy events as compared to negative events. For the negative events, people may scrutinise information more carefully and systematically at the time of recall, whereas people remembering positive events rely more on their general knowledge and intuitions (Bless et al., 1996). One consequence of this is that positive events are more likely to include peripheral details that are erroneous (Bless et al., 1996; Bohn & Berntsen, 2007; Kensinger & Schacter, 2006; Levine & Bluck, 2004; Park & Banaji, 2000; Storbeck & Clore, 2005). Regardless of accuracy, the quantity and type of detail recalled about emotional autobiographical memories is informative.

The few studies that have examined central versus peripheral details as a function of affect generally support the idea that positive emotion enhances recall of peripheral details relative to negative emotion (Berntsen, 2002; Libkumen, Stabler, & Otani, 2004; although see Butler & Wolfner, 2000). Similarly, more sensory details have been found for positive memories than for negative (D'Argembeau, Comblain, & van der Linden, 2003; Destun & Kuiper, 1999). Participants in these studies were typically asked to provide only one example each of a positive and a negative memory, however. Furthermore, in most cases, the negative memory was specifically a traumatic event, which is useful for generalising to clinical populations but may be less useful for describing normative emotional experience. In other cases, no specific emotion was identified for either positive or negative affect, allowing participants to select from a range of discrete emotions, without regard to the specific influence of each. Therefore, when choosing our emotion cues, we deliberately selected four discrete emotions from each affect category.

Although dimensional accounts of emotion are informative, the influence of discrete emotions should not be underestimated (Levine & Burgess, 1997; Levine & Pizarro, 2004). Appraisal theory in general predicts that the specific event details identified as central or peripheral will vary as a function of the cognitive appraisal that leads to that particular emotional reaction in a given situation. In a study examining discrete emotions specifically, Levine and Burgess (1997) found that happy moods lead to enhanced memory for all aspects of an event narrative (e.g., central and peripheral details about the setting, goal, agent, and outcome), whereas angry or sad moods selectively enhanced recall of goals and outcomes, respectively. Different negative moods have been found to have distinct influences on behaviour (Raghunathan & Pham, 1999) and cognition

(Lerner, Gonzalez, Small, & Fischhoff, 2003), yet the differences between emotions that are dimensionally alike (high arousal, negative affect) but categorically different (fear vs. anger) are rarely examined. One aim of the current study was to clarify dimensional vs. discrete effects of emotion on memory. We predicted that all of our emotional memories would contain more central than peripheral details, but that recall of peripheral information would be influenced by affect such that memories for positive events would include more peripheral information than memories for negative events. Furthermore, we predicted that the least peripheral details would be recalled for fearful memories, consistent with the notion of tunnel memories.

METHOD

Participants

Duke University undergraduates ($N = 170$, 68 males; $M = 19$ years old) completed the experiment for partial course credit. The study was reviewed and approved by The Institutional Review Board for the Protection of Human Subjects in Non-medical Research at Duke University.

Procedures

Participants were asked to recall eight distinct emotional events—happy, calm, in love, positive surprise, negative surprise, angry, sad, and afraid. The description of the emotions and examples given were based on appraisal theory (Lazarus, 1991). The first four of these are considered positive emotions and the latter four are negative; happiness, love, anger, and fear are highly arousing emotions, the others are low in arousal (Fredrickson, 1998; Russell, 1980; Watson & Tellegen, 1985). Thus, these emotions were chosen as the minimum necessary to represent the spectrum of emotional experience. By limiting our request to one memory from each emotional experience, we can control for the preponderance of positive experiences in everyday life (Carstensen, Mayr, Pasupathi, & Nesselroade, 2000; Zelenski & Larsen, 2000) and focus on quintessential examples of each emotion.

Following the procedures of Berntsen (2002), participants were first given one minute to think back on their lives and consider which episode had been the most fearful (or happiest, etc.). Previous investigators have estimated that recall of autobiographical memories takes 10–15 seconds (Robinson, 1976; Rubin, 1980), however, we wanted to provide sufficient time for participants to identify a specific memory characterised by a distinct emotional tone. The full minute of reflection allowed participants to reject the first memory brought to mind in favour of a subsequently recalled event that better exemplified the emotion, if necessary. After this minute of

reflection, they were given five minutes to record the details of the memory. Pilot testing had revealed that three minutes was insufficient for most participants to record the details of each memory to completion. By extending that time to five minutes, participants were finished reporting all details of each memory before moving on to the next event in all but a few cases. A detail was operationally defined as “any natural unit of information about the event” and they were encouraged to “include everything—the most obvious to the most insignificant items”.

Participants also answered various rating scale questions about phenomenological properties (reliving, vividness, and perspective), metacognitive properties (belief in the memory’s accuracy), and event properties (significance) taken from the Autobiographical Memory Questionnaire (AMQ; Rubin, 2006; Rubin, Schrauf, & Greenberg, 2003; Sheen, Kemp, & Rubin, 2001). There is evidence that recall of central details is correlated with vividness in high-intensity memories regardless of affect (Butler & Wolfner, 2000; Christianson & Hubinette, 1993) and with reliving and rehearsal for positive memories (Butler & Wolfner, 2000).

The AMQ asked participants for the *affect* (“*extremely negative*” – 3 to “*extremely positive*” 3) and *intensity* (“*not at all intense*” 1 to “*extremely intense*” 7) of the event so that we could examine the independent effects of these dimensions on recall. We also asked participants how old they were at the time of the event so that we could calculate *recency of the event*. Participants were asked if they believed the event really occurred as they remember it (“*100% imaginary*” to “*100% real*”) to get an estimate in their *belief* in the memory’s accuracy. The question about how much *reliving* they experienced while recalling the event was anchored at “*not at all*” (1) and “*as clearly as if it were happening now*” (7). We also asked how often they thought or talked about the event (*rehearsal*) and how *significant* the event was in their life, both anchored at “*not at all*” (1) and “*more than for any other memory*” (7). Some participants ($n=68$) were asked how *vivid* the memory was (from “*not at all*” 1 to “*as clearly as if it were happening right now*” 7) whereas others ($n=60$) were asked from what *perspective* they recalled the event (from “*my own eyes*” to “*as an outside observer*” 7). A third subset ($n=42$) was asked both questions and was asked to complete the AMQ prior to recording the details of each memory. A *group* variable identifying each procedure was initially included in the analyses described below and there were no significant interactions with the variables of interest. Therefore, data from all participants were included in the subsequent analyses with the *group* factor excluded.

Finally, participants were asked to rate each previously recorded detail as either central or *peripheral*. Berntsen (2002) found no differences between independent judge- and participant-rated coding of details, therefore we opted for the more efficient self-rating. However, Berntsen

(2002); Experiment 2) did find a main effect of order such that later memories included more central details when she had participants code the details as central or peripheral after each memory. Therefore, our participants identified each detail as central or peripheral only after recording all eight memories. To make the central/peripheral judgement, we instructed participants to ask, "Does this detail make a difference? That is, is it possible to leave out/replace this detail without changing the main content of the memory OR what created your emotional reaction?" This joint criterion is often used to define centrality in studies where encoding occurred outside the experimental setting and is more closely related to "thematic centrality" as defined by Reisberg and Heuer (2004) than to "perceptual centrality". Participants were also allowed to mark any detail with an X if they could not determine if it was central or peripheral. However, this option was used quite sparingly and the overall mean proportion of total details that were marked as neither central or peripheral never exceeded .02 for any emotion and only 14 subjects had a mean proportion of "neither" details in excess of .05. Therefore, although we report analyses conducted on proportion of details rated peripheral, the conclusions would remain the same (just in the opposite direction) if we had analysed proportion of details rated central instead.

RESULTS

Events recalled

We have no objective data as to the number or nature of details present at the original event; we are relying on participants' written descriptions of the event. Because we asked participants to report their memories by identifying discrete details that need be intelligible only to themselves (to increase the likelihood of honest recall of emotional experiences), detailed content analysis of the events recalled was not possible. However, gross-level analysis revealed some striking similarities in the types of events recalled by our sample. Table 1 lists any category of event that was recalled by more than 10 participants as coded by a research assistant naïve to the experimental hypothesis. Our classification had to be more general than the individual events that fell into each category and may give the misimpression that the events recalled were more general than they actually were. Although some types of events are more obviously recalled for particular emotions (e.g., arguments recalled as memories of anger), there is also considerable overlap with some events being recalled with different emotions (e.g., death of a loved one can be both a negative surprise and sad; being accepted into an organisation can be both positively surprising and happy). Many participants described unique experiences such that for any one emotion, there are

TABLE 1
Event categories recalled by at least 10 participants for each emotion

<i>Emotion</i>	<i>Event</i>	<i>Number of memories</i>
<i>Positive surprise</i>	Accepted into an organisation	52
	Winning a prize/award	34
	Surprise party	25
	Receive a gift	16
	Succeeded at a task	10
<i>Calm</i>	Vacation	73
	Content with self/life	21
	Spiritual/religious experience	18
	Time with friends	10
<i>Happy</i>	Accepted into an organisation	29
	Vacation	24
	Time with friends	20
	Content with self/life	17
	High school graduation	14
	Romantic encounter	14
	Victory in competition	10
<i>In love</i>	Special time together	85
	"I love you" for first time	13
	Wanting to be with someone	11
	Love reciprocated	10
<i>Sad</i>	Death of loved one	49
	Romantic break-up	19
	Friend/family moving away	18
	Disease/injury	17
<i>Negative surprise</i>	Failed at a task	30
	Rejected from an organisation	28
	Expectations not met	17
	Disease/injury	16
	Death of a loved one	15
<i>Afraid</i>	Childhood fright	30
	Crime	22
	Automobile accident	18
	Near death experience	15
	Disease/injury	13
<i>Angry</i>	Argument with loved one	37
	Mocked/humiliated	23
	Another exerted authority	22
	Unjust occurrence	18
	Physical conflict	13

Note: "Organisations" include colleges, fraternities/sororities, and other clubs.

numerous events that were recalled by only one individual (e.g., fearful memories of a roller coaster or the experience of being in love during religious conversion). The one emotion for which coding event descriptions proved most difficult was “in love”, with most participants describing idiosyncratic shared experiences (e.g., sitting on the sofa watching election returns) and detailing the lovable/loving characteristics of the person they were with (e.g., supportive, reassuring, made me laugh).

Emotion and memory content

Our main question was, how may emotion influence the proportion of details rated as peripheral? The results of a one-way repeated-measures analysis of variance (ANOVA) were significant, $F(7, 1148) = 18.77$, $p < .0001$. Mean proportions for each of the eight emotions and the results of planned pairwise contrasts among the emotions are shown in Figure 1. As Figure 1 illustrates the four emotions with positive affect had more peripheral details ($M = 0.43$, $SD = 0.15$) than the four with negative affect ($M = 0.35$, $SD = 0.13$); $t(164) = 10.49$, $p < .0001$. The mean emotion ratings for each (shown in Table 2) confirm that valence roughly divides the emotions in the two halves shown in Figure 1, but that intensity does not

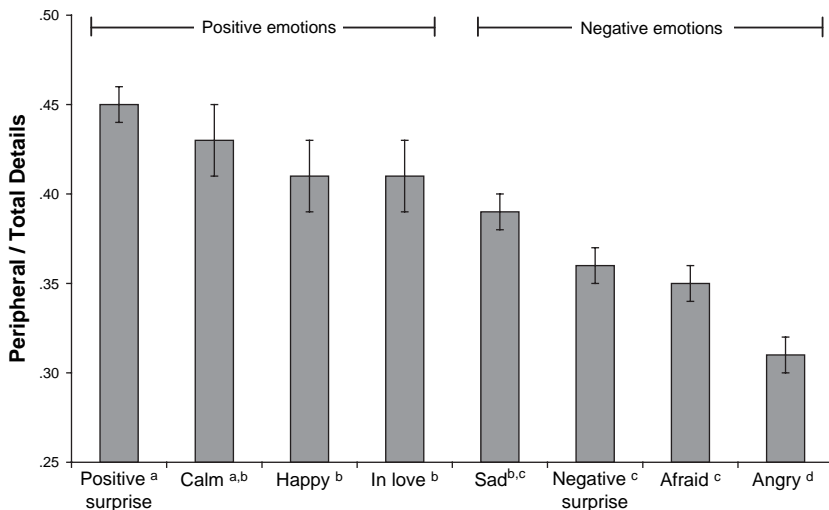


Figure 1. Mean proportion of total details rated as peripheral for each of the eight individual emotions. The emotions are ranked from the highest to the lowest proportion of peripheral details. Emotions sharing a superscript are not significantly different from each other according to planned pairwise contrasts ($p < .01$). Note: $N = 165$, error bars are standard error of the mean.

TABLE 2
 Mean emotion ratings (affect and intensity) and how many years ago the event occurred (recency) for each memory, in order of proportion peripheral details recalled

	<i>Affect</i>		<i>Intensity</i>		<i>Recency</i>	
	<i>M</i>	<i>SEM</i>	<i>M</i>	<i>SEM</i>	<i>M</i>	<i>SEM</i>
Positive surprise	2.59	0.06	5.65	0.08	2.82	0.22
Calm	1.68	0.08	3.70	0.12	2.38	0.22
Happy	2.58	0.07	5.55	0.09	2.21	0.19
In love	2.34	0.09	5.82	0.08	1.73	0.14
Sad	-2.35	0.07	6.25	0.07	3.54	0.25
Negative surprise	-2.11	0.07	5.57	0.09	3.19	0.25
Afraid	-2.21	0.07	6.08	0.08	5.60	0.37
Angry	-2.26	0.07	6.07	0.08	2.64	0.21

vary systematically with the proportion of peripheral details recalled. For example, positive surprise and negative surprise were rated as equally intense, $t(166) = 0.67$, $p > .05$, but nonetheless varied significantly with regard to the proportion of peripheral details, $t(166) = 6.43$, $p < .01$. Table 2 also shows that age of the memory cannot account for differences in the types of details recalled. This is most clearly illustrated by positive surprise and angry, which were equally old, $t(166) = 0.60$, $p > .05$, but nonetheless differed significantly on the proportion of peripheral details, $t(167) = 9.28$, $p < .01$. Thus, overall positive versus negative valence accounts for some of the variance in the proportion of peripheral details, whereas intensity and recency show no systematic pattern.

In addition to the overall effect of emotional valence, there is an effect of discrete emotions. In particular, fear and anger are nearly identical in their ratings of valence and intensity, $t(169) = 0.66$ and $t(168) = 0.11$, respectively, both $ps > .05$, yet angry memories have a significantly lower proportion of peripheral details, $t(169) = 3.07$, $p < .01$. Positive surprise and happy also have similar ratings of valence and intensity, $t(167) = 0.15$ and 0.98 , respectively, both $ps > .05$, but significantly different proportions of peripheral details, $t(166) = 2.55$, $p = .012$. Therefore, a dimensional account of emotion is insufficient to explain the pattern of data that we obtained.

Given that the idea of emotion enhancing recall of central details at the expense of peripheral details (i.e., tunnel memories) was first identified in (and meant to generalise to) memories involving fear, it is surprising that fearful memories here do *not* result in the least recall of peripheral details. Angry memories had the smallest proportion of peripheral details and were significantly different from all other emotions. Probing this difference, we find that 101 participants had a higher proportion of peripheral details for

fear than anger while only 60 individuals had higher proportion for anger than for fear. There were also a small number of participants who rated no detail within a given memory as peripheral, three of whom did so for their fearful memory and ten who did so for the angry memory (including one participant who did so for both). Therefore, the finding that angry memories exhibit the least recall of peripheral details does not seem to be an artefact of averaging. It may be that fearful memories are more focused on central details when compared to neutral or happy memories, but that they are not the most acute examples of tunnel memories overall.

Memory content and remembering experience

We also asked how recalling a greater proportion of peripheral details may influence other characteristics of the autobiographical memory. Therefore, we calculated correlations between the proportion of peripheral details recalled and each of the AMQ variables under the liberal assumption that each memory was an independent observation to allow for comparisons with earlier work that did not specifically examine distinct emotions. Proportion of peripheral details recalled was correlated with positive affect, $r(1353) = .17$, $p < .0001$, and intensity, $r(1352) = -.17$, $p < .0001$, but not recency, $r(1345) = .03$, $p > .05$. Thus, the effects of affect and intensity could not be caused by the age of the memory. Perspective at recall and belief in the memory's accuracy have been postulated to interact with recall of central details in clinical populations (van der Kolk, Hopper, & Osterman, 2001), but have not previously been investigated in healthy adults. Recall of peripheral details was negatively correlated with belief in the memory's accuracy, $r(1353) = -.07$, $p < .01$, but not with recalling the memory from one's own eyes (i.e., a field perspective), $r(811) = .00$, $p > .05$. A feeling of reliving while remembering the event was negatively correlated with recall of peripheral details, $r(1351) = -.17$, $p < .0001$, whereas vividness of the memory was unrelated to recall of peripheral details, $r(874) = -.06$, $p > .05$. Furthermore, significance of the event and how often the event was thought or talked about were also negatively correlated with recall of peripheral details, $r(1352) = -.07$, $p < .01$ and $r(1352) = -.09$, $p < .01$, respectively.

To provide a more conservative statistical test, we calculated Pearson's correlations between proportions of details rated as peripheral and each of the Autobiographical Memory Questionnaire (AMQ) ratings across all 8 emotions for each individual. Then, we examined the mean correlation coefficients across all participants using a one-sample *t*-test to determine if those average coefficients were significantly different from zero. As with the above analysis, proportion of peripheral details recalled was positively correlated with positive affect, mean $r = .26$, $t(169) = 9.66$, $p < .0001$, and negatively correlated with intensity, $r = -.19$, $t(169) = -6.90$, $p < .0001$,

but not correlated with recency, $r = .01$, $t(168) = 0.44$, $p > .05$. Unlike above, where belief in the memory's accuracy was negatively associated with proportion of peripheral details, no relationship was found in this analysis, $r = -.01$, $t(162) = -0.36$, $p > .05$. Recalling the memory from one's own eyes (i.e., a field perspective), was unrelated to recall of peripheral details, $r = -.02$, $t(96) = -0.62$, $p > .05$, as it was above. Similarly, in this more conservative analysis, vividness was not associated with proportion of peripheral details recalled, $r = -.03$, $t(108) = -0.90$, $p > .05$, and the relationship between increased proportion of peripheral details and decreased reliving was only marginally significant, $r = -.06$, $t(168) = -1.90$, $p = .059$. Significance of the event and how often it was rehearsed were still negatively correlated with proportion of peripheral details recalled, $r = -.07$, $t(169) = -2.16$, $p = .033$ and $r = -.08$, $t(169) = -2.55$, $p = .012$, respectively. That statistical significance was obtained with small correlations indicates that the correlations calculated within subjects did not vary much.

In order to ease comparisons with previous work involving only one or two emotions, we also calculated the correlations for each of the eight emotions individually (see Table 3). Because each participant provided only one memory from each emotional category, the observations within the correlation matrix for each emotion are independent. However, the range of affect and intensity are obviously restricted in this analysis. Given that, it is perhaps not surprising that increasing affect is correlated with recalling a greater proportion of peripheral details only for angry memories and that intensity is negatively correlated with recall of peripheral details in only half of the emotions: positive surprise, in love, sad, and angry. Recency is correlated with greater recall of peripheral details for calm and fearful memories.

Berntsen (2002) failed to find a relationship between recall of peripheral details and the experience of remembering in memories for shocking or happy experiences, which is consistent with our relatively low correlations overall, and the fact that we found no significant correlations between proportion of peripheral details and recall perspective or vividness within any particular emotion and a negative relationship between proportion of peripheral details recalled and belief in the memory's accuracy for calm memories only. Consistent with the two types of correlations calculated above, the experience of reliving the experience at recall was most related to the proportion of peripheral details. Ratings of reliving were associated with recall of fewer peripheral details for all memories but those of positive surprise and fear. This is consistent with previous work showing positive correlations between recall of central details and reliving in positive memories (Butler & Wolfner, 2000).

TABLE 3
 Pearson's correlations between proportions of details rated as peripheral and each of the Autobiographical Memory Questionnaire (AMQ) ratings within each emotion, in order of proportion peripheral details recalled

	<i>Affect</i>	<i>Intensity</i>	<i>Recency</i>	<i>Belief</i>	<i>Perspective</i>	<i>Reliving</i>	<i>Vividness</i>	<i>Significance</i>	<i>Rehearsal</i>
Positive surprise	-.11	-.17*	.04	-.08	-.07	-.11	-.01	-.15	-.10
Calm	-.11	-.11	.16*	-.18*	-.03	-.30*	-.17	-.14	-.06
Happy	-.14	-.07	.08	-.13	.10	-.24*	-.12	-.14	-.21*
In love	-.05	-.28*	-.06	-.05	-.03	-.18*	-.08	-.18*	-.18*
Sad	.00	-.16*	.04	-.11	.17	-.16*	-.06	-.16*	-.03
Negative surprise	.07	-.11	.04	-.08	.01	-.25*	.00	-.04	-.10
Afraid	.11	-.11	.15*	.02	.01	-.09	-.05	-.01	-.01
Angry	.15*	-.18*	.04	-.11	-.04	-.26*	-.14	-.17*	-.08

Notes: Due to missing values, $N = 100$ – 102 for field/observer, $N = 108$ – 110 for vividness, and $N = 167$ – 170 for all other variables. * $p < .05$.

Significance of the event was negatively correlated with recall of peripheral details for memories of being in love, sad, and angry, just as it was in the two previous analyses. Consistent with Butler and Wolfner (2000), who found recall of peripheral details and rehearsal to be correlated in positive, but not negative, event memories, we found rehearsal to be negatively correlated with recall of peripheral details for memories of happiness and being in love. However, Berntsen (2002) found recall of peripheral details to be negatively correlated with rated frequency of talking about the event for memories of shocking events. Our rehearsal question asked how often participants both thought about and talked about the event, perhaps explaining why we failed to show a correlation for any of our negatively valenced memories.

DISCUSSION

The primary goal of the current study was to examine the influence of emotion on recall of peripheral details in autobiographical memory. We found that a greater proportion of peripheral details were recalled for positively valenced events. This is consistent with previous studies (Berntsen, 2002; Libkumen et al., 2004) and may be explained in terms of Fredrickson's (1998, 2001; Fredrickson & Branigan, 2005) *broaden-and-build* theory of positive emotions. Like many appraisal theories, broaden-and-build argues that the aspects of an emotional event that help identify and perpetuate the discrete emotion elicited by that experience will be enhanced relative to the other aspects of the event. In the case of negative emotions, this is evidenced by focusing attention on the threatening (in the case of fear) or frustrating (in the case of anger) element. For positive emotions, in the absence of a specific target of emotion, the ambient characteristics take on greater importance and one attends to and later recalls more of these peripheral details.

Within negative emotions, we found the impairment of peripheral recall to be greatest in memories of anger, not of fear, a finding not predicted by the original concept of tunnel memory. However, cognitive appraisal theories can help explain our data by appealing to emotion-specific characteristics. These theories would predict that angry and fearful memories should emphasise central, threat-relevant information. In contrast, memories of sadness, though negative and often intense, can be more broad, especially if the event generates thoughts of what might have been had the failure or loss not occurred. Similarly, for positive emotions, happiness and calm encourage a broadening of thinking and reflection on the overall experience resulting in greater recall of peripheral details. However, memories of romantic love may emphasise the target of one's affection, therefore resulting in relatively more

central details than other positive emotions. An emotion-specific cognitive appraisal would be needed to distinguish among the individual emotions, such as fear and anger (e.g., Lazarus, 1991). These post hoc suggestions would need to be tested. Unfortunately, the non-narrative nature of the recall task employed here prohibits precise content analysis, but we expect this to be a fruitful topic for future investigations.

Koss, Tromp, and Tharan (1995) argued that the recall of peripheral details is important to understanding autobiographical memory because they are less likely to be reconstructed from semantic knowledge and therefore may be used as an indicator of accurate recollection (rather than plausible reconstruction) by both outside observers (e.g., experimenters or juries) and by the individual (i.e., as a means of reality monitoring; Johnson, 1988; Johnson, Hashtroudi, & Lindsay, 1993). Under this assumption, in addition to the theoretical significance, a fuller understanding of how peripheral details are encoded and recalled in emotional situations is of utmost practical importance. Our findings provide important future directions for investigating the role of central versus peripheral details in emotional memory overall, as well as defining what makes an element of experience central or peripheral within each discrete emotion.

We investigated several phenomenological properties of memories in addition to intensity and affect. In the existing clinical literature, perspective at recall and belief in the memory's accuracy have been postulated to interact with recalling more central details (van der Kolk et al., 2001). In the current study with healthy adults, recalling the event from the same perspective as it occurred was unrelated to greater recall of peripheral details in any level of analysis. Belief in the memory's accuracy was correlated with less recall of peripheral details when examining all memories individually, but not in the more conservative analysis and only within calm memories.

Looking within particular emotions, we found recall of peripheral details to be negatively correlated to reliving in six of the eight emotions (calm, happy, in love, sad, negatively surprising, and angry). Similarly, across all memories, reliving was strongly related to recall of a lesser proportion of peripheral details. We had no particular expectations for the direction of influence between the recall of peripheral details and reliving the event. However, recall of peripheral details was only marginally related to less reliving when individual differences were accounted for, even though we had sufficient power to detect a relationship if one were present. Therefore, it may be that within a given individual, the type of details recalled are not related to the experience of reliving the event, but that, on average, more peripheral details are associated with less reliving for particular experiences. Whether greater recall of peripheral details dampens reliving or if reliving serves to enhance recall of central details at the expense of peripheral details remains an open question given the correlational nature of the data.

One area that has produced contradictory findings in the literature is rehearsal. Butler and Wolfner (2000) found talking about the event to be correlated with recall of peripheral details for positive events but not traumatic events whereas, in contrast, Berntsen (2002) found such a correlation for shocking but not for happy memories. We asked about both covert and overt rehearsal and found consistently negative correlations between recall of peripheral details and rehearsal, including for memories of being in love and happy. Significance of the event was also consistently correlated with recall of fewer peripheral details. Within specific emotions, this includes a negative correlation between significance of the event and proportion of peripheral details recalled for memories of anger, sadness, and being in love.

Determining the relationship between memory content and phenomenology is a question ripe for future investigation, especially when combined with appraisal theories of emotion and consideration for the role of discrete emotions in memory. Here we have expanded previous work showing that negative, but not positive, emotion decreases memory of peripheral details. We have shown that this valence effect is found consistently across a variety of emotionally negative and positive events. In addition we have demonstrated that the specific content and appraisal pattern of discrete emotions interact with this overall valence effect in autobiographical memory.

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