Cognition and Emotion

The effect of divided attention on emotion-induced memory narrowing

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Individuals are more likely to remember emotional than neutral information, but this benefit does not always extend to the surrounding background information. This memory narrowing is theorised to be linked to the availability of attentional resources at encoding. In contrast to the predictions of this theoretical account, altering participants’ attentional resources at encoding by dividing attention did not affect emotion-induced memory narrowing. Attention was divided using three separate manipulations: a digit ordering task (Experiment 1), an arithmetic task (Experiment 2) and an auditory discrimination task (Experiment 3). Across all three experiments, divided attention decreased memory across the board but did not affect the degree of memory narrowing. These findings suggest that theories to explain memory narrowing must be expanded to include other potential mechanisms beyond the limitations of attentional resources.

Keywords: Emotion; Memory; Attention.

Memory narrowing (Reisberg & Heuer, 2004), tunnel memory (Safer, Christianson, Autry, & Osterlund, 1998), weapon focus (Steblay, 1992) and the emotion-induced memory trade-off (Kensinger, Garoff-Eaton, & Schacter, 2007) are related phenomena whereby an emotional item is remembered at the expense of its non-emotional context (see Levine & Edelstein, 2009). These

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phenomena have been described as the result of attentional narrowing (Easterbrook, 1959) or attentional prioritisation towards emotional stimuli (see Reisberg & Heuer, 2004). Yet there is evidence that overt attention alone cannot explain these effects (Christianson, Loftus, Hoffman, & Loftus, 1991; Riggs, McQuiggan, Farb, Anderson, & Ryan, 2011; Steinmetz & Kensinger, 2013). Other factors, such as the automatic processing of emotional information (Maddox, Naveh-Benjamin, Old, & Kilb, 2012), post-stimulus elaboration on the emotional item (Christianson, 1992) or consolidation over sleep-filled intervals (Payne & Kensinger, 2010) may lead to memory narrowing. Eye-tracking studies have found that memory narrowing is not explained by less overt attention to the background context when an emotional item is present (Steinmetz & Kensinger, 2013), and narrowing remains when gaze is limited to one fixation on the emotional stimulus (Christianson et al., 1991). However, eye gaze only measures overt attention and cannot be used to make inferences about allocation of covert attention, which can occur without shifting the eyes. The present study circumvented this limitation by assessing effects of dividing cognitive attention on memory narrowing.

To our knowledge, no study has examined how divided attention affects memory for emotional and neutral components within a single scene. However, studies have divided participants’ attention while encoding negative and neutral scenes separately. These studies found that divided attention reduced memory for neutral scenes but not negative scenes (Kern, Libkuman, Otani, & Holmes, 2005; Talmi & McGarry, 2012). This pattern could suggest that divided attention would enhance memory narrowing. When scene-processing resources are limited, available resources may be directed towards the emotional component of the scene, leaving fewer attentional resources to process the neutral context. If memory narrowing occurs because an arousing element restricts the focus of attention (Bocanegra & Zeelenberg, 2009) or reduces the capacity of attention (Easterbrook, 1959), then divided attention should affect the magnitude of the narrowing by further taxing participants’ ability to distribute attention to all scene elements. By contrast, if memory narrowing occurs for other reasons, possibly because the arousing elements are processed more automatically than the non-arousing elements, or because those elements are elaborated or rehearsed differently during the study phase or after viewing, then divided attention during the encoding phase should not affect the degree of memory narrowing. The current set of experiments tested these alternatives.

PRESENT STUDY

Across three experiments, we varied whether attention was divided during the presentation of the stimulus or during the interstimulus interval (ISI) (manipulated within-subjects in Experiment 1) and whether attention was divided through use of a task that required manipulation of numeric information (Experiments 1 and 2) or through monitoring of auditory non-verbal patterns (Experiment 3). In all experiments, memory narrowing was considered to occur when there was an interaction between valence and scene component, such that the difference in memory between items and background contexts was greater for emotional scenes than for neutral scenes. To preview the results, regardless of the task parameters, divided attention always had an across the board detrimental effect on memory without altering the magnitude of memory narrowing onto the emotional item.

GENERAL METHOD

Participants

In all studies, participants were Boston College students having normal or corrected-to-normal fluent in English and having no history of neuropsychological or psychiatric disorders. Participants taking medication that would affect the central nervous system were excluded. Participants with self-reported symptoms of depression were not included due to potential biases in attention and memory for emotional stimuli, due to impairments in cognition that could affect performance on the divided attention tasks, and to keep sampling
consistent with the previous studies (e.g., Kensinger et al., 2007; Steinmetz & Kensinger, 2013; Waring & Kensinger, 2009). Informed consent was obtained as approved by the institutional review board from Boston College. Participants were given payment or class credit for participation. No participant completed more than one experiment.

Materials and procedure
For each experiment, study-phase stimuli were composite scenes that had an emotional (positive or negative) item or a neutral item placed on a neutral background (see Kensinger et al., 2007 and Figure in Supplementary data). Scenes were matched for size and location of the item and were constructed so that each item plausibly could be found on the accompanying background (e.g., a chipmunk would not be paired with a dining room). Normative data confirmed that item and background pairings were congruent and that there were no significant differences in congruency between the positive, negative or neutral scenes (Waring & Kensinger, 2009). During study, attention was divided in the manner specified for each experiment.

On the surprise recognition test, old scenes from the study were broken down into item and background components that were shown separately, one at time, and intermixed with new items (half negative and half neutral) and backgrounds (all new backgrounds were, by definition, neutral, since they had not been paired with any item at study). Whether items and backgrounds were new or studied were counterbalanced across participants by varying which scenes were viewed during the study phase. On the recognition test, order of stimulus presentation was varied across participants to minimise order effects and effects of fatigue. See Table 1 for a methods and results comparison across experiments.

Data analysis
All memory scores were calculated as hits minus false alarms. For consistency, the analyses across all three studies include an Attention Condition × Valence (Negative, Neutral) × Scene Component Type (Item, Background) analysis of variance (ANOVA). For the studies that also included positive scenes in the stimulus set, a separate ANOVA was conducted that included positive and neutral scenes as levels within the valence factor.

EXPERIMENT 1
Method
Participants
Forty-four adults (ages 18–22, 23 women) participated. Five participants (4 females) were excluded from analysis due to elevated depression scores (scores > 10 on the Beck Depression Inventory, BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Thus, 39 participants were included in the analyses.

Materials and procedure
Each participant studied 124 composite scenes (62 included negative items, 62 included neutral items), judging whether they would approach or back away from each scene. Eye gaze patterns were tracked at 120 Hz by a SensoMotoric Instruments (SMI) Portable Eye Tracker (Content in Supplementary data). There were three divided attention conditions, all within-subjects. In one condition, the participant simply made the approach/back away decision (full attention [FA] Condition). In a second condition, attention was divided while viewing the picture (DA PIC Condition). In a third condition, attention was divided during the ISI (DA ISI Condition). The order of these three conditions was counterbalanced across study lists and the 124 scenes were randomly split across the conditions with the constraint that half of the scenes in each condition included a negative item and half included a neutral item.

For the DA PIC Condition, a random set of five digits appeared briefly on the screen for 2000 ms immediately preceding the picture. Once the numbers were removed, participants...
Table 1. Summary of experiments

<table>
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<tr>
<th>Experiment</th>
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Arousal ratings on a scale from 1 to 5; 1 = low arousal, 5 = high arousal.
mentally put the numbers into sequential order while viewing the scene. The scene was on the screen for 4000 ms. The participant was then asked whether a certain number from the scrambled list was the first, middle or last number on the list. For example, if presented with the numbers sequence: 8, 4, 2, 1, 7 participants would mentally order the numbers as 1, 2, 4, 7, 8. If the prompt asked: “4 MIDDLE?” the correct answer would be yes. There were an equal number “first”, “middle” and “last” number prompts and there were an equal number of correct “yes” or “no” answers. In the DA ISI Condition, the procedure was the same except the participant first saw the picture, then saw the numbers and then unscrambled the numbers during the ISI.1

After a 30-minute delay participants underwent a self-paced recognition memory test, including 248 “old” components (half items and half backgrounds) and 248 “new” components (half items and half backgrounds) for a total of 496 components tested. Participants indicated if each component was “old” or “new” via a button press.

Results and discussion
An Attention Condition (DA PIC, DA ISI, FA) × Valence (Negative, Neutral) × Scene Component Type (Item, Background) ANOVA was conducted (see Figure 1A). The results revealed a main effect of attention condition, $F(2, 76) = 18.994, p < .001, \eta^2_p = .333$, such that memory was worse in DA PIC, $M = .57, SD = .13$, than in DA ISI; $M = .64, SD = .13; t(38) = 5.546, p < .001, d = .54$, or FA, $M = .63, SD = .12; t(38) = 4.475, p < .001, d = .5$. There was no significant difference between the DA ISI and the FA condition, $t < 1, p > .2$. This analysis also revealed a main effect of scene component type, $F(1, 38) = 82.609, p < .001, \eta^2_p = .685$, qualified by a scene component type × valence interaction, $F(1, 38) = 257.662, p < .001, \eta^2_p = .871$. This interaction indicated that memory narrowing did occur: there was significantly better memory for negative items ($M = .78, SD = .12$) compared to neutral items ($M = .65, SD = .16$), $t(38) = 8.489, p < .001, d = .91$, but worse memory for backgrounds previously paired with negative items ($M = .45, SD = .14$) than with neutral items ($M = .59, SD = .14$), $t(38) = 11.543, p < .001, d = 1.0$). There was no three-way attention condition × valence × scene component type interaction, $F < 2, p > .3$: divided attention did not affect the magnitude of emotion-induced memory narrowing.2

EXPERIMENT 2
Next we examined whether divided attention would affect the magnitude of emotion-induced memory narrowing when using a more difficult divided attention task, and when positive as well as negative items were studied in scenes.

Method
Participants
Forty-six participants were included in analyses (mean age = 19.7 years, 21 women). Data from 16 other participants were not used due to elevated depression scores (5 participants), failure to complete the task (3), computer problems (2) or poor performance (fewer than 1/3 correct) on the math-based divided attention task; 6 participants).

Materials and procedure
Each participant studied 75 composite scenes (25 included positive items, 25 included negative items

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1 For the accuracy on the divided attention tasks, participants did better on the divided attention task during the ISI than during the picture, $F(1, 38) = 63.909, p < .001$. Participants also did better on the divided attention task for neutral than negative scenes, $F(1, 38) = 6.095, p < .05$. There was no significant interaction between valence and divided attention task, $F < .5, p > .5$.

2 This pattern also remained when each scene was considered separately. Negative scenes were more likely than neutral ones to have the item remembered and the background forgotten, and this likelihood was unaffected by divided attention.
and 25 included neutral items). Positive and negative items were matched on arousal (see Table 1).

In the FA group, participants rated on a 7-point scale if they would like to approach or back away from each scene. In the divided attention group, before each picture appeared, a number between 17 and 100 appeared for 750 ms. While the scene was presented, participants were asked to double the number and subtract 16. After the picture was removed, participants entered their response to the mental math task and then rated if they would like to approach or back away from the scene.

There was a 10-minute delay before a recognition memory test, including 150 “old” components (75 items and 75 backgrounds) and 150 “new” components (75 items and 75 backgrounds). Participants had up to 3000 ms to

Figure 1. The effect of divided attention on memory for emotional and neutral items and memory for neutral backgrounds. “Divided Attention—Picture”, indicates that the divided attention task was conducted while the picture was still on the screen. “Divided Attention—ISI” indicates that the divided attention task was conducted after the picture left the screen, during the interstimulus interval. All backgrounds were neutral but paired with positive, negative or neutral items. Thus, the figures represent memory for positive, negative or neutral items and memory for neutral backgrounds that were paired with emotional or neutral items.
view each test component. They indicated if the item was “old” or “new” as well as their confidence in the accuracy of their old/new response (1 = guessing, 2 = sure and 3 = very sure).

Results and discussion

A $2 \times 3 \times 2$ ANOVA was first conducted using only the negative and neutral memory data (see Figure 1B). This ANOVA included Attention Condition (DA, FA) as the between subjects variable, and Valence (Negative, Neutral) and Scene Component Type (Item, Background) as the within subjects variables. There were main effects of attention condition, $F(1, 45) = 18.928$, $p < .001$, $\eta^2_p = .296$, and scene component type, $F(1, 45) = 266.802$, $p < .001$, $\eta^2_p = .856$. These effects were qualified by a scene component type x attention condition interaction, $F(1, 45) = 6.717$, $p < .05$, $\eta^2_p = .130$, indicating that divided attention affected items, $t(45) = 5.286$, $p < .001$; DA: $M = .86$, $SD = .07$, FA: $M = .71$, $SD = .12$, $d = 1.5$, more than backgrounds, $t(45) = 1.977$, $p = .054$; FA: $M = .54$, $SD = .10$, DA: $M = .48$, $SD = .11$, $d = .57$. It was also qualified by a scene component type x valence interaction, $F(1, 45) = 11.091$, $p < .01$, $\eta^2_p = .198$, such that there was significantly better memory for the negative items ($M = .81$, $SD = .13$) compared to the neutral items ($M = .76$, $SD = .13$), $t(46) = 3.815$, $p < .001$, $d = .38$, but no significant difference between memory for backgrounds previously paired with negative items ($M = .50$, $SD = .11$) and memory for backgrounds previously paired with neutral items ($M = .53$, $SD = .15$), $t < 1.5$, $p > .1$. Similar to Experiment 1, there was no three-way attention condition x valence x scene component type interaction, $F < 1$, $p > .3$.

We also conducted a parallel analysis comparing positive and neutral scenes. For the most part the effects were in the same direction as the previous analysis: a main effect of scene component type, $F(1, 45) = 372.699$, $p < .001$, $\eta^2_p = .892$, and attention condition, $F(1, 45) = 11.506$, $p < .01$, $\eta^2_p = .204$, and a significant scene component type x valence interaction, $F(1, 45) = 21.441$, $p < .001$, $\eta^2_p = .323$, with significantly better memory for the positive items ($M = .85$, $SD = .09$) compared to the neutral items ($M = .76$, $SD = .12$), $t(46) = 5.368$, $p < .001$, $d = .80$, and significantly worse memory for backgrounds previously paired with positive items ($M = .48$, $SD = .15$) than memory for backgrounds previously paired with neutral items ($M = .53$, $SD = .15$), $t(46) = 2.101$, $p < .05$. $d = .33$. There were no interactions with attention, all $t < 2.0$, $p > .13$.

EXPERIMENT 3

The results of Experiment 2 again revealed no effect of divided attention on the magnitude of emotion-induced memory narrowing. Next we assessed whether this pattern would hold when the divided attention task was of a different modality (auditory) from the to-be-remembered stimuli (visual).

Method

Participants

Forty-two participants (ages 18–22, 20 male) were included in the analyses. Participants were a subset of those tested as part of a larger study ($N = 52$) examining individual differences in anxiety levels. Because anxiety is positively correlated with the magnitude of memory narrowing (Waring, Payne, Schacter, & Kensinger, 2010), participants with higher anxiety were not included in our analysed sample. As in the previous experiments, participants with higher depression scores were also excluded from our analysed sample. The participants included in analyses were those who had a BDI-II (Beck et al., 1961) at or below the ninetieth percentile and a Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) at or below the ninetieth percentile (i.e., below a cut-off score of 19). These different percentiles were used due to the different published percentiles available.

Materials and procedure

Each participant studied 200 composite scenes (80 included positive items, 80 included negative items and 40 included neutral items). The subset
of scenes used for analyses were 55 positive, 55 negative and 39 neutral scenes chosen so that the positive and negative items were matched on arousal and absolute valence (all $p > .05$), and neutral items were less arousing than both positive and negative images both for the published ratings (Lang, Bradley, & Cuthbert, 1999) and the ratings from the participants in this experiment.

Each participant completed one study block under FA and another under divided attention. The order of the FA and the divided attention conditions was counterbalanced across participants. For the FA block, participants rated the scene’s valence while viewing the scene. In the divided attention block, participants performed an auditory discrimination task while rating the scenes. Participants listened to two different 1500 ms auditory patterns (created using Sound Edit; MacroMedia, Inc., San Francisco, CA) while they viewed the scenes. These two different patterns changed randomly throughout the task. The participants pressed a button if the pattern changed from pattern A to pattern B or vice versa.3

After a 30-minute delay, participants performed a recognition memory test, 300 “old” components (half items and half backgrounds) and 300 “new” components (half items and half backgrounds). Participants had up to 3000 ms to view each test component. They indicated via a button press if the component was “remembered”, “known” or “new”. Remember and Know responses were collapsed into a single category of “old” responses.

## Results and discussion

To mirror the analyses in the previous experiments, an Attention Condition (DA, Full Attention) × Valence (Negative, Neutral) × Scene Component Type (Item, Background) ANOVA was conducted (see Figure 1C). Similar to the previous experiments, this analysis revealed a main effect of attention condition, $F(1, 41) = 14.316$, $p < .001$, $\eta^2_p = .259$, with worse memory under divided attention ($M = .40$, $SD = .03$) than FA ($M = .47$, $SD = .16$), $t(41) = 3.784$, $p < .001$, $d = .32$. A main effect of scene component type, $F(1, 41) = 91.800$, $p < .001$, $\eta^2_p = .69$, and a main effect of valence, $F(1, 41) = 5.660$, $p < .05$, $\eta^2_p = .121$, were qualified by a scene component type × valence interaction, $F(1, 41) = 6.312$, $p < .01$, $\eta^2_p = .133$. This interaction was such that there was significantly better memory for the negative items ($M = .56$, $SD = .20$) compared to neutral items ($M = .48$, $SD = .18$), $t(41) = 3.287$, $p < .01$, $d = .52$, but no significant difference in memory for backgrounds previously paired with negative items ($M = .32$, $SD = .17$) as compared to backgrounds previously paired with neutral items ($M = .33$, $SD = .16$), $t < 1$, $p > .8$. There was no three-way attention condition × valence × scene component type interaction ($F < 1$, $p > .3$): divided attention did not modulate the memory narrowing.

We also conducted an ANOVA comparing memory for positive and neutral scene components. Main effects of attention condition, $F(1, 41) = 29.410$, $p < .001$, $\eta^2_p = .418$, scene component type, $F(1, 41) = 52.285$, $p < .001$, $\eta^2_p = .560$, and valence, $F(1, 41) = 10.977$, $p < .01$, $\eta^2_p = .211$, were qualified by a scene component type × valence interaction, $F(1, 41) = 8.330$, $p < .01$, $\eta^2_p = .169$. This interaction was such that there was significantly better memory for the positive ($M = .58$, $SD = .18$) items compared to neutral items ($M = .48$, $SD = .18$), $t(41) = 4.416$, $p < .001$, $d = .56$. However, unlike Experiment 2, there was no significant difference in memory for backgrounds previously paired with positive items ($M = .33$, $SD = .18$) as compared to backgrounds previously paired with neutral items ($M = .33$, $SD = .16$), $t < 1$, $p > .8$. This may be due to the longer scene encoding time for Experiment 3. There was no three-way attention condition × valence × scene component type interaction, $F < 2$, $p > .3$.

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3 The percent correct for the divided attention task did not differ by valence $F(2, 102) = 0.31$, $p = .589$. 
GENERAL DISCUSSION

In three different studies, divided attention did not modulate memory narrowing. Though divided attention reduced memory across the board, there was no interaction among attention condition, valence and scene component type. These experiments add to the growing evidence that availability of attentional resources at encoding may not be the main factor that leads to memory narrowing.

The results of the present study are generally consistent with three eye-tracking studies, which also suggested that memory narrowing could not fully be explained by attention at encoding. Christianson et al. (1991) had participants view a slide show with one critical emotional slide. There was enhanced memory for that slide even when only one fixation to that slide was allowed, suggesting that extensive fixations are not a requirement for emotional memory enhancement. Mickley Steinmetz and Kensinger (2013) tracked participants’ eyes when they viewed composite images such as the ones used in the current study. Longer fixation times on the emotional items did not predict memory narrowing. This effect was replicated in the current study (see Supplementary Data). Riggs et al. (2011) similarly found that, although presenting an emotional stimulus in the centre of a screen led to a decreased number of fixations to images presented in the periphery of the screen and to poorer memory for those peripheral items, the two findings were unrelated: changes in the number of fixations did not relate to the impairment in memory for the peripheral items. All three of these studies suggest that overt visual attention is not the only factor that predicts memory narrowing.

Critically, in the current studies, the divided attention paradigms likely depleted covert attentional resources as well as overt visual attention. This should have been true in all experiments, but particularly so in Experiment 3 when the modality of the secondary task (auditory) differed from the modality of the scene-viewing task (visual). Yet there was no evidence that divided attention affected the degree of memory narrowing. This finding strongly suggests that attentional capacity is not the only factor that leads to memory narrowing in emotional scenes. This conclusion seems to hold true for positive scenes as well as for negative ones: despite evidence that attention at encoding may be especially important for immediate memory enhancements of positive information (Talmi, Schimmack, Paterson, & Moscovitch, 2007), we found no evidence that availability of attentional resources were disproportionately important for memory narrowing onto a positive item.

The present results also suggest that memory narrowing is not driven by post-stimulus elaboration immediately following stimulus presentation. Divided attention during the ISI did not modify memory narrowing, generally consistent with other studies which divided attention after viewing separate emotional and neutral stimuli. Hulse, Allan, Memon, and Read (2007) found that even when attention was divided after an emotional or neutral video, participants remembered the negative video better than the neutral video. In addition, Harris and Pashler (2005) limited post-stimulus elaboration by speeding the presentation of emotional and neutral stimuli. They found that memory for negative information over neutral information remained even when post-stimulus elaboration was not allowed. Though these studies did not examine scenes that included both emotional and neutral components, the results suggest that consolidation or retrieval factors later in the processing stream may play more of a role in selectively remembering emotional details of events than processes initiated immediately after stimulus processing (and see Payne, Chambers, & Kensinger, 2012 for evidence).

There are three caveats to the claim that post-stimulus elaboration immediately after stimulus presentation does not account for memory narrowing. First, post-stimulus elaboration may play more of a role for events that have a meaningful narrative associated with them such as in eyewitness memory experiments. Second, attention was divided during the ISI only in Experiment 1, and so further replication is warranted. Third, it has been proposed that there are separate processes for internal and external attention (see Chun, Golomb, &
Turk-Browne, 2011 for review). External attention guides processing of sensory stimuli, while internal attention guides internal reflection and refreshing (see Chun & Johnson, 2011) as may occur during the ISI. It is possible that different distractor tasks would more effectively deplete internal attention during the ISI.

While this study has ruled out some explanations for memory narrowing, determining the encoding mechanism remains an open question. Neuroimaging evidence has revealed that processes engaged at the moment of scene processing relate to memory narrowing (Waring & Kensinger, 2011); that study revealed a connection between memory narrowing and engagement of visual regions (e.g., fusiform gyrus) as well as regions associated with memory and attention. Coupled with the present results, it seems plausible that emotion may facilitate visual processing even when little attention is granted. Emotion may enhance perceptual processes, separately from attention (Phelps, Ling, & Carrasco, 2006), enabling individuals to more quickly and accurately perceive selective emotion-based information even when attention is limited.

In addition to demonstrating that memory narrowing is not affected by the availability of attentional resources during stimulus processing, the present results also reveal variability in whether memory narrowing conveys only benefits or also decrements to memory (also see Bennion, Ford, Murray, & Kensinger, 2013; Mather & Sutherland, 2011 for discussion). While enhanced memory for emotional items over neutral items was found in each experiment, the associated background memory detriment only reached significance for negative scenes in Experiment 1 and for positive scenes in Experiment 2. Because the background decrement for negative scenes occurred in the only experiment that did not present positive scenes, one possibility is that participants adopted the more narrow, detailed processing style often associated with negative mood (Fredrickson, 2004). However, a background memory decrement also occurred for the positive scenes in Experiment 2, which is hard to reconcile with that explanation.

While positive affect may lead to broader processing and less memory narrowing than negative affect in some cases (Levine & Edelstein, 2009; Yegiyan & Yonelinas, 2011), the way affect influences processing may be more flexible than once thought (Huntsinger, 2013). The most consistent evidence for broadening effects of positive affect has come from studies examining mood (Fredrickson, 2004). Although similar effects have been revealed when processing affectively positive stimuli, task instructions may be more likely to affect these patterns. By influencing participants’ encoding motivations, task characteristics—intentional (e.g., Yegiyan & Yonelinas, 2011) or incidental, emphasising specific aspects of the scenes or encouraging holistic processing (Kensinger et al., 2007)—all may influence whether memory narrowing occurs for positive or negative valence.

In summary, the current experiments found no interactions between attention condition, valence and scene component type indicating that divided attention at encoding did not modulate memory narrowing. Further, divided attention immediately post-encoding also did not modify memory narrowing. These results suggest that the amount of attentional resources available is not sufficient to explain memory narrowing.

Supplementary Data

Supplementary figure and content are available via the ‘Supplementary’ tab on the article’s online page (http://dx.doi.org/10.1080/02699931.2013.858616).

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