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Effects of Emotional Content on Boundary Extension

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Effects of Emotional Content on Boundary Extension

by

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Abstract

Eye-fixation tasks have demonstrated that emotionally charged and novel stimuli draw greater attentional resources than familiar or neutral stimuli. In the present study, these findings are tested as a possible cause for the consistent scene perception phenomenon of boundary extension. Three groups of participants were shown happy, sad, and neutral images and asked to recall these images after a period of 20 minutes. A drawing task was used to assess how boundary extension effects varied across emotional content groups. Each individual drawing was assessed for distortions in central image size. Magnitude percentage changes in central image size show significant differences in how emotionally charged stimuli are processed and remembered. Self-report data also indicates possible differences in how participants allocate attentional resources.

Introduction

Attention is often considered the driver of memory. The way we distribute our attention has major implications on the way we perceive and remember the world around us (Johnson, Hawley, Plewe, Elliot, & Dewitt, 1990). However, the world around us does not draw our attention evenly. Novel and emotionally charged stimuli have been demonstrated to draw greater attentional resources, that can result in more accurate memories of visual scenes. These are images that are either processed as new to the observer or out of the ordinary in content or context (Johnson, Hawley, Plewe, Elliot, & Dewitt, 1990).

Picture memory tasks have become a popular way to assess the accuracy of visual memory, as well as the effects of novel and emotional stimuli on short and long-term memory (Intraub & Richardson, 1989). One consistent pattern of the visual memory and recall system that has been demonstrated consistently is referred to as "boundary extension" (Intraub & Richardson, 1989). Boundary extension describes the tendency to falsely recall surrounding regions of visual stimuli that were not present during the time of encoding. For example, if a viewer were attempting to remember the front of a house, they may inaccurately include a garage or trees, knowing that these images would likely exist in an image of a house. This phenomenon is an example of long-term memory distortion. Long-term memory can be broken up into three distinct processes, encoding, storage, and retrieval

(Johnson, W.A., Hawley, K.J., Plewe, S. H., Elliot, H. M.G. & Dewitt, M.J., 1990). While "boundary extension" is demonstrated through the distorted retrieval of visual stimuli, it remains unclear which stage of long-term memory boundary extension errors occur (Intraub & Richardson, 1989)

The hyper-selective attention process is drawn towards specific types of stimuli, altering our awareness of peripheral and boundary events. Typically, these more attention-grabbing stimuli are bits of sensory information processed as more critical to our understanding of the world around us (Christainson & Loftus, 1991). In drawing tasks, that ask participants to draw a previously studied image, results show significant proportional errors between peripheral and central images (Intraub & Richardson, 1989). Drawers tend to dramatically reduce the size of central images, possibly to compensate for this uneven distribution of attention.

Boundary extension was first explored empirically in the 1989 Intraub and Richardson study "Wide Angle Memories of Close up Scenes." In this study, investigators asked participating students to study images projected on a screen. Images were primarily outdoor scenes of everyday objects in a natural context (i.e. trashcans in front of a fence, a teddy bear on stairs). After a period of 30 – 40 minutes, students were asked to recall these scenes through a drawing task. For each studied image, an identical image was created proportional to the piece of paper used for participant drawing. This allowed researchers to calculated percentage change in central image size. Results showed that these students not only had the tendency to reduce central image sizes of images they were asked to recall, but also tended to add new information to the periphery of their recalled drawing.

Researchers consider this phenomenon to be an adaptive function of anticipation (Christianson, Loftus, Hoffman, & Loftus, 1991). During the recall process, people tend to use previously learned information and experiences to interpret what may have been included in the presented visual stimulus. This often results in reducing the size of central images during recall to include more information pertaining to the boundaries of images (Intraub & Bodemer, 1993). Inaccuracy in drawings, specifically around the boundaries of images, has led researchers to explore what variables contribute to this effect and what role attention plays in this context.

Further research has demonstrated that content and context play major roles in the degree to which observers may extend boundaries and add information to visual images during recall. Evidence of boundary extension has only proven stable when using specific types of images. The literature on boundary extension differentiates between "pictures" and "scenes." A "scene" is defined as having a real world background or context with which the dominant figure in the image is interacting, such as a street, park, or room. Conversely, a "picture" is defined as a photo or drawing on a blank or colored background. While boundary extension is commonly demonstrated during the recall of "scenes," boundary extension is rarely exhibited during the recall of "pictures" (Gallagher, 2002).

This result supports the *scene context hypothesis.* This explanation of boundary extensions states that observers use schema-driven information about the scene based on past experiences to complete recalled images. Without the contextual information of a "scene," observers tend to be more accurate in their approximation of image boundaries as well as their estimate of central image size (Gottesman & Intraub, 2002).

When this type of "scene" stimulus is used, the results of boundary extension tasks yield robust results across demographics and task type. Boundary extension has been demonstrated in both drawing and scene recognition tasks (Intraub, Bender, & Magnels, 1992). This effect can be seen in participants ranging from young children to adults (Candel, Merckelbach, Houben, & Vandyck, 2004). Increasing the amount of exposure time to an image does not improve the observer's recall accuracy in relation to image boundaries or central image size (Intraub, Gottesman, Willey, & Zuk, 1996). Even when made aware of this phenomenon and warned against errors of boundary extension, observers still demonstrate a significant tendency to extend boundaries and add information to visual representations during recall (Intraub & Bodamer, 1993).

Several variations of the boundary extension task have been examined since the original 1989 Intraub and Richardson publication. Manipulations of boundary shape, scene setting, drawing style, task type etc. have examined which elements of visual images lead to observers being more or less susceptible to this visual memory error. However, one underexplored area within the literature on boundary extension is the possible role of the emotional content of the studied visual stimuli.

EMOTIONAL CONTENT

Emotional content of visual images has been strongly linked to the way in which our brain attends to different visual images. The process of recalling a visual scene is largely dependent on a process called "memory binding," whereby multiple features of an event are combined to create one cohesive image (Mather, 2007). Recent literature on memory binding alludes to the overwhelming role of emotional content in one's ability to accurately bind episodic memories, though contradicting theories do exist. The more recent "Arousal-benefits-binding hypothesis" (MacKay, Hadley, & Schwartz, 2005) states that emotionally arousing images forces the observer to "bind" an emotional stimulus to its surroundings, improving memory of peripheral and boundary events. Literature on memory binding is specific to our visual memory field. Therefore, "peripheral" events refer specifically to information processed on the perimeter of our visual perception of scenes (Mather, 2007). This falls in direct contrast with the "Arousal-impairs-binding hypothesis", which states that emotionally charged stimuli hinder the binding process, making peripheral events and boundaries of a visual image difficult to recall (Nadel & Jacobs, 1998). Each of these hypotheses is controversial, yet has been successfully operationalized in varying ways (Mather, 2007).

A third, significantly older hypothesis, similar to that proposed by Nadel and Jacobs, has become more popular in recent years. This theory largely discounts the process of memory binding, placing more emphasis on the role of attention in the encoding process. This hypothesis states that emotionally charged elements of an image draw a higher proportion of attentional resources, yielding a more accurate recall of the central image at the expense of memory for surrounding objects in our visual field (Eastbrook, 1959). These central images can be considered the general focus of a scene or the characters portrayed in an image (Eastbrook, 1959). This hypothesis, called *The Attentional Narrowing and Memory for Gist Versus Peripheral Details Hypothesis* has been supported by several studies where participants' eye fixations and recall of slide shows of emotionally arousing and neutral images were examined (Christianson and Loftus, 1991).

Eastbrook's hypothesis may be fundamental in explaining boundary extension. Previous studies of boundary extension do not differentiate between stimuli of contrasting emotional contents. These studies tend to include an array of "scene" images, which may evoke varying types and degrees of emotional responses from the observer. For example, it is possible that the emotional experience evoked by studying an image of a teddy bear scene may cause significant differences in the distribution of attention than when studying a picture of a trashcan. If Eastbrook's hypothesis is applied in the context of boundary extension, the relative emotional arousal produced by a given image could be the key factor that results in the varying levels of boundary extension demonstrated across participants. Emotionally stimulating images may attract more attention to the central image of the scene, and increase the likelihood of boundary extension errors. Because attention may be more localized on central images, it is possible that a greater unawareness of peripheral information may occur, increases the likelihood of a boundary extension effect.

In the present study, Eastbrook's hypothesis is examined as a possible explanation to the phenomenon for boundary extension. Participants in the present study undergo a drawing task in which boundary extension and central image size reduction during recall are assessed. Three groups of participants are asked to draw happy, sad or neutral pictures respectively. If "The Attentional Narrowing and Memory for Gist Versus Peripheral Detail Hypothesis" explains how viewers perceieve of visual scenes, we can expect participants recalling happy and sad images to demonstrate significantly greater levels of boundary extension during the recall process than participants asked to recall emotionally neutral images. Based on the findings of Christianson et al., (1991) which demonstrate that emotional stimuli garner greater attentional resources than the neutral stimuli, in the current study it was predicted that participants would be more accurate in estimating the size of central images in neutral scenes than in happy or sad scenes.

Methods

Participants

Participants in this study were 61 undergraduate Montclair State University students, 20 males and 41 females, enrolled in introductory psychology courses. Participants were recruited through SONA systems, an online recruitment tool used commonly at academic institutions. Participating students received one of two course credits required for the completion of an introductory psychology course.

Apparatus

A Sony Vaio projector was used to display PowerPoint presentations of happy, sad, and neutral images onto a 72" by 96" screen. After studying the image for a period of 5 minutes, participants viewed an emotionally neutral, school psychology training video to produce a distraction from the studied images. During the drawing phase of this experiment, participants received pieces of 8" x 11" pieces of paper and pencils and erasers. A survey (see Appendix 1) was also administered upon completion of the task. This survey was used to quantify participant emotional reactions to images as well as collect self-report data on attention distribution during the task.

Stimuli

Stimuli included six similar images, each selected with the intention of being perceived as distinctly happy, sad, or neutral scene. "Scene" quality

(Gallagher, 2005) and general image similarity were taken into account when selecting stimuli. A Likert scale was used to determine how participants reacted to images were perceived (Item 2, Appendix I). Table 1 shows the average rating of each image group. Based on the data collected, participants responded congruently with the intended emotional content. No images were excluded due to incongruent emotional ratings. Sample images from each emotional content group can be seen in Appendix II.

Table 1.

Happy Condition Average Response	Neutral Condition Average Response	Sad Condition Average Response
.66	3.5	5.9

Table 1: Participant assessment of emotional content.

Stimuli were selected based on size and clarity of central images, as well as the images "scene" qualities (Gottesman & Intraub, 2002). Each presentation was designed to show two images of similar emotional content side by side, labeled in bold font, "A" and "B". Students were seated around tables facing the image projection, 8 to 12 at a time. After studying the image, participants viewed an emotionally neutral, school psychology training video to produce a distraction from the studied images. During the drawing phase of this experiment, participants were given pieces of 8" x 11" pieces of paper and pencils with erasers. *The Memory of Scene Survey* (Appendix I) was also administered upon completion of the task.

Three groups were formed based on the image content viewed. For each group of participants, ranging in size between 18 and 21, participants viewed two images of similar emotional content simultaneously (either two sad, two happy, or two neutral images). Participants viewed two images to increase the overall generalizability of the results. Before conducting this experiment, the size of original scene projections, as well as the size of central images in these projections, was measured in square inches for each of the six images shown to participants. The percentage of the projection taken up by central images was calculated by dividing the area of the central image by the total area of the projection.

Procedure

Participants were randomly assigned into one of three emotional content groups. Participants were assigned to content groups based on which experimental time slot they were available to participate in. To simulate the classroom setting of the 1989 Intraub and Richardson study, each of these groups met in a Montclair State University classroom. After reading and signing the Letter of Informed Consent, participants were asked to study two images simultaneously, labeled "A" and "B" displayed side by side for 5 minutes on a 72" by 96" inch projector screen. As in previous studies of boundary extension, participants were made aware that they would be studying images for later recall in a drawing task, but no prior explanation of boundary extension was given.

After the five-minute study phase, participants were asked to participate in a "class" discussion to briefly distract their attention away from the images they had studied. Participants watched a 90-second video used as a training tool for school psychologist. The video portrayed a school psychologist and a 13-year old female student predicting the behavior of a balance scale. As the task progresses, predicting which side of the balance scale will tip becomes more and more difficult. After the 90-second video, students were prompted on what they saw. Discussion questions like "What can we learn about a student from this task?" and "How would you diagnose this student?" were used to keep participants generally engaged in discussion, and distracted from the previously studied images.

Discussions were limited to fifteen minutes. Upon completion of the simulated classroom experience, students received pieces of 8.5" x 11" white paper, labeled with either an "A" or "B" in the top left corner of the page. Participants were then given 10 minutes to remember and recreate their randomly assigned images as accurately as possible. As in Intraub's original 1989 study, students were given specific instruction to consider the boundaries of the paper replications of the boundaries of the image. At the completion of the 10-minute drawing phase, students were administered a survey to assess their reactions to the individual scene projections and collect self report data on how each participant felt they were able to distributed their attention when studying the assigned image.

Measuring the phenomenon of boundary extension is a generally inconsistent practice, stemming from the multitude of variables used to identify this pictorial representation phenomenon. As mentioned previously, literature on boundary extension points to two major characteristics of the phenomenon; participants tend to both remember information that was not present during the time of encoding, as well as reduce the size of central images during recall. After all participants had finished their participation in the experiment, the central image sizes of participant drawings were measured (as a percentage to the total area of the image) and compared to the original projections. Average magnitude change in central image size was calculated for each of the three groups. Qualitative, descriptive data is often used to describe the types of objects participants tend to falsely remember when recalling scene images. In the present study, a quantitative approach was taken in which the reduction of central image size was calculated and the results across emotional content groups were compared.

Results

Evidence of boundary extension was observed in all 3 conditions of the present study. Of the 61 total participants, 43 participants (roughly 70%) engaged in some degree of boundary extension, resulting in a reduction of central image size during recall. Of the remaining 18 participants, 10 belonged to a single image assignment (image "A" opposed to "B" in a single content group) that all showed a similar yet opposite effect to boundary extension. In this condition, 9 out of 10 increased the central image size in their drawings by an average of 65% (expanding central image proportions more than one and half times the size that they had studied). To account for distortions of boundary in both directions, a "magnitude change" factor was calculated for each drawing. A magnitude change of 2, for example, can account for participants both halving and doubling central image size equally.

Two statistical analyses were conducted to evaluate differences in magnitude change across emotional content groups. In the first analysis, physical changes in central image size were averaged in each of 3 groups, resulting in an overall average size change per group. This figure was then used to calculate magnitude change from the original image. In the second analysis, percentage changes, not physical changes, were evaluated and used to create a separate magnitude change to account for variation in central image size across stimuli. Each strategy has its advantage, depending on how one chooses to define boundary extension.

Table. 2

Condition	N	Means	Standard Deviation	Standard Error
Happy	20	2.080	1.124	.2128
Sad	22	1.894	.345	.075
Neutral	19	1.214	.896	.2059

Table.2: Descriptive statistics analysis I

Figure 1 below shows the results of the first analysis. In this figure, it is evident that happy images and sad images resulted in greater level of boundary estimation errors than neutral images. Happy images were distorted by an average magnitude of 2.08 times the original central image size, sad images were distorted by an average of 1.89 times the original central image size, while neutral images were distorted by an average of 1.21 times the original central image size. A 3x1 ANOVA for this data shows that the difference between these three groups is statistically significant ($F(2,58)=6.576$, $p< .022$). A post hoc Tukey test reveals a significant difference between the happy and neutral condition ($p<.019$) but not between the sad and neutral condition or between the sad and happy condition. These results imply a difference in perceptual experience when viewing happy and sad images.

Figure 1.

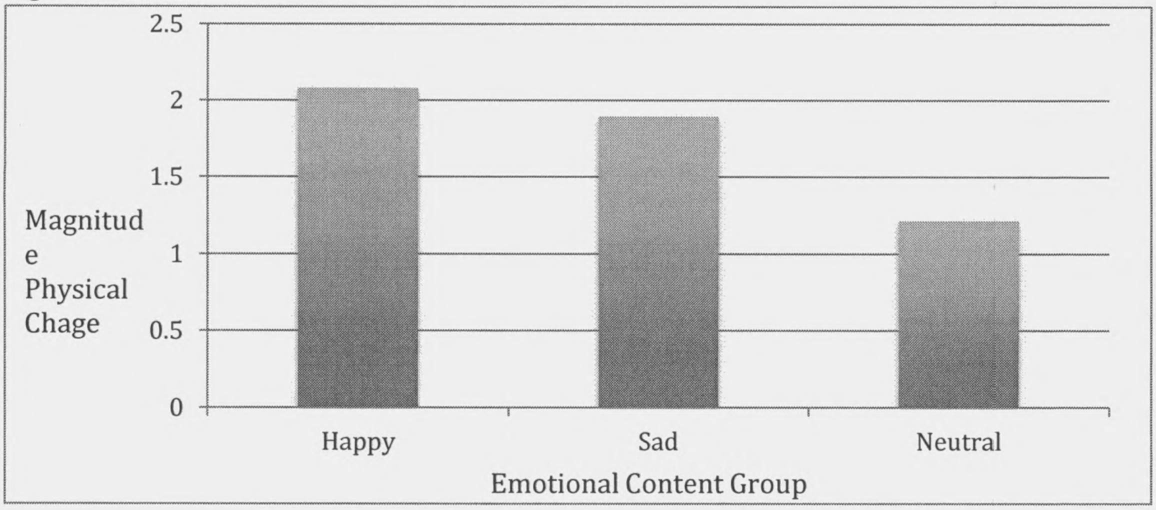

fig.1: Magnitude change of central images using physical size change

In the second analysis, the magnitude of percentage size change for each image was calculated compared using a 3x1 ANOVA design. As stated earlier, this method accounts for relative distortions across images, not physical changes in image size. Figure 2 below shows the results of the second analysis.

Figure 2.

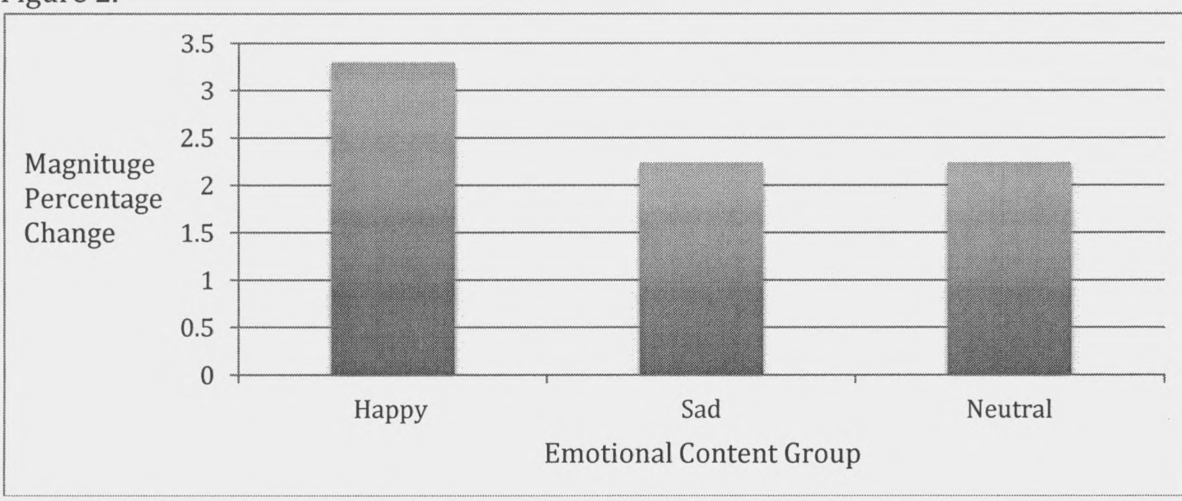

fig. 2: Magnitude change of central images using %changes

Using this method of assessing boundary extension, almost no differences can be seen between sad and neutral emotional content groups (each distorted by a magnitude of 2.24 times the original central image size). However, participants in the happy image condition demonstrated the highest degree of boundary representation error, distorting images by an average magnitude of 3.3 times the original central image size. The 3x1 ANOVA conducted shows that these differences between groups approach, but do not reach significance ($F(2,58) = 2.227$, $p < .117$).

Table 3.

Condition	N	Mean	Standard Deviation	Standard Error
Happy	20	3.308	2.66	.6115
Sad	22	2.241	1.05	.2414
Neutral	19	2.249	1.88	.4322

Table 3.: Descriptive statistics analysis II

Self-report data on how participants used their attentional resources demonstrate a key difference across emotional content groups. Item 5 of the administered survey asks participants how they distributed their attention while studying their respective images. Figures 3, 4, and 5 show the results of this item. Notice that participants who studied emotionally charged images were more likely to report keeping their attention towards the center of the image and on characters portrayed. Conversely, participants who studied neutral were more likely to report distributing their attention equally throughout the image during the study phase of the present task.

Figure 3.

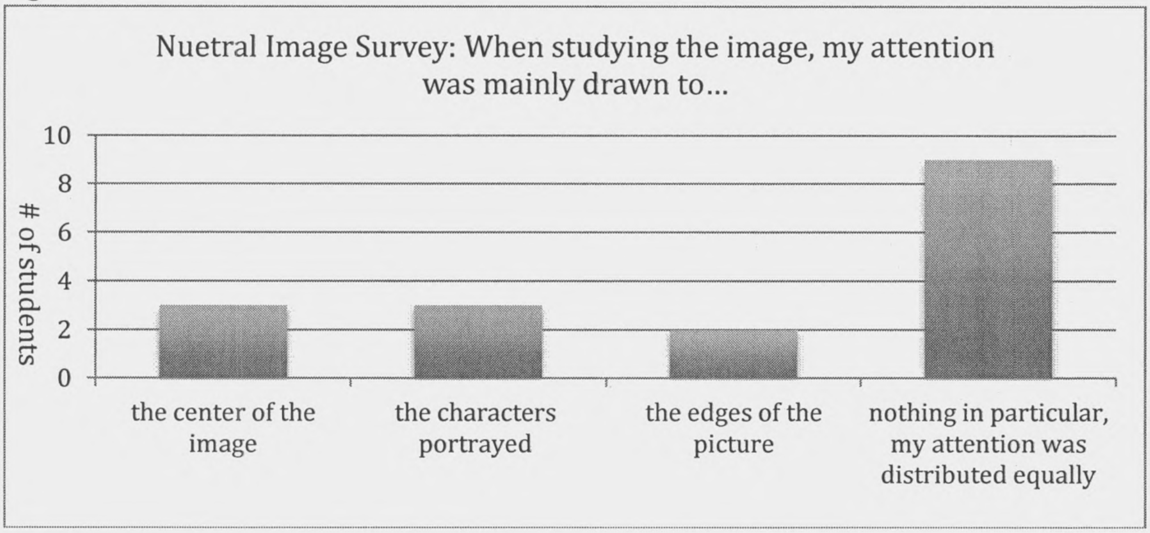

fig. 3: Self-report data on attention distribution from participants who viewed neutral images

Figure 4.

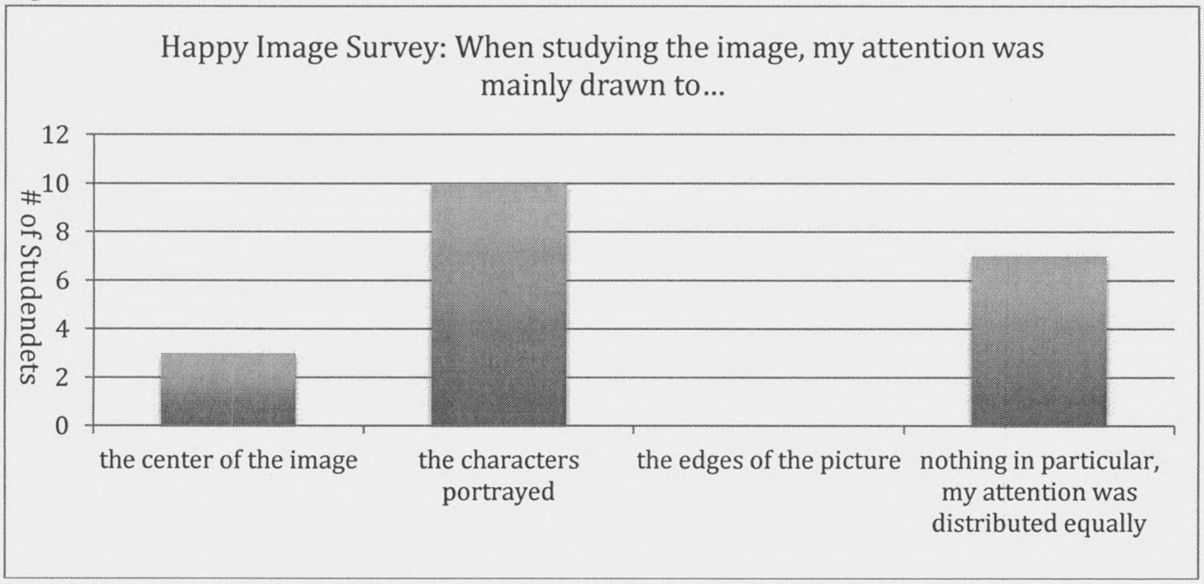

fig. 4:Self-report data on attention distribution from participants who viewed happy images

Figure 5.

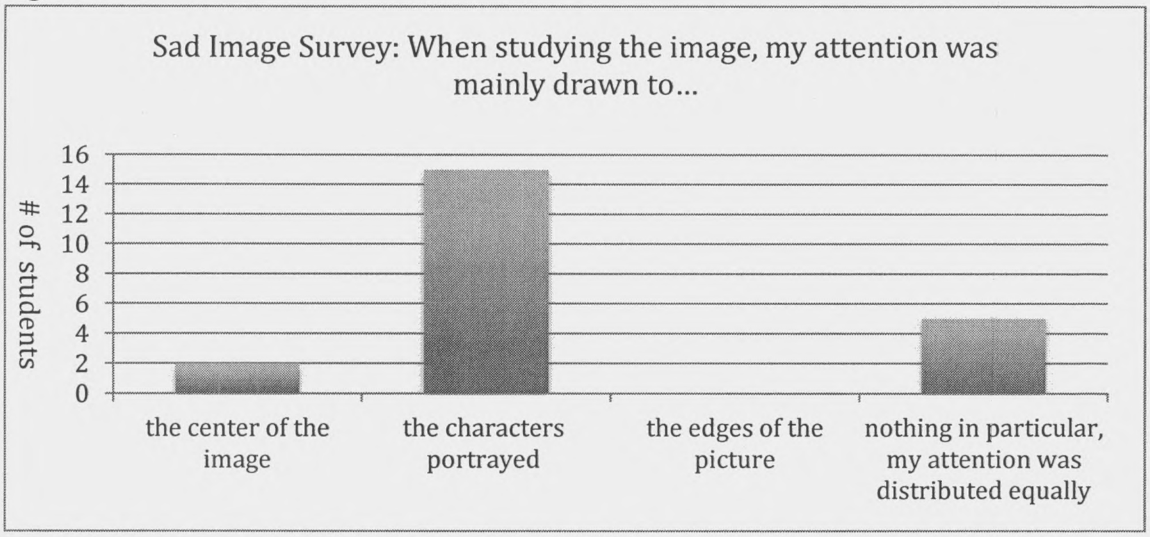

Fig. 5:Self-report data on attention distribution from participants who view sad images

Discussion

In this study, participants were asked to draw studied images from memory 20 minutes after with a distracter task presented after the original image exposure. Studied images varied across groups in their emotional content. Eye-fixation studies have shown that emotionally charged images draw greater resources of attention than neutral or common images (Christainson, Loftus, & Loftus, 1991). The results of this study demonstrate that the difference in attention caused by the emotional content of images may account for some differences in how learners replicate the boundary and peripheral information of studied images.

The overwhelming degree of boundary representation errors exhibited across all three emotional content conditions implies that the emotional variation of the images themselves cannot alone account for the tendency towards extending boundaries and reducing central image sizes. However, the magnitude and direction of this effect, as well as post experimentation self-report data demonstrate that attention distribution does vary with changes in scene content in several instances. This result supports the hypothesis that attention distribution differences caused by varying emotional content may not cause boundary representation errors, but does account for some of the variation seen in across boundary extension tasks.

It is important to note that boundary representation errors were demonstrated in both directions, whereas typically boundaries are extended, not retracted and central image sizes are reduced, not expanded. This result complicates our ability to make inferences on the effect of emotional content on boundary extension, but does allow for an analysis of the effect of emotional imagery on general accuracy, or boundary distortion as opposed to extension. In the present study, only sad images resulted in this similar yet opposite tendency to increase central image size. Future studies may examine whether this effect shows any consistency across other sad or generally negative images. This result may imply a difference in sensory processing between these types of stimuli.

The first analysis of the present data somewhat supports the hypothesis proposed by Eastbrook (1959), which states that emotionally charged images will more efficiently draw our attention, clouding our ability to accurately recall peripheral and boundary information. In this analysis, physical changes in size of recalled central images were significantly different in neutral images from happy images, although no difference was found between sad and neutral images. Using this method of measurement, participants tended to be most accurate in their representations of neutral images than the other two groups. In some groups, recalled representations of neutral images were almost perfect in their estimation of central image size (one neutral central image in particular was remembered quite accurately; originally represented 8% of a studied projection, participants redrew this image to represent an average of 8.5% of the total image).

The self-report data on attention distribution similarly supports Eastbrook's *Attentional Narrowing and Memory for Gist Versus Peripheral Details Hypothesis* (1959). Eastbrook states that differences in recall across emotionally charged and neutral images stem from differences in attention distribution. This effect is typically reported as an unconscious effect of studying and recalling images. However, survey data in the present study shows that individuals are aware of their tendency to focus their attention differently across contexts. Participants who viewed neutral images showed a consistent tendency to report distributing their attention evenly throughout studied images. Conversely, those who studied happy and sad images tended to report focusing on the center of the image or the characters portrayed in the image.

Due to variations in central image size across studied images, it is necessary to both analyze changes in physical size as well as magnitude changes of central image size. This second analysis did not produce similar results as the first; no significant differences in boundary distortion errors were found between emotional content groups when magnitude changes were assessed. Though these differences were not significant, we can make several assertions from this analysis. The first is that levels of boundary extension and distortion seen across these three emotional content groups are still exceedingly large. Using this method of measuring boundary representation errors further demonstrates that boundary errors occurred in all three experimental conditions.

Similarly, neither analysis of the present data showed any evidence that emotionally charged stimuli assist in what Mather refers to as "memory binding" (2007). In both instances, recalled images of neutral stimuli were equally or more accurate than emotionally charged stimuli. While prevailing theories reduce the role of memory binding in the generation episodic memories, evidence does exist supporting this hypothesis. If we subscribe to the idea that memory binding, not differences in attention to images, drives visual perception of scene stimuli, these data would support Nadel and Jacobs' 1998 *Arousal-impairs-binding hypothesis.*

Second, for both methods of calculating boundary extension (or boundary distortion in this case), happy images resulted in the greatest level of boundary representation error. Measured as a function of magnitude change, participants falsely remembered happy central image sizes by a magnitude of over 3. This may imply that happy images tend to more efficiently hold individuals attention than other, equally emotionally arousing images. This difference did approach significance, though was found to not be statistically. Further research may evaluate boundary extension, attention distribution, and other visual memory phenomena to evaluate this difference in processing between happy conditions and other emotional contents.

Future studies of boundary extension may also look to more specifically analyze emotion type and arousal levels displayed in studied images. In the present study, two emotional content groups, happy and sad, were analyzed in contrast to neutral. However, emotions are not always so finite; individuals may process different types of happy events (joyful, celebratory, lucky etc…) differently. Likewise, individuals may process variations of sad images (mournful, violent, disgusting etc…) differently. Any of these emotions themselves exist along a spectrum, processed in varying degrees depending on contextual cues. Future studies on the effects of emotional content on scene representation and recall may look to vary the specificity of emotional content used as well as the relative emotional arousal portrayed in each image. It is possible, based on the present data, that heightened arousal levels within the same emotional content may produce varying degrees of boundary extension or boundary distortion.

Several limitations exist in the present study. The contradictory analyses described above stem from a possible flaw in the present design. In future studies of boundary extension, central image sizes should be relatively stable in studied images. Because central image sizes were not kept at a constant size, each recalled drawing resulted in two, often very different, pieces of data (size change and magnitude change of recalled central images). If central image sizes are held to a constant, size and magnitude change should follow a more interpretable, linear trend. The results of the present study serve as an example of how choosing to analyze one type of change and not the other can vastly distort the nature of one's results. It is important to note that the present study only focuses on one of two elements that define boundary extension. Analysis of participant drawings included only distortions in central image size However, a second element of boundary extension does exist, whereby individuals tend to add information not present during the time of encoding to their recalled images. Though harder to quantify, this tendency may also vary based on the relative emotional content of studied images. Further analysis may identify similar trends across emotional content groups in these two, often co-occurring memory phenomena.

Last, though participants reported the expected reactions to individual images, gauging exactly how each individual responded to each image is still inexact. It is possible that participants responded to each image based on social expectations, though their own perception of an image may have been different. For example, one image used included a man opening a bottle of champagne during a celebration. The socially acceptable reaction to this image is that celebrating with champagne is considered a happy image. However, if a participant has had a negative life experience with champagne, they may respond view this image as sad and still have reported that the image was happy. More precise measures of participant reactions may be necessary in accurately analyzing how emotional content of images affects individual perceptual experiences.

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Appendix I

Memory of Visual "Scene" Survey

1. Which image were you assigned to draw? :

____ A ____B

Circle the number/letter that best describes your response:

2. How would you describe the emotional content of this image?

Happy			Neutral				Sad
0	1	2	3	4	5	6	7

3. Did you find the image to be emotional arousing?

Very			Somewhat				Not at all
0	1	2	3	4	5	6	7

4. How confident are you that your replication is accurate?

Very			Somewhat				Not at all
0	1	2	3	4	5	6	7

5. When studying the image, my attention was mainly drawn to...
a. the center of the picture
b. the character(s) portrayed in the image
c. the edges of the picture
d. nothing in particular, my attention was distributed equally through out the picture

Appendix II

Figure 6.

A B

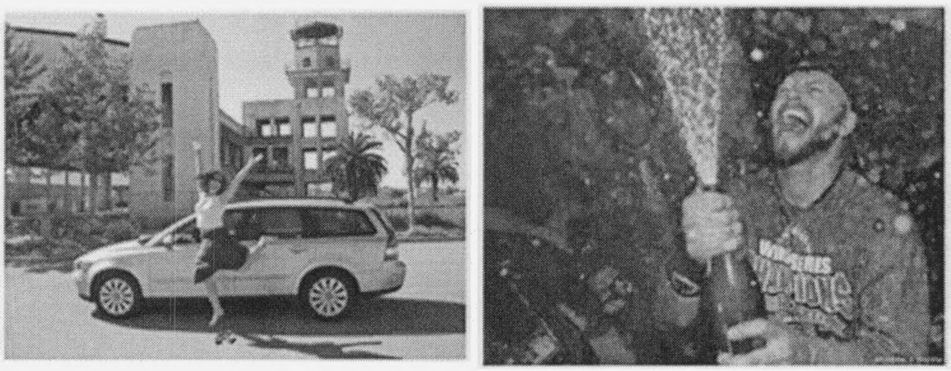

fig. 6: Happy image stimuli

Figure 7.

fig.7: Neutral image stimuli

Figure 8.

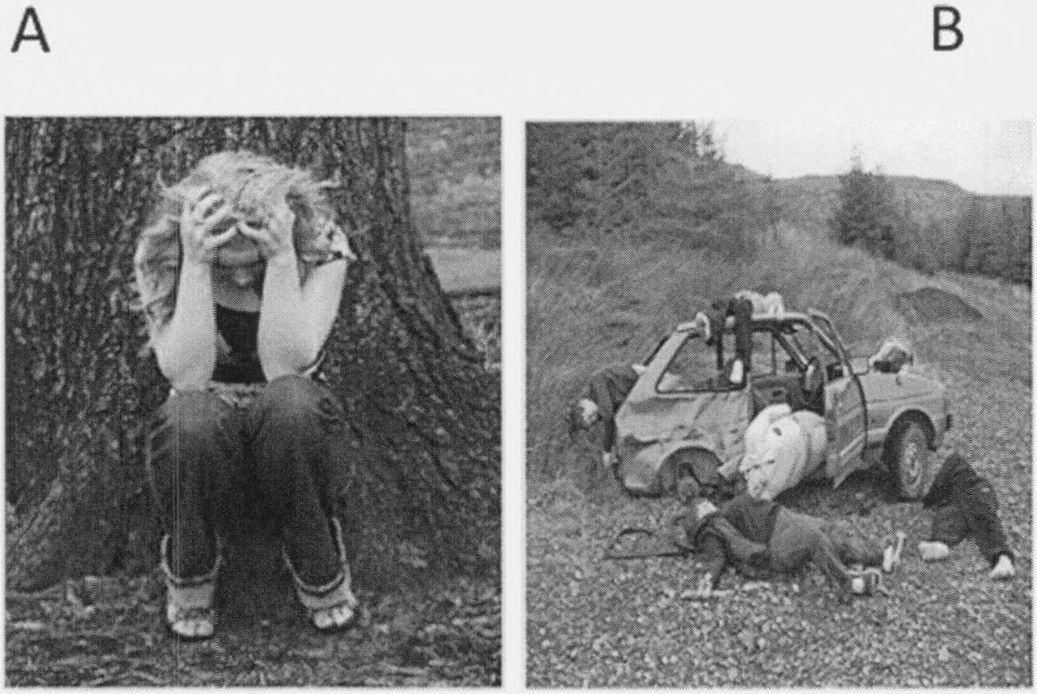

fig. 8: Sad image stimuli