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Attentional Effects on Memory for Emotional Faces and Events

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ATTENTIONAL EFFECTS ON MEMORY FOR EMOTIONAL FACES AND EVENTS

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Table of Contents

Attentional Effects on Memory for Emotional Faces and Events

Currently in psychology, there is discord in the literature about whether emotional stimuli enhance or diminish memory. While it may be widely believed that emotional memories improve one's memory for past events, it may not be true. For example, emotional memories could be more salient, but less accurate. Furthermore, whether or not a person remembers an emotionally powerful image could depend on how much attention other objects in the environment demand of him or her. It could then be speculated that how attention is directed is what truly determines an individual's memory for emotional stimuli. The main focus of this study is on the interaction between attention and emotion on memory.

Emotion and Memory

It is evident from various research studies that emotion has some effect on how humans form and recall memories (Dreisbach, 2006; Dreisbach & Goschke, 2004; Phelps, 2004). As Phelps (2004) explained, the hippocampal complex and amygdala are part of the emotional and memory circuitry of the brain. The amygdala can modify how the hippocampal complex stores memory. Meanwhile, the hippocampal complex's ability to construct emotional representations of episodic memories shapes how the amygdala responds when confronting emotional stimuli. Although different brain areas are involved in emotion, the nature of this association is not well understood. Some researchers have concluded that emotion enhances memory (Spachtholz, Kuhbandner, & Pekrun, 2014), while others claim that it hinders memory (Brainerd, Stein, Silveira, Rohenkohl, & Reyna, 2008). Upon viewing the literature in this area, it is evident that the exact nature of this interaction varies across studies.

The interaction between attention and emotion may impair the ability to recall images. Although emotion has been shown to enhance a person's memory for the central portion of images, it also has led to false memories for the peripheral areas of visual stimuli (Van Damme & Smets, 2013; Yegiyan and Yonelinas, 2011). When negative stimuli were located in the edges of an image (the periphery); people were more likely to claim that they had seen something that was not actually present. Moreover, the effect that emotion had on memory was altered by suggestion (Van Damme & Smets, 2013). Van Damme and Smets (2013) found that when they asked participants misleading questions about images they had just viewed, participants were more likely to support false facts about peripheral details than central details. Similarly, during picture coding tasks, individuals had improved recognition of neutral images preceding emotional pictures when they were told to pay attention to the neutral images (Sakaki, Fryer, & Mather, 2014).

Sakaki, Fryer, and Mather (2014) manipulated participants' prioritization of images. In one group, individuals were told to focus on images that were presented before an emotional target stimulus. Others were told to focus on an image after the target stimuli or some other image within the sequence. After viewing images, participants were presented with two similar pictures of the same object. Participants were then asked which object they had seen during the study. The researchers found that emotional stimuli improved recognition of preceding neutral images if participants were asked to prioritize them. From these results, it may be concluded that emotional memory enhancement depends on selective attention to images.

As the previously discussed studies exhibit, the way in which attention alters memory can be manipulated. One can simply implant the idea that an image has been seen before or shape memory by selecting specific prioritized items. It would then stand to reason that individual experience plays a large role in how emotion affects memory. Factors such as the surrounding environment, the other people present, and the spectator's viewpoint could ultimately change how emotional memories are processed and stored. Although it has been shown that biological structures can influence how memory and emotion interact, one cannot ignore the way in which emotional memory can be altered by one's environment.

In some situations, any emotional experience will enhance memory when compared to neutral emotional experiences. When using an auditory divided attention and picture coding task, recollection of negative images was better than that of neutral images (Talmi, Schimmack, Paterson, & Moscovitch, 2007). In their study, Talmi et al. (2007) also found that negative emotion directly impacted memory and was not related to attention. In contrast, the effect positive emotion had on memory was completely accounted for by attention. This effect was found by controlling for the effect of attention in the divided attention task.

Attention

Attention can be shifted by altering cognitive load. Cognitive load refers to the amount of demand placed on working memory. Something like driving a car while talking on the phone would be a high cognitive load task while an activity like scanning a magazine would be a low cognitive task. When manipulating cognitive load, memory is affected. In a study done by Srinivasan and Gupta (2010), participants were asked to read a string of colored letters. In the low-load task they had to identify whether the string was red or blue. In the high-load task the string was still one color, but the participants had to identify one letter within the string conditions. For example, in the low-load task, participants would be presented with a string of letters, such as "BXPRTA." The entire string was either blue or red and participants had to press either the left or right key on a keyboard to indicate the color. In the high-load task, the colored strings contained one target letter. When presented with the string, participants had to press the left key for one target letter and the right key for the other target letter. While performing the task, a face with a positive, negative, or neutral emotional expression would flash behind the letters. The researchers found that happy faces were remembered better under low-cognitive load conditions. Conversely, recognition of sad faces did not differ across any cognitive load.

Low-load perceptual tasks are more strongly related to distributed attention (Theeuwes, Kramer, & Belopolsky, 2004). Distributed attention leads to features of the environment being quickly recognized. Essentially, distributed attention equates to identifying the general meaning of a visual scene. This is fast, low-processing attention. In contrast, high-cognitive load tasks require greater attention and reduce recognition accuracy.

Yegiyan and Yonelinas (2011) dealt more with the aspects of focused and distributed attention rather than cognitive load. In their task, participants viewed either positive or negative pictures that showed only the center or periphery of the image. An image was edited so that only the middle of the image was shown or the periphery was shown. When it was a peripheral image, the middle of the picture had a black box over it. Their results showed that negative details were remembered better when presented centrally. In other words, negative emotion caused memory narrowing. On the other hand, positive images prompted increased recognition accuracy for peripheral images. Therefore, positive images were associated with memory broadening. These findings are in accordance with the Theeuwes et al. (2004) research that exhibited low-load tasks being associated with broader attention and the Srinivasan and Gupta (2010) study that found happy (positive) faces being better remembered under low-load tasks.

Events versus Faces

There may also be a distinction between memory for faces and memory for events. In the context of the present study, an event is classified as an image that displays some action or situation occurring, such as a hunter standing over the animals that he had caught that day. Events could also be referred to as "object" images.

Humans are masters of recognizing faces. Infants as young as 4 days old display a predisposition for looking at their mother's face (Pascalis, Schonen, Morton, Deruelle, & Fabre-Grenet, 1995). Evolutionarily, a high level of skill in finding and identifying faces would be extraordinarily useful. In order to survive and propagate the species, people have to find other people. More importantly, when humans are very young they are relatively helpless. At this point, it is vital that they be able to recognize their families, especially their mothers. They have to be able to recognize the individuals that they must rely on for food and survival.

In the brain, the fusiform gyrus seems to be at the center of this face recognition specialization. The fusiform face area is located in the fusiform gyrus in the temporal lobe (Sergent, Ohta, & Macdonald, 1992). This structure appears to exhibit significant activation when viewing faces (Kanwisher, McDermott, & Chun, 1997). The fusiform gyrus' apparent role, and the human skill of distinguishing faces, is made clearer when compared to the recognition of objects. In 1969, Yin examined the difference in recognition performance between inverted faces and inverted objects. His findings suggested that there are considerable differences in how the brain perceives and processes objects and faces. In particular, inversion had a much greater effect on face perception than it did on objects. Furthermore, by using functional magnetic resonance imaging, Kanwisher et al. (1997) found that the fusiform gyrus emits a more intense activation signal when a person is viewing faces as compared to when viewing objects. From these studies it can be assumed that there are different cortical areas, structures, and processes that occur during perceptual recognition of objects and faces. Because of this marked distinction between the processing of faces and objects, the present study was designed to examine whether attentional load would differentially alter memory for faces and objects.

For the current study, I expanded upon Srinivasan and Gupta's (2010) study on distractor faces. Given their findings, it was predicted that happy faces and events would be remembered better under lighter cognitive load, while sad faces and events would be remembered under greater cognitive load. It was also hypothesized that overall performance on face recognition would be greater than recognition of event scenes because humans are masters of face recognition; it is reasonable to assume that their memory for faces should be better than their memory for objects.

Method

Participants

Thirty-nine undergraduate volunteers enrolled in introductory psychology at Eastern Illinois University with a mean age of 19.20 years took part in the study. Participants signed up online and were given course credit for participating. The majority of students who participated were underclassmen and the sample's mean self-reported GPA was 3.13. All participants had normal or corrected vision. Three participants were excluded from analysis as a result of performing the task incorrectly.

Materials

Images

For the face recognition task, 59 face images were obtained from the Cohn-Kanade (CK and CK+) database. Twenty happy, 19 sad, and 20 neutral human faces were selected. From these, nine faces from each condition were used during the Stroop task. Twenty-seven faces were employed as distractor faces in the recognition test. Likewise, 60 event images (20 happy, 20 sad, 20 neutral) were taken from the Geneva affective picture database (GAPED). Nine of the images from each emotion category were shown during the Stroop task, and the remaining images served as distractor images in the recognition test. All images were changed to grayscale and cropped to 4.9 inches in height and 6.3 inches in width. Each image was then inserted into a gray background slide in a PowerPoint slideshow.

Stroop Task

The Stroop task is a cognitive task in which participants are presented with the names of colors printed in either the corresponding color (“ ” written in red ink) or a conflicting color (“red” written in black ink). The participants are then asked to name the printed color of the word instead of the word itself (Stroop, 1935). Reaction time and number of errors increase during the conflicting color version of the task.

Procedure

For this study, 39 undergraduate students were randomly assigned to one of two conditions: the face recognition task (n = 19) or the event recognition task (n = 20). When participants arrived, they were asked to sit at a computer. The instructions of the experiment were explained and any participant concerns were addressed. After this procedure, consent forms were signed and collected. Participants also completed a demographic/background survey.

Participants were first presented with a blank screen with a cross in the middle that served as a fixation point. Then, a slide with the Stroop task was shown. When reading the Stroop task, participants were asked to identify the word color while their reaction times and number of errors were recorded. After a varying delay of two through 5 seconds, a happy, sad, or neutral picture was flashed in the background for two seconds. These stimuli differed depending on the participant group. The participants in the face group were shown 10 happy, 10 sad, and 10 neutral human faces one at a time. Those in the event group were shown 10 happy, 10 sad, and 10 neutral event photos one at a time. Cognitive load was manipulated by varying the difficulty of the Stroop task across each trial.

At the end of the experiment, participants were given a surprise recognition test. They were shown faces or events that were presented during the experiment as well as novel photos to measure how well they recognized photos from the experiment. Before participants were dismissed, they were given a debriefing form and asked for any questions or concerns.

Data Analysis

The independent variables were cognitive load (low/high), emotion (happy/sad/neutral), and type of image (faces/events). The dependent variables were accuracy of recognition as measured by number of images correctly identified, Stroop task completion time, and the number of Stroop task errors. A three-way mixed ANOVA was performed on the data with each of the dependent variables, with alpha levels at 0.05.

Results

A three-way analysis of variance was conducted on the number of images recognized (hits). Results indicated that there was no significant three-way interaction among the cognitive load, emotion, and group of the images, $F(2, 37) = 1.33, p = .27, \eta_p^2 = .04$. However, there was a significant two-way interaction between cognitive load and emotion, $F(2, 37) = 13.36, p = .000, \eta_p^2 = .27$. As shown in Figure 1, sad images were recognized more often in the low cognitive load condition compared to the high cognitive load condition, whereas the neutral and happy images were recognized similarly under both low and high cognitive load. No other two-way interactions were significant.

The main effect of image type was not significant, $F(1, 37) = .009$, $p = .92$. However, the main effect of the emotion of the image was significant, $F(2, 37) = 4.10$, $p = .02$, with sad images being recognized better ($M = 2.07$, $SE = .18$) than neutral images ($M = 1.68$, $SE = .18$). Neutral images were recognized better than happy images ($M = 1.60$, $SE = .21$). The main effect of cognitive load was not significant, $F(1, 37) = 3.62$, $p = .065$. Participants correctly identified more faces under low cognitive load ($M = 1.91$, $SE = .17$) than under high cognitive load ($M = 1.65$, $SE = .18$). Table 1 displays these results.

A three-way analysis of variance was conducted on the Stroop task completion time. At an alpha level of .05, results indicated that there was no significant three-way interaction among the cognitive load, emotion, and group of the images, nor were any significant two way interactions.

The only significant main effect was cognitive load, $F(1, 37) = 93.69$, $p = .000$, in which the conflicting color/word version of the Stroop task took considerably longer to complete ($M = 14.02$, $SE = 52$) than the congruent Stroop task ($M = 9.96$, $SE = .29$). Table 2 displays these results.

A three-way analysis of variance was conducted on Stroop task errors. At an alpha level of .05, results indicated that there was no significant three-way interaction among the cognitive load, emotion, and group of the images, $F(2, 37) = .91$, $p = .41$, $\eta_p^2 = .02$. However, there was a significant two-way interaction between cognitive load and emotion, $F(2, 37) = 3.53$, $p = .03$, $\eta_p^2 = .09$. No other two-way interaction was found significant.

The main effect of faces and scenes was not significant, $F(2, 37) = 2.18$, $p = .60$. Likewise, the main effect of the emotion of the image was not significant, $F(2, 37) = 4.10$, $p = .12$. However, the main effect of cognitive load was found to be significant, $F(1, 37) = 24.08$, $p =$

.000. More errors were made under high cognitive load (*M* = .56, *SE* = .11) than low cognitive load (*M* = .08, *SE* = .04). Table 3 displays these results.

Table 1.

Sources of Variance	*SS*	*df*	*MS*	*F*	*p*
Between Subjects Effects					
Group	.06	1	.06	.009	.92
Error (Group)	228.66	37	6.18		
Within Subjects Effects					
Cognitive Load	4.08	1	4.08	3.62	.065
Cognitive Load x Group	.08	1	.08	.067	.80
Error(Cognitive Load)	41.65	37	1.13		
Emotion	9.80	2	4.90	4.10	.02
Emotion x Group	5.63	2	2.81	2.35	.10
Error(Emotion)	88.50	74	1.20		
Emotion x Cognitive Load	26.89	2	13.44	13.36	.00
Emotion x Cognitive Load x Group	2.68	2	1.34	1.33	.27
Error(Emotion x Cognitive Load)	74.49	74	1.01		

Table 2.

Sources of Variance	*SS*	*df*	*MS*	*F*	*p*
Between Subjects Effects					
Group	9.18	1	9.18	.30	.59
Error (Group)	1134.17	37	30.65		

Within Subjects Effects					
Cognitive Load	964.46	1	964.46	93.69	.00
Cognitive Load x Group	16.47	1	16.47	1.60	.21
Error(Cognitive Load)	380.89	37	10.29		
Emotion	17.30	2	8.65	2.36	.10
Emotion x Group	8.61	2	4.31	1.18	.32
Error(Emotion)	271.20	74	3.67		
Emotion x Cognitive Load	4.48	2	2.24	1.40	.25
Emotion x Cognitive Load x Group	5.32	2	2.66	1.66	.20
Error(Emotion x Cognitive Load)	118.81	74	1.61		

Table 3.

Sources of Variance	*SS*	*df*	*MS*	*F*	*p*
Between Subjects Effects					
Group	.30	1	.30	.28	.60
Error (Group)	39.12	37	1.06		
Within Subjects Effects					
Cognitive Load	13.74	1	13.74	24.08	.00
Cognitive Load x Group	.002	1	.002	.003	.96
Error(Cognitive Load)	21.12	37	.57		
Emotion	1.79	2	.90	2.18	.12
Emotion x Group	1.01	2	.50	1.23	.30

Error(Emotion)	30.36	74	.41		
Emotion x Cognitive Load	1.66	2	.83	3.53	.03
Emotion x Cognitive Load x Group	.43	2	.21	.91	.41
Error(Emotion x Cognitive Load)	17.40	74	.24		

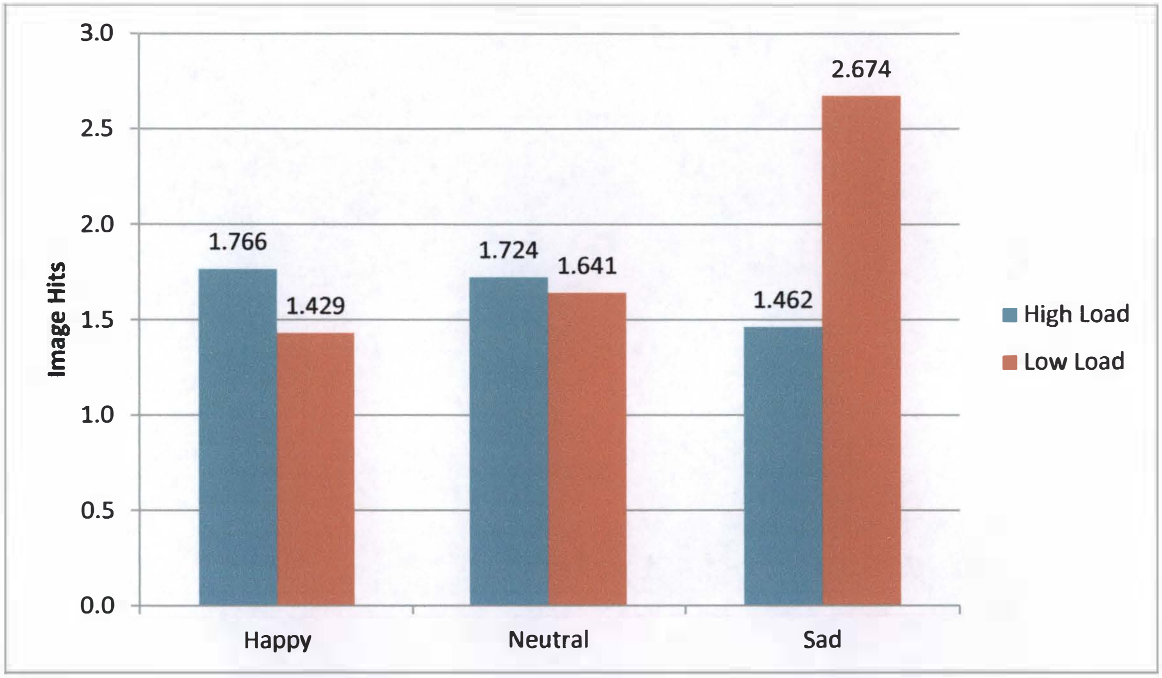

Fig. 1. The marginal means for recognition of happy, neutral, and sad emotional images under high and low cognitive load

Discussion

The purpose of this study was to examine how cognitive load and emotion affected memory for emotional faces and events. The main hypothesis of the study was not supported. There was no significant difference between memory for events and memory for faces. Furthermore, the two specific hypotheses related to cognitive load and emotion were not supported, and in fact, were the exact opposite of what was predicted. Sad images were remembered better under low cognitive load and happy and neutral images were best recognized under high cognitive load. Additionally, sad images were better remembered overall in each group condition.

These results also contradict the previous study done by Srinivasan and Gupta (2010), upon which this study was based. It is often thought that happy emotion is related to low-load, distributed attention (Theeuwes, Kramer, & Belopolsky, 2004). Meanwhile, sad emotion is associated with more narrowed and focused attention. Furthermore, sad images are usually less often remembered correctly than happy emotional stimuli (Srinivasan and Gupta, 2010).

In terms of the overall study, it should be noted that the effect of cognitive load was significant. This means that the desired effect of altering attention by manipulating cognitive load was achieved. In fact, variations of the Stroop task had an extraordinarily powerful effect on reaction time and number of errors. Therefore, it is reasonable to state that the goal of altering attention was reached. Likewise, the effect of emotion was significant. Because of this, it can be said that the selected emotional stimuli produced some kind of emotional response in participants. However, it cannot be said how strong the emotion was across individuals. The interaction between these two factors once again supports the fact that cognitive processing and emotion have an impact on one another.

In the results, there was no significant difference between memory for faces and memory for objects. Given the previous literature on the fusiform gyrus (Kanwisher, McDermott, & Chun, 1997), these results are interesting. The original hypothesis was based on the idea that humans are extraordinarily skilled at face recognition. It is difficult to say why the face group and the object group did not vary in their results. One explanation is that the object photos are actually event photos. An event photo implies that the viewer is gaining some kind of episodic context for the photo while viewing it. As a result, the participant could be spending time processing the context of the photo as well as the initial emotion it elicits. On the other hand, it could mean that there is no true difference between the two types of images. Faces and objects may be processed in two different parts of the brain that are equally sufficient at recognizing their respective visual stimuli. It may be that the two recognition systems can only be described as "different" as opposed to "better" or "worse." Perhaps once emotion is added into the equation, it overrides any biases humans have toward face recognition.

There are several possible reasons why the results of this study conflict with previous research. One major factor could be the population studied. Many of the prior research studies sampled individuals from populations considerably different than this study's sample of predominantly white undergraduate students. This is a far cry from the Indian population that was used as participants in Srinivasan and Guptas's (2010) study. Second, as seen in prior research (Sakaki, Fryer, & Mather, 2014; Van Damme & Smets, 2013), individual differences in experience may account for the extent of effects in emotional memory. As a result, how the brain interprets and remembers emotional events under differing attentional loads may depend greatly on individual differences. As a researcher, it is unknown exactly how a participant is interpreting a particular image or stimuli. Therefore, the assumed differences in emotion between the selected target images may not be generalizable to other cultures. Third, it could also be argued that this task was perhaps too difficult, producing a floor effect, as no one group did exceptionally well on the image recognition test. Fourth, the majority of the students that performed the task were tested after being in class. Some individuals had already attended at least 2 hours of class by the time they arrived to complete the study, encountering a day full of high attentional load tasks. This may have caused individuals to exert less effort on the task. Finally, the effects of gender also need to be addressed. In this study, there were three times as many women as men. While there was no main effect of gender found, gender could have produced data that conflicted from other studies. The original research that this study was based on did not divulge the gender ratio of its sample.

In terms of procedural changes, there are a few crucial alterations that could be made to, perhaps, produce different results. To begin, the obtained sample should be larger. In this case, there were only 39 participants tested. A larger sample may produce results that are more similar to those obtained in other studies. Because each participant was tested individually, a larger sample size was not viable in this instance. Furthermore, a larger sample should also aim to include more diversity. As was just discussed in the previous few paragraphs, this study is based on a very specific group of individuals. While this exclusivity was not intended, the participant pool happened to be rather homogenous.

Although this research appears to focus on the basic mechanisms of attention, emotion, and memory, the results do extend to useful applications. For instance, understanding the interaction between attention and emotion could help improve therapy treatment. An ever-growing body of research is examining why people with depression tend to narrow their attention to focus on negative things (Everaert, Duyck, & Koster, 2014). Furthermore, researchers desire to find out why depressed individuals ruminate on these emotional feelings and memories. By exploring the results found in this study, and others like it, researchers and medical professionals may shed some light on the cognitive workings of individuals with depression. Likewise, this research could assist in helping individuals with Alzheimer's disease and dementia. It would be interesting to know if actively shifting an Alzheimer's patient's attentional focus would change how they remembered emotional events, or if emotional stimuli can be used to help these individuals better direct attention and remember stimuli.

In conclusion, the results in this area of research are often contradictory, and will require further research. It is also a topic that is particularly prone to being influenced by individual differences. One can never be sure that the emotional stimuli selected are having the intended effect on participants. Participants will always have different personal experiences that alter their interpretation of an emotional stimulus. However, it is likely that studies on attention, emotion, and memory will have applications in the fields of both psychology and medicine.

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