Blinking our Attention Backwards: The Dual-Direction Emotional Blink of Attention

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Abstract

The Emotional Blink of Attention paradigm reveals a significant relationship between emotion and attention. In the current study, we tested the effects of a forward and backward Emotional Blink of Attention (EBA) on participants' ability to accurately report a target image in an RSVP stream. In both the forward and backward task, emotional images impaired detection of a target, with nude images being particularly debilitating. Nude images were also significantly more likely to break out of the EBA created by a target image presented 200 milliseconds beforehand than neutral or gory images were. Skin Conductance Recordings were recorded for the duration of the study to measure arousal level for each trial, but significant differences between categories were not found.

Introduction

In the past 20 years, a body of research detailing the “Attentional Blink” paradigm has emerged. When a target stimulus is presented in an RSVP stream, the stimulus causes a “blink” for 200 – 500 milliseconds post-target. During the blink, encoding of other stimuli is impaired, and the degree of impairment is dependent on a multitude of factors including valence and motivational state. Before we can understand the significance of the paradigm, we must first understand some of the studies in the fields of attention, memory, and emotion that have led us to the understanding of the Emotional Blink of Attention as it stands today.

An early debate in attention and memory was whether parallel processing or serial processing was responsible for encoding information into short-term working memory. Parallel processing is the idea that a person can look at a group of items and process all of the characteristics of every item at once. Serial Processing proposes that items must be attenuated to one by one in order to “absorb” their information (Treisman & Gelade, 1980). Treisman and Gelade’s paper supported serial processing and proposed the “Feature Integration Theory” where the brain combines complex objects’ features into “Feature Integration Maps” that encode for the shape, color, and orientation of an object. Treisman states that if an object is not attended to, then the subject may be able to identify a single feature of the object such as its color, but the subject will not be able to combine multiple characteristics of the object to know precisely what the object is. In order for a conjunction of features to take place in working memory, an object must be fully attended to. Because almost all objects in a visual array are complex and require features to be integrated, Treisman proposes that a task where a subject has to find a target among distractors almost solely uses serial processing and that parallel processing does not play a role beyond extracting simple features. Her evidence was a 2:1 reaction time slope ratio for target absent responses to target present responses when participants searched for a target picture among distractors. When targets were not present in a visual array, subjects had to search the entire array to identify if the target was not there. However, if a target were present, participants would locate it about halfway through going through all the items on average. Treisman argues that if parallel processing were responsible, there would be no 2:1 slope ratio because participants would locate the target almost immediately and with no difference in slope ratio between target-present and target-absent conditions.

Treisman's findings strongly supported the notion that serial processing was responsible for target location in a search task, but her study failed to account for set size. A later paper by Pashler found that in set sizes of up to 8 items, there was a 1:1 slope ratio of reaction time to set size, not the 2:1 ratio proposed by Treisman. In the study, subjects searched for target green T's among green O's and red T's. When the display size varied from 2 – 8 items, the slopes relating response time to display size were 1:1 - evidence that parallel processing was responsible. It was only when the number of items was greater than 8 that a 2:1 slope ratio (showing serial processing) was found (Pashler, 1987). Although his paper was not the end-all to the debate, Pashler did prove that both parallel and serial processing are important in search tasks, and that serial processing alone was not responsible. His paper also touched on the "magic number" – the number of items that can be held in working memory at once (7).

Further research on attention and memory saw short-term memory renamed to "working memory" and spawned the theory that working memory is split up into 3 distinct components- the central executive store, the visuospatial store, and the phonologically-based (verbal) store (Baddeley & Logie, 1999). The visuospatial component deals with tasks such as spatial movement and visual patterns, the phonologically-based component deals with language-based tasks, and the central-executive store oversees and controls each component. One limitation of the theory is that although areas of the brain have been found to be associated with verbal and visuospatial tasks and support the idea of visuospatial and verbal working memory, there is no evidence for the central-executive store that is the central control region for the other components. Despite this, the theory is prominent in many attention and memory studies today. Baddeley & Logie recently added a fourth component to their model of working memory referred to as the "episodic buffer". The buffer is a temporary storage system capable of integrating information from a variety of sources (Baddeley & Logie, 2000) and is especially relevant to the Attentional Blink paradigm where rapidly streaming images compete for attentional resources.

Next, we must look at studies in emotion, and specifically studies concentrated on a brain region heavily involved in emotional processing – the amygdala. LeDoux's 1987 paper summarizes findings up to that point that focus on the amygdala and its importance. Up until then, researchers believed the Papez Circuit was the main cognitive system that assigned emotional significance to the environment and facilitated emotional responses from a person. Papez specifically stated that "Physiologic results imply that the emotive process is mediated by the hypothalamus" (LeDoux, 421). Papez also found that “the gyrus cinguli is the seat of dynamic vigilance by which environmental experiences are endowed with an emotional conscious” (Ledoux) and that lesions of the anterior thalamic nucleus produced spontaneous laughing and crying. Although areas such as the hypothalamus, gyrus cinguli, and anterior thalamic nucleus are important in emotional processing, Papez did not include the amygdala in his circuit and did not believe it played as significant a role in emotion.

Kluver and Bucy (Kluver & Bucy, 1939) showed the first hint that the Amygdala may play a part in emotional processing. Kluver and Bucy discovered a syndrome in monkeys with lesions of the hippocampus and amygdala where they did not display proper emotional responses. The monkeys displayed visual agnosia, oral tendencies, hyper metamorphosis, and extreme changes in emotional and sexual behavior and dietary habits (Kluver & Bucy, 1939). Kluver and Bucy originally proposed that damage to the hippocampus was responsible for the syndrome but it has since been found that damage to the amygdala, not the hippocampus, may have been responsible. A later experiment by Downer reinforced the discovery (Downer, 1961). In his study, Downer destroyed only the Amygdala on one side of the brain and sectioned the forebrain to eliminate transfer of information between the two hemispheres. He also sectioned the optic chiasm so that visual information was restricted to the hemisphere ipsilateral to the open eye. He found that when the monkeys viewed the world through the eye of the hemisphere with the intact Amygdala, the monkeys exhibited normal emotional reactions to visual stimuli. However, when only the eye connected to the amygdalectomized hemisphere was open, they displayed unusual behavior and acted tame and unafraid even when threatening stimuli were presented (Downer, 1961). Downer's study proves that the Amygdala is essential to emotional processing, not only the Papez Circuit as originally proposed.

Recently, there has been increased interest in the Amygdala and its role in emotional processing and role in encoding emotional events into memory. Studies have discovered results strongly implicating the Amygdala in emotional processing. One example is Adolphs and colleagues' 1994 study where he found that bilateral Amygdala damage impairs people's ability to recognize and recall faces displaying fear (Adolphs, Tranel, Damasio, & Damasio, 1994). Another study used fMRI imaging and discovered the Amygdala was preferentially activated in response to fearful faces vs. neutral faces and in happy faces vs. neutral faces (Breiter et al. 1996). The specific role of the Amygdala on emotion is still unclear, but it clearly plays an important role in both how we process emotional stimuli and how we encode those stimuli into memory.

With this background in attention, memory, and emotion, we can look at a paradigm that can be used to test the effect of emotion on attention and memory – the Emotional Blink of Attention (EBA). Before the EBA, researchers discovered a separate paradigm which would lead directly to the discovery of the EBA. This paradigm called the "Attentional Blink" was first described in a 1992 paper by Raymond and colleagues. In it, Raymond described a phenomenon where, when 2 target stimuli were presented in an RSVP stream with the second target immediately following the first, there was a "blink" where the brain did not process the second target (Raymond et al., 1992). The paper influenced further studies, and in a 2001 paper, Anderson and Phelps used the Attentional Blink to test the effects of negative emotional words in a rapidly presented stream on a participant with bilateral Amygdala damage. The patient with Amygdala damage, S.P., showed a normal attentional blink with higher accuracy at later lag periods than when T1 immediately preceded T2. However, unlike participants with intact Amygdalas, S.P.'s accuracy did not improve when negative stimuli were presented immediately following T1. Participants without Amygdala damage were able to identify negative words within the Attentional Blink 72% of the time, whereas S.P. only identified the negative words 25% of the time. When compared to her accuracy at identifying neutral words (23% of the time), the results showed negative words did not hold her attention the same way they did in participants with fully functioning Amygdalas (Anderson & Phelps, 2001). Because participants with Amygdala lesions exhibited normal subjective and psycho physiological responses to negative words, it seems that the problem occurred when emotional stimuli were actually being encoded into memory.

Anderson's study proved the importance of the Amygdala in encoding emotional stimuli into memory and also proved that the Attentional Blink can be used to test the effects of emotional stimuli in capturing a person's attention. A body of literature based on the Emotional Blink of Attention, a version of the Attentional Blink where emotional images or words elicit a "blink" in attention, not a target, has since been released. In 2005, Anderson released a paper focused on the Emotional Blink of Attention that found that emotional stimuli capture attention based on their level of arousal more so than valence. His paper also indicated that the Emotional Blink of Attention occurs during a stage of resource-limited encoding (Anderson, 2005). Theoretically, awareness of emotional stimuli did not depend on the participating paying attention to stimulus, but instead was due to emotional images requiring less limited-capacity resources to be processed. There is some debate in the literature as to whether the Attentional Blink occurs due to attention resource depletion (Dux, Asplund, & Marois, 2008), or is due to temporary loss of control of attention due to switches in stimuli category (Di Lollo, V., Kawahara, J. I., Ghorashi, S. M., & Enns, J. T., 2005; Olivers, Spalek, Kawahara, & Di Lollo, 2009). While it is unclear what the exact attentional mechanisms are that cause the attentional blink, other literature has focused on the affects of emotional stimuli on the Emotional Blink of Attention and the effects stimuli of different valence and arousal levels have on it.

In 2005, Most, Chun, Widders, and Zald looked at the effect task irrelevant emotional information had on a subject when it was presented in a stream of images (Most, Chun, Widders, & Zald, 2005). They predicted that when task-irrelevant emotional stimuli were presented, it would cause a temporary visual processing impairment. They were also interested as to whether subjects could strategically override the blink. The experimenters found that when an emotionally negative picture was presented, the subject was significantly worse at detecting a sole target in a picture stream immediately following the negative picture. The experimenters coined the term "emotion-induced blindness" to describe the blink caused by emotional pictures but not neutral ones. They also found a correlation between a subject's harm avoidance level and his/her ability to filter out the negative stimuli, indicating personality has an influence on the extent of the blink.

Conditioned images can also create an Emotional Blink of Attention. When participants in a study were conditioned to associate neutral stimuli with aversive auditory bursts of white noise, the neutral stimuli elicited an EBA. (Smith, Most, Newsome, & Zald, 2006). Neutral images associated with a non-aversive noise (sound of the waves of the ocean) did not elicit an EBA. The study indicates that items don't have to be aversive by nature to create an EBA, but can simply be associated with them. Further studies have found that erotic distractors (generally rated as both pleasing and arousing) consistently elicit emotion-induced blindness (Most, 2007). Only males were tested in these studies since they rated the erotic stimuli as more visually pleasing than did women. Even when subjects were also told they would receive a monetary award depending on how well they did in the experiment, they were still unable to block out the positive distractors. Overall, the study found that erotic pictures have a more robust effect than negative ones on men whereas women are more affected by negative stimuli.

The Emotional Attentional Blink is not only limited to aversely negative and arousingly positive stimuli; when people are hungry, there is a cognitive effect of hunger that increases capture of attention by images of food (Piech, Pastorino, & Zald, 2010). Participants completed the EBA task during two sessions, one where they were "hungry", and another when they were "sated". Results showed that pictures of food caused a greater attentional blink when participants were in a "hungry" state than when they sated. The study was the first to indicate that motivational state can cause a top-down effect on Attention and on the Attentional Blink.

A final study showed that emotional images can have a retroactive effect on the accuracy of reporting a target. In their 2008 study, Most and Junge presented a target image preceding an emotional picture by 100 milliseconds in an RSVP stream (Most & Junge, 2008). They discovered that when a negative image was presented at one position behind the target image, accuracy of reporting T1 suffered. However, when the negative image was presented two positions behind the target image, participants' accuracy in reporting T1 actually improved (Most & Junge, 2008). Most's results support the theory that rapidly streamed stimuli are all present in a Stage 1 "buffer" of Attention but compete for limited resources in a second stage of attentional processing. His results also support Di Lollo's explanation of the Attentional Blink where the blink is caused by a temporary loss of control of attention due to switches in stimuli category. Because Most did not find Lag -1 sparing (when a stimulus immediately following a target image tends to escape the Attentional Blink) following emotional distractors in his experiment, it supports earlier findings that when the image immediately following the target image changes categories from the target image, the emotional image is also caught in the Attentional Blink, possibly because of reconfiguration of the attentional system (Kawahara, Zuvic, Enns, & Di Lollo, 2003).

Combining all aspects of research, I chose to investigate the effects of a dual-direction Emotional Blink of Attentional while incorporating Skin Conductance to measure arousal of each emotional stimulus. We chose to investigate the effects of three categories of emotional images: Neutral, Nude (positive), and Gory (negative). The study was divided into three parts. We first looked at the results of a Rating task where participants rated each emotional image they'd seen on a scale of "Arousal" (how activating the image was) and "Pleasantness" (how pleasant the image was). For the actual experiment, this was chronologically the last task participants performed. However, for the sake of progressing form the simplest to most complex task, we listed it as the first task for this paper.

In the second task, the classic "forward" Emotional Blink of Attention was tested where a target image was presented within the attentional blink of an emotional image. In this case, emotional images acted as a distractor and participants responded whether they saw a target image following the distractor by 200 or 800 milliseconds. In the third task, the target-distractor direction was switched. The target image appeared first and the emotional image appeared in the EBA of the first target. Participants were asked to actively search for and answer questions about the emotional image, making it a second target. This was considered the “backwards” EBA condition. Skin Conductance Recordings were recorded for the duration of the study across all three tasks.

There were a few main effects we were interested in discovering. The first question we asked referred to task 3 (the backwards EBA). We asked if there would be different retroactive effects of each category of emotional images on the accuracy of reporting T1. The second question we asked was would the same images that caused the greatest EBA in the forward-direction task be the same images that were most likely to break out of the EBA in the backward-direction task? To do so, we planned on measuring which emotional images caused the greatest Emotional Blink of Attention in task 2, and whether the same images broke out of the backwards EBA in task 3. Skin Conductance was to play a crucial role in determining the arousal level of each emotional stimulus and in determining a “threshold” level of arousal, beyond which emotional images would cause an EBA (in the forwards task) or break out of an EBA (in the backwards task). Skin Conductance Recordings were analyzed to help measure arousal for each category of images.

Task 1: Rating

The Rating section was chronologically the final section of the study, but is listed first here for the sake of progressing from the simplest to the most complex aspect of the study. Participants rated 192 images in three categories (72 Neutral, 60 Nude, 60 Gory) on two scales – Arousal (how activating the picture was) and Pleasantness (how pleasant or unpleasant they found each picture).

Methods

Participants

Participants were 27 students (ages 18 – 25; all male) from Vanderbilt University. Each subject participated for course credit and gave informed written consent. Because positively-associated stimuli were pictures of nude women, only male subjects were selected as it was assumed female participants would view the pictures negatively.

Materials & Procedure

Participants conducted the Rating section on a Dell Optiplex computer displayed on a 17-inch CRT monitor. The software program "E-Prime" was used to stream images and record responses. Stimuli were color photographs measuring 9.5 cm wide and 7.5 cm tall with luminosity adjusted across each image. 192 total images were displayed, consisting of 72 neutral images, 60 negative (gory) images, and 60 positive (nude) images. Neutral images were drawn from the International Affective Picture System (IAPS) database and consisted of fully clothed women against neutral backgrounds and were chosen because of their neutral valence and low arousal ratings. Negative images (gory) consisted of images depicting mutilated, injured, or lacerated humans. Positive (nude) images consisted of fully nude females. Positive and negative images were drawn from the internet. Each image in each distractor category consisted of only a single person who was clearly either nude, fully clothed, or injured.

A single image was presented on-screen for 100 milliseconds and was followed by two scales. The first scale asked the participant to rate the image on its arousal level, or how "activating" they found the image. The scale ranged from "Not arousing at all" to "Most Imaginable" (0 – 100). (See Figure 1). Participants used the computer mouse to directly click the point on the scale that they believed represented the arousal level of the picture. The second scale appeared immediately after the first and rated the "Pleasantness" of the previous image. The scale ranged from "Most unpleasant imaginable" to "Neutral" to "Most pleasant imaginable" (-100 – 0 – 100). (See Figure 2).

Participants directly clicked on the point on the scale that corresponded with their pleasantness rating of the image. This process was repeated for 192 distractor images (60 gory, 60 nude, 72 neutral).

<u>Results</u>

Participants rated the three categories of images (neutral, nude, gory) across two scales: Arousal and Valence (Pleasantness). The Arousal scale ranged from 0 – 100 while the Valence scale ranged from -100 – 100. Neutral images were rated as having little valence but being slightly arousing (valence, M = 7.8, SD = 10; arousal, M = 23.6, SD = 17.5). Nude pictures were rated as having both the highest valence and arousal (valence, M =

45.0, SD = 15.8; arousal, M = 65.0, SD = 16). Gory pictures were rated as having the lowest valence and arousal slightly below the nude category (valence, M = -61.1, SD = 16.4; arousal, M = 58.4, SD = 15.5). All ratings fell within expectations and differences between categories were significant for both the valence and arousal scales (valence, F = 364.763, p = .000; arousal, F = 79.859, p = .000). (See Figure 3)

Results confirmed that subjects viewed nude images as overwhelmingly positive with the highest level of arousal. Similarly, gory pictures were rated as being overwhelmingly negative but were not rated as highly on the Arousal scale. Neutral images were rated as having very little valence or arousal. All ratings fell in line with expectations.

Task 2: The Forward Emotional Blink of Attention

The forward Emotional Blink of Attention was chronologically the first section presented in the study. The section was designed to replicate the classic Emotional Blink of Attention where an emotional distractor elicits an Attentional Blink and a target appears at Lag 2 (within the blink) or at Lag 8 (outside the blink).

Method

Participants

Participants were 29 students (ages 18 – 25; all male) from Vanderbilt University. Each subject participated for course credit and gave informed written consent. Because positively-associated stimuli were pictures of nude women, only male subjects were selected.

Materials and Procedure

Stimuli were color photographs measuring 9.5 cm wide and 7.5 cm tall with luminosity adjusted across each image. Participants were instructed to search for a rotated image of a landscape among upright landscape images. 252 upright landscape images were used while 192 images were landscapes rotated either 90 degrees clockwise or 90 degrees counter-clockwise. Distractors consisted of 72 neutral images, 60 negative (gory) images, and 60 positive (nude) images. Neutral images were drawn from the International Affective Picture System (IAPS) database and consisted of fully clothed women against neutral backgrounds. The images were chosen because of their neutral valence and low arousal ratings. Negative images (gory) consisted of images depicting mutilated, injured, or lacerated humans. Positive (nude) images consisted of fully nude females. Positive and negative images were drawn from the internet. Each image in each distractor category consisted of only a single person who was clearly either nude, fully clothed, or injured.

Stimuli were presented in a rapidly occurring stream with each stimulus appearing for 100 milliseconds. The experiment included 192 total trials divided over 6 blocks. 17 images appeared per trial, and 15 of the 17 pictures presented were upright landscapes. Of the other two remaining pictures, one was a target image and the other was an emotional distractor. The single target stimulus in each stream was a landscape rotated 90 degrees clockwise or counter-clockwise so that the upper edge of the picture faced either right or left. The single distractor (emotional image) fell in one of three categories: 1) neutral (fully clothed females) 2) nude (fully nude females) or, 3) gory (mutilated, injured, or dismembered human beings). At the end of each trial, the participant answered the following questions: 1) Did you see a rotated landscape? 2) Which way was it rotated? Participants responded to question 1 by pressing “Y” (yes) or “U” (No) on the keyboard. They responded to question 2 by pressing “4” (Left) or “6” (Right).

The ordering of the target and distractor in section 2 was modeled on the classic Attentional Blink. The distractor appeared first within the stream and the target appeared at either lag 2 (2 pictures behind the distractor) or lag 8 (8 pictures behind). Because each picture lasted on screen for 100 milliseconds, images at lag 2 would appear within the emotional blink of attention (200 – 500 milliseconds) while images at lag 8 would appear outside of it. Lag 8 is designed as a control for the Lag 2 experimental condition. (See Figure 4).

Results

The percentage of correct trials in each condition was measured as the dependant variable. A 2 (Lag: Lag 2, Lag 8) by 3 (Category: Neutral, nude, gory) ANOVA revealed a main effect of lag, as accuracy was significantly higher at Lag 8 then Lag 2 ($F = 226.835$, $p = .000$). We could then confirm that distractors successfully created an attentional blink at Lag 2. (See Figure 5)

Because images at Lag 8 fell outside of the Attentional blink, there was no difference in categories at L8. Therefore, we focused analysis on data from the Lag 2 condition to determine if different emotional categories affected performance at Lag 2.

Lag 2

The ANOVA at Lag 2 addressed a single repeated-measures factor – Category (Neutral, nude, gory). The ANOVA revealed a main effect of Category (F = 112.224; p = .000). As expected, participants were significantly worse at detecting the target image in the stream when the target directly followed a nude or gory image compared to a neutral one (neutral, M = 70%, SD = 18%; nude, M = 31%, SD = 15%; gory, M = 42%, SD = 17%). In line with reports from other papers, nude images caused the greatest impairment in detection of T1. Negative images also caused a significant drop in accuracy, although it did not impair accuracy as much as nude images did. Experiment 1 was designed to replicate the Emotional Blink of Attention paradigm and results follow expectations to show the Emotional Blink interfered with target images at the Lag 2 condition.

Task 3: Retroactive Effects of the Emotional Blink of Attention

In task 3, images were streamed in an RSVP stream with each image appearing for 100 milliseconds, similar to task 2. The important differences were the switched positions of the distractor and target (target first, distractor second), and instructions to participants to actively search for the emotional image, making it a second target (T2) instead of a distractor.

The first question we asked was would the emotional image (T2) have an effect on the participant's accuracy in reporting T1. In other words, would there be a retroactive effect of the emotional image on T1? The second question was to what degree do different types of emotional images (neutral, gory, or nude) at T2 interfere with or aid in perception of T1. Lastly, we asked if the images that created an Attentional Blink in

Experiment 1 would be the same images that broke out of the Attentional Blink of T1 in Experiment 2.

Methods

Participants

Because the overall experiment is a within-subjects design, the same subjects who participated in task 2 participated in section 3. Of the 31 total who participated, 4 participants' data were lost or thrown out for a total of 27 male students who participated.

Materials and Procedure

Materials for part 3 of the study were identical to materials in section 2. Stimuli were color photographs with 72 neutral images, 60 negative (gory) images, 60 positive (nude) images, 192 target images (rotated landscapes), and 252 upright landscapes. Each image measured 9.5 cm wide x 7.5 cm tall with luminosity adjusted across each image. Stimuli were presented in a rapidly occurring stream with each stimulus appearing for 100 milliseconds. The experiment included 192 total trials divided over 6 blocks. 17 images appeared per trial, and 15 of the 17 pictures presented were upright landscapes. One of the other two pictures presented was a target rotated landscape (T1) and the other was an emotional image (neutral, nude, or gory) that participants were instructed to search for, making it a second target (T2). T2 appeared 2 positions (Lag 2) or 8 positions (Lag 8) behind T1. (See Figure 6)

The procedure for part 3 was similar to part 2. The main difference was the ordering of the target and the emotional image (what was the distractor in experiment 1).

Participants were instructed in to actively search for the emotional image, making it a target (T2) instead of a distractor. The emotional image was also located at Lag 2 or Lag 8 behind T1. This stands in contrast to the forward Emotional Blink of Attention where the emotional image appeared first and T1 appeared at Lag 2 or Lag 8 behind it. Following each trial, the participant was asked three questions: 1) Which way was the rotated landscape turned, 2) Did you seen an image of a person, 3) Was the person a) clothed, b) naked, c) injured.

Because T1 should grab attention to create an Attentional Blink, section 3 of the study tested a few questions: 1) Will there be a retroactive effect of attending to T2 (the emotional image) on T1? Previous literature has found an effect (Most& Junge, 2008), which we attempted to replicate in this study. 2) Can emotional images at T2 break out of the attentional blink caused by T1, to what degree they break out based on category, and are the same images that break out of the Attentional Blink in part 3 the same images that cause the Attentional Blink in part 2? We expect that images in the nude or gory category will have greater effects than images in the neutral category.

Results

Subjects responded to three questions part 3. The first was what direction was the rotated landscape (T1) turned. The second was, was there a person (T2). The third questions asked for the subject to categorize the person.

Like in the forward Emotional Blink of Attention, a 2 (Lag: lag 2, lag 8) by 3 (Category: neutral, nude, gory) repeated-measures ANOVA was used to test significance. The first step we took was to measure accuracy in responding to which direction T1 faced

(Question 1). We found that there was no significant difference in accuracy between reporting images at lag 2 and lag 8 ($F = 1.454$, $p = .239$). However, there was a significant difference between categories ($F = 8.747$, $p = .001$) and a significant interaction between lag and category ($F = 8.214$, $p = .001$). (See Figure 7)

While response accuracy in lag 8 was similar across all categories (neutral, M = 84.1%, SD = 11.2%; nude, M = 83.9%, SD = 9.1%; gory, M = 84.1%, SD = 11.3%), there were some differences at lag 2. When we looked specifically at Lag 2, subjects responded most accurately when neutral images were presented (neutral, M = 88%, SD = 10.5%), least accurately when a nude image was presented as T2 (nude, M = 76%, SD = 14.8%), and responded slightly more accurately for gory images compared to nude images but lower than neutral images (gory, M = 84%, SD = 9.1%). Differences across categories were significant ($F(2, 25) = 15.846$, $p < .005$). Our findings contrast to other papers where they found that negative images appearing at Lag 2 actually increase response accuracy in reporting T1.

The next step was to look at the number of accurate responses to the second and third questions, given T1 was answered correctly. We were most interested in seeing how accurate subjects were in identifying the correct category the image of the person fell into at T2 (Question 3). Therefore, accuracy for the third question (which category did the person fall into) was calculated only given that T1 was identified correctly (if they answered the first question correctly) and given the subject correctly identified a person was present (if they correctly answered question 2 having correctly answered question 1). (See Figure 8)

Overall, we found no significant difference between lag ($F(1, 26) = .95$, $p =.339$) or between interactions of lag and category($F(2, 25) = 1.696$, $p = .193$). However, there was a significant difference between categories ($F(2, 25) = 4.007$, $p = .024$). We therefore analyzed differences between categories at Lag 2 and Lag 8 separately.

At lag 2, given that subjects identified T1 correctly, subjects correctly categorized neutral T2 90% of the time (neutral, M = 90.1%, SD = 17.9%), nude 93% of the time (nude, M = 93.2%, SD = 14.5%), and gory 91% of the time (gory, M = 91.0%, SD = 13.9%). We found no significant difference between categories ($F = 2.377$, $p = .103$). At lag 8, subjects correctly categorized neutral T2 91% of the time (neutral, M = 91.3%, SD = 17.5%), correctly categorized nude T2 92% of the time (nude, M = 92.3%, SD = 17.3%), and correctly categorized gory T2 89% of the time (gory, M = 88.7%, SD = 15.8%). Differences between categories were significant ($F = 3.638$, $p = .033$). When we examined results further, we discovered that images in the nude category show a strong tend towards breaking out of the Attentional Blink more than gory images ($p = .062$). However, no significance difference was found when comparing neutral to nude ($p = 1$) or neutral to gory images ($p = .176$).

Skin Conductance

The final aspect of the study centered on Skin Conductance. We analyzed overall differences in average amplitudes between images in each category. We also analyzed differences between image categories within each task separately. The next step for the Skin Conductance analysis will be to look at differences in participants' Skin Conductance Responses for each individual image.

Methods

All Skin Conductance Data was recorded by AcqKnowledge software on a computer connected to the computer one running E-prime for Tasks 1, 2, and 3. Two electrodes were hooked up to participants' fingertips prior to the beginning of the study. The first electrode was hooked up to the index finger of the left hand, the second to the middle finger of the left hand. The electrodes were held in place by Velcro straps. Prior to strapping on the electrodes, electrode gel was applied to ensure proper conduction between the participants' fingertips and the electrodes themselves.

Electrodes were connected to an MP100 GSR machine, which sent signals to a computer running AcqKnowledge software where the SCR data was stored. Actual SCR data was recorded through Channel 4 from the MP100 machine and "triggers" sent from E-prime were recorded through Channel 35. The gain was set at 5µS/V. Timing of the triggers, which indicated the start and end times of a particular image and the start and end times of a particular trial, allowed for SCR data to be compared to the specific image being presented at the time. After Skin Conductance Responses were recorded for each participant, we extracted the amplitude of each trial from 0 – 4 seconds post-trial onset. From the data, we were able to extract the maximum value, minimum value, average, peak-to-peak value, and standard deviation of the response data for each trial.

Data was extracted in volts. Following extraction, we converted Skin Conductance data measured in volts into Microsiemens via the formula G (µS) =gain (µS /V) *Vrecorded (V).

Results

We concentrated analysis on the average amplitude for each 4 – second period post-trial. Looking at the overall analysis, nude images tended to have slightly higher average amplitude per four-second window (nude, M = .2142 μS, SD = .0062) than did neutral (neutral, M = .2131μS, SD = .0063) or gory (gory, M = .212 μS, .0091) (See Figure 8). However, there was no significant difference between categories (F(2, 21) = .631, P = .537) and no significant difference between nude and neutral categories (P = 1.000), no significant difference between nude and gory categories (P = .875), and no significant difference between neutral and gory categories (P = 1.000). We broke analysis down into each individual task to see if there would be significant differences within individual tasks. Results showed no significance difference between each category's mean amplitude in task 1 (F(2,21) = .256, p = .775) (neutral, M = .2093 μS, SD = .0139; nude, M = .0298 μS, SD = .0134; gory, M = .2077 μS, SD = .0127), no significant difference between each category's mean amplitude in task 2 (neutral, M =.2147 μS, SD = .01; nude, M = .2168 μS, SD = .0119; gory, M = .2124 μS, SD = .0116) (F(2,21) = .733, P = .486) , and no significant difference between each category's mean amplitude in task 3 (F(2,21) = .017, P = .984) (neutral, M = .2154 μS, SD = .0101; nude, M = .2161 μS, SD = .0126; gory, M = .2159 μS, SD = .0131) (See Figure 9).

Discussion

Emotion has the ability to capture our attention and dictate how we perceive and attend to stimuli in our surrounding environment. Our results in this study replicate findings of other papers in which emotional images, especially ones depicting nude women, caused enhanced Emotional Attentional Blinks compared to neutral images. In our forward EBA task, when nude images were presented as a distractor 200 milliseconds before the target, accuracy was severely impaired compared to trials where neutral images were presented (31% vs. 70%). Nude images also caused greater impairment in accuracy than gory images (31% vs. 42%). Where our results deviate from other findings is in the third task in the backward EBA. Whereas other papers have shown evidence that negative images presented 200 milliseconds behind a target image actually help facilitate perception of Target 1 (Most & Junge, 2008), our results did not show an increase in accuracy when negative images were presented at Lag 2. In fact, average accuracy in reporting T1 was lower when gory images were presented at lag 2 than when a neutral image was presented (84% gory, 88% neutral). Furthermore, we discovered that nude images retroactively impaired accuracy in processing T1 to a greater affect than did gory images (nude, 76%; neutral, 88%; gory, 84%). These results are not surprising given that nude pictures in the forward EBA task elicited the most enhanced EBA's and caused participants to miss the target image more so than neutral or gory images. However, they *are* surprising considering Most & Junge's results from their 2008 study.

Most & Junge proposed that their results support a two-stage model of the attentional blink. The first stage buffer holds limited representations of stimuli presented in the RSVP stream, while the same images compete for low-capacity stage 2 resources which consolidate the images into usable representations (Most & Junge, 2008). If we take this two-stage model and apply it to our results, our study may indicate that even with a 200 millisecond head start, target images may still be in the Stage 1 buffer when the RSVP stream presents the emotional image. The target images and emotional images may then compete for Stage 2 resources, with the target images taking precedence because of the time already spent in the Stage 1 buffer. 200 milliseconds may be the critical time point when target images are fully encoded. If this is the case, then emotional images may "arrive" in the Stage 1 buffer just prior to the critical encoding point for the target images. Only the most highly arousing emotional images would then capture the limited-capacity attentional resources in stage 2 and cause a retroactive EBA. Nude images' lessened ability to cause retroactive EBA's in task 3 compared to forward EBA's in task 2 may provide evidence for such a finding (participants accurately reported T1 76% of the time for the retroactive task when nude images were present vs. 36% accuracy when nude images acted as a distractor in the forward task). However, current results are inconclusive and require further testing.

Our Skin Conductance Recordings did not find significant differences in arousal between categories. We expected emotional images to cause significantly greater average amplitudes than neutral images. In particular, we expected nude images to cause the greatest average arousal because they created the most enhanced EBA's in the forward EBA task. They were also most likely to break out of the EBA of T1 in the backwards EBA task. However, results deviated from expectations with no significant difference found between categories ($F(2, 21) = .631$, $p = .537$). SCR results are currently inconclusive, but the next step of the analysis will be to analyze Galvanic Skin Response for each individual image. We will then link SCR data for each image to the likelihood of that image to cause an enhanced EBA in task 2 or to break out of the EBA of T1 in task 3. In this way, we hope to discover a "threshold" for Skin Conductance arousal that determines when an image will cause / break out of the Emotional Blink of Attention. Thresholds may differ according to individual differences. Further analysis between behavioral data and Skin Conductance data for each individual will be analyzed to determine variations in individual thresholds.

The EBA has important implications in the way we perceive our environment. One possible explanation as to why we attend to negative stimuli more so than neutral images may be a result of our flight or fight instincts where images that elicit fear or disgust grab attention so that we may be better prepared to avoid them. Other studies have shown that motivational states also strongly influence the objects that grab our attention (Piech et al. , 2010). The types of images that grab our attention the most may be the ones that directly reflect our needs and desires (nude images grabbing attention the most in sexually-minded young males, for example). The mechanisms that cause the EBA are unknown, but through further testing and studying, we can hopefully shed light on the workings of the brain responsible for the paradigm.

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Figure Captions

(Figure 1) Rating scales for Arousal and Valence in the first Rating task. Participants used their mouse to click directly on the scale to rate each image.

(Figure 2) Averaged participant responses to images for the Rating task.

(Figure 3) Design for the forward Emotional Blink of Attention (task 2). The target image appeared at either lag 2 or lag 8 behind the distractor.

(Figure 4) Results for the forward Emotional Blink of Attention (task 2). Nude and gory images caused significant impairment compared to neutral images with nude images especially affecting accuracy in reporting the target.

(Figure 5) Design for the backwards EBA (task 3). An emotional image appeared either 200 or 800 milliseconds after T1.

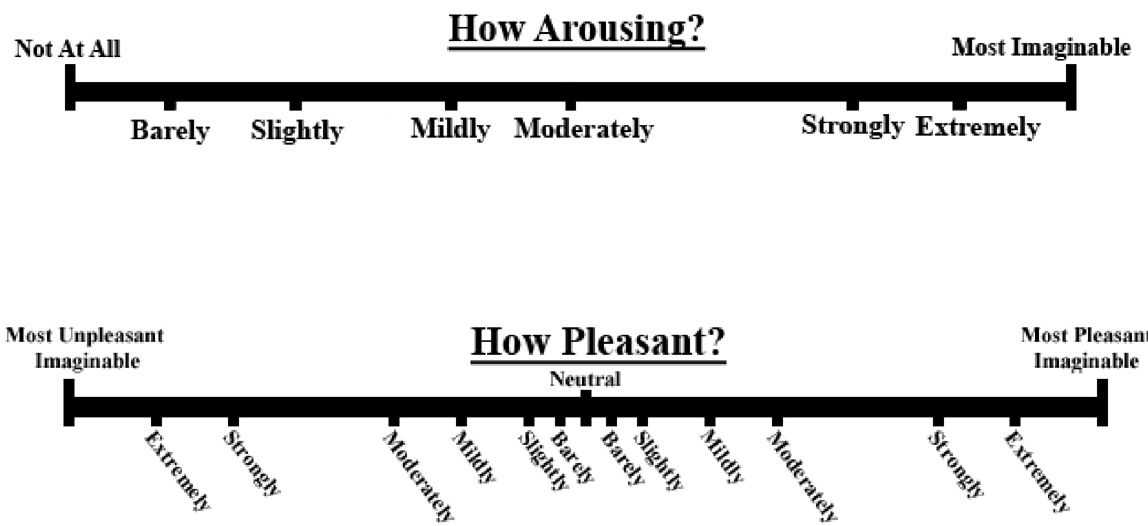
(Figure 6) Results from the backwards EBA (task 3) for accuracy of reporting T1. No effect was found at lag 8 but at lag 2 gory and nude images retroactively impaired accuracy for reporting T1.

(Figure 7) Results from backwards EBA – accuracy in categorizing the neutral, nude, or gory image given that the participant accurately reports T1.

(Figure 8) Overall results from Skin Conductance data across all tasks. Measured in Microsiemens.

(Figure 9) Skin Conductance results for all three tasks presented individually. No significant differences between categories were found.

(Figure 1)


How Arousing?
Not At All
Most Imaginable
Barely
Slightly
Mildly
Moderately
Strongly
Extremely
How Pleasant?
Most Unpleasant Imaginable
Most Pleasant Imaginable
Neutral
Extremely
Strongly
Moderately
Mildly
Slightly
Barely
Barely
Slightly
Mildly
Moderately
Strongly
Extremely

(Figure 2)

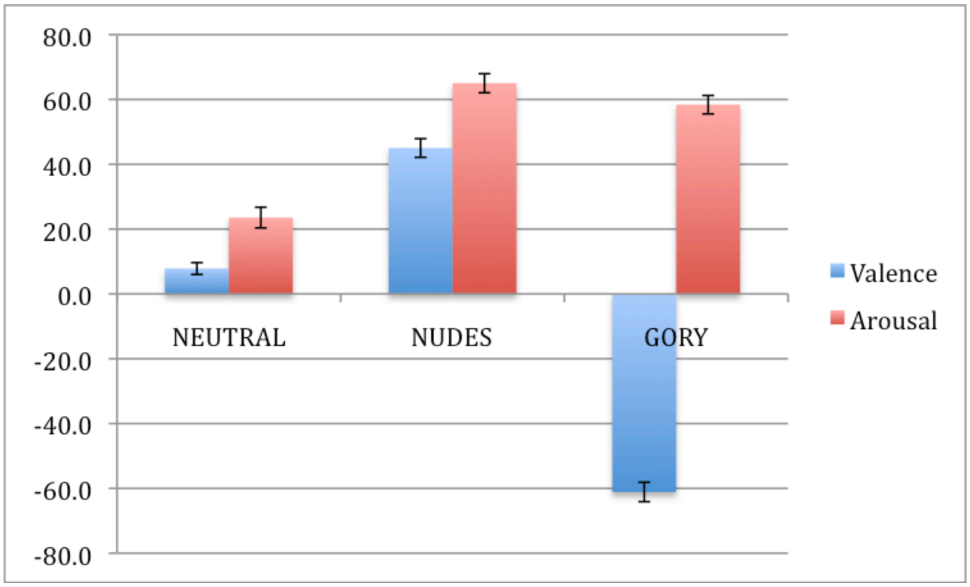

80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
NEUTRAL
NUDES
GORY
Valence
Arousal

Figure 3


Task 2: Forward EBA
Time
Distractor
Target
Neutral
Nude
Gory
Q1: Did you see the turned picture?
Q2: Which way was it turned?

Figure 4 – Overall Results Task 2

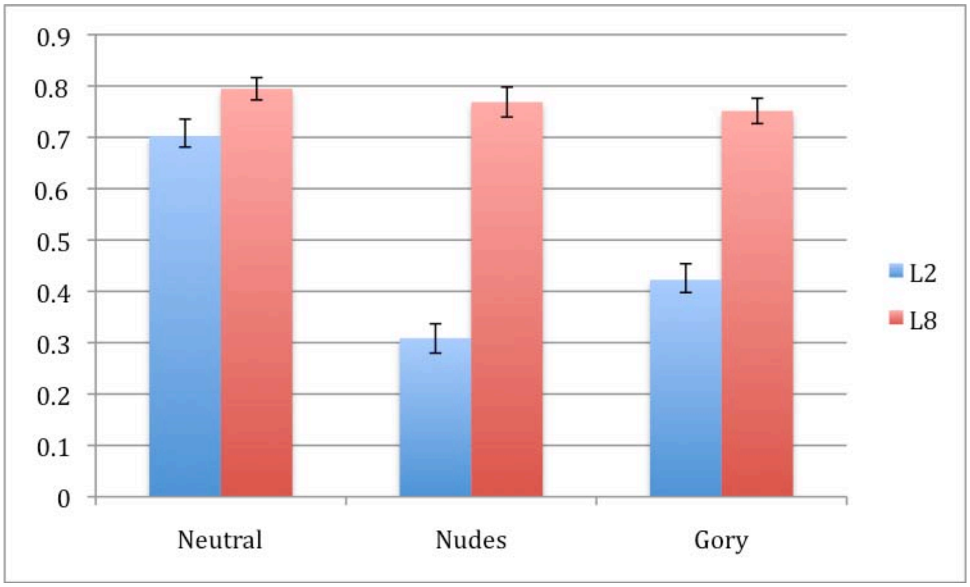


Figure 5 – Backward EBA

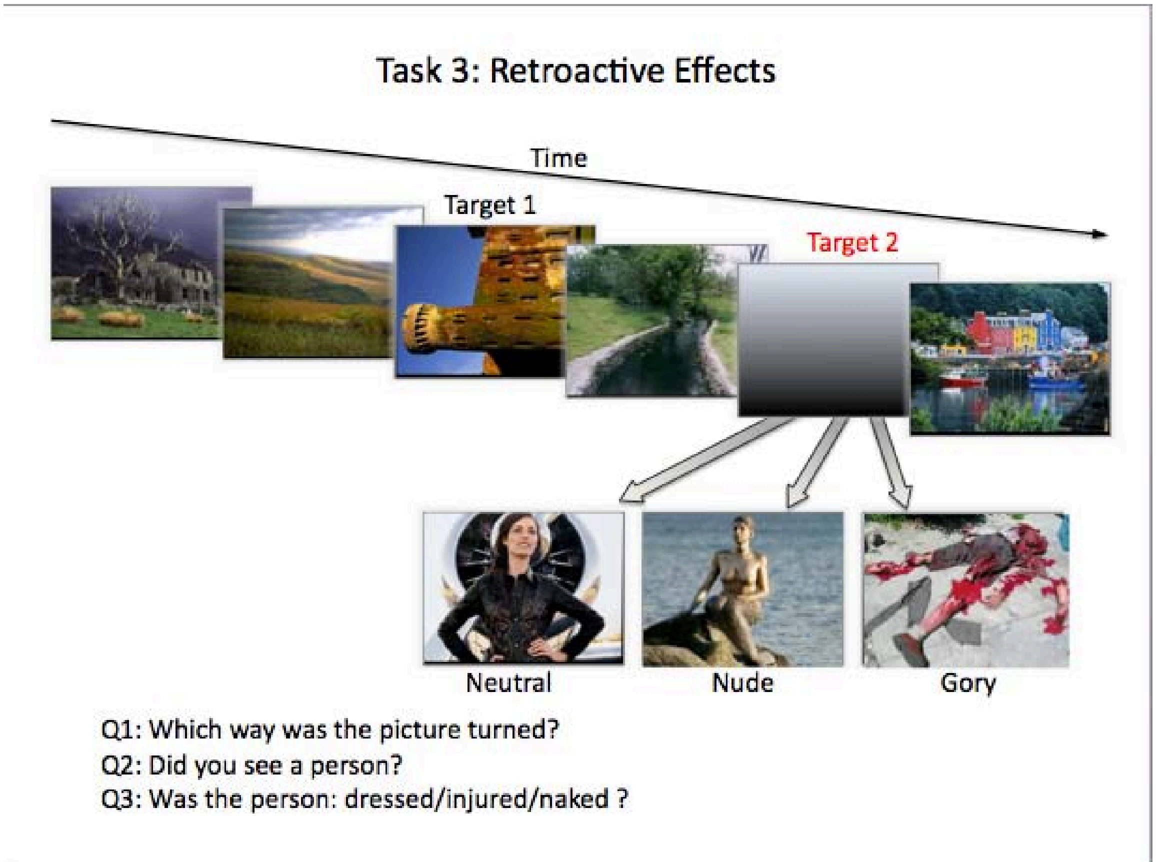


Figure 6 – Overall Correct T1 Results Retroactive Effects (task 3)

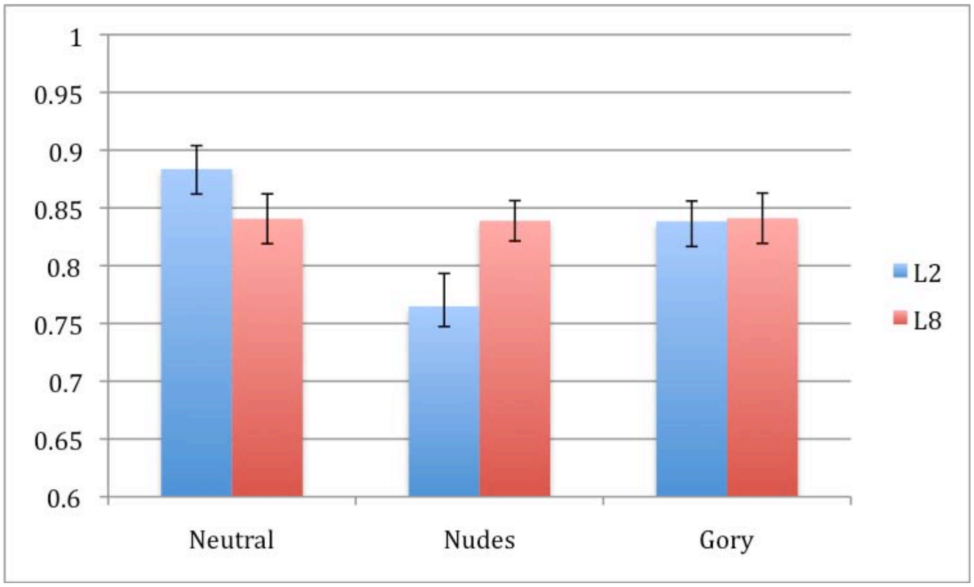


Figure 7 – Retroactive EBA Results – Overall Correct T2 given correct T1

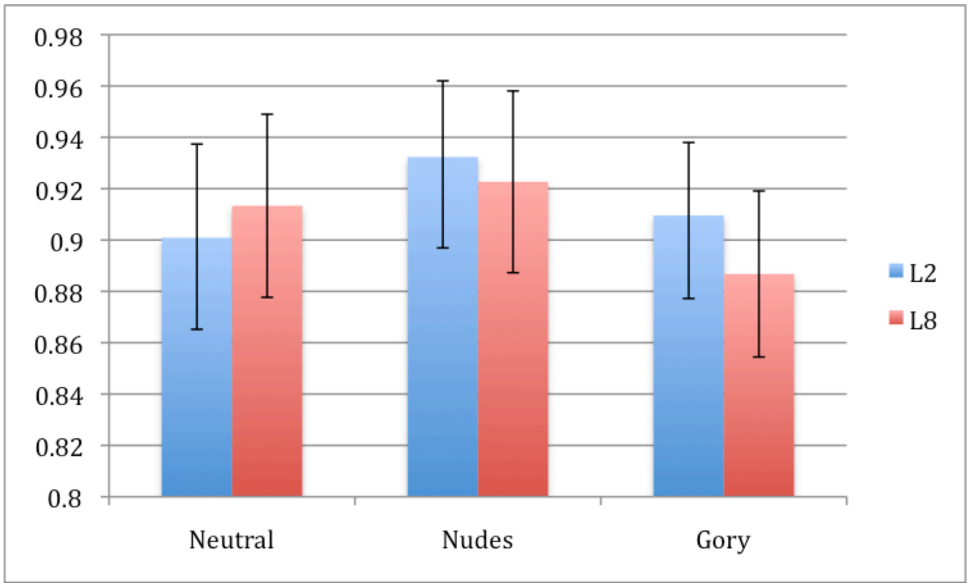


Figure 8 – Overall Skin Conductance Results

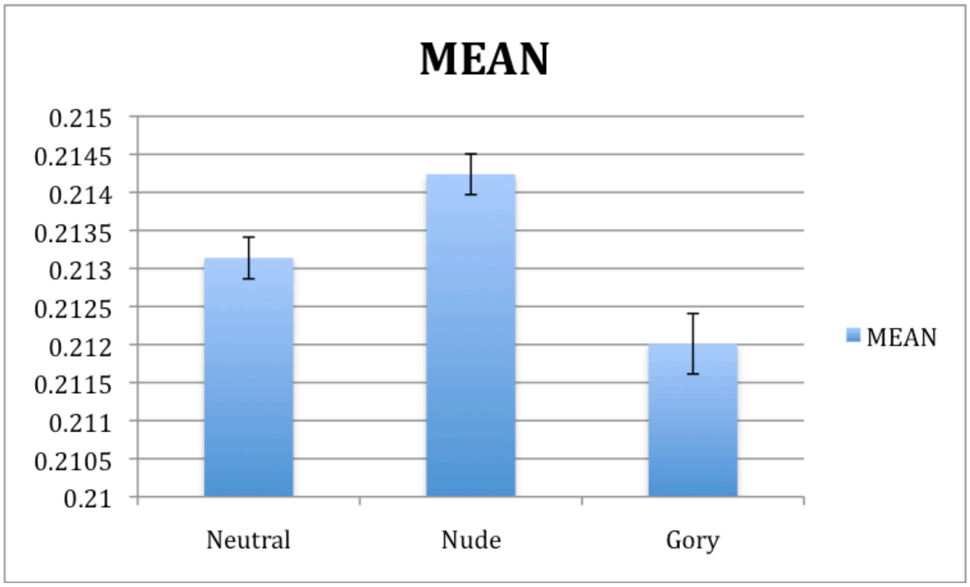
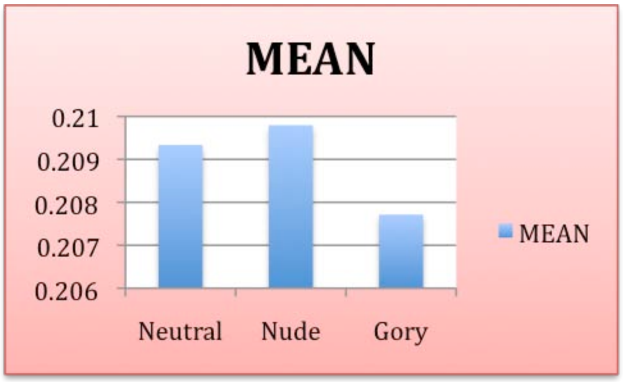
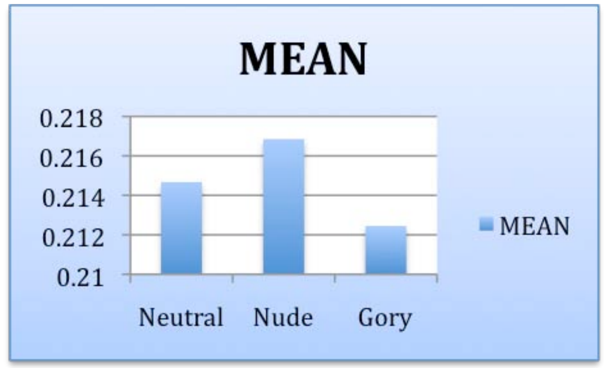


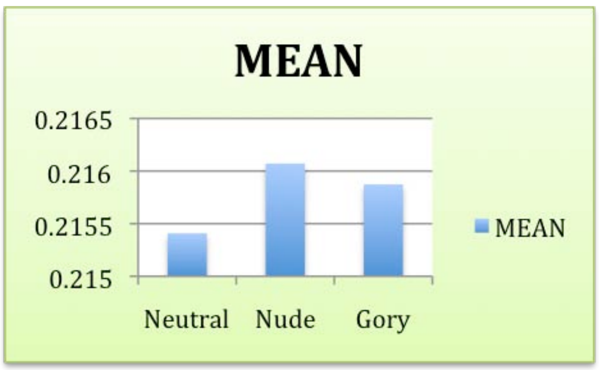
Figure 9 – SCR results for individual tasks



Results for Rating task 1. Scale in Microsiemens



Results for task 2 (forwards EBA)



Results for task 3 (backwards EBA)