The Influence of Emotional Context on Memory for Faces

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

The present thesis investigates whether the emotional background (context) in which a neutral face is viewed changes one's memory for that face. In Experiment 1, neutral faces were overlaid centrally onto emotional (positive or negative) or neutral background scenes, and recognition memory for faces was assessed. Memory for faces initially encoded in negative contexts was boosted relative to memory for faces initially encoded in neutral contexts. Further investigation was necessary to reveal the mechanism behind the influence that emotional context had on memory for faces. In Experiments 2 and 3 the spotlight theory of attention was tested to examine whether visual attention was mediating the memory effect. The spotlight theory of attention postulates that positive affective states broaden one's scope of attention, while negative affective states narrow one's scope of attention (Easterbrook, 1959; Derryberry & Tucker, 1994). According to this theory, the negative contexts may have narrowed attentional scope and therefore led to a richer processing of the face which happened to be presented centrally in Experiment 1, leading to boosted recognition of these faces. To test whether the varying emotional contexts did indeed shift attentional scope, Experiment 2 was designed in which neutral faces were presented once again in positive, negative or neutral contexts, however location of face presentation was peripheral rather than central. Results revealed a loss of the memory boost, for faces paired with negative contexts, reported in Experiment 1. Experiment 3 was designed to test the spotlight theory of attention using an intermixed design in which faces were presented either centrally or peripherally, randomly across trials, in emotional and neutral background scenes. In this experiment, faces were better remembered when they were viewed peripherally in positive, relative to neutral, contexts at time of study. Experiment 4 was designed to assess the validity of the spotlight theory in accounting for how emotional scenes change visual attention, by examining how performance on a flanker task differed when emotionally positive or negative scenes were presented centrally. Results suggest that positive scenes broaden the spotlight of attention, relative to negatives ones. In summary, emotional contexts lead to a boost in memory for faces paired with negative information, and this effect may be due to shifts in attention varied by the valence of the context.

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Dedication

I dedicate this thesis to my remarkable parents, Muayad and Brwa Koji. They have been there for me every step of the way and I am very grateful for their unconditional love and support.

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Chapter 1

General Introduction

1.1 Introduction to the Influence of Emotion on Cognition

If you've ever been unlucky enough to get bitten by a snake when you were camping, you will likely be more cautious in your future encounters with snakes and in forests, because the sight and sound of the snake and of the context in which the negative event occurred have become emotional stimuli linked to the negative event. How you subsequently pay attention to these stimuli on future trips, remember that particular trip, and perhaps how fond (or not fond in this case) you become of this campsite since experiencing that event will likely all be affected by this experience.

The influence of emotion on cognition is vast and important. From the moment a new born baby opens its eyes, emotion is already playing a role in shaping the infant's cognition. Studies suggest that an early positive emotional bond with our mothers may aid in the development of our earliest mental representations (Hofer, 1994). Research has also shown that early visual processing of stimuli is improved by signals of emotionality. That is, positive or negative valence (relative to neutral) of a stimulus can change how we process that information. In a study by Sato and colleagues (2001), event related potentials (ERPs) were used to measure brain activity of participants viewing emotional (happy or fearful) and neutral faces. Statistical analyses of the ERP data revealed that brain regions involved in early visual processing were more activated for emotional relative to neutral faces. If emotionality affects processes as primary as early visual processing, then emotionality may also affect higher order cognitive processes such as memory.

Studies have shown that emotion may influence our memories, such that it increases how well we remember information (Cahill & McGaugh, 1995; Hadley & MacKay, 2006). This "emotionality boost" has been demonstrated using different types of stimuli including pictures, words, sentences and narrated slide shows. In all of these studies, more emotional stimuli (positively and negatively valenced) were recalled or recognized better than neutral stimuli (see Buchanan & Adolphs, 2002 for review). There is also evidence, at the level of the brain, that the emotional valence of a stimulus can change how it is processed. Various methods, including neuroimaging, neuropsychological, drug, and neural stimulation studies have shown that emotional stimuli are more memorable relative to neutral stimuli (e.g. Cahill & McGaugh, 1995; Hamann, Ely, Grafton, & Kilts, 1999; Mather, Canli, English, Whitefield, Wais, Ochsner, Gabrieli & Carstensen, 2004; Hadley & MacKay, 2006). Several studies have suggested that the amygdala plays a critical role in mediating the emotionality boost in memory for positively and negatively valenced information, possibly by enhancing consolidation processes within the hippocampus (see Hamann, 2001 for review). In a neuroimaging study, Hamann, Ely, Grafton and Kilts (1999) used positron emission tomography (PET) to examine the relationship between brain activity at encoding and later explicit memory for neutral and emotional (positive and negative) picture stimuli. They found that for both positive and negative stimuli, bilateral amygdala activity during encoding correlated with enhancement of recognition memory for the stimuli one month later. This correlation was not observed for neutral stimuli. Since the amygdala is the brain region involved in emotional processing (see Phelps, 2006 for a review), the correlation of improved memory for emotional stimuli with activation of the amygdala provides further evidence that memory is improved for emotional relative to neutral stimuli.

These studies have demonstrated that the valence of the item changes how well it is later remembered, but what if the emotion was present only in the background context rather than in the target item (i.e. not directly portrayed by the stimulus itself)? Would this change the way we perceive and remember the otherwise neutral target? For example, would you perceive and remember a specific brand of toothpaste differently if you first encountered the tube on the shelf in a drugstore (neutral context), versus in your newly renovated dazzling bathroom (positive context), or thrown away in a dirty trash can (negative context)? It seems advertisers already know of the power of emotion in affecting perception and memory, as target merchandise is often paired with emotionally positive background contexts; for example people eating fast foods in beautiful parks and cars ads with gorgeous women modeling the cars. These advertisers are on the right track, as many studies have shown that our perception and memory of an otherwise neutral item is indeed influenced by the valence of the context.

I will first review the literature on how perception or evaluation is influenced by emotion, and then move on to research suggesting memory can also be affected by emotion.

One study that examined how emotion can influence perception considered how participants' liking for the smell of alcohol was influenced by context (Mennella & Garcia, 2000). They showed that children whose parents drank alcohol to escape problems were more likely to dislike the smell of alcohol compared with children whose parents did not drink to escape. A similar study investigating subjects' liking for the smell of cigarette smoke showed that children whose mothers smoked and were happy liked the smell better, relative to children whose mothers smoked and were depressed (Forestell & Mennella, 2005). These studies show a relation between the liking of a smell and its emotional context. A positive evaluative rating was related to an experience in a positive emotional context, and a negative evaluative rating was related to an experience in a negative emotional context. Similarly, in a study by Field (2006) children were conditioned to dislike novel cartoon characters that were consistently paired with Brussels sprouts, and to like similar novel characters that were consistently paired with ice cream. The author termed the phenomenon 'evaluative conditioning', meaning the evaluative ratings of the characters could be modified based on the valence of the item with which each was paired. Though the described studies have all involved children, similar results have also been found in adults (see De Houwer, Thomas & Baeyens, 2001 for a review).

From these studies it is evident that emotional context can change the way we interpret and perceive a neutral item, and as already mentioned, we also know that the emotional valence of an item changes how well the item is remembered, but can the *context* in which we view a stimulus change how well it is *remembered*? One study investigated this question using neutral words in emotional contexts and found no influence of emotional contexts on memory for the neutral words (Erk, Martin & Walter, 2005), but it is not often that we see a neutral word paired with an emotional stimulus in everyday life. What we do see in everyday life are people in a variety of contexts, so it is surprising that there have been no studies investigating how memory for people is influenced by emotional relative to neutral contexts. In the current thesis I considered how our memory for faces (with neutral expressions) is affected by the context, or social milieu, in which they are first encountered.

1.2 Influence of Context on How we Process Faces

The influence of context on how we process faces is a long-standing area of research. There is still much controversy on the extent to which emotional contexts can influence how we perceive and evaluate a face. Goodenough and Tinker (1931) were among the first to examine this question. They designed a paradigm which involved simultaneous presentation of photographs of faces portraying different emotional expressions and context (verbal descriptions of emotion-eliciting situations), and participants were asked to decide which emotion each combination suggested. This study, and many others which have used versions of this paradigm since then, have concluded that participants are more likely to report the emotion conveyed by the face rather than the accompanying context (Knudsen and Muzekari, 1983; Nakamura et al., 1990; Wallbott, 1988; Watson, 1972); leading some to conclude that faces hold special meaning, are preferentially processed, and relatively uninfluenced by contextual variables. However, many have disagreed with the validity of this procedure and have demonstrated its weaknesses, suggesting that the design includes technical problems which may bias participants' responses towards the emotion of the face (Carroll & Russell, 1996; Ekman, Friesen, & Ellsworth, 1982). One such problem is that the face is presented as a photograph and the context is given in a sentence, thus confounding context and modality of presentation. Furthermore, each subject encounters the same few contexts repeatedly with only the face being different in every single trial, thus participants likely habituate to the context, weakening any effect it might have had on face processing. Thus the influence of context on the processing of faces may have been underestimated. Indeed more recent work suggests a more prominent role for context.

A study by Leppänen and Hietanen (2003) tested whether manipulating the context in which an emotional face was viewed would change how quickly one could identify its emotional expression. They found that happy expressions were identified faster than faces portraying disgust in a pleasant smelling-context, but that the identification of happy faces was slowed in unpleasant-smelling contexts. They concluded that the emotion of the context in which a face is processed changes the mental representations formed of the face, in turn facilitating speed of processing.

Further evidence for a significant influence of context on face processing comes from a study by Rightart and deGelder (2006). They provided physiological evidence of this phenomenon by measuring event related potentials during processing of facial expressions in various emotional background contexts. They found enhanced N170 amplitude on left occipitotemporal sites when participants were viewing a face in a fearful context compared to in a neutral context. This suggests that the emotion of the context in which a face appears influences brain regions involved in processing of the face. Other studies have also used ERP to investigate this question and have reported similar findings (Galli, Feurra, & Viggiano, 2006), suggesting that higher-order brain regions which are devoted to face processing are influenced by contextual information.

In one line of my research program (Fernandes & Koji, under revision) we demonstrated an influence of emotional context on the evaluation of a neutral item embedded within different emotional scenes. Neutral faces (Experiment 1) and emotional faces (Experiment 2) were superimposed upon background images of positive (e.g. a garden), negative (e.g. a landfill) and neutral (e.g. a generic office) photos. Participants were asked to rate how positive or negative a face with a neutral expression appeared to them when viewed in these different contexts. Faces with neutral expressions (in both experiments) viewed in a positive context were rated as appearing significantly more positive than when viewed in a neutral or negative context, and faces viewed in negative contexts were rated as more negative than when viewed in positive and neutral contexts. When the faces portrayed emotional expressions similar results were found, such that the valence of the context significantly altered ratings of faces (i.e. positive contexts led to more positive ratings of the faces and negative contexts led to more negative ratings of the faces). These results suggest that emotional valence of the context in which a face is viewed changes the immediate evaluation of a face, and that this influence is so strong it occurs regardless of the emotion the face is portraying.

Thus, studies have shown that emotion has a significant influence on the way we perceive and process faces. However, how emotional context may also change how the memory trace is formed, and how robust that memory becomes has yet to be investigated, and is the focus of my Master's thesis.

1.3 Goals of the Current Thesis

Imagine walking down the street from your house to the corner store. On the way you will likely encounter a variety of people in an assortment of contexts. For example, you may pass by a man sitting on a bench at a bus stop, a lady watering her flowers in her garden, and someone standing in front of their broken down car with smoke steaming out of the engine on the side of the road. In this short walk you have passed three different people in three very different contexts, each with a different emotional valence portrayed by the scene. As demonstrated in the previously described studies, context has an impact on how we process emotional items, and also on how we perceive neutral items in emotional contexts. But how does our memory for people encountered in these different emotional scenes change depending on the valence of the context? Imagine that you have now arrived at the store, and there is a police officer interviewing people for a crime that just occurred nearby. He asks you to describe the people you had passed on your way. Would your memory for the person standing by their broken down car be different, and more robust, than for the person in the garden or on the bus stop bench? This is the sort of question this thesis was designed to investigate.

The current work is important in contributing to our current understanding of emotion-item interactions, particularly on memory. To date very few studies have examined the influence of emotional contexts on memory for items encoded within that context, and even fewer have examined this influence on memory for *faces*. Not only does the literature lack research on face memory and emotional contexts, there is a major lack in research on mechanisms to explain such interactions. Furthermore, as suggested by Carroll and Russell (1995), the traditional methods of studying emotion-face interactions is not satisfactory as there are many technical biases and confounds, making it vital to find different methods of testing the influence of emotional contexts. The current thesis is important because it examines new questions, explores mechanisms to answer these questions, and provides new methods of testing these matters.

Chapter 2

Experiment 1: Memory for Faces Presented Centrally in Emotional Contexts

2.1 Introduction

As described in the previous section, many studies have examined how our memory changes depending on the target item's emotional valence. However, few studies have examined the influence that emotional contexts may have on neutral faces. Experiment 1 was designed to investigate this question. As previously discussed, when a target item holds a positive or negative valence, they are better remembered than neutral items (Cahill & McGaugh, 1995; Hadley & MacKay, 2006). According to this literature, we hypothesize that faces initially viewed in positive and negative contexts should be better remembered than faces initially viewed in neutral contexts. In this experiment, faces portraying neutral expressions were overlaid onto background images conveying neutral or emotional (positive and negative) valence. Recognition memory for the faces was tested, and a surprise recognition memory test was administered for the background images.

Another factor which may influence the way we process faces is the arousal of the context in which the face is viewed. Valence is defined as a continuum of how negative or positive a stimulus or event is, whereas arousal refers to the intensity of the stimulus or event, ranging from very calming to highly exciting or agitating (Kensinger & Schacter, 2006; Lang, Greenwald, Bradley, & Hamm, 1993; Mehrabian & Russell, 1974; Russell, 1980). Although, arousal was not the variable of interest in the current work, since it is difficult to separate valence from arousal in emotional stimuli, careful selection of the background images was made to ensure that arousal levels were held constant across the different emotional valence categories. Furthermore, all face-context pairings were counterbalanced to ensure that each face had a chance to be paired with images of each valence, to avoid any systematic influence arousal might have had on face memory performance.

Specifically, background images (context), were chosen such that half were high arousal and half were low arousal within each valence condition (positive, negative, neutral), and that overall arousal level, within each valence category was held constant (see methods section for more details). This is a common method used to take into account, and control for, arousal when dealing with stimuli of different valences (e.g. Kensinger & Schacter, 2006; Kensinger, Gutchess & Schacter, 2007; Smith, Henson, Dolan, & Rugg, 2004).

2.2 Methods

2.2.1 Participants

Sixty undergraduate students completed the study (26 males, M age = 19.47, SD = 1.80, Range = 16-25 years). Participants were enrolled in Psychology classes and received course credit or token monetary remuneration for their participation.

The mean number of years of education was 13.5 (SD = 1.59). The National Adult Reading Test – Revised (NART-R) was administered to allow an estimate of Full Scale IQ (FSIQ), and is based on number of errors in pronunciation during vocabulary reading (Nelson, 1982). Participants had a mean FSIQ estimate of 105.83 (SD = 6.15), within the normal range.

2.2.2 Materials

Mood. To assess mood at time of test, we asked participants to complete the Positive and Negative Affective Schedule – Expanded (PANAS-X; Watson & Clark, 1994). They were asked to indicate the extent to which they were currently experiencing the emotion conveyed by 60 different words (e.g. sad, contented) printed on a sheet of paper, using a 5-point scale.

Stimuli. Stimuli were neutral faces presented in black and white, overlaid upon background scenes. Faces were chosen from Matsumoto & Ekman's set of Japanese and Caucasian facial expressions of emotion (1988). To allow viewing of both the face and scene, the transparency of each face was altered. These alterations were made using Adobe Photoshop using the "normal" transparency setting and with opacity at 65%. See Figure 1 for sample stimuli.

The background scenes were chosen from the International Affective Picture System (IAPS), and consisted of 12 positive, 12 negative, and 12 neutral scenes. Half of the scenes were high in arousal and half were low in arousal within each valence group, according to a normative study (Lang, Bradley & Culbert, 2001) in which the valence and arousal of each picture was assessed. In that study, affective norms, including ratings of pleasure, arousal, and dominance, for the pictures currently in the IAPS were obtained from college students, using the Self-Assessment Manikin (SAM; Lang, 1980), an affective rating system. See Figure 1 for sample stimuli and Table 1 for valence and arousal means of the IAPS images.

Neutral Face on a Positive Background

Neutral Face on a Negative Background

Neutral Face on a Neutral Background

Figure 1. Sample stimuli from Experiment 1

Table 1

Mean Valence and Arousal Scores of IAPS Images Used in Experiment 1 (Standard Deviation in Parentheses)

	High Arousal		Low Arousal	
	Valence	Arousal	Valence	Arousal
Negative	2.93 (.50)	6.03 (.51)	3.53 (.49)	3.78 (.60)
Neutral	5.23 (.69)	5.26 (.45)	4.88 (.13)	2.47 (.73)
Positive	7.42 (.25)	5.72 (.33)	7.31 (.28)	3.33 (.40)

2.2.3 Design

A within subjects design was used, with the independent variable being valence of the background (positive, negative and neutral), and the dependent variable memory for faces, measured using d prime (d'; a measure of discriminability derived from signal detection analysis). We also examined memory (d') in a surprise test of memory for the backgrounds. We chose to calculate d' to measure recognition performance because it provides a bias-free estimate of the participant's tendency to respond 'old' and 'new' in each condition (Snodgrass & Corwin, 1988). Higher d' values indicate better ability to discriminate between old and new items. When calculating estimates of d' for each participant in each condition, a correction for hit rates of 1 and false alarm rates of 0 was made using a constant (± .001), such that hit rates of 1 were replaced by .999, and false alarm rates of 0 were replaced by .001.[1]

2.2.4 Procedure

Two study lists were created, each list consisting of 18 pictures. For List A, 18 different neutral faces were overlaid onto 18 different background pictures (6 positive, 6 negative and 6 neutral). The group of faces included 5 Caucasian males, 5 Caucasian females, 4 Asian males and 4 Asian females. Of the background pictures 6 were positive (3 high arousal and 3 low arousal), 6 were negative (3 high arousal and 3 low arousal) and 6 were neutral (3 high arousal and 3 low arousal). List B was created in the same manner, but consisted of a different set of faces and backgrounds.

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[1] There is controversy over which method is best to use as a correction for hit rates of 1 and false alarm rates of 0 (Macmillian & Creelman, 1991). In general, hit rates of 1 are replaced by 1-1/(2N), and false alarm rates of 0 are replaced by (1/2N), where N is the maximum number of hits and false alarms that the participant could make in that condition. However, 1/N is the smallest false alarm rate possible, and so if you measure a false alarm rate of zero, you know the true false alarm rate lies somewhere between 0 and 1/N, so it would make sense to use the average (1/2N) as the false alarm rate. However, this is assuming that the true false alarm rate is not 0. There is no logical necessity to make this assumption, as the true false alarm rate can be 0. Therefore if it is assumed that the false alarm rate can be 0, it would be best to use a point as arbitrarily close to zero as possible, and so using .001 was the best correction in this case.

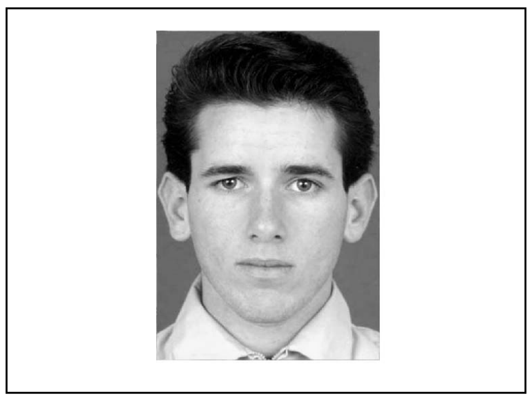
For the recognition memory test for the faces, alternate lists were created such that all 18 of the study faces were presented, intermixed with 12 lure faces. For the background memory test, all 18 of the backgrounds originally paired with faces and 12 lure backgrounds were presented (4 positive, 4 negative and 4 neutral valenced IAPS scenes), balanced for high and low arousal levels.

Participants studied either List A or List B (counterbalanced across participants) images, presented at a rate of 3.5 seconds per image. Participants were asked to study the faces for a later memory test and to code the faces as either male or female with a key press response. This was done to ensure that the face was processed. Next they were asked to complete the face recognition test. Here neutral faces were presented alone (without a background scene), one at a time, for up to 5 seconds. Participants were instructed to indicate, using a key press response, whether each face was "new" or "old" (i.e. from the study list). Next, participants were given a surprise recognition test for the backgrounds. Here, background scenes were presented alone, one at a time, for up to 5 seconds. Participants were asked to indicate, using a key press response, whether the background was "new" or "old" (i.e. from the study list). See Figure 2 for a flow chart of the procedure.

Neuropsychological Tests. Either before or after the experimental session each participant completed the neuropsychological tests including the National Adult Reading Test (NART) and the Positive and Negative Affect Schedule – Expanded (PANAS-X).

Study Phase - Encoding of Neutral Faces on Emotional Backgrounds

↓



Memory Test - for Faces Presented Alone

↓

Surprise Memory Test - for Backgrounds Presented Alone

Figure 2. Overview of Experiment 1

2.3 Results

2.3.1 Memory for Faces

Table 2 shows mean d' scores for memory of faces initially viewed in contexts of different valences. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in memory for faces depending on the valence of the background image. A main effect of valence was found, $\underline{F}$ (1.7, 99.8) = 4.00, $\underline{MSE}$ = 1.84, $\underline{\eta}^2$ = .06, $\underline{p}$ < .05 (sphericity was violated (p < .05) and so the Greenhouse-Giesser correction is reported), such that memory for faces initially viewed on negative backgrounds was significantly better than for faces viewed on neutral backgrounds, $\underline{F}$ (1, 59) = 5.86., $\underline{MSE}$ = 6.23, $\underline{\eta}^2$ = .09, $\underline{p}$ < .05. While memory for faces initially viewed on positive backgrounds was higher than for faces viewed overlaid on a neutral background, the difference was not significant, $\underline{F}$ (1, 59) = 2.78., $\underline{\eta}^2$ = .05, $\underline{p}$ = .10.

It should be noted that these analyses were also carried out using accuracy (hit rate – false alarm rate) and also hit rate as the dependent measures, and the pattern of results was identical.

2.3.2 Response Times for Face Memory

Table 2 shows mean response times (RTs) for correct face recognition. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in RT for correct identification of old faces depending on the valence of the background image. A main effect of valence was found, $\underline{F}$ (2, 118) = 5.609, $\underline{MSE}$ = 398536.810, $\underline{\eta}^2$ = .087, $\underline{p}$ < .01, such that faces initially encoded on negative backgrounds were recognized slower than face initially encoded on neutral backgrounds, $\underline{F}$ (1, 59) = 5.949, $\underline{MSE}$ = 888894.382, $\underline{\eta}^2$ = .092, $\underline{p}$ < .05, and positive backgrounds $\underline{F}$ (1, 59) = 9.422, $\underline{MSE}$ = 888894.382, $\underline{\eta}^2$ = .138, $\underline{p}$ < .01. No other differences were significant.

Table 2

Mean d' Memory Scores and Response Times for Memory of Faces Encoded in Different Emotional Contexts (Standard Deviation in Parentheses)

	Memory	RT
Negative	1.29 (.98)	1327.69 (441.88)
Neutral	.96 (.93)	1205.97 (351.86)
Positive	1.11 (.79)	1172.94 (349.01)

2.3.3 Memory for Backgrounds

Table 3 shows mean d' scores for memory of background scenes of different valence. A repeated measures ANOVA was conducted, the within-subject factor being valence of the background scene. A main effect of valence was found, $\underline{F}$ (1.78, 105.27) = 10.75, $\underline{MSE}$ = 8.57, $\underline{\eta}^2 = .15$, $\underline{p} <.001$ (spchericity was violated ($p < .05$) and so the Greenhouse-Giesser correction is reported), such that negative backgrounds were remembered significantly worse than neutral, $\underline{F}$ (1, 59) = 11.32, $\underline{MSE}$ = 10.96, $\underline{\eta}^2 = .16$, $\underline{p} < .05$, and positive backgrounds, $\underline{F}$ (1, 59) = 20.37, $\underline{MSE}$ = 30.16, $\underline{\eta}^2 = .26$, $\underline{p} < .001$. No other difference was significant.

These analyses were also carried out using accuracy (hit rate – false alarm rate) and also hit rate as the dependent measures, and the pattern of results was identical.

2.3.4 Response Times for Background Memory

Table 3 shows mean RTs for background memory. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in RT for correct identification background image of different valences. There was no significant main effect of valence, $\underline{F}$ (2, 112) = .59, $\underline{\eta}^2 = .01$, $\underline{p} = .56$, and although negative backgrounds were recognized slower than neutral and positive backgrounds, these differences were not significant, $\underline{p} >.05$.

Table 3

Mean d' Memory Scores and Response Times for Memory of Backgrounds of Different Emotional Contexts (Standard Deviation in Parentheses)

	Memory	RT
Negative	1.69 (1.46)	1046.29 (400.90)
Neutral	2.12 (1.46)	1032.24 (438.51)
Positive	2.40 (1.77)	991.18 (310.34)

2.3.5 Correlations

Bivariate correlations were conducted to examine whether there were any trade-offs between face memory and background memory. None of the important correlations were significant, suggesting that these results cannot be explained by memory trade-offs.

2.3.6 Mood as a Moderating Factor

The Positive and Negative Affective Scale Expanded (Watson & Clark, 1994) was administered to all participants in order to determine the mood at time of test. The average score for the positive items was 56.02% (SD = 12.71), and the average score for the negative items was 35.33% (SD = 10.11). Bivariate correlations revealed that mood did have some effect on memory for the faces. Positive scores on the PANAS-X correlated negatively with memory for faces initially viewed in negative backgrounds, $r = -.368$, $p < .05$, and neutral backgrounds, $r = -.294$, $p < .05$, indicating that the more positive the mood, the worse memory was for negative and neutral backgrounds. Scores on the PANAS-X did not significantly correlate with memory for the background images.

2.4 Discussion

These results indicate that faces initially presented on negative backgrounds were better remembered in a later recognition task relative to faces initially presented on neutral backgrounds. They also indicate that negative backgrounds were remembered significantly worse than neutral and positive backgrounds. It seems like there may be a trade-off between memory for faces encoded on negative backgrounds and memory for the negative backgrounds themselves, however correlations did not reveal any such trade-offs. Response times revealed that faces encoded in negative backgrounds were recognized slower in the later memory test relative to faces encoded in neutral and positive backgrounds, in line with Leppänen and Hietanen's (2003) findings. There is a clear effect of negative contexts on memory for faces and background images, but there seems to be no influence of the positive backgrounds.

It is interesting that results do not fully support our hypothesis according to the emotionality boost literature. We predicted that since both positive and negative stimuli are remembered better than neutral stimuli, than emotional contexts should have a similar influence on memory for a neutral item viewed in these different contexts. In trying to account for this unexpected finding, we considered whether a phenomenon known as the 'weapon focus effect' could explain our pattern of results in Experiment 1. Weapon focus refers to the visual attention that eyewitnesses give to a perpetrator's weapon during the course of a crime (see Steblay, 1992 for a review). Usually we focus on the central information in a negative scene at the expense of the peripheral details. For example, if you are held at gun-point, when you are later questioned you will likely remember details about the gun at the expense of other important details such as the assailant's garment type. The weapon focus phenomenon has led researchers to investigate how affective states can change where one's attention is focused in a scene. I first review this literature and then consider how this phenomenon might have influenced the results of Experiment 1.

Easterbrook (1959) was one of the first to examine how emotion may influence attention, and proposed that negative states (such as anxiety and fear) narrow one's scope of attention. His model proposed that there is a relationship between emotional arousal and attentional resources, such that when a negative stimulus increases emotional arousal within the observer, available attentional resources for information processing are constricted to the stimulus which is eliciting this negative arousal, thus narrowing the aperture of attention.

In a study by Christianson and Loftus (1991) participants were shown a slideshow of a series of images which told a story, with one critical slide in the middle changed to be either neutral or negative in valence. In the neutral condition, the critical image was of a lady riding her bike, whereas in the negative condition the critical image was of the woman lying on the ground beside her bike bleeding from a head injury. Participants were better able to recall central details (the colour of the woman's coat) and were worse able to recall peripheral details (the colour of a car on the road) in the negative condition compared to the neutral condition. Similar studies have also shown that central information is better remembered at the expense of peripheral information from emotional compared with neutral scenes (Christianson, 1984; Christianson & Loftus, 1987). These studies support Easterbrook's theory that negative affective states narrow one's spotlight of attention.

Related studies have demonstrated a widening of the spotlight of attention by positive affective states. That is, Derryberry and Tucker (1994) have suggested that positive affective states (such as amusement and contentment) broaden the aperture of attention. In a study by Fredrickson and Branigan (2005) participants viewed films that elicited amusement, contentment, neutrality, anger or anxiety. They assessed the spotlight of attention using a global-local visual processing task and found that participants who viewed the positive films made more global selections compared to those who viewed the other types of films. They concluded that positive emotional states broaden the spotlight of attention.

Perhaps the boost in memory for faces initially viewed in negative contexts is due to a change in the participant's spotlight of attention. Specifically, when participants viewed the faces in negative contexts, their attention may have been narrowed, and focus was mostly on the central features of the image, which happened to include the face, accounting for the enhanced face memory effect we observed for faces paired with a negative relative to a neutral scene. As well, if attention was focused centrally on the face when the background was negative, then the negative backgrounds themselves would have received processing only for the central features (not the whole image). This would thus decrease memory for the background scene, relative to when the scene is positive or negative. Indeed this is what was found in Experiment 1.

Since all of the faces were presented centrally in Experiment 1, there is no way of knowing if the effect of negative background valence on face memory was really due to valence, or due to a change in visual attention. Experiment 2 was designed to test the alternative explanation that the pattern of face memory performance was due to changes in one's spotlight of attention, which changed depending on the valence of the background scene. This was accomplished by presenting faces in the same emotional and neutral contexts as in Experiment 1, but rather than presenting all faces in the centre of the background scene, all faces were presented in the periphery of the background scene.

We also implemented other changes in the design of Experiment 1 to account for some other limitations in the original design. The face stimuli in Experiment 1 were dated, black and white faces transposed onto coloured photographs at a low opacity of only 65%, making the stimuli look unreal and the faces and backgrounds difficult to see. Therefore, in Experiment 2 faces were chosen from the AR Face Database (Martinez & Benavente, 1998) instead of from the Matsumoto and Ekman (1988) set of faces, as the former are in colour and are more modern looking faces, and the opacity was increased to 80%. In so doing, we hoped to create stimuli that would be clearer to see and appear more realistic. Since the faces and backgrounds would be easier to see, we increased the number of study trials (from 18 to 24) to avoid ceiling effects.

Experiment 2: Memory for Faces Presented Peripherally in Emotional Contexts

2.5 Introduction

In order to test whether the valence of the context changes one's aperture of attention, Experiment 2 was designed in a similar manner to Experiment 1, but this time faces were all presented peripherally rather than centrally. In Experiment 1 we found a significant boost in memory for faces initially encoded in negative contexts, but no boost in memory for faces encoded in positive contexts. As previously mentioned, this may have been due to the negative images inducing a narrowing of one's spotlight of attention. If negative scenes do indeed lead to a narrowing of attentional aperture, then the boost in memory for faces overlaid onto negative backgrounds should disappear when the faces are presented in the periphery, rather than centrally (as in Experiment 1). As well, Derryberry and Tucker's (1994) suggestion that positive affective states broaden the scope of attention should improve memory for faces encoded in positive relative to negative background scenes, when those faces are overlaid in the periphery of the background scene.

2.6 Methods

2.6.1 Participants

Forty-eight undergraduate students completed the study (14 males, M age = 20.35, SD = 1.78, Range = 18-25 years). Participants were enrolled in Psychology classes and received course credit or token monetary remuneration for their participation. The mean number of years of education was 14.81 (SD = 1.14). As in the previous experiment, NART-R was administered, and participants had a mean estimated FSIQ of 106.27 (SD = 8.34).

2.6.2 Materials

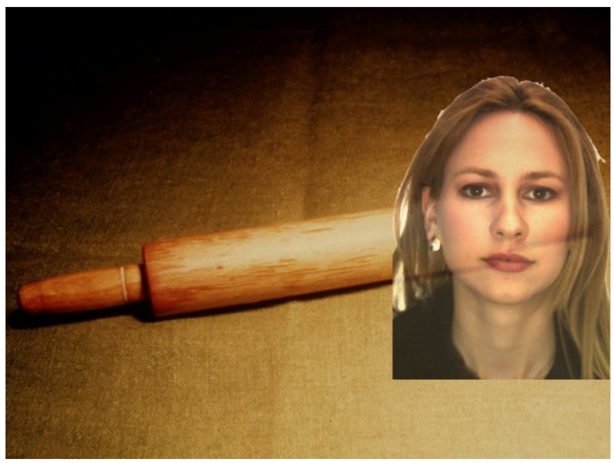
Mood. As in Experiment 1, to assess mood at time of test, participants were asked to complete the PANAS-X (Watson & Clark, 1994).

Stimuli. Stimuli were neutral faces presented in colour, overlaid upon background scenes. Faces were chosen from The AR Face Database (Martinez & Benavente, 1998). To allow viewing of both the face and scene, the transparency of each face was altered. These alterations were made using Adobe Photoshop using the “normal” transparency setting and with opacity at 80%. As in Experiment 1, the background scenes were chosen from IAPS.

Twenty-four faces with neutral expressions (12 male), and 24 background images were chosen for Experiment 2. Of the background images 8 were positive, 8 negative and 8 neutral, with half the backgrounds rated as being high arousal and half low arousal within each valence group. From these stimuli, 6 lists were created such that each face had an equal opportunity to be paired with a positive, negative, or neutral background, and also so that each face was presented either on the left or on the right of each type of background. Within each list, 12 of the faces were presented on the left and 12 on the right. See Figure 3 for sample stimuli and Table 4 for valence and arousal means of the IAPS images.

Neutral Face on a Positive Background

Neutral Face on a Negative Background



Neutral Face on a Neutral Background

Figure 3. Sample stimuli from Experiment 2

Table 4

Mean Valence and Arousal Scores of IAPS Images Used in Experiment 2 (Standard Deviation in Parentheses)

	High Arousal		Low Arousal	
	Valence	Arousal	Valence	Arousal
Negative	2.60 (.38)	5.07 (.54)	3.07 (.66)	3.84 (.82)
Neutral	4.82 (.65)	5.43 (.17)	4.99 (.43)	2.69 (.22)
Positive	7.54 (.38)	5.68 (.60)	7.11 (.51)	3.28 (.55)

2.6.3 Design

A within subjects design was used, with the independent variable as the valence of the background (positive, negative and neutral), and the dependent variable as memory for faces measured with d'. We also examined memory (d') in a surprise test of memory for the backgrounds.

2.6.4 Procedure

Participants studied one of the 6 lists (counterbalanced across participants) presented at a rate of 3.5 seconds per image. The rest of the procedure was identical to that of Experiment 1.

For the face recognition memory test, all 24 study faces were presented centrally on white backgrounds, along with 12 lure faces (6 male). For the surprise memory test, all 24 study backgrounds were re-presented without the face, plus 12 lure backgrounds. Of the lure backgrounds 4 were positive (M = 6.89, S.D. = .26), 4 negative (M = 3.25, S.D. = .61), and 4 neutral (M = 5.02, S.D. = .47), with half high arousal and half low arousal within each valence group.

Furthermore, 8 different faces and 8 different backgrounds were paired for a practice session prior to the experiment. All 8 pairings were presented and participants were instructed to memorize each face. Then, all 8 original faces plus 4 lure faces were presented centrally on white backgrounds for a practice recognition memory test. The surprise memory test was not administered in the practice session.

2.7 Results

2.7.1 Memory for Faces

Table 5 shows mean d' scores for memory of faces initially viewed in contexts of different valences. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in memory for faces depending on the valence of the background image. Unlike in Experiment 1, there was no main effect of valence, F (2, 94) = .89, η^2 = .02, p = .42. Also unlike in Experiment 1, memory was highest for faces paired with neutral backgrounds, though none of the simple contrasts was significant, p >.05.

2.7.2 Response Times for Face Memory

Table 5 shows mean RTs for face memory decisions. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in RTs for correct identification of old faces depending on the valence of the background image. Unlike in Experiment 1, there was no main effect of valence, F (2, 86) = .59, η^2 = .01, p = .56. Similar to in Experiment 1, faces initially encoded on negative backgrounds were recognized slower than faces initially encoded on neutral and positive backgrounds, though these differences were not significant, p >.05.

Table 5

Mean d' Memory Scores and Response Times for Memory of Faces Encoded in Different Emotional Contexts (Standard Deviation in Parentheses)

	Memory	RT
Negative	1.42 (.80)	990.20 (189.31)
Neutral	1.65 (1.09)	973.18 (206.27)
Positive	1.54 (1.09)	953.91 (235.55)

2.7.3 Memory for Backgrounds

Table 6 shows mean d' scores for memory of background scenes of different valence. A repeated measures ANOVA on the d' scores for the memory of backgrounds was conducted, the within-subject factor being valence of the background scene. Unlike in Experiment 1, there was no main effect of valence, $\underline{F}$ (2, 94) = .79, $\underline{\eta}^2$ = .02, $\underline{p}$ = .46. Similar to Experiment 1, negative backgrounds were remembered worse than neutral and positive backgrounds, however none of the simple contrasts were significant, p > .05.

2.7.4 Response Times for Background Memory

Table 6 shows mean RTs for background memory. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in RTs for correct identification background image of different valences. There was a significant main effect of valence, $\underline{F}$ (2, 72) = 4.97, $\underline{MSE}$ = 89565.82, $\underline{\eta}^2$ = .12, $\underline{p}$ <.05, such that negative backgrounds were recognized significantly slower than neutral backgrounds, $\underline{F}$ (1, 36) = 7.19, $\underline{MSE}$ = 241824.78, $\underline{\eta}^2$ = .18, $\underline{p}$ <.01, and positive backgrounds were recognized significantly slower than neutral backgrounds, $\underline{F}$ (1, 36) = 7.32, $\underline{MSE}$ = 293106.37, $\underline{\eta}^2$ = .17, $\underline{p}$ <.05. This is unlike Experiment 1, where the valence of the background image did not change speed of recognition.

Table 6

Mean d' Memory Scores and Response Times for Memory of Backgrounds of Different Emotional Contexts (Standard Deviation in Parentheses)

	Memory	RT
Negative	2.67 (1.53)	864.49 (193.26)
Neutral	2.86 (1.35)	783.65 (126.75)
Positive	2.84 (1.18)	872.65 (213.45)

2.7.5 Correlations

Bivariate correlations were conducted to examine whether there were any trade-offs between face memory and background memory. None of the correlations were significant, suggesting that these results cannot be explained by memory trade-offs.

2.7.6 Mood as a Moderating Factor

The PANAS-X (Watson & Clark, 1994) average score was 59.04% (SD = 14.34) for the positive items, and 34.77% (SD = 11.31) for the negative items. Bivariate correlations revealed that mood did have some effect on memory for the background images: the more positive the mood, the better memory was for positive backgrounds, $r = .301$, $p < .05$. Scores on the PANAS-X did not significantly correlate with memory for faces.

2.8 Discussion

Results from Experiment 2 indicate that when faces are presented peripherally, the boost in memory from negative backgrounds is lost. This finding is in line with a 'weapon focus' or narrowing of spotlight of attention explanation for Experiment 1 results, as the benefit of negative backgrounds is lost when the faces were presented peripherally. In Experiment 1, attention may have been focused centrally for negative scenes, and since this is where the faces were presented at time of study, faces inadvertently received additional attentional processing relative to faces in positive scenes. According to this theory, the positive scenes would not have led to the same narrowing of attentional focus, hence there would be no benefit to memory for centrally presented faces paired with positive images, which is what was found in Experiment 1.

Following Derryberry and Tucker's (1994) suggestion that positive affective states broaden the scope of attention, we had predicted that presenting faces in the periphery would improve memory for faces encoded in positive relative to negative background scenes. Contrary to our predictions however, Experiment 2 showed that positive backgrounds did not confer an advantage in subsequent memory for faces presented in the periphery of the scene. From these results we are faced with two options: we can either 1) conclude that positive backgrounds do not broaden attentional focus, or 2) examine whether our methodology may have prevented us from observing the true effect of positive valence. A study by Gruhn, Smith and Baltes (2005) showed that effects of emotion are reduced or lost in blocked presentation, and intermixed trials are needed to really see the influence of emotion on certain cognitive processes. If the type of presentation of emotional stimuli can change the way these stimuli are processed, perhaps the blocked presentation of our "face location" manipulation may have prevented us from seeing the true effect of valence. The effect of emotional scenes on visual attention may be more clearly observed when the location of the target face is not in a predictable location, as would occur in an intermixed design, but not in a blocked design. To explore this possibility, Experiment 3 was designed such that face location (central and peripheral) trials were intermixed.

Experiment 3: Memory for Faces Presented Centrally and Peripherally in Emotional Contexts: A Mixed Design

2.9 Introduction

Studies have shown that effects of emotion can differ depending on whether items are presented in a mixed versus a blocked designed (e.g. Gruhn et al., 2005). In Experiment 1 faces were repeatedly presented centrally, whereas in Experiment 2 faces were repeatedly presented peripherally. The predictability of where the face would be located may have influenced where participants chose to look when viewing each image, limiting our ability to see how positive scenes change how we process and remember faces. It is also possible that the blocked presentation underestimated the influence of negative contexts on face memory. In this Experiment faces were presented either centrally or peripherally in a random order so participants did not know in which location to expect the face to appear. All other aspects of the procedure were similar to Experiments 1 and 2. We predicted that in Experiment 3, faces presented centrally would be remembered best when encoded in a negative context, replicating Experiment 1 and supporting Easterbrook's (1959) 'weapon focus' theory for negative scenes, and faces presented peripherally would be remembered best when encoded in a positive context, supporting Derryberry and Tucker's (1994) theory that positive states serve to broaden the spotlight of attention.

2.10 Methods

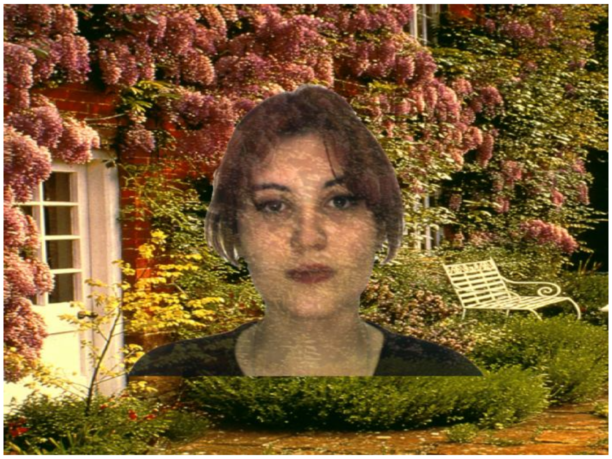
2.10.1 Participants

Forty-eight undergraduate students completed the study (22 males, M age = 20.19, SD = 3.44, Range = 18-36 years). Participants were enrolled in Psychology classes and received course credit or token monetary remuneration for their participation. The mean number of years of education was 14.17 (SD = 1.65). As in the other experiments, NART-R was administered; participants had a mean FSIQ estimate of 102.27 (SD = 8.35).

3.2.2 Materials

Mood. As in the other experiments, mood was assessed at time of test by asking participants to complete the PANAS-X (Watson & Clark, 1994).

Stimuli. Stimuli were the same as in Experiment 2, with the same neutral faces presented in colour, overlaid upon the same background scenes. The only difference was that from the twenty-four faces with neutral expressions (12 male), and 24 background images, 6 lists were created such that each face had an equal opportunity to be paired with a positive, negative, or neutral background, and also such that each face was presented either centrally or peripherally on each type of background. Within each list, 12 of the faces were presented centrally and 12 peripherally (6 on the left and 6 on the right). See Figure 4 for sample stimuli.



Neutral face on a positive background
presented centrally

Neutral face on a negative background
presented peripherally

Neutral face on a neutral background
presented peripherally

Figure 4. Sample stimuli from Experiment 3

2.10.2 Design

A 3 (background valence) x 2 (face location) within subjects design was used, with the independent variables being valence of the background (positive, negative and neutral) and the location of the face (central or peripheral), and the dependent variable being memory for faces measured with d', and background memory (d') on the surprise test of memory for backgrounds.

2.10.3 Procedure

Participants studied one of the 6 lists (counterbalanced across participants), and the rest of the procedure was the same as in Experiments 1 and 2.

Also similar to Experiment 2, for the face recognition memory test, all 24 study faces were represented centrally on white backgrounds, plus 12 lure faces (6 male). For the surprise memory test, all 24 study backgrounds were re-presented without the face, plus 12 lure backgrounds.

Furthermore, a similar practice session as in Experiment 2 was administered with 8 different faces and 8 different background pairings.

2.11 Results

2.11.1 Memory for Faces

Table 7 shows mean d' scores for memory of faces initially viewed either centrally or peripherally in contexts of different valences. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in memory for faces depending on the valence of the background image and the location of the face at time of study. A significant Valence X Face Location interaction was found, F (2, 94) = 3.13, MSE = 4.52, η^2 = .06, p <.05. The overall main effect of Valence was not significant F (2, 94) = 1.64, η^2 = .03, p = .20, nor was the overall main effect of Face Location, F (1, 47) = .02, η^2 = .00, p = .88. For faces presented peripherally there was a significant main effect of valence, F (2, 94) = 4.72, MSE = 6.29, η^2 = .09, p <.05, whereas for faces presented centrally the effect of valence was non-significant, F (2, 94) = .30, η^2 = .01, p = .74. A priori planned simple contrasts revealed that when faces were viewed in the periphery, they were best remembered in positive backgrounds compared to those viewed in neutral backgrounds, $\underline{F}$ (1, 47) = 13.12, $\underline{MSE}$ = 25.04, $\underline{\eta}^2$ = .22, $\underline{p}$ <.01. None of the other simple contrasts were statistically significant, p >.05.

2.11.2 Response Times for Face Memory

Table 7 shows mean RTs for face memory. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in RT for face recognition depending on the valence of the background image and the location of the face at time of study. The Valence x Face Location interaction was non-significant, $\underline{F}$ (2, 94) = .23, $\underline{\eta}^2$ = .01, $\underline{p}$ = .80, and no main effect of Valence was found, $\underline{F}$ (2, 94) = .89, $\underline{\eta}^2$ = .02, $\underline{p}$ = .42. Results revealed a significant main effect of Face Location, $\underline{F}$ (1, 47) = 22.18, $\underline{MSE}$ = 7878025.18, $\underline{\eta}^2$ = .32, $\underline{p}$ <.001, such that faces that were viewed in the periphery at encoding were recognized faster than faces viewed centrally at encoding. A priori simple contrasts revealed that when faces were encoded in the periphery, they were recognized faster when encoded in positive contexts compared to neutral contexts, though this difference was marginal, $\underline{F}$ (1, 47) =3.62, $\underline{MSE}$ = 724136.90, $\underline{\eta}^2$ = .071, $\underline{p}$ = .06. None of the other differences approached significance, p >.05.

Table 7

Mean d' Memory Scores and Response Times for Memory of Faces Encoded Centrally or Peripherally in Different Emotional Contexts (Standard Deviation in Parentheses)

	Centre		Peripheral	
	Memory	RT	Memory	RT
Negative	1.30 (1.14)	1190.01 (701.64)	1.36 (1.37)	880.85 (517.82)
Neutral	1.48 (1.52)	1190.22 (671.30)	1.05 (1.18)	809.74 (465.03)
Positive	1.33 (1.26)	1235.28 (607.69)	1.77 (1.33)	932.56 (414.13)

2.11.3 Memory for Backgrounds

Table 8 shows mean d' scores for memory of background scenes of different valences. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in memory for backgrounds depending on the valence of the background image and the location of the face at time of study. The Valence X Face Location interaction was non-significant, F (2, 94) = .39, η^2 = .01, p = .68, and Face Location did not influence memory for the background images, F (1, 47) = 1.70, η^2 = .04, p = .19. There was a significant main effect of Valence, F (2, 94) = 4.49, MSE = 9.19, η^2 = .09, p <.05, such that positive backgrounds were remembered better than neutral, F (1, 47) = 7.69, MSE = 25.76, η^2 = .14, p <.01, and negative backgrounds, F (1, 47) = 7.75, MSE = 29.25, η^2 = .14, p <.01. A priori planned simple contrasts revealed that when the face was presented peripherally, positive backgrounds were better remembered than neutral, F (1, 47) = 5.77, MSE = 22.20, η^2 = .11, p <.05, and negative backgrounds, F (1, 47) = 4.49, MSE = 17.24, η^2 = .09, p <.05. When the face was presented centrally, positive backgrounds were remembered marginally better than negative backgrounds, F (1, 47) = 3.40, MSE = 12.22, η^2 = .07, p = .07.

2.11.4 Response Times for Background Memory

Table 8 shows mean RTs for background memory. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in RTs for correct identification of background images dependent on its valence and on the location of the face at time of study. The Valence x Face Location interaction was non-significant, F (2, 94) = .11, η^2 = .00, p = .89. There was a significant main effect of valence, F (2, 94) = 5.58, MSE = 1180634.80, η^2 = .11, p <.01, and a significant main effect of Face Location, F (1, 47) = 18.65, MSE = 4331360.28, η^2 = .28, p <.001. A priori planned simple contrasts revealed that for backgrounds in which the face was presented centrally at encoding, neutral backgrounds were recognized significantly faster than positive backgrounds, F (1, 47) = 4.14, MSE = 2589717.59, η^2 = .08, p <.05. For backgrounds in which the face was presented peripherally at encoding, neutral backgrounds were recognized significantly faster than positive backgrounds, F (1, 47) = 10.38, MSE = 2138692.11, η^2 = .18, p <.01, and negative backgrounds were recognized marginally faster than positive backgrounds, F (1, 47) = 3.31, MSE = 870620.01, η^2 = .07, p = .08.

Table 8

Mean d' Memory Scores and Response Times for Memory of Backgrounds of Different Emotional Contexts Encoded with Faces Presented Centrally or Peripherally (Standard Deviation in Parentheses)

	Centre		Peripheral	
	Memory	RT	Memory	RT
Negative	2.94 (2.18)	958.18 (707.34)	2.76 (1.87)	682.32 (413.28)
Neutral	3.09 (1.63)	825.29 (476.06)	2.68 (1.74)	605.91 (311.50)
Positive	3.44 (1.65)	1057.57 (673.39)	3.36 (1.71)	816.99 (439.27)

2.11.5 Correlations

Bivariate correlations were conducted to examine whether there were any trade-offs between face memory and background memory. Memory for faces viewed centrally in negative contexts was negatively correlated with memory for positive backgrounds with faces presented peripherally, $r = -.292$, $p < .05$. Since none of the important correlations were significant, this suggests that these results cannot be explained by memory trade-offs.

2.11.6 Mood as a Moderating Factor

The Positive and Negative Affective Scale Expanded (Watson & Clark, 1994) was administered to all participants in order to determine the mood at time of test. The average score for the positive items was 56.17% (SD = 11.58), and the average score for the negative items was 37.74% (SD = 15.88). Bivariate correlations revealed that mood did have some effect on memory for the faces and background images: Negative scores on the PANAS-X correlated negatively with memory for faces encoded centrally on neutral backgrounds, $r = -.286$, $p < .05$. Negative scores on the PANAS-X correlated negatively with memory for negative backgrounds viewed with faces presented centrally at encoding, $r = -.302$, $p < .05$, and with memory for negative backgrounds viewed with faces presented peripherally at encoding, $r = -.294$, $p < .05$.

2.12 Discussion

Results revealed that in a mixed design where faces were viewed both centrally and peripherally across trials, in positive, negative and neutral contexts, there was a significant influence of valence of the background scene, which interacted with the location in which the face was viewed. Faces viewed peripherally were best remembered, and were recognized more quickly when encoded in a positive relative to a neutral context, however this influence of the background disappeared when faces were presented centrally. This finding is partially in support of the spotlight theory of attention. Derryberry and Tucker (1994) and others have proposed that positive affective states broaden one's spotlight, leading us to hypothesize that participants should remember faces viewed in the periphery in positive contexts best. Furthermore, regardless of whether the face was viewed centrally or peripherally at study, positive backgrounds were remembered best. This further supports the notion that the spotlight of attention was broadened for the positive contexts, leading to a deeper processing of, and therefore better memory for the positive background scenes.

However, the results for centrally presented faces in this experiment does not replicate results from Experiment 1, and also does not support the spotlight theory of attention according to Easterbrook (1959) who proposed that viewing negative contexts should narrow one's scope of attention. Since Experiments 1 and 2 essentially represent the same design as Experiment 3, but in a blocked design, we reanalyzed those data together to directly examine whether the effect of background context differed depending on face location, and whether that variable was blocked on intermixed across trials.

A Re-analysis of Experiments 1 and 2: Memory for Faces Presented Centrally and Peripherally in Emotional Contexts: A Blocked Design

2.13 Introduction

By comparing Experiments 1, 2 and 3 it is evident that the interaction between attention and emotional contexts, and its influence on memory, is different when the stimuli location is manipulated in an intermixed manner. In order to see if there is truly a difference between a mixed or blocked presentation of face location, Experiments 1 and 2 were amalgamated into one study and analyzed as a blocked design experiment.

A robust finding is that when participants view two similar stimuli in an intermixed exposure, they are better able to discriminate between the two stimuli (positive versus negative) on a later test than when the two similar stimuli are viewed in different blocks (Mitchell, Nash & Hall, 2008). This phenomenon is known as the 'intermixed-blocked effect' and has been found in flavour discrimination tests (Dwyer, Hodder, & Honey, 2004), visual discrimination tests (Lavis & Mitchell, 2006), and memory tests (Gruhn et al., 2005). It is evident that the way stimuli are presented can change how one processes specific stimuli, and so it is important to investigate the influence of presentation style in the current work.

2.14 Results

Experiments 1 and 2 were amalgamated into one study and analyzed as a blocked design experiment with the within subjects factor as memory for faces and backgrounds (measured with d' scores), and the between subjects factor as the location the face was presented (central vs. peripheral).

2.14.1 Memory for Faces

Table 9 shows mean d' scores for memory of faces initially viewed either centrally or peripherally in contexts of different valences. A mixed model repeated measures ANOVA was carried out to determine if there was an interaction between the valence of the background scene (positive, negative, neutral) and face location (central vs. peripheral) in memory for the faces. A significant Valence X Face Location interaction was found, $\underline{F}$ (2, 212) = 3.78, $\underline{MSE}$ = 2.08, $\underline{\eta}^2$ = .034, $\underline{p} < .05$, suggesting that the way the background valence influences memory for faces is dependent on the location the face is presented, in a blocked design. This result is similar to that found in Experiment 3 (the intermixed design).

Also similar to the intermixed design, the main effect of Valence was not significant F (2, 212) = .092, η^2 = .001, p = .912. Dissimilar from the intermixed design, there was a significant main effect of Face Location in the blocked design, F (1, 106) = 8.58, MSE = 4.59, η^2 = .075, $p < .01$, such that faces viewed in the periphery were better remembered overall compared to faces viewed centrally. This may simply reflect that the faces in Experiment 2 (presented in colour) were easier to see and therefore to memorize compared to the faces in Experiment 1 (presented in black & white).

2.14.2 Response Times for Face Memory

Table 9 shows mean RTs for face memory. A within-subjects repeated measures ANOVA was carried out to determine if there was a difference in RT for face recognition depending on the valence of the background image and the location of the face at time of study. The Valence X Face Location interaction was non-significant, F (2, 204) = 2.067, η^2 = .020, p = .129. Results revealed a significant main effect of Face Location, F (2, 204) = 4.801, MSE = 247432.958, η^2 = .045, $p < .01$, such that faces that were viewed in the periphery at encoding were recognized faster than faces viewed centrally at encoding. There was also a main effect of Valence, F (1, 102) = 25.300, MSE = 1757237.514, η^2 = .199, $p < .001$, such that faces encoded in negative contexts were recognized significantly slower than faces encoded in neutral contexts, F (1, 102) = 4.617, MSE = 488667.254, η^2 = .043, $p < .05$, and positive contexts, F (1, 102) = 8.055, MSE = 926498.078, η^2 = .073, $p < .01$.

Table 9

Mean d' Memory Scores and Response Times for Memory of Faces Encoded Centrally or Peripherally in Different Emotional Contexts (Standard Deviation in Parentheses)

	Centre (Experiment 1)		Peripheral (Experiment 2)	
	Memory	RT	Memory	RT
Negative	1.29 (.98)	1327.69 (441.88)	1.42 (.80)	990.20 (189.31)
Neutral	.96 (.93)	1205.97 (351.86)	1.65 (1.09)	973.18 (206.27)
Positive	1.11 (.79)	1172.94 (349.01)	1.54 (1.09)	953.91 (235.55)

2.14.3 Memory for Backgrounds

Table 10 shows mean d' scores for memory of background scenes of different valences. A mixed model repeated measures ANOVA was carried out to determine if there was an interaction between the valence of the background scene (positive, negative, neutral) and face location (central vs. peripheral) in memory for the background scenes. Dissimilar to Experiment 3 (the intermixed design) a marginally significant Valence X Face Location interaction was found, F (2, 212) = 2.95, MSE = 1.98, η^2 = .027, p = .055, suggesting that the way the background valence influences memory for the scenes is dependent on the location the face is presented, in a blocked design.

Similar to the intermixed design, the main effect of Valence was significant F (2, 212) = 8.00, MSE = 5.37, η^2 = .070, p<.001, such that when faces were presented centrally, positive backgrounds were remembered significantly better than negative backgrounds F (1, 59) = 20.37, MSE = 30.16, η^2 = .26, p < .001. Furthermore, when faces were presented centrally, negative backgrounds were remembered significantly worse than neutral backgrounds, F (1, 59) = 11.32, MSE = 10.96, η^2 = .16, p < .05. Dissimilar to the intermixed design, when faces were presented peripherally, there were no differences in memory for the different background valences.

Also dissimilar from the intermixed design, there was a significant main effect of Face Location in the blocked design, F (1, 106) = 7.94, MSE = 13.84, η^2 = .070, p < .01, such that backgrounds viewed with faces in the periphery were better remembered overall compared to faces viewed centrally. This result indicates that participants were better able to see the backgrounds when the face was in the periphery in the blocked design, but they did not receive this advantage in the intermixed design.

2.14.4 Response Times for Background Memory

Table 10 shows mean RTs for background memory. A mixed model repeated measures ANOVA was carried out to determine if there was a difference in RT for correct identification of background images dependent on its valence and on the location of the face at time of study. The Valence X Face Location interaction was non-significant, F (2, 184) = 1.710, η^2 = .018, p = .184, as was the main effect of Valence, F (2,

184) = .910, η^2 = .010, p = .404, as was the. There was a significant main effect of Face Location, F (1, 92) =11.197, MSE = 751145.223, η^2 =.109, p <.01, such that backgrounds encoded with faces presented peripherally were recognized faster than backgrounds encoded with faces presented centrally, which simply suggests that the backgrounds could be better seen and therefore encoded when the faces weren't blocking the image.

Table 10

Mean d' Memory Scores and Response Times for Memory of Backgrounds of Different Emotional Contexts Encoded with Faces Presented Centrally or Peripherally (Standard Deviation in Parentheses)

	Centre (Experiment 1)		Peripheral (Experiment 2)	
	Memory	RT	Memory	RT
Negative	1.69 (1.46)	1046.29 (400.90)	2.67 (1.53)	864.49 (193.26)
Neutral	2.12 (1.46)	1032.24 (438.51)	2.86 (1.35)	783.65 (126.75)
Positive	2.40 (1.77)	991.18 (310.43)	2.84 (1.82)	872.65 (213.45)

2.14.5 Correlations

Bivariate correlations were conducted to examine whether there were any trade-offs between face memory and background memory. None of the correlations were significant, suggesting that these results cannot be explained by memory trade-offs.

2.15 Discussion

An interaction between valence of the context and face location was found in both the blocked design (Experiments 1 & 2 amalgamated) and the intermixed design (Experiment 3), suggesting that the way the background valence influences memory for faces may be modulated by location, which likely reflects attentional effects. Results also indicate that the effect of face location is dependent on the type of the experimental design, such that in a blocked design faces encoded in negative contexts received a boost in memory when viewed centrally at study, but lost this boost when viewed peripherally; whereas in an intermixed design faces encoded in positive contexts received a boost in memory when viewed peripherally at study, but lost this boost when viewed centrally.

The difference in results dependent on the experimental design may explain why results differed between Experiments 1 and 2 compared to Experiment 3. When these results are all taken together, there is clear support for the notion that the emotional context in which a face is encountered changes how well it will later be remembered, and that this effect may be explained by a shift in attention which occurs depending on the valence of the context.

2.16 Experiments 1-3 General Discussion

In conclusion, when considered together, the results from Experiments 1 through 3 are in full support of the idea that a change in attentional scope is driven by the valence of the background context, and that this change in attention may explain differences in memory for faces encoded in contexts of varying valence.

In summary, Experiment 1 demonstrated a boost in memory for faces encoded in negative contexts when the faces were viewed in the centre of the background image, whereas the boost in memory was lost in

Experiment 2 with peripheral presentation. Experiment 3 showed that in an intermixed design, faces viewed in the periphery of a scene were best remembered when encountered in positive contexts. A re-analysis of Experiments 1 and 2 amalgamated as a blocked design revealed that the experimental design has an influence on results when studying emotion and attention, such that negative context boosted memory for faces viewed centrally in the blocked design, but positive contexts boosted memory for faces viewed peripherally in the intermixed design. This finding identifies a need for careful experimental design when investigating item-emotion-attention interactions.

To assess the validity of the spotlight theory of attention, test how emotion might affect visual attention, and also help elucidate the mechanism by which emotional backgrounds might affect target item processing, Experiment 4 was designed as a follow-up study to the current line of research.

Chapter 3

Experiment 4: Examining the Influence of Emotional Contexts on Visual Attention

3.1 Introduction

As discussed, Experiments 1 through 3 have demonstrated that there is an influence of emotional contexts on how we remember faces and that this influence may be due to changes in attentional aperture, which in turn depend on the valence of the context. In my work thus far this shift in attention has been tested using memory techniques. However, it is important to test the way emotion might affect visual attention using a *visual attention* paradigm for a clearer picture of the mechanisms at play.

Experiment 4 was designed to determine whether the distribution of visual attention changes depending on the emotionality of the scene or context. Previous studies have used a digit-parity task to examine how/whether emotion influences visual attention. In one study, participants were shown a centrally presented word with two digits flanking the word on either side (Wolford & Morrison, 1980). Participants were asked to make a parity judgment of the flanking digits (both odd or both even = match/one odd and one even = mismatch), by making a key press response as quickly and accurately as possible. They found that participants' responses to the digits were significantly slowed when the word presented centrally was their last name, suggesting that it had narrowed their attentional focus and distracted them from the peripherally-presented digits. A study by Harris and Pashler (2004) extended this finding to examine arousing versus neutral words. They found that threatening words captured attention, and so slowed RT to the digit parity task. Aquino and Arnell (in preparation) examined the same question as Harris and Pashler (2004) using sexually explicit words rather than threatening words. They found that participants were slower to respond to the parity task when the word in the centre of the screen was sexual relative to when it was neutral in nature. From these studies it is evident that when there is a central stimulus which captures visual attention, participants pay less attention to peripheral items (the digits) leading to hindered performance on the digit parity task.

In Experiment 4, we wished to use this paradigm to test the influence of emotional scenes on visual attention by measuring changes in performance on a digit parity task. That is, we examined participants' accuracy and RT in a similar parity task with numbers presented in the periphery, immediately following an image of positive or negative valence, presented centrally. Performance was assessed in two blocks because it was assumed that presenting any novel image would influence performance on the parity task, masking any effect of emotion on visual attention. Thus, in a second block the same emotional images (no longer novel) were re-presented, and performance here was taken to reflect the influence of emotional images on the spotlight of attention. We predicted that participants would become faster and more accurate at the digit parity task in the second block when positive compared to negative scenes were presented centrally, providing converging support that the emotionality of stimuli changes the spotlight of attentional resources. Specifically, positive pictures should broaden the aperture of the attentional spotlight so that the digits fall within the spotlight, leading to faster parity judgments. By contrast, negative pictures should narrow the aperture of attention, causing the digits to fall outside the spotlight of attention, leading to slower parity judgments.

3.2 Methods

3.2.1 Participants

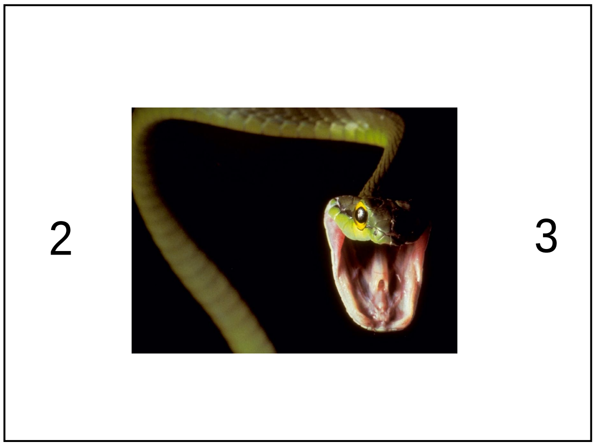
Thirty-two undergraduate students completed the study (14 males, M age = 20.50, SD = 1.37, Range = 18-24 years). Participants were enrolled in Psychology classes and received course credit or token monetary remuneration for their participation. The mean number of years of education was 14.63 (SD = 1.18).

3.2.2 Materials

Mood. As in the other experiments, mood was assessed at time of test by asking participants to complete the PANAS-X (Watson & Clark, 1994).

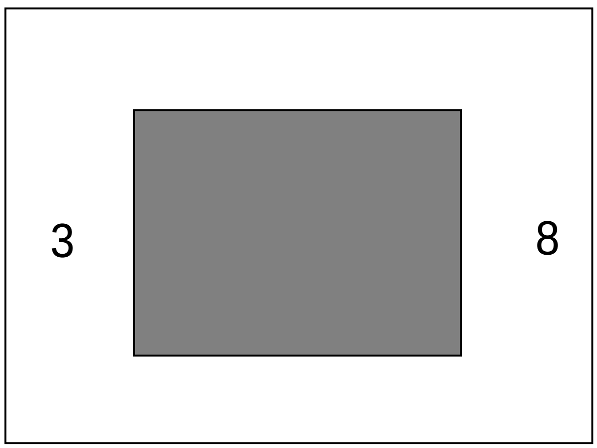
Stimuli. Stimuli for the digit parity task consisted of two digits. Only the digits 2, 3, 5, and 8 were used as stimuli. Digits and were presented in 18-point bold Courier New font. The digits were randomly paired with the constraint that on half of the trials the pair of digits were a match (both odd or both even), and the other half were a mismatch (one odd and one even).

The background scenes were chosen from the IAPS, and consisted of 24 positive and 24 negative scenes (half high arousal and half low arousal within each valence group). See Figure 5 for sample stimuli and Table 11 for valence and arousal means of the IAPS images (from the normative study; Lang, Bradley & Cuthbert, 2001).



A negative trial with mismatched digits

A positive trial with matched digits



A blank trial with mismatched digits

Figure 5. Sample stimuli from Experiment 4

Table 11
Mean Valence and Arousal Scores of IAPS Images Used in Experiment 4 (Standard Deviation in Parentheses)

	High Arousal		Low Arousal	
	Valence	Arousal	Valence	Arousal
Negative	2.96 (.55)	6.08 (.48)	3.67 (.60)	3.67 (.69)
Positive	7.29 (.36)	5.71 (.28)	7.07 (.57)	3.26 (.60)

3.2.3 Design

A 3 (Background Valence) x 2 (Block) within subjects design was used, with the independent variables as the valence of the background (positive, negative and blank) and block (1 or 2), and the dependent variables as accuracy on the parity task (measured as # hits/total number possible hits), and RT for hits.

3.2.4 Procedure

The experiment consisted of two blocks of 48 parity trials each, with 10 practice trials prior to block 1 and 48 blank trails following block 2. In block 1, 24 positive and 24 negative images were presented in pseudorandom order. In block 2 the same 48 images were again shown in pseudorandom order.

Each parity trial began with the presentation of a fixation cross in the center of the computer screen for 500 ms, followed by a 500 ms blank interval (white screen) before the presentation of an image. The image was presented alone for 100 ms followed by the image with a digit to the left and right of it for 150 ms. The screen then went blank (all white) until a response was made. Participants were told to press the ‘M’ key if the digits matched (both odd or both even), and to press the ‘N’ key if the digits mismatched (one odd and one even). Participants were asked to respond as quickly and accurately as possible.

Twelve practice trials were presented at the beginning of the experimental session with neutral IAPS images presented in the centre. At the end of the experimental session 48 blank trials were administered, with the same 48 digit pairs as in blocks 1 and 2, with a simple grey box in place of the image for all trials.

Neuropsychological Tests. Either before or after the experimental session (counterbalanced across participants) each participant completed the PANAS-X.

3.3 Results

3.3.1 Accuracy

Table 12 shows the mean accuracy scores (%) and the mean accuracy scores (%) for each of the background conditions across block. A repeated measures ANOVA was carried out on the mean accuracy score for each of the 3 background conditions (positive, negative and blank), the within-subject factor being valence. A main effect of valence was found, $\underline{F}$ (2, 62) = 5.54, $\underline{MSE}$ = .22, $\underline{\eta}^2$ = .151, $\underline{p}$< .01, such that participants were significantly more accurate on blank trials than on positive trails, $\underline{F}$ (1, 31) = 10.35, $\underline{MSE}$ = .057, $\underline{\eta}^2$ = .250, $\underline{p}$< .01, and negative trails, $\underline{F}$ (1, 31) = 9.08, $\underline{MSE}$ = 0.075, $\underline{\eta}^2$ = .227, $\underline{p}$ <.01. The difference between accuracy for negative and positive backgrounds, however, did not reach significance, $\underline{F}$ (1, 31) = 0.123, $\underline{\eta}^2$ = .004, $\underline{p}$ = .728.

A 2 (image valence) X 2 (block) repeated measures ANOVA was performed on mean accuracy scores, with valance (positive and negative) and block (1 or 2) as within-subject variables. There was a significant main effect of block $\underline{F}$ (1, 31) = 7.17, $\underline{MSE}$ = .050, $\underline{\eta}^2$ = .188, $\underline{p}$< .05, such that participants were more accurate on trials in the second block relative to the first block. There was no main effect of valence, $\underline{F}$ (1, 31) = 0.157, $\underline{\eta}^2$ = .005, $\underline{p}$ = .695, and no significant valence X block interaction $\underline{F}$ (1, 31) = 1.173, $\underline{\eta}^2$ = .053, $\underline{p}$ = .198. However, a priori planned simple contrasts revealed that when the image was positive, participants were more accurate in block 2 compared to block 1, $\underline{F}$ (1, 31) = 7.23, $\underline{MSE}$ = .061, $\underline{\eta}^2$ = .189, $\underline{p}$< .05, but when the image was negative, participants were not more accurate in block 2 compared to block 1, $\underline{F}$ (1, 31) = .649, $\underline{\eta}^2$ = .021, $\underline{p}$ = .427, indicating that the advantage of a repeated exposure to the image was not present when the image was negative.

3.3.2 Response Time

Table 12 shows the mean RTs for each of the background across block. A repeated measures ANOVA was carried out on the mean RTs (for correct parity decisions only) for each of the 3 background conditions (positive, negative and blank), the within-subject factor being valence. A main effect of valence was found**,** $\underline{F}$ (2, 62) = 4.178, $\underline{MSE}$ = 46830.134, $\underline{\eta}^2$ = .119, $\underline{p}$ <.05, such that participants were significantly faster to respond correctly on blank than on positive trials, $\underline{F}$ (1, 31) = 6.579, $\underline{MSE}$ = 172726.501, $\underline{\eta}^2$ = .175, $\underline{p}$ <.05, and marginally faster to respond correctly on blank than on negative trails, $\underline{F}$ (1, 31) = 3.626, $\underline{MSE}$ = 97607.979, $\underline{\eta}^2$ = .105, $\underline{p}$ = .066. The difference between accuracy for negative and positive backgrounds, however, did not reach significance, $\underline{F}$ (1, 31) = .756, $\underline{\eta}^2$ = .024, $\underline{p}$ = .391.

Of critical importance, however, a 2 (image valence) X 2 (block) repeated measures ANOVA was conducted on mean RT, with valance (positive and negative) and block (1 or 2) as within-subject variables. There was a significant main effect of block $\underline{F}$ (1, 31) = 11.507, $\underline{MSE}$ = 295644.935, $\underline{\eta}^2$ = .271, $\underline{p}$< .01, such that participants were faster to respond correctly on trials in the second relative to the first block. There was no main effect of valence, F (1, 31) = .880, η^2 = .028, p = .356, and a marginally significant valence X block interaction F (1, 31) = 3.069, MSE = 33660.719, η^2 = .090, p = .090. A priori planned simple contrasts revealed that when the image was positive, participants were faster to respond correctly in block 2 compared to block 1, F (1, 31) = 9.398, MSE = 264410.639, η^2 = .233, $p < .01$, and the same when the image was negative, F (1, 31) = 7.609, MSE = 64895.015, η^2 = .197, $p < .05$. However, the effect size is larger when the image was positive, indicating that the advantage of a repeated exposure to the image had less of an impact for the negative relative to the positive images.

Table 12

Mean Accuracy and Response Times on the Parity Task (Standard Deviation in Parentheses)

	Overall		Block 1		Block 2	
	Accuracy	RT	Accuracy	RT	Accuracy	RT
Negative	.74 (.14)	922. 61 (275.04)	.74 (.16)	953.16 (279.43)	.75 (.15)	889.48 (284.94)
Positive	.75 (.12)	940.85 (296.54)	.72 (.13)	1005.22 (333.77)	.78 (.14)	876.67 (304.40)
Blank	.79 (.12)	867.38 (247.02)	N/A	N/A	N/A	N/A

3.3.3 Mood as a Moderating Factor

Mood, as assessed by the PANAS-X was correlated with RT and accuracy scores on the parity task. Bivariate correlations revealed that positive mood on the PANAS-X correlated negatively with accuracy on the parity task, $r = -.36$, $p < .05$, such that the more positive mood participants were in, the less accurate they were on the parity task when the image was positive. Although non-significant, all other correlations with accuracy were negative, except for accuracy in block 2 when the image was positive, which was positively correlated with negative PANAS-X scores. All correlations with RT were negative, however non-significant.

3.4 Discussion

Experiment 4 was designed to test the spotlight theory of attention using a paradigm that does not involve memory. Following an initial orienting phase to the images in Block 1, results indicated that participants became faster and more accurate at the digit parity task in Block 2, when positive, compared to negative scenes were presented centrally (see Figures 6 and 7). These results are further converging support that the emotionality of stimuli can indeed change the aperture of attention, with positive images leading to a broader, and negative images to a narrower spotlight of processing.

Future versions of this study with simple changes would help make the results clearer. Increasing the length of time of picture presentation would be important to ensure the valence of the image is easily noticeable. In the present study each image was displayed for a very short amount of time which may have reduced the effect, and possibly account for the fact that the effects were most noticeable in block 2. Increasing power would also be beneficial which could be accomplished by increasing the number of trials, increasing the number of blocks, or running more participants.

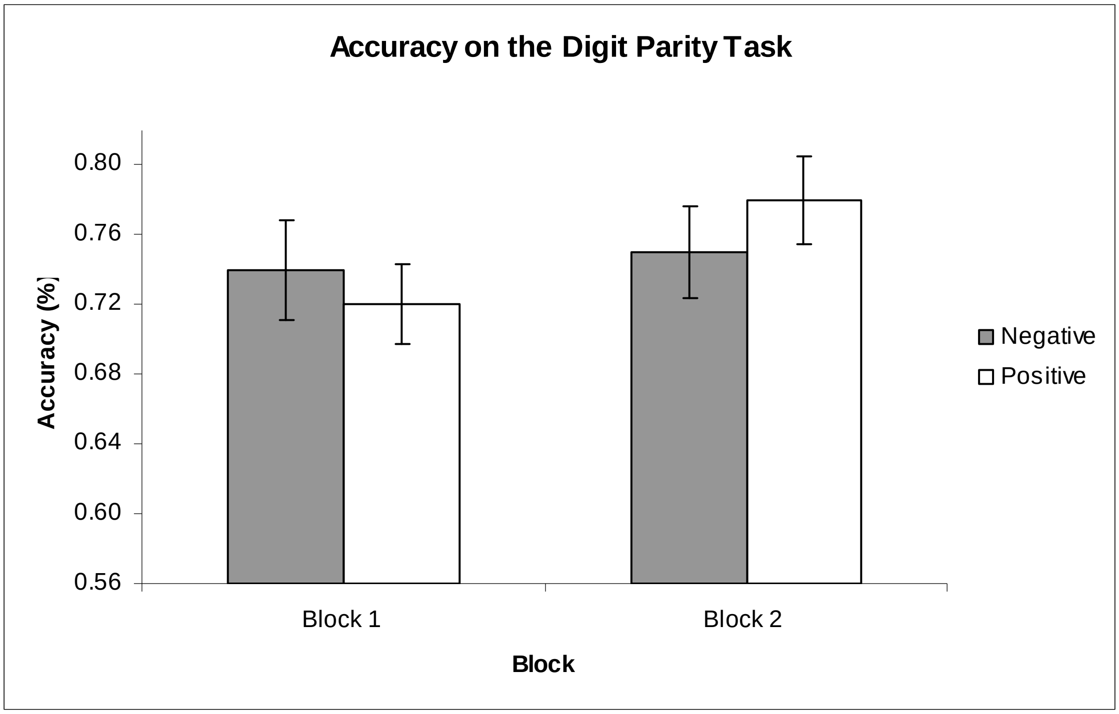


Figure 6. Graph depicting mean accuracy scores on the digit parity task across image valence and block

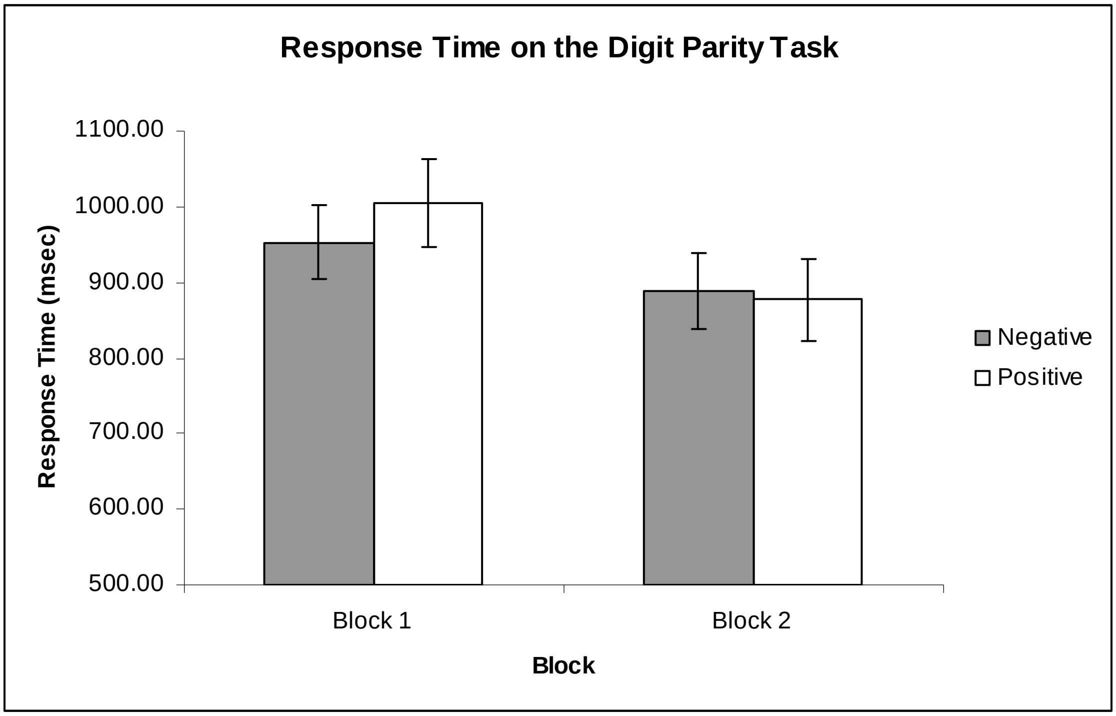


Figure 7. Graph depicting mean response times on the digit parity task across image valence and block

Chapter 4

General Discussion

4.1 Re-visiting the Original Question

The current line of research was designed to investigate whether the emotional context in which a neutral face is viewed changes one's memory of that neutral face. In Experiment 1, neutral faces were overlaid centrally onto positive, negative or neutral backgrounds, and recognition memory for faces was assessed to determine whether the emotional background during the study phase affected later memory for that face. Memory for faces initially encoded in negative contexts was boosted relative to memory for faces initially encoded in neutral contexts, while faces encoded in positive contexts did not receive this boost in memory. Further investigation was necessary to reveal the mechanism behind the influence that emotional contexts had on memory for faces. Experiments 2 and 3 tested whether the spotlight theory of attention could account for the effect of emotional contexts on memory. To test whether the varying emotional contexts did indeed shift attentional scope, Experiment 2 was designed in which neutral faces were presented once again in positive, negative or neutral contexts, however location of face presentation was peripheral rather than central. Results revealed a loss of the memory boost found in Experiment 1. Experiment 3 was designed to test the spotlight theory of attention using an intermixed design in which faces were presented both centrally and peripherally in emotional and neutral background scenes. Experiment 3 demonstrated a broadening of attentional aperture such that when faces were viewed peripherally in positive contexts at time of study they were better remembered than faces viewed peripherally in neutral contexts at time of study. Experiment 4 was designed to assess the validity of the spotlight theory of attention and test of how emotion affects visual attention, and also to help reveal the mechanism by which emotional backgrounds might affect target item processing. Following an initial orienting phase to the images, participants became faster and more accurate at the digit parity task when positive compared to negative scenes were presented centrally, suggesting that positive contexts led to a broadening of attentional scope, providing converging evidence for the spotlight theory of attention.

In summary, I discovered that the specific influence of emotional contexts entails a boost in memory for what is paired with negative information, but this effect interacts with where the target item is located within the scene. For centrally presented target items, negative contexts provide a boost in memory, and this boost is lost when target is in periphery. When target is paired with a positive context, the memory boost may be seen if the target is in the periphery. Of note, these effects of emotionality are further influenced by what trials came before it (whether blocked in one predictable location, or appearing in a random location – as on mixed location trials).

Let’s revisit the scenario discussed earlier in which you are walking from your house to the corner store. In this imaginary stroll you passed by a man sitting on a bench at a bus stop, a lady watering her flowers in her garden, and someone standing in front of their broken down car with smoke steaming out of the engine on the side of the road. When you arrived at the store there was a police officer interviewing people to get to the bottom of a crime that had just occurred nearby the store. When he asks you to recall the people you have passed by, will your memory for the different people vary depending on the valence of the context in which you encountered them? According to the studies presented, your memory for these people will indeed be different depending on which context, and also in which area of your vision you viewed them (i.e. if you looked at them straight on or if you only saw them in your peripheral vision). If you turned to look at each person as you passed by, your memory would be best for the man in the unfortunate situation of a broken down car (negative valence). If you had been focused on getting to the store and only saw these people in your peripheral vision, your memory would be best for the lady watering her garden (positive valence).

4.2 Contributions to the Literature

The current work is important in contributing to our current understanding of item-emotion interactions, particularly on memory. To date very few studies have examined the influence of emotional context on memory for items encoded within that context, and even fewer have examined this influence on memory for faces. Not only does the literature lack research on face memory and emotional contexts, there is a major lack in research on mechanisms to explain such interactions. The current thesis demonstrates that the emotion portrayed by a context in which a person is encountered can change how well this person is later remembered. The presented studies demonstrate a crucial need to consider attention when looking at these item-emotion interactions, as emotion and attention have an interaction of their own. Shifts in attention have been documented by many. Easterbrook (1959) suggested that negative affective states induced a narrowed spotlight of attention. This was demonstrated in a study by Christianson and Loftus (1991) who showed that participants were better able to recall central details but worse able to recall peripheral details in a negative scene compared to a neutral scene, along with other studies which have shown similar findings (Christianson, 1984; Christianson & Loftus, 1987).

Other studies have demonstrated a similar phenomenon in the opposite direction. Derryberry and Tucker (1994) have suggested that positive affective states (such as amusement and contentment) broaden the scope of attention. Fredrickson and Branigan (2005) demonstrated this in a study where participants viewed films that elicited amusement, contentment, neutrality, anger or anxiety and found that more global selections were made (broadened spotlight) when participants viewed the positive relative to when they viewed the negative films, suggesting that positive emotional states broaden the spotlight of attention.

Furthermore, as suggested by Carroll and Russell (1996), the traditional methods of studying emotion-face interactions is not satisfactory as there are many technical biases and confounds, making it vital to find different methods of testing the influence of emotional contexts. The current thesis is important because it provides new methods of testing these matters. The majority of studies to date have examined the influence of emotional contexts on face processing using methods such as displaying a picture of a face and giving a written description of an emotional context (Goodenough & Tinker, 1931; Watson, 1972; Wallbott, 1988; Fernandez-Dols, Wallbott & Sanchez, 1991; Knudsen & Muzekari, 1983). Our research provides a novel way of testing face processing and emotion by creating real-life stimuli in which faces were directly overlaid upon background scenes in order to have the faces and backgrounds presented simultaneously. As stated by face researchers Spignesi and Shor (1981), when studying something as real as human faces, stimuli need to appear as though they were a “slice of life” and our method of displaying stimuli did just that.

4.3 Alternate Explanations

Research in several domains including attention, impression formation and motivation have shown that negative stimuli such as objects, events, information and personality traits impact psychological processes much more than positive versions of these stimuli (for reviews, see Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Rozin & Royzman, 2001; Taylor, 1991). In one particular study by Skowronski and Carlston (1987) young adults were better able to remember negative personality traits of people than positive and neutral traits. Taylor (1991) suggested that this general negative bias is important because our wellbeing and survival depend on us avoiding negative items. Theories have been developed which suggest that because of their superior importance, negative stimuli receive more processing than positive and neutral stimuli, and in turn reduce processing resources available to process other information simultaneously (Ohman, 1979). Studies have shown that people report thinking more about negative than positive events (Klinger, Barda, & Maxeiner, 1980), have slower RTs for negative relative to positive words (Ohira, Winton & Oyama, 1998), and spend a greater amount of time viewing negative compared to positive pictures. This idea could be an alternate explanation to our findings. Lewis and Critchley (2003) proposed that when neutral material is presented with emotional material, the neutral item receives a "tag", and so in retrieval of the neutral item the emotional material is also retrieved from memory. Perhaps the faces encoded in our different emotional contexts were themselves tagged in memory with that valence (i.e. perhaps the valence of the context 'bled' over to the neutral face). If this had occurred, it would make the negative faces become negative entities, and according to the 'negativity effect' theory, they would therefore receive more processing, and therefore be better remembered later, as we found. This alternate explanation however cannot explain why the boost in memory for faces encoded in negative contexts was lost when the faces were presented peripherally. According to the 'negativity effect' theory, the faces viewed in negative contexts should have received more processing regardless of the location of the face. This lends more support for the idea that there is a change in one's spotlight of attention due to the varying emotional contexts.

4.4 Future Directions

What is still unclear is *how* emotional stimuli leads to a narrowing or widening of the aperture of attention. Future studies would be beneficial in unveiling the mechanism behind this shift in attentional focus. Perhaps there is an actual shift in parts of the image upon which viewers focus. We are currently in the process of conducting an eye tracking study to investigate whether people's viewing focus is indeed different depending on the emotional valence of the scene. In this study, positive, negative and neutral IAPS images (similar to the ones used in the present studies) will be displayed on a computer monitor and participants will be asked to passively view each scene. Participants' eye movements across each image will be tracked and the number of eye fixations, time spent viewing each area of the image, and path of eye movement will be documented. Figure 8 shows how each image will be divided into 16 sections for analysis. The pink squares represent the central region of the image while the blue squares represent the peripheral region of the image. We predict that if positive stimuli or states do indeed broaden the spotlight of attention while negative stimuli or states narrow the spotlight of attention, there should be more eye fixations and more time spent looking at the central portion of the negative images, while there should be more eye fixations and more time spent looking at the peripheral portion, or perhaps the entire area of the positive images. Figure 9 is a sample image from the study which is negative in valence and shows a pilot participant's path of eye movements and eye fixations across the image.

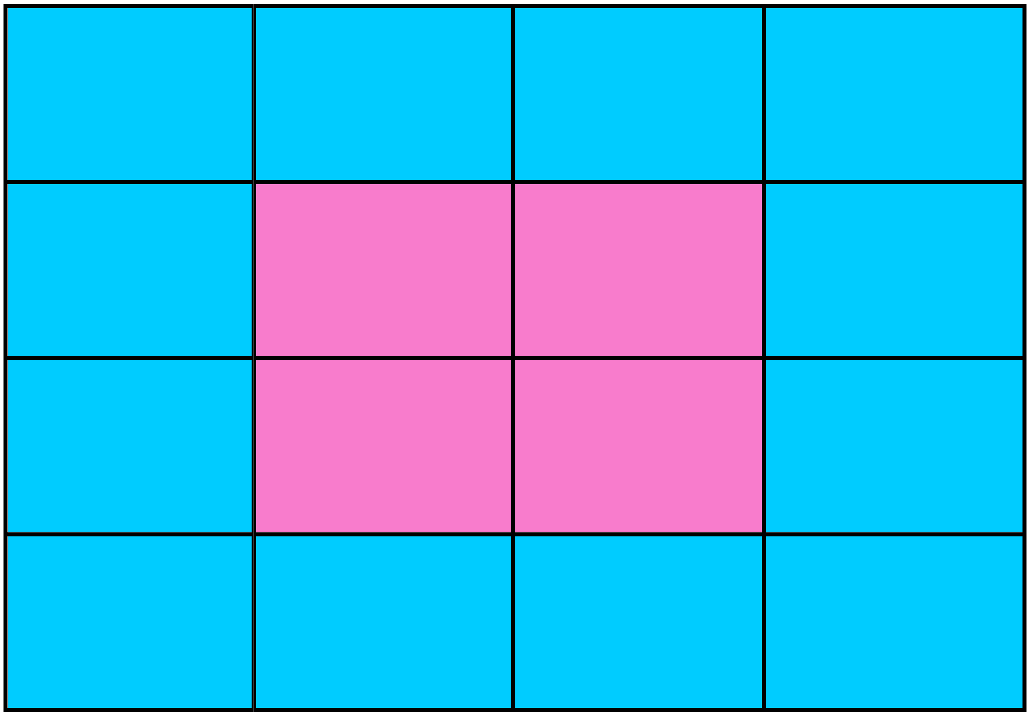


Figure 8. Grid by which each image will be divided into in our eye tracking study

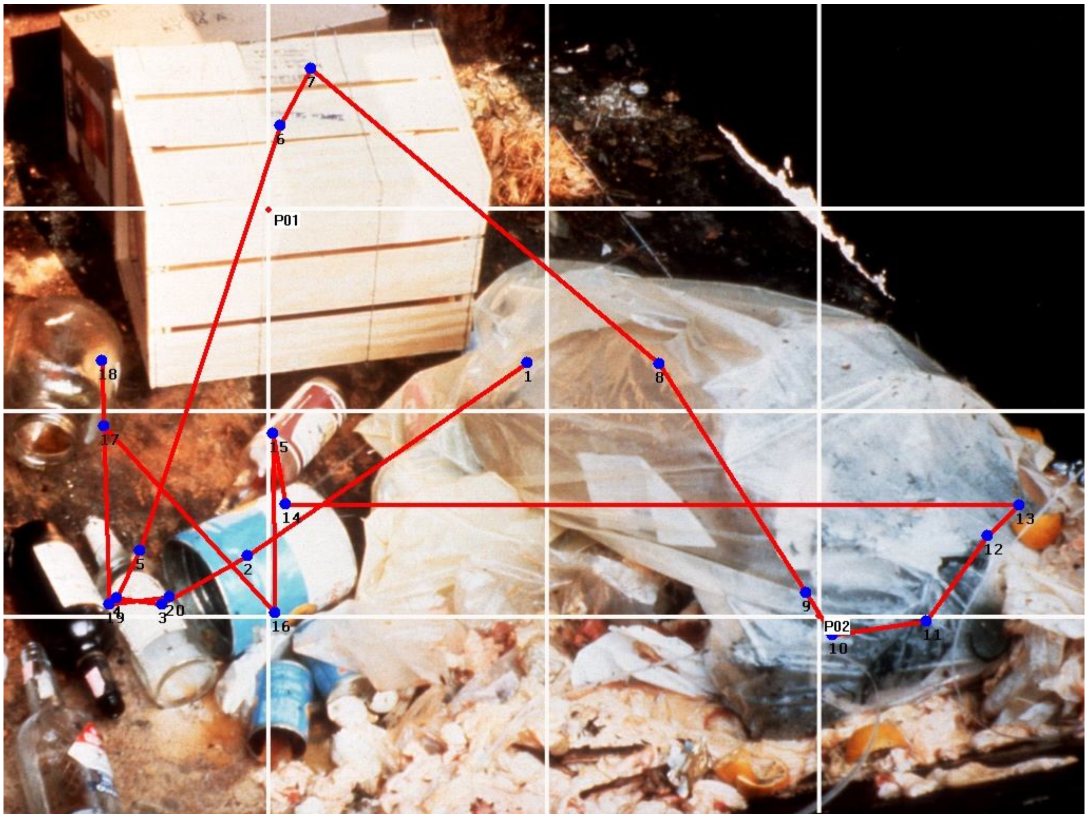


Figure 9. Sample of a negative image from our eye tracking study depicting a pilot participants eye movements (red line) and eye fixations (blue dots) across the image (note that the participant will not see the white grid lines, they are simply for demonstration and analysis purposes only)

Another question which is yet to be answered is *why* these emotional contexts actually change one's attention. Studies have been conducted using various methods to induce mood and then examine changes in attention, including videos (Fredrickson & Branigan, 2005), slide shows (Christianson & Loftus, 1991), music (Bouhuys, Bloem & Groothuis, 1995), and smells (Leppänen & Hietanen, 2003). In the current studies we found shifts in attention due to varying emotional contexts using displays of single images for as little as 3.5 seconds. Is it really mood that is being manipulated in our experiments and other similar studies? In our experiments, participants' mood at time of test was measured and correlations of mood with memory could not explain the findings. Perhaps it is something different than mood being manipulated? Perhaps in some cases mood is indeed changed (such as when using extended videos) and in some cases it's simply an instantaneous experience of an emotion congruent to that of the scene which dissipates as soon as the scene is gone. Would this well-documented shift in attention due to emotional states and stimuli be different when it is a change in mood that is induced versus a change in instantaneous feelings? Further studies are required to untangle this web.

An interesting extension of this research would be to investigate how emotional contexts influence attention, and therefore memory for faces, viewed in these contexts when the faces were also portraying an emotion (rather than the neutral faces used in the present studies). In work by Fernandes and Koji (under review) emotional faces (happy, angry and neutral) were displayed in positive, negative, and neutral contexts. We showed that the emotion of the face does influence how we evaluate that person, but it is the valence of the context which is more influential on how positively or negatively we evaluate that person. How would this translate to memory research? Perhaps when it comes to memory for emotional faces in different contexts the interaction between the face emotion and context emotion is what matters the most, such that incongruent combinations (e.g. a happy face in a landfill, or an angry face in a garden) would lead to better memory for both the faces and backgrounds relative to congruent combinations (e.g. a happy face in a garden, or an angry face in a landfill). Only future studies can answer this question definitively.

A necessary follow-up study would be to change the type of memory test from a recognition test to a recall test. In many studies the influence of emotional contexts on memory has been found to be stronger when participants must actively recover information from memory, which is more likely to occur in recall than in recognition memory tests (Fiedler, 1991). Furthermore, studies have shown that free recall is supported by positive mood whereas recognition is supported by negative mood (Ashby, Isen & Turken, 1999; Fiedler, 2001). In these studies, positive mood has been shown to encourage creative problem solving, which then becomes useful for free recall memory tasks. On the other hand, negative mood encourages avoidance of mistakes, for example if you see a threatening stimuli such as a poisonous snake, you want to memorize that snake to the best of your ability and avoid misremembering it so you can avoid it in future encounters. It would be interesting to test a similar paradigm as used in our experiments, but change the memory test to recall rather than recognition. Famous faces could be used to allow participants to have a name for each face with which they could use in the recall task. According to this literature, memory for the faces encoded in positive contexts should be better compared to those encoded in negative contexts when the test is recall, but this is an empirical question and only a future study will reveal the answer.

In conclusion, the current work has shown that the emotion portrayed in a scene can change how well we remember a person viewed in that scene, and that the influence of emotion on attention is likely the mechanism behind this phenomenon. Future research is needed to further investigate the manner in which emotional contexts and states shift attention.

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