The Influence of Personality Traits on Mood Induction and Memory

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Ph.D. Dissertation

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Dedication

To my wonderful and loving wife Christine O'Leary who patiently supported me through this process. Her love and compassion are provided without restraint.

To my parents Glenn and Nicole Cyr who offered me the choice to be whatever I wanted to be and believed that I could finish what I had started.

Finally, this is dedicated to all students who are like me, a blind man trying to describe an elephant while precariously balanced on the shoulders of giants.

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Abstract

This study examines how recall measured over three time periods can be affected by mood induction, personality traits, and image characteristics. There were 101 people who participated in Session 1, 92 participants completed Session 2, and 77 participants completed Session 3. Subjects were randomly assigned to a group with negative mood induction or to a control group. Personality traits were measured using the NEO-FFI. The participants were asked to view 57 images and rate them by pleasantness and arousal. Following the presentation of images participants were asked to recall as many images as possible immediately after the presentation, one day after presentation, and one week after presentation. Generalized Linear Models were used to analyze the data. Unpleasant images were recalled with greater frequency during all three time periods. In addition, a quadratic expression was used to demonstrate that pleasant images also were recalled with greater frequency than neutral images. The personality trait of Neuroticism was negatively correlated with recall during Session 1 and Session 3. It is postulated that higher levels of Neuroticism provide a protective role when viewing negative images through reduced attention. Alternatively, it is possible that people with a higher level of Neuroticism may be desensitized to negative images and therefore less affected by unpleasant images. People who experienced a negative mood induction experienced images more pleasantly although this did not affect recall ability. This study is one of the first to examine how mood induction can interact with personality variables the hedonic valence of the images to affect recall over three time periods. The implications for these findings are discussed and suggestions are provided for future research.

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Introduction

Images have a long history of use for providing information, which over time has included cave paintings, hieroglyphics, and the Bayeux Tapestry. Images often leave lasting impression on the viewer; for example, the National Geographic image of the "Afghan girl" Sharbat Gula became one of the most popular images the magazine has had on its cover. The popularity of her photograph led to the production of a television documentary 17 years later entitled the Search for the Afghan Girl. The utility of images can be seen in the use of billboards and logos. Images are often used to convey information in a meaningful and lasting way. The intention of this study is to further explore why people to remember some photographic images but not others. To examine why some images are better recalled than others one could analyze the physical properties of the image, which include the composition of the image, the dimensions of the image, and the clarity of the image. By the same token, variables inherent to the observer can be important in understanding which images are remembered. This thesis will focus on identifying individual factors associated with the viewer that influence which images are recalled.

Television shows, movies, and storytellers have long used a congruent tone of voice and/or congruent music to enthral audiences. Music in horror movies will often change before frightening moments increasing levels of arousal and attention to enhance the event that is about to occur. Images are also able to produce mood shifts and, in contrast to stories and movies, are able to succinctly summarize information. If mood can be demonstrated to affect recall, a presenter could increase the likelihood of the audience to recall an image, and consequently the message, by preceding the image with

a congruent mood induction. In this way the audience is primed for attending to information in the image and will more likely remember the image. Similarly, if personality traits can be demonstrated to affect mood induction and/or the memory for images, understanding of the influence of personality traits could allow people to tailor the presentation of images for target audiences. This could be useful in a variety of settings, for example, clinical settings, non-profit organisations, and public health advertisements. The objective of this study is to examine the effects of personality traits and moods on the memory for images.

Viewing and recalling an image engages various cognitive processes within the viewer; for example, perception, encoding, and retrieval. Visual processes are not managed in isolation from other cognitive processes specifically during the earlier stages of processing. For example, people viewing the optical illusion of the old lady and the young lady can be influenced if they are told which image to expect. The cognitive process of focus in this study is the emotional state of the viewer, which includes the emotional state prior to viewing the image and the viewer's emotional reaction to the image. The presence of an emotion prior to viewing the image has been demonstrated to affect the viewer's ability to recall the image. Stones and Bygate (2009) induced a slightly anxious mood in half their participants before viewing a set of images. For those individuals who experienced a slightly negative mood induction, Stones and Bygate found an increased memory for unpleasant images. That is, an individual's memory for images was demonstrated to be influenced by the congruency between mood state of the viewer and the image composition. This study and others (Anderson, Wais, & Gabrieli, 2006; Bradley, Codispoti, Cuthbert, & Lang, 2001; Eich, & Metcalfe, 1989; Hamann,

2001) demonstrate that the emotional state of the viewer and the emotional interpretation of the image each affect the recall of the image.

There are many individual factors that can affect the recollection of an image. Our perceptions and interpretations of images has the ability to affect our emotions, consequently, the emotional content of the image will also influence how an image is recalled. Studies have demonstrated that the emotional content of the image often affects the recall of the image; positive and negative images are recalled with greater frequency and over longer periods of time when compared to neutral images (Eich & Macauley, 1989). Additional studies have demonstrated that while an emotional experience or interpretation of the image can enhance the consolidation of memories, the addition of a β-adrenergic receptor antagonist (relaxing smooth muscles) blocks this enhancement (Cahill, Prins, Weber, & McGaugh, 1994).

Emotional states and reactions are shaped by individual characteristics. A rich area of research regarding individual characteristics is in the field of personality as measured by the five-factor model, also called the Big Five Personality model (Digman, 1996). Personality traits from the five-factor model have been shown to predict a variety of experiences such as the predisposition for individuals to experience emotional states; specifically, Neuroticism is defined by the propensity to experience emotional states (Costa & McCrae, 1992) that are relevant across a variety of emotional experiences. A study by Arana, Meilan, and Perez (2008) demonstrated that personality traits were moderately related to the execution of memory task. They used the *16-PF Questionnaire* (Cattell, Cattell, & Cattell, 1993) and examined memory functioning using a prospective memory task indicating whether they had seen images of people with beards or glasses.

Without indication of time, participants had to indicate their responses every five minutes. In a second task participants were shown a list of 32 words, then asked to complete a 60-minute questionnaire, followed by a recall task for the word list. The personality traits of "global self-control", "reasoning", and "rule-consciousness" were related to recall (Arana, Meilan, and Perez, 2008). Consequently, it is anticipated that personality differences will influence the type of pictures remembered for this study. Mood differences and personality differences may direct an individual's attention to emotionally or personally congruent information and in so doing increase the memory for that information. The recollection of mood congruent information is not expected to affect the capacity for recall. An individual's capacity for recall is limited by their cognitive capabilities. Mood congruent information is expected to affect the salience of mood congruent information and thereby direct the cognitive resources to that task. Studies to date have not described a difference in recall ability; they have only demonstrated a difference in the type of information recalled. As such, mood and personality differences are not expected affect the overall number of pictures remembered, they are only expected to affect the type of images recalled.

The aims of this study is to examine how the ability to recall an image could be affected by the emotional content of the image, the emotional disposition of the viewer, and the personality of the viewer. Most studies that examined image recall reported recall ability that occurs either immediately after image presentation (e.g., Eich, & Macaulay, 2000; Rusting, & DeHart, 2000; Talmi, Schimmack, Paterson, & Moscovitch, 2007) or less frequently, one week later (e.g., Anderson, Wais, & Gabrieli, 2006). This study examined recall over three time periods; immediately after presentation, 24 hours

later, and one week later. This allows for the examination of how the variables of mood and personality affect recall over time. The use of three time periods also allows for inferences to be made regarding differences in the strength of memory consolidation.

A commonly used tool used to examine the effect of mood upon memory is the image library in the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008). The IAPS was first published in 1988 and had 460 pictures. The library of images has increased to more than 800 images and each image has normative data for the emotions generated by viewing the image. The authors characterize the emotion generated by using two factors: the degree of pleasure or displeasure experienced, which they term hedonic valence, and the degree of arousal experienced. The degree or type of hedonic valence is described as providing people with an appetitive or defensive motivation (Lang et al., 2008); a positive hedonic valence would generate an appetitive motivation while a negative hedonic valence would generate a defensive motivation. The level of arousal produced by an image is posited to describe the amount of motivational activation generated. For example, most people interpret an image of puppies as very pleasant and moderately arousing. Most people viewing an image of puppies would have an appetitive motivation toward the image (e.g., they would choose to look at the image longer) and the intensity of arousal generated by viewing the image would contribute to the level of behavioural activation expressed by the viewer to enact their appetitive motivation.

Research and theories examining the influence of emotions on cognitions will be presented. These will demonstrate that emotions are an integral part of the processing information and support the investigation of emotions to affect the recall of information.

Following the review of moods and cognitions, specific research examining memory and mood will demonstrate that the mood of an individual can affect their memory and studies describing these findings will be described. Next, literature that examines mood induction will be reviewed. This research demonstrates that a mood induction can shift mood and that those shifts in moods can affect which images or words will be remembered. Then, the literature describing personality traits and moods will be examined with particular focus on the big five personality factors of neuroticism, extraversion, openness, agreeableness, and conscientiousness.

These topics are relevant to the hypothesis that mood and personality differences will influence which pictures are remembered. This study will replicate and expand upon the research of Stones and Bygate (2009) and examine how mood induction and personality traits interact to affect the memory for images. Attending to personality traits presenters may be able to more appropriately target their messages by tailoring a mood induction that is suitable to their audience so as to increase the effectiveness of their presentations. Additionally, this study provides a contribution to the research by examining memory over three time periods which to examine how the characteristics of the image, of a person's mood, or of a person's personality are more meaningful indicators of recall for short-term memory and for long-term memory.

Theories of Emotion

Theories outlining the nature of emotions have a long history predating Socrates (Solomon, 2008). In his historical review of some of the philosophies of emotion Solomon (2008) indicates that the most common metaphor used to describe reason and emotion has been of master and slave. Solomon states that some philosophers like

Aristotle have argued that emotions are inferior to reason while other philosophers like Hume have argued the opposite asserting that we are a slave to our passion. Pertinent to this study, Solomon asserts that it is now generally accepted that reason and emotions can affect each other (Solomon, 2008). Mood induction studies provide good examples for how reason and emotion affect one another. Following a period of mood induction, these studies seek to change an emotional state to explore how emotions affect thinking. It is now commonly understood that emotions have efferent and afferent pathways between other cortical functions; by biological definition emotions and cognitions can affect each other (e.g., Johnsen, Tranel, Lutgendorf, & Adolphs, 2009; Panksepp, 2005). Current theories of emotions will be examined to provide indications for potential reasons that emotions may influence other cognitive processes.

The experience and interaction between emotion and cognition has been an area of contention and there is a well-known story about blind men and an elephant that is particularly fitting to describe why this contention exists. The story begins with a group of blind men who are asked to describe an elephant and each one touches a different part of the elephant to determine what they are touching. The blind men only touch one area of the elephant and come up with very different descriptions according to the areas they touched (e.g., like a trunk, like a wall, like a snake). This analogy fits for the study of emotion because the definitions for emotion have often been shaped by the theoretical perspective used to study emotions in the author's field of study. An overview of the biological, sociological, and psychological definitions of emotion will demonstrate the differences between these perspectives. A biological approach will be presented, which identifies emotions based upon the neural correlates. Then some research by sociological

researchers will be examined to see how emotions are common across cultures. Finally, psychological definitions will be presented that will demonstrate the utility and consequences of emotions. Each of the definitions is shaped by the methodologies used for examination. Each of the following authors was reluctant to define a "basic" emotion, but they were willing to provide common emotions.

The biological underpinnings of emotion have been described by Panksepp (e.g., Panksepp 1982, 1991, 2003, 2008). Panksepp (2008) defines emotions as "diffuse global states generated by deep subcortical brain structures, interacting with primitive viscerosomatic body (core self) representations that remain poorly mapped" (p. 48). Panksepp and Watt (2011) distinguish three types of emotional processes; these include sensory processes (like foods experienced as tasty or disgusting), body-homeostatic processes (like pain, fatigue, hunger, and thirst), and brain emotional processes that most closely resemble colloquial examples of emotion. For the brain emotional processes, Panksepp (2005) has identified seven basic emotional types: seeking, fear, rage, lust, care, panic, and play. Although this list of basic emotions lacks sadness as an emotion, Panksepp defines sadness as a lack of the emotion of "play". Panksepp and Watt (2001) reported that many of these definitions were derived from animal studies and he acknowledges that some researchers from other fields are reluctant to use animal data to define "human" emotions.

Using a sociological approach, researchers like Ekman (e.g., Ekman 1972, Ekman & Cordaro 2011) have compared facial expressions of people from different cultures during periods of emotions in an attempt to identify basic emotions. Ekman's observations led to the discovery of the striking similarities in how disparate cultures

physically express emotion. (Ekman's research was the basis of the television show Lie to Me.) Ekman and Cordaro (2011) have outlined a list of 7 universal emotion processes: anger, fear, surprise, sadness, disgust, contempt, happiness. Ekman and Cordaro further assert that they expect to find evidence for many more universal emotional processes.

Izard (2011) stated that there are no basic emotions but there are emotions that are more fundamental. Ekman and Izard both released their thesis of facial expression of emotion in 1971 (Ekman 1971, Izard 1971). The coincidental timing of their theories on emotion and facial expressions were brought about by the late Silvan Tomkins (Ekman, 1993) who had encouraged each to study facial expressions of emotion without telling the other. This came as an unwelcome surprise to both Ekman and Izard (Ekman, 1993). The development of his theory of emotions was through the analysis of the facial expressions of infants and young children (Izard, 1971; Izard, Fantauzzo, Castle, et al., 1995; Izard, Hembree, & Huebner, 1987). Emotions were hypothesized to emanate from facial expressions. The population studied, infants and young children, shaped the theory by Izard to examine the evolutionary or biological benefits of emotion that produced a different list of fundamental emotions. Izard lists the fundamental emotions: interest, joy, sadness, anger, and fear. Izard asserts that fundamental emotions do not require complex cognitions, fundamental emotions are more specific, fundamental emotions emerge earlier in ontogeny than do emotion schemas, and fundamental emotions contribute to motivational processes that assist in survival and well-being. Izard emphasises that the experience of fundamental emotions is rare and limited to periods of early development and highly threatening situations; conversely, during most situations, emotion schemas are part of everyday life. Emotion schemas, Izard affirms, always involve interactions

among emotion feelings and cognitions that include thoughts, strategies, and goals.

The preceding theorists presented (Panksepp, Ekman, and Izard) were disinclined to identifying emotions as "basic" because they see emotions as part of a more complicated cognitive process. In contrast to these authors who have attempted to provide fundamental or low-level emotions, Ortony and Turner (1990) and Turner and Ortony (1992) claimed that there are no basic single state emotions. One of their reasons for rejecting the notion of basic emotions is for the reason that leading researchers have differing opinions on which emotions are basic. Panskepp, Ekman, and Izard have postulated a set of basic emotions that ranges from five to seven or more in number. Turner and Ortony (1992) further asserted that the differences in their identification of basic emotions are different due to the method used to study emotion (Panskepp studied the biology, Ekman and Izard studied facial expressions using different populations). Turner and Ortony asserted that due to these factors it is more reasonable to consider emotions to be a combination of a physiological state and a cognition that makes sense about that situation.

An alternative view of emotions is that all emotions can be reduced to two dimensions – affective valence, ranging from positive to negative, and arousal level, ranging from excited to calm. Psychologists have attempted to identify emotions using a utilitarian point of view. In the past, some authors have suggested that emotions are the product of cognitive processes, which includes the anticipation, experience, and imagining of environmental outcomes. Others had suggested that emotions are automatic experiences that are influenced by classical conditioning. In 1962 Schachter and Singer identified physiological states of arousal and cognitive appraisal as each being important

in the experience of emotions. Their study examined the role of cognitions in the experience of emotion. All participants in their experiment were informed that they were receiving a vitamin; participants were divided into a group that was injected with adrenaline and a group that was injected with a saline solution. Further, half of the participants in each group were told that the injection would cause physiological side effects such as trembling and a pounding heart. The other half of the adrenaline group was informed that they might experience irrelevant side effects or none at all. Schachter and Singer discovered several important interactions that have held up over time. The first was that the people who were informed that there would be some physiological effects of the injection, regardless of the group, experienced less emotion, both positive and negative, across situations. Secondly, people who had no explanation for the adrenalin induced physical arousal labeled their arousal in terms of the available cognitive explanations.

The two factor theory of emotion that resulted from the Schachter and Singer (1962) study establishes that emotions are a product of a person's physiological state of arousal combined with their cognition that makes best sense of the situation. A parallel cognitive explanation for the findings Schachter and Singer (1962) theory can be found by examining Festinger's (1957) theory of cognitive dissonance. Festinger stated that cognitive dissonance, an unpleasant state, was created when there is an individual experience of incongruent thoughts, knowledge, actions, beliefs, and/or feelings. Further, an individual will be motivated to reduce cognitive dissonance by resolving the by explaining away the differences or by changing one of the incongruent conditions. Participants in the study by Schacter and Singer (1962) did not have an explanatory

mechanism and their mood state had to change to reflect their current level of physiological arousal. In response, their emotional state changed to reflect the physical arousal that they were experiencing. Another way of understanding the process outlined by Schacter and Singer could be to use the theory of cognitive therapy (CT) developed by Beck, Rush, Shaw, and Emery's (1979). They posit that the initial interpretation of environmental events is often an automatic process that is congruent with existing emotions. Further, CT proposes that thoughts generated while experiencing a depressive mood or episode are inevitably congruent with the existing emotional, these distorted thoughts contribute to the maintenance of depression.

Rather than viewing emotions as discrete physiological states, independent of other emotions, some researchers have examined dimensional models for describing affect. The circumplex model of affect was described by Russell (1980). Through the use of factor analysis and multidimensional scaling, he posited that affect had two dimensions, valence and arousal, and that all emotions could be located on those two dimensions (Figure 1). Valence described the pleasantness of the experience and it ranged from unpleasant to pleasant. Arousal described the level of activation during the affective state and it ranged from deactivation to activation.

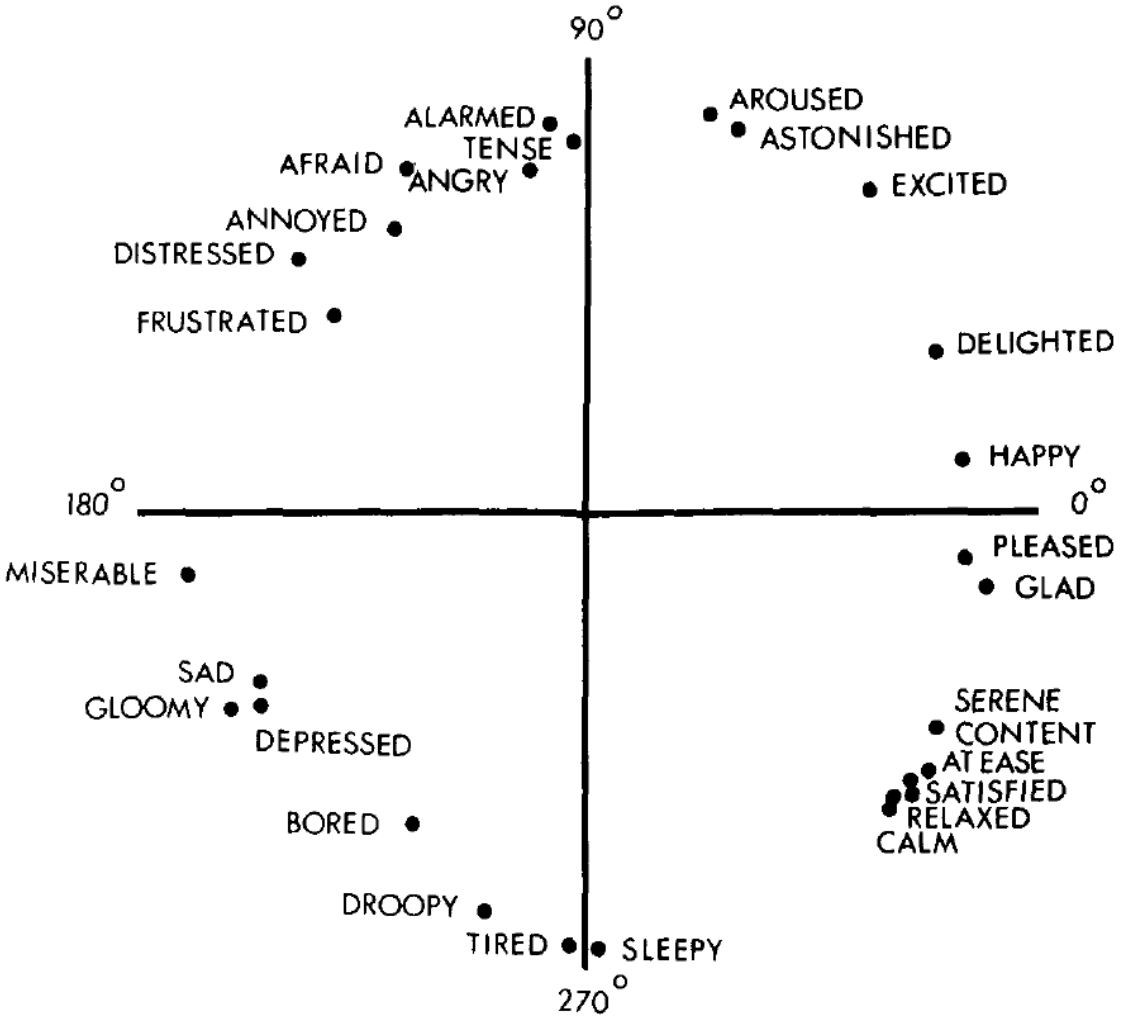

Figure 1: Russell's 1980 formulation of the circumplex model for 28 affect words.

This model has been refined over time and Figure 2 provides an elaboration of the circumplex model (Posner, Russell, & Peterson, 2005). An additional benefit to using the circumplex model is that the dimensions of valence and arousal can be described by neurological correlates. The valence process is associated with the processes of reward and pleasure and is hypothesized to be related to the cortical structures typically associated with mesolimbic centre – the ventral tegmental area to the nucleus accumbens

and has abundant connections to the prefrontal cortex, amygdala, and hippocampus (Posner, Russell, & Peterson). Arousal, in contrast, is associated with more basic correlates neurological functioning, the reticular formation, the thalamus, the amygdala, and the parietal cortex. As depicted in Figure 2, the emotions of depressed and stressed are relatively close together in this two dimension space. The circumplex model of affect provides some explanation for the high comorbidity between mood and anxiety disorders because of their proximity in affective space.

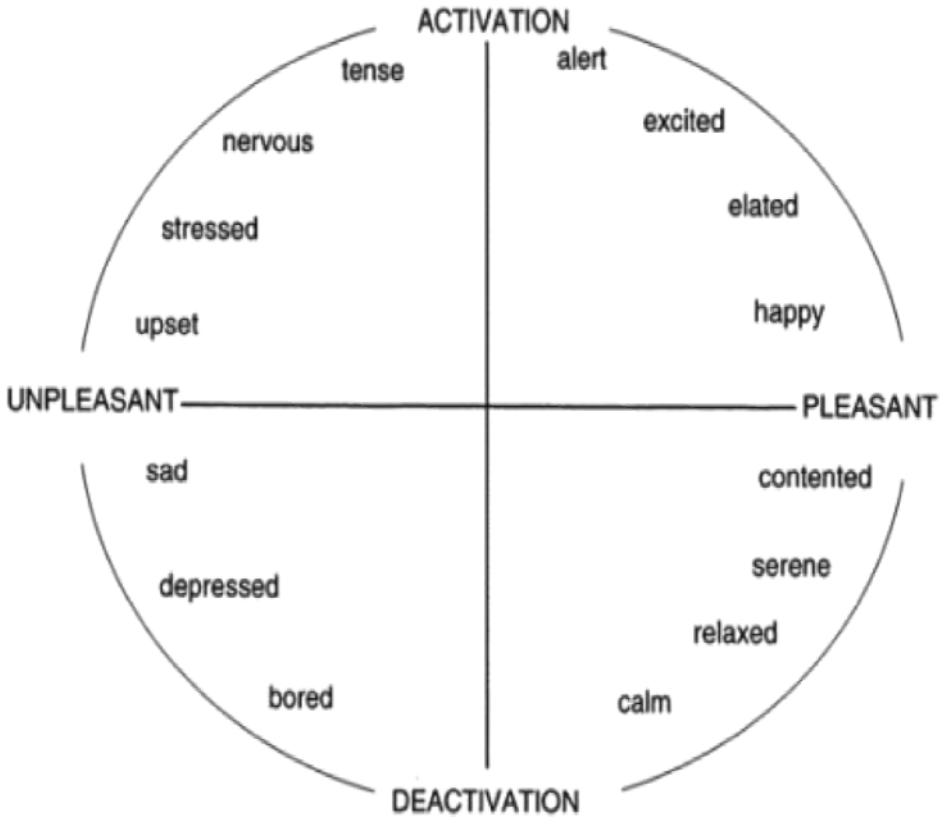

Figure 2: Posner, Russell, and Peterson (2005) depiction of the circumplex model of affect.

Posner, Russell, & Peterson (2005) further presume that the proximity in affective space between mood and anxiety disorders provides some explanation for why antidepressant medication is often effective for both. Although the circumplex model describes emotions as a combination of valence, arousal, and cognitions, Schacter and Singer describe emotions as the product of arousal and cognitions. While these may seem like different descriptors of emotion, Schacter and Singer are describing the development of an emotion when there is no emotion present. Emotional states are pervasive in life and occasions without the experience of emotion are uncommon. In this manner, the degree of affective valence experienced by a person becomes as important as the arousal level of the person in determining how they will interpret an event. That is, a person experiencing an unpleasant valence will experience an event much differently than someone experiencing a pleasant valence, which would be epitomized in the work by Beck, Emery, and Shaw with their theory of CT. Perhaps most revealing of how these measures are similar is rotate the Posner, Russell, and Peterson figure counter clockwise by 45° (Figure 3). This rotation produces well-known positive and negative affect components as measured by scales like PANAS (Watson, Clark, &Tellegen, 1988). Such measures are respectively predicted by neuroticism (valence) and extroversion (arousal) suggesting that temperament underlies these affective components (Watson & Clark, 1994). While Schacter and Singer described emotion as a product of cognitions and arousal, the circumplex model examines emotions as a product of cognitions and experiences upon the two dimensional affective state. Further, the circumplex model can applied to personality traits like neuroticism and extroversion.

Figure 3. The circumplex model rotated counter clockwise by 45° demonstrating a y-axis of elated and depressed and an x-axis of relaxed to stressed.

Summary

This section has provided an examination of emotions and how they are defined in different ways by different researchers. Rather than being superfluous, each of these prominent theorists has supported and affirmed the interaction between emotions and cognitions. The interplay between cognitions and emotions has been witnessed and described for some time in various manners depending on the field of study. There are

two distinct models used to understand the emotional experience, categorical models and dimensional models. Models were presented by Panksepp, Ekman, and Izard examined the biological underpinnings of emotion to categorize and catalogue emotions by attaching them to specific biological processes or facial expressions. Ortony and Turner described some problems with the concept of basic emotions, and indeed, all categorical authors (Ekman & Cordaro, 2011; Izard, 2011; Panksepp & Watt, 2011) did not believe that the idea of basic emotions was accurate. An alternative to basic emotions is the circumplex model of emotions, a dimensional model that seeks to describe the experience of emotion along two dimensions. This model has been demonstrated to be flexible in the conceptualization of affect, while including a hierarchical component of cognitive processes to further refine the emotional expression. Further, as previously described, the IAPS utilizes this conceptualization of emotions and the IAPS images have been used extensively to study mood and behaviour. Therefore, the two-dimensional model is sufficient and appropriate tool for the investigation of emotions. The following section examines this combination by more specially focusing on how moods affect memory, beginning with a description of the factors of memory central to this study.

Memory and Moods

Memory is a broad field of research and researchers in different areas of science described memory in a manner suitable to the area of research. Baddeley (2000), who developed the concept of working memory in 1974, demonstrated that working memory in the field of cognitive psychology generally refers to a limited capacity system allowing the temporary storage and manipulation of information necessary for such complex tasks as comprehension, learning, and reasoning. In contrast, working memory in the animal

learning laboratory where the term refers to the storage of information across several trials performed within the same day, such as the radial arm maze (Baddeley, 2000). Finally, Baddely reports that in the field of artificial intelligence working memory refers to a system component, often unlimited in capacity, which is responsible for holding the productions. For present purposes two general aspects of memory will be discussed to provide clarity on the way memory will be delineated. The first aspect of memory examined is the difference between recall memory and recognition memory. Recall memory is the ability to recall information without assistance whereas recognition memory is to be shown information and asked whether they had seen that information in the past. Recognition and recall are often correlated from .45 to .65 depending on the method used to test for memory. Because of the differences in rates of correlations, it has been hypothesized that recognition and recall are subsumed by different neural systems (Kahana, Rizzuto, & Schneider, 2005).

In addition to recall, a second aspect of memory, the time of recall after initial exposure to the information will also be examined. McGaugh (2000) reviewed the history of memory consolidation and he described three stages of memory consolidation: short-term (seconds to hours), long-term (hours to months), and long lasting memory (months to lifetime). McGaugh reported that there exists a considerable overlap between the three stages of memory and he stated that the stages of memory are not sequential. His reasoning was derived from research demonstrating interaction effects of drugs administered at various times before, during, or after learning could impair memory consolidation for one stage but not another (McGaugh, 2000). Due to the selective memory impairment findings produced by some drugs, he hypothesized that the stages of

memory consolidation are likely independent processes acting in parallel. The implication for research in memory is the possibility that an experimental manipulation may affect one stage of memory more than others. For example, Sharot and Phelps (2004), described below, demonstrated an effect upon long-term memory but not short-term memory.

Sharot and Phelps (2004) examined how attention and level and arousal modify memory for words over an extended period of time. In their study, half of the participants were asked to complete a two-forced-choice recognition task immediately after being shown the words (short-term memory) while the other half were asked to complete the recognition task 24 hours after viewing the words (long-term memory). Sharot and Phelps found that arousing words were recognized to the same extent as less arousing or neutral words if participants were tested immediately following the experiment. For those participants who were tested 24 hours later, neutral words were recognized less often than would have been immediately after testing. More importantly, recognition memory for arousing words 24 hours later was equal to or superior to immediate memory. Sharot and Phelps concluded that level of word arousal decreases the rate of memory decay but does not affect the initial memory for the word. An alternative account is that the level of arousal affects a different stage of memory consolidation. Regardless, this finding demonstrates that researchers should be aware that experiments could reveal different results depending on when participants are asked to recall information.

At a more fundamental level, Anderson and Phelps (2001) examined how damage to the amygdala decreases the perception of aversive stimuli due to the role of the

amygdala in processing emotions. They examined the ability of people to recall emotionally charged words versus neutral words. Anderson and Phelps examined how damage to the amygdala affected the participants' attentional blink (Raymond, Shapiro, & Arnell, 1992). The "attentional blink" effect is the inability to distinguish a second target if it is presented too quickly after the first target. Anderson and Phelps presented 15 words per trial in a rapid sequence; there were 2 target words identified by being typed in a green font and 13 distractor words that were typed in a black font. Previous research has demonstrated an "attentional blink" if the two targets are presented less than 600ms apart and if there were less than four intervening distractor items. This is to say that the "attentional blink" effect caused individuals have a greatly impaired ability to identify the second target word though participants were able to remember the first target word. Anderson and Phelps (2001) and Anderson (2005) demonstrated that the presentation of high arousal words as the second target word greatly reduced the impairment normally associated with the "attentional blink". If the second target word was arousing, then the word was remembered even if presented within the time span of what normally would have been an attentional blink.

Functional magnetic resonance imaging (fMRI) was also used during the Anderson and Phelps (2001) experiment. Specifically, they were interested in brain functioning when participants were asked to recall the second target word that was presented in each trial they were also using. Following the completion of all the trials, Anderson and Phelps (2001) asked the participants to rate the level of emotion generated from reading a word presented to them. Anderson and Phelps also asked participants to rate the level of arousal generated by each word. They observed that the left amygdala

was more active when aversive words were presented to participants. Anderson and Phelps used fMRI with one person who had a bilateral amygdala lobectomy, five people with left amygdala lobectomy, five people with right amygdala lobectomy, and 20 control participants. Anderson and Phelps found that the one person with bilateral amygdala lobectomy and the five people with left amygdala lobectomy demonstrated no enhanced perception, no protection against the attentional blink, when they were presented with arousing word targets. Individuals with left amygdala lobectomy were able to provide normal Likert-type scale ratings to aversive stimuli indicating that they had understood the affective meaning of words presented. The difference between people with left amygdala lobectomies was that they did not demonstrate enhanced ability to perceive and hence remember emotionally aversive words.

Summary

This section identified a few critical features of memory and how it affects mood. Firstly, experimental manipulations could affect one stage of memory consolidation but not another. This finding was attended to in this study by asking participants to provide recall of images immediately after the experiment, one day after presenting the images, and one week after presenting the images. Second, there is evidence for mood congruent memory consolidation. Finally, the studies examining "attentional blink" reinforce the first two findings by demonstrating the parallel processing of memory and emotions where emotions can direct perceptions. Prior to examining how memory is related to moods, the following section will examine the various methods used by researchers to induce mood.

Mood Induction

Mood induction for research purposes has been implemented in a controlled manner since Velten described his method of mood induction in 1968. Although mood induction is widely used there are various methods used by researchers to accomplish mood induction of participants. This section will provide an overview of some of the most popular mood induction techniques. Then, findings regarding the type of mood induction and methods of mood induction will be examined. This will establish that imagined mood induction used by Stones and Bygate (2009), is a quick and effective method of mood induction.

Researchers have examined the effects of mood on behaviour using various strategies. Some studies explore the function of naturally occurring mood differences while other studies examine experimentally induced mood. Gerrards-Hesse, Spies, and Hesse (1994) provide background regarding the methods used to examine the effects of mood upon behaviour. Mood may be studied as a naturally occurring variable. When examining mood as a naturally occurring variable, the mood of participants is rated before any experimental procedures are conducted and the differences between participants are examined for correlations to mood differences (e.g., Parrott & Sabini, 2990, Schwarz & Clore, 1983). The effects of mood on behaviour have also been examined by comparing clinical populations (e.g., depressed people) against non-clinical populations (Weingartner, Cohen, Murphy, Martello, & Gerdt, 1981). In addition, the effects of mood can be examined by inducing the desired mood through experimental manipulation.

Gerrards-Hesse et al. (1994) reviewed five general categories of mood induction techniques for the effectiveness of mood induction. Their review documented similar findings to the review by Westermann, Spies, Stahl, and Hesse (1996) who examined the effectiveness of 11 mood induction techniques. Westermann et al. (1996) differentiate two of the following nine techniques by whether participants are provided with explicit instruction or not to attempt to get into the desired mood. Each of the mood induction procedures will be briefly described followed by a description of the overall effectiveness for these procedures. The 11 mood induction procedures were:

1. Imagination. Participants are asked to imagine emotion-ridden events. To intensify this process, participants are asked to write down the imagined event and to write down their related thoughts and feelings. For example, Wright and Mischel (1982) asked participants to as vividly as possible imagine a situation that would make them feel sad and to imagine the situation as vividly as possible. To induce a sad mood, participants in a study by Kavanagh and Bower (1985) were asked to remember an occasion when they had attempted a romantic approach to a member of the opposite sex and had failed and had been completely rejected.
2. Velten. This is the most widely used mood induction procedure (Westermann et al., 1996) and was developed by Velten (1968). Participants are asked to read a list of 60 self-referent statements describing either positive/negative self-evaluations or somatic states. Participants are instructed to try to feel the mood generated by these statements (Velten, 1968).

3. Film/story mood induction (with and without instruction). Participants are presented with a narrative or descriptive material to be imagined. The procedure for instructions asks participants to get involved in the film or story described and the feelings that are suggested. For example, Isen, Daubman, and Nowicki (1987) induced a positive mood by asking participants to watch comedic bloopers and outtakes from the television westerns Gunsmoke and Have Gun Will Travel for five minutes.
4. Music (with and without instruction). Participants are asked to listen to a piece of classical or modern music and asked to get into the mood of the piece (with instruction). In some studies, participants are asked to choose a piece of music that will put them in the desired mood. In the presentation of music without instruction, participants are asked to listen to a piece of music without emphasis on the emotional character of the piece. An example of music with instruction was conducted by Eich and Metcalfe (1989) who asked participants to listen to a piece of classical music that to help them to develop a sad mood. Furthermore, they informed participants that the music alone could not alone create the desired effect so the participants should concentrate on sad events.
5. Feedback. Some studies give participants positive or negative feedback on performance to induce a positive or negative mood. Most often participants are provided with false feedback, although some studies use correct feedback. For example, Parrot and Sabini (1990) used exam marks as the natural feedback mechanism. They asked participants

to record the mark they think they achieved prior to obtaining their grades. This allowed researchers to compare their expected grades to their obtained grades. They then requested that students write down a few memories from high school to examine how their moods were related to their memories. Their information was only requested at the end of the experiment and students were free not to submit their data. It is noteworthy that 109 out of the 233 students declined to submit their data (Parrott & Sabini, 1990).

6. Social interaction. For this mood induction procedure participants interact with a confederate who is instructed to act as if depressed or elated or neutral. The assumption is that participants will be affected by the mood of the confederate and experience a similar mood experience. In an experiment by Yinon and Landau (1987) they provided subjects with the opportunity to "help" a friend of the experimenter by filling out an unrelated questionnaire. Yinon and Landau (1990) hypothesized and confirmed that people feel good after helping others.

7. Gift. This method provides participants with a small gift (e.g., chocolate bar, gift certificate) which is expected to cause a degree of elation in participants. A junior chocolate bar was used by Isen, Daubman & Norwiki, (1987) and successfully induced a positive affect.

8. Facial expression. Some researchers manipulate the facial expressions of the participants to induce a mood state. To obscure the nature of the experiment participants are often told that the task is designed to assess muscle activity while performing a cognitive task.

For instance, Srivastava, Sharma, and Mandal (2003) asked participants to look at sad faces to help them feel sad.

9. Combined. Some researchers use a combination of techniques to induce a mood state. Some of the combinations used use Velten and imagination or Velten and music.

Westermann et al. (1996) reviewed 250 mood induction studies using the techniques previously described. They found that for both positive and negative mood induction, the most effective technique was film or story, especially when participants were instructed to enter the desired mood state. For a positive mood induction, all other mood induction procedures were less effective than the film/story technique. For a negative mood induction, imagination, Velten, music, social interaction, and feedback were as effective as film/story without instruction. The lack of studies examining the film/story with instruction procedure translated into larger ranges for a 95% confidence interval than other techniques, which suggests caution in interpreting this methods as more effective than other methods. The authors concluded that except for facial expression, most methods are useful for the induction of negative moods. The lack of support in facial expressions to induce moods is curious given the research of Ekman on facial features.

Researchers often varied the implementation of the mood induction procedure. For example, Eich and Metcalfe (1989) employed a continuous music technique; during their experiment the mood inducing music is played throughout the experiment. In that experiment, Eich and Metcalfe (1989) examined the change in mood induced by the continuous music technique versus the Velten technique before and after their

experiment. They found that the Velten technique for mood induction was strong at the outset but had disappeared by the end of a 30-minute experiment, whereas the continuous music technique had the desired effect of producing a reliable mood shift for the duration of the experiment.

Alternatively, Rusting and DeHart (2000) primed a negative emotion by using an imagination mood induction. They asked participants to read a vignette that described a negative experience (a friend is terminally ill) and to imagine themselves in that situation. Rusting and Dehart (2000) reported that they used deception so that subjects did not guess that negative mood was important to the experiment. Participants allocated to the negative mood induction condition were told that there were a variety of possible vignettes that were possible, when only one (the negative mood induction) was available. To increase the level of motivation of the participants for engaging in the vignette task, participants were asked to write down the vignette after they had read it. One of Rusting and Dehart's (2000) main findings was that the process of positive reappraisal negated the negative mood induction. In fact, positive reappraisal caused participants to recall more positive memories, a mood-incongruent retrieval effect.

Other researchers have examined how the presentation of stimuli affects the degree of mood caused by particular stimuli. Baños et al. (2008) examined the differences in three dimensional presentation of visual stimuli versus two dimensional presentations of visual stimuli for inducing relaxed or positive emotions. Baños et al. (2008) found no differences between the two methods of stimuli presentation for the induction of mood. They also found no difference between the two methods for generating the intensity of arousal generated by the stimuli. Another study also

demonstrated the stability of image ratings when visual material is manipulated. Bradley Codispoti, Cuthbert, and Lang (2001) presented images in greyscale or in colour and found that there were no differences between the image presentations.

Codispoti and De Cesarei (2007) examined the effect of picture size upon the affective responses of participants. Codispoti and De Cesarei reported that there is a small but significant modulation of self-report affective response due to picture size. They found that as image size decreased, the affective rating of the pleasant images of erotic couples, opposite sex nudes, and babies decreased as did the affective ratings of neutral pictures. Conversely, as the image size decreased there was a small but significant tendency to rate mutilated bodies and contaminations more negatively. Sánchez-Navarro, Martínez-Selva, Román, and Torrente (2006) also examined for the effects of image size upon mood ratings and found no differences in affective ratings or arousal ratings for displaying images in differing sizes.

Summary

This section examined the breadth of techniques used to generate mood in laboratory settings and demonstrated that most mood induction techniques are effective. Further, the mood induced by specific images in the IAPS catalogue is resilient to changes in size, shape, colour. Taken together, these studies demonstrate that IAPS images are resistant to changes in hedonic valence and arousal level possibly indicating a Gestalt-like effect wherein the interpretation of each IAPS image is more important than the specific details of each image. The next section will describe research on how mood induction studies have contributed to the understanding that memory is affected by moods.

Mood Induction and Memory

Mood states have been induced by the experimenters wishing to examine the interaction between mood states and various cognitive processes, often memory. The changes in mood that occur from mood induction are temporary and flexible and can be readily altered by the individual (Rustng & DeHart, 2000). Mood has been demonstrated to enhance the ability to recall information when the induced mood state is present during the presentation of the items to be remembered. Additionally, this finding of modulating memory consolidation has been found when moods are induced after the presentation of the items to be remembered. A distinction between the two general methods of enhanced retrieval due to mood states, mood congruent memory and mood dependent memory (Weingartner, Miller, & Murphy, 1977), will also be presented.

Positive and negative mood states can increase the ability of individuals to remember positive and negative events respectively (Haas & Canli, 2008). There are two processes that describe the effects of mood upon memory, mood congruence and mood dependence (Blaney, 1986; Weingartner, Miller, & Murphy, 1977). Mood congruence refers to the enhanced encoding or retrieval of a stimulus through the experience of a mood that is congruent with the target stimulus. The congruent mood at the time of encoding or retrieval assists memory encoding or retrieval. An example of mood congruence would be the increased likelihood of recall for a pleasant image if that person experienced a pleasant mood at the time of encoding the target stimulus. A mood congruent memory effect would still be possible if a person had a neutral mood at the time of encoding but was experiencing a pleasant mood at the time of retrieval. Mood dependence refers to the experience of a mood at both encoding and at retrieval that

enhances the ability to recall information irrespective to the affective valence of the recalled stimulus (Eich & Macaulay, 2000). Similar to mood congruence, the mood at the time of viewing the image is important. Moreover, for mood dependent memory the individual also needs to be experiencing the same mood at the time of retrieval. In contrast to mood congruent memory in which the affective valence of the individual needs to be similar to the affective valence of the target stimulus, mood dependent memory is an increase in the ability to recall a target stimulus regardless of whether the affective valence of the stimulus matches the mood valence of the individual. Most of the studies reviewed here provide mood congruent findings.

The issue of external validity is raised when discussing the issue of mood induction. Westermann et al. (1996) also discussed how demand characteristics could induce participants to guess the purpose of the experiment and act "as if" they were experiencing the anxious mood state. They argued that the simulated mood state would adversely affect the external validity of study findings. Further, it was suggested that the use of mood rating scales could increase the likelihood of demand characteristics due to the face validity of the questionnaires (Westermann et al. 1996). Examining this very issue, Perrig and Perig (1988) examined if a simulated induced mood would demonstrate a mood congruent memory effect. Participants in Perrig and Perrig (1988) first study read the following written instruction: "With a tape recorder a number of words will be presented to you. Your task is to study these words. Please behave in this learning task as if you were in a state of extreme happiness" (p. 104). There are two interesting points about their simulated mood induction procedure. First, Perrig and Perrig (1988) found that participants in the simulated positive mood condition recalled more positive moods

when asked to behave as if they were in a state of extreme happiness. Their study demonstrated that a simulated mood could create mood congruent memory. The second salient point demonstrated by Perrig and Perrig was that their mood induction procedure was very short. This demonstrated that it is possible to induce moods quickly.

Eich and Macauley (2000) were intrigued by the Perrig and Perig (1988) study and wished to further examine whether simulated moods for mood congruent memory and mood dependent memory. Perrig and Perrig (1988) had attempted but failed to find mood dependent memory in their study. Eich and Macauley (2000) examined if simulated positive and simulated negative moods were different in how they affected mood congruent memory. They found that positive moods produced a reliable mood congruent memory effect that was similar to mood induction studies using continuous music technique. However, Eich and Macauley (2000) found that in the simulated sad condition, participants recalled more negative words than positive words. This contradicted their earlier findings where they demonstrated negative moods provided asymmetrical mood congruent memory. Eich and Macauley (2000) also found that simulated moods created larger memory effect of mood congruent memory. Finally, Eich and Macauley (2000) found that simulated moods could not create mood dependent memory. This final finding was puzzling given that mood congruent effects were more pronounced in simulated conditions rather than mood induced conditions. The salient point from their study and from the study by Perrig and Perrig (1988) is that simulated moods can reliably produce mood congruent effects. This study will be examining mood congruent memory thereby reducing the need to determine whether simulated or real emotions experienced.

Given the stated effectiveness of mood inductions, to have participants undergo a negative mood induction could seem as unsafe; however, studies have demonstrated the relatively short-lived duration of mood inductions. Rusting and DeHart (2000) induced negative and positive moods at retrieval in several experimental designs and to examine the mood-congruent memory effect. The memory task in their study was for participants to remember five events from their high school years. When participants were experiencing a positive mood, they remembered more positive events and when participants were experiencing a negative mood they remembered more negative events. Further, Rusting and DeHart observed that mood-congruent retrieval was present when the participants maintained the induced mood and that mood-congruent retrieval was absent when participants lost the induced mood. Participants in their study were able to ameliorate their negative mood by changing their thinking to reflect the opposite mood state and thereby not display any the negative mood-congruent memory effect.

The ability of participants to mollify the effects of mood induction on recall demonstrates the ease and flexibility of participants to return to a baseline level of mood. This is in contrast to typical conceptual thinking of moods. Mood states are often diffuse and enduring while emotions, in contrast, tend to be short-lived and directed at particular objects (Larsen, Berntson, Poehlmann, Ito, & Cacioppo, 2008). While it may be more accurate to label "mood inductions" as "emotion inductions", it could be argued that the purpose of the mood induction experiments is to simulate mood states. Nonetheless, it is favourable that emotions generated from mood induction experiments are transient mood states that last for seconds or minutes rather than long lasting moods that can last for days or longer. The short-lived moods provide a safer environment for participants. The

flexibility or short-lived nature of emotions generated from mood inductions may better approximate real world instances of negative mood induction that would occur for the majority of people on a daily basis.

Bradley, Codispoti, Cuthbert, and Lang (2001) examined the influence of these two component factors upon human physiology. In their study, Bradley et al. (2001) demonstrated the presentation of pleasant images induces modest increases in electrodermal activity and initial cardiac deceleration. They also demonstrated that in contrast to unpleasant pictures, pleasant pictures are not equally arousing for individuals; that is, there is a greater variance in arousal scores for pleasant images. They hypothesized that the degree of variation for arousal levels for pleasant images is likely related to the degree of deprivation associated with the pleasant image. For example, a hungry person would report a greater arousal rating to an image of food. Bradley et al. reported that the images rated as most unpleasant were pictures of mutilations, followed by pictures of human attack, accidents, loss, and illness. Those images were rated as more unpleasant than pictures of contamination, pollution, and animal attack. For the arousal levels of negative images, the images of human attack or animal attack were rated as more arousing than non-threatening images. Bradley et al. (2001) reported that the participants rated the highest levels of pleasantness for viewing images of family scenes and rated the highest level of arousal for erotic images.

When participants view IAPS images the initial physiological changes occur very quickly. Junghöfer, Bradley, Elbert, and Lang (2001) found that when 700 IAPS images were presented at three or five a second, the normative arousal ratings of the IAPS images predicted event-related potentials (ERPs) as measured by electroencephalography

(EEG). Junghöfer et al. observed that the emotional arousal differences occurred bilaterally over the occipital cortex and unilaterally over the right parietal cortex. Interestingly, participants in their study could not verbalize whether images were presented randomly or whether they were presented in blocks of different arousal levels. This lack of insight regarding item presentation was likely due to the fast presentation (200 or 333 ms per image).

Junghöfer et al. also examined variables associated with IAPS image presentation. They varied the levels of colour, brightness, spatial frequency, and the complexity of the images (complexity was modified by compressing the images using the JPEG format). The physiological observations were not significantly different between high and low arousal states for any of these variables. Cuthbert, Schupp, Bradley, McManis, and Lang (1998) examined how attentional resources affected the affected ratings of the IAPS images. They measured startle responses by observing reflexive eye blinks to startle tones and they measured ERP using an EEG. Half of the participants were asked to ignore the startle tone while the other participants were given a reaction time task whereupon they were asked to make a forced-choice decision concerning the startle tones. They found that blink responses increased during the presentation of unpleasant images in comparison to pleasant images. Cuthbert et al. found that participants had lower levels of EEG (P300) readings for arousing images (irrespective of hedonic valence) as opposed to low-arousal materials. In summary, blink responses were affected by the hedonic valence of the image, and EEG readings were affected by arousal levels. With regard to attention, Cuthbert et al. found the biological measures were robust to demands on attention when viewing IAPS images. Participants displayed the same

biological responses to images regardless of whether participants were engaged in a secondary task requiring timed forced choice decisions or whether their focus was entirely on the images.

Other studies have also examined attention level. Talmi, Schimmack, Paterson, and Moscovitch (2007) examined how the level of attention affects emotion enhanced memory. They coined the term emotion enhanced memory to describe the findings that arousing events are remembered better than neutral events. The authors stated that the importance of attention or arousal depended on the hedonic valence from the stimuli. Talmi et al. examined the recall of items after either a 20 second delay or a 50 minute delay and found that negative but not positive emotions generated from the IAPS images enhanced memory for those images even in conditions requiring divided attention. They concluded that for their study, the effect of positive emotion on memory was completely accounted for by the increased levels of attention. They demonstrated that divided attention affected the memory of neutral stimuli but did not affect the memory for emotional stimuli, particularly for negative emotion stimuli. In the previously described study by Sharot and Phelps (2004), the researchers examined how the participants' were able to recognition memory of peripheral objects in a divided attention task and they found that the level of attention did not affect recognition memory. Cutherbert et al. did not find any physiological effect of attention level by studying blink startle effects and P300 waves. Therefore, attention level is not likely to be a strong confounding factor even though a basic level of attention is necessary to demonstrate emotion enhanced memory. The lack of attention being a confounding factor may be due to a low-level orienting biological process involved for emotion enhanced memory.

Researchers have demonstrated that working memory can affect levels of emotional experience generated when viewing the IAPS images. Van Dillen and Koole (2007) varied the loads of working memory when participants were viewing pictures from the IAPS. They found that as working memory loads were increased, participants were less likely to feel a mood difference when comparing very negative images to slightly negative images. Their results indicate that the extent of negative hedonic valence was altered but the hedonic valence from the images were not eliminated nor were they changed to neutral. Further, their results were limited to demonstrating that working memory affected hedonic valence ratings, they did not demonstrate that it affected memory. This study demonstrates that even under high working memory loads images with negative hedonic valence will still be considered negative.

Anderson, Wais, and Gabrieli (2006) examined the function of emotional arousal following the presentation of neutral images. The authors induced a negative mood following the presentation of neutral faces or neutral houses, by showing participants images from the IAPS library that were emotionally negative arousing scenes, emotionally positive arousing scenes, or emotionally neutral scenes. After a one week delay, they asked participants to complete a recognition test regarding the images they had seen. For participants whose positive or negative emotions were aroused immediately following the presentation of neutral scenes, their recognition rate of the preceding neutral pictures or houses was improved (Anderson et al., 2006). Due to the similar memory modulation effect that both positive and negative images had upon preceding neutral events, the authors collapsed the positive and negative valence images and sorted them by degree of emotional arousal for their statistical analyses. The authors

had designed the study to minimize any carry-over effects between trials of the IAPS images by adding a flanker task and ensuring that the minimum duration of a trial would be between 23 and 28 seconds. Anderson et al. also examined the effect of novel neutral arousal or novel positive arousal post picture presentation would affect memory and they found that novelty without arousal was not sufficient to improve recall or recollection.

The study by Anderson et al. (2006) is important because it is the first to demonstrate that emotionally arousing images can enhance the recognition memory of a preceding neutral image (McGaugh, 2006). Anderson et al. provide evidence for retrograde memory enhancement. One week following the presentation of paired neutral and negative items, the neutral items were recalled with greater success. This means that memories of images that have neutral hedonic valences can be enhanced by negative emotions that immediately follow the image. It also indicates that future studies must be aware of the potential consequences of having short intervals between serially presented stimuli and should control for this by changing the study design or by choosing the appropriate statistics for interpretation of the data.

Negative stimuli again demonstrated an influence upon retrograde memory enhancement in a study by Finn and Roediger (2012). In their experiment, they asked participants to study lists of Swahili-English translations and then recall the English translation of a Swahili word following the study period. If participants correctly recalled a translation, they were presented with a blank screen, a neutral image, or an emotionally negative high arousal image. The image was present on the screen for 500ms. The neutral and negative images were taken from the IAPS (Lang et al., 1993). Following 10 lists of 10 word pairs, participants were asked to recall as many of the translations as

possible to indicate their memory for words. Finn and Roediger (2012) conducted this experiment with three different groups of people. Experiment 1 presented the images immediately after recall while in Experiment 2 images were presented two seconds after recall. For Experiment 3 participants were asked to restudy the words on a screen (rather than given a recall test) that were immediately followed by a blank screen, a neutral image, or an image with negative hedonic valence and high arousal. Finn and Roediger found that participants in Experiment 1 and 2 had a greater recall of vocabulary when presented with negative and high arousal images. Experiment 3 did not demonstrate any differences between types of images presented to the participants. The authors suggest that active retrieval is necessary for the participants to experience any benefit from highly negative and highly arousing images. This study again demonstrates the retrograde memory enhancement for negative stimuli using recall memory.

Atienza and Cantero (2008) investigated how sleep and emotions affect recall and recognition tasks. They asked half their participants to not sleep the night after they had been exposed to the emotional and non-emotional words. A week later, participants were tested for recall and recognition memory using the remember-know procedure. The remember-know procedure (Tulving, 1985) asks participants to view images and to state whether the image is new, remembered (considered to be recall memory), or known (considered to be recognition memory). Atienza and Cantero (2008) found that emotional images were remembered better than neutral images even when participants were sleep deprived the night following the experiment. Recall of images was affected by lack of sleep, but recognition memory was not. They also found that high arousal positive pictures were remembered better than 18% of the high arousal negative pictures

(Atienza & Cantero, 2008). Curiously, Atienza and Cantero elected to only have 40% of their picture stimulus come from the IAPS image database although they did testing to normalize their own image set. This finding from Atienza and Cantero is similar to the findings from Anderson et al. (2006) who found an effect for positive and negative images but not for neutral images.

Studies have also been examined gender differences to determine if gender differences affect mood and memory. Anderson et al. (2006) did not find any gender differences in their study suggesting that for their recognition ability, men and women are affected by emotional induction to the same degree. Bradley, Codispoti, Sabatinelli, and Lang (2001) also examined gender differences in rating the IAPS images. Bradley, Codispoti, Sabatinelli, and Lang (2001) wished to examine gender differences by comparing biological differences to socio-cultural differences by comparing electrodermal ratings and cardiac speed (less sensitive to cultural processes) to facial expressions and judgement scores respectively (more sensitive to socio-cultural processes). Overall, they found that men and women rated the images similarly, although there were some sex differences. Women tended to react to unpleasant and arousing pictures more negatively, while men tend to be more aroused by erotic imagery. There was concordance between biological measures and socio-cultural measures. This high concordance rate between physiological ratings and self-report ratings provides evidence suggesting that participants in their study were open and accurate in describing their responses to the images. Consequently, Bradley, Codispoti, Sabatinelli, and Lang suggest that these differences in image meaning between men and women are largely

biological. Nevertheless, they state that cross cultural studies would be beneficial to identify if differences are biological, socio-cultural, or a combination of both.

Stones and Bygate (2009) examined how mood induction would affect the memory for IAPS images. They induced a slightly anxious mood in half of their participants and displayed 57 images for six seconds each. They asked participants to rate the hedonic valence and the arousal level of each image as it was presented. They found that in general, high arousal items were recalled more frequently than low arousal items. Stones and Bygate reported that participants who had experienced an anxious mood induction recalled more unpleasant photographs. In addition, participants who had experienced an anxious mood induction rated the images more negatively, indicating that the mood induction was successful.

Summary

The literature in this section provides some background describing how moods affect memory. Research has demonstrated that moods have an effect upon memory especially for negative valence emotions and high arousal states that are generated from viewing IAPS images. Additionally, it also seems that the IAPS images affect men and women roughly equally. Next, an examination of individual differences will demonstrate how personality factors may be important in moderating the effectiveness of mood induction and thereby moderating the effectiveness of emotion enhanced memory.

Personality

Sojka and Guise (2006) examined how mood and cognition affect how people like an advertisement and how they like a brand. They measured mood using an 11-item Likert-type scale that asked people to identify their level of affinity for affect. Sojka and

Guise measured cognitive style using The Need For Cognition Scale. They found that people who described themselves as high affect type responded more favourably to visual stimuli. They also found that scores for both self-described affect affinity and need for cognition were correlated with responding more favourably to visual or verbal stimuli. Another study also demonstrated that people with higher levels of Neuroticism were more attentive to negative self-relevant information and Neuroticism (Reed & Derryberry, 1996). These studies provide some support for how personality traits affect personal choice. This section will provide an overview of the definition of personality traits followed by research describing how personality traits are relevant when investigating mood and memory.

There are various ways to classify normal personality functioning. The five-factor model was empirically developed using a lexical approach. In 1933 Thurstone stated that a list of 60 personality adjectives could be accounted for by the use of five factors (Digman, 1996). However, Thurstone did not follow up on this line of research and instead developed his own questionnaire, the Thurstone Temperament Schedule (Digman, 1996). Thurstone was the first to identify five factors but other researchers had also been working to identify personality factors that could explain human behaviour. Cattell and Eysenck developed the other notable conceptualizations of personality that were being developed in the early 20th century. Hans Eysenck developed his version of personality factors in the 1940s outlining three factors – extraversion, neuroticism, and psychoticism. Eysenck's factor of psychoticism has been described as a combination of conscientiousness and agreeableness (Digman, 1996). Cattell also began identifying personality factors in the 1940s and categorized personality functioning into 11

personality factors (Catell, 1947). Cattell eventually settled on 16 personality traits and developed the *16 PF Personality Questionnaire*, which identifies 16 personality factors. Goldberg (1990) has argued that only five personality traits of Cattell's 16 have been able to be replicated as independent factors. Goldberg describes these five personality traits as the "big-five". The big-five personality traits as described by Goldberg (1992) are: surgency (or extraversion), agreeableness, conscientiousness (or dependability), emotional stability (vs. neuroticism), and culture (or intellect or openness).

Personality factors have demonstrated predictive validity for many factors. Wilson, Krueger, Gu, et al. (2008) followed 6158 people aged 65 and older for a period of six years. They wished to examine if there was any correlation between morbidity and the personality traits of neuroticism and extraversion. To measure neuroticism, Wilson et al. used four items from the *NEO-PI-R* neuroticism scale (items 1, 21, 36, and 51). To measure extraversion, they used four items from the *NEO-PI-R* extraversion scale (items 2, 7, 27, and 32). For both brief versions of the scales, scores ranged from 0 to 48. To examine the validity of the brief four question measure of personality, the authors examined 903 older adults and compared their responses to the four questions to the broader 12 items. The correlation between the brief and standard measures was 0.83 for neuroticism and 0.84 for extraversion. After six years 2430 (39.5%) of the participants had died. Wilson et al. found that for each point of neuroticism there was a 1.6% elevated risk of death; for each point of extraversion there was a 1.6% decrease risk of death. However, the authors reanalyzed the data to control for cognition, level of socializing, and activity patterns. When these variables were controlled, the level of elevated risk for neuroticism was reduced by 54% and the elevated benefit of

extraversion was reduced by 54%. This study by Wilson et al. demonstrates a few important facets of normal personality testing. Firstly, personality measures are correlated with mortality rates. Second, is that it demonstrates that even very short versions of the *NEO-PI-R* have adequate validity. Research regarding the links between personality, mood, and memory will be described next.

Bienvenu, Samuels, Costa, et al. (2004) examined the relationships between normal personality functioning and a lifetime history of mental health issues. They examined the correlations between psychiatrist diagnoses using the *Schedules for Clinical Assessment in Neuropsychiatry* (*SCAN*; Wing et al., 1990) and the *Revised NEO Personality Inventory* (*NEO-PI-R*; Costa & McCrae, 1992) for 798 participants. Bienvenu et al. correlated the psychiatric diagnoses with the *NEO-PI-R* profiles. They found that simple phobia, panic disorder, and generalized anxiety disorder were correlated with higher scores of neuroticism. Social phobia and agoraphobia were correlated high neuroticism and low extraversion. Obsessive compulsive disorder was correlated with high neuroticism, high openness. Major depressive disorder was correlated with high neuroticism and dysthymia was correlated with a high neuroticism and a low extraversion. Other authors have examined how personality traits as measured by the *NEO-PI-R* were correlated to anxiety sensitivity (Cox, Borger, Taylor, Fuentes, & Ross, 1999). They found that anxiety sensitivity was correlated with high levels of neuroticism and low levels of extraversion. Cox et al. (1999) hypothesized that anxiety sensitivity could make some people more susceptible for mood induction. They believed that inducing moods could possibly lead to better memory.

Bienvenu et al. (2004) reported that the research literature has been consistent in demonstrating changes in normal personality functioning (higher neuroticism scores) while people are experiencing major depressive disorder than during symptom remission. This is particularly important because it may be demonstrated that people who have higher scores of neuroticism, which is normal for mental health disorders, have a greater /better memory for images that are negative. This would indicate that mental health clients are inclined to remember negative events, which could act to sustain the disorder.

Hooker, Verosky, Miyakawa, Knight, and D'Espisito et al. (2008) examined the neurological activation during fear and reward conditioning in addition to personality correlates. These authors used the five-factor model, specifically examining the role of neuroticism and extroversion. Historically high neuroticism was associated with increased sensitivity to punishment and a tendency to feel negative (Eysynk, 1967). However, Hooker et al. reported there has been little success in replicating this association. High extroversion is associated with increased sensitivity to reward resulting in greater risk in developing addiction disorders (Eysenck, 1967). Hooker et al. (2008) used the 44-question *Big Five Inventory* (John & Srivastava, 1999) to measure neuroticism and extroversion. They analyzed responses to happy, fearful, and neutral stimuli and examined 12 participants' ability to learn while being scanned with an fMRI (Hooker et al., 2008). The results from the fMRI demonstrated that high neuroticism was correlated with increased activity in the amygdala during fear learning, whereas, low extraversion was associated to greater amygdala activity during happy learning. The authors reported that they did not measure arousal. Hooker et al. hypothesized that low

extraversion may be related to a low basal level of arousal and that this low level of arousal may provide an advantage for learning (in certain contexts).

A study by LaRowe, Patrick, Curtain, and Kline (2006) supports this optimal arousal learning paradigm. LaRowe et al. found that extraversion was correlated with quicker habituation to an acoustic startle. The acoustic startle could be considered as a higher level of arousal and thereby requiring a higher basal arousal rate as suggested is need using the Optimal Arousal Theory.

Canli, Sivers, Whitfield, Gotlib, and Gabrieli (2002) demonstrated that extroversion is related to the degree of activation in the amygdala when presented with happy pictures. The higher the level of extroversion measured in participants, the greater the activation in the amygdala when presented with happy pictures. In addition, the authors demonstrated that the amygdala activation for negative pictures was not affected by extraversion scores. The authors did not detect any differences due to neuroticism scores, unlike the study by Hooker et al (2008). Canli et al. (2002) reported that this finding demonstrates the need for researchers to control for personality characteristics.

Using an fMRI Canli et al. (2001) examined if brain reactivity to emotional stimuli was correlated with personality traits. The authors used the *NEO-FFI* to measure personality traits. Canli et al. found that extraversion correlated significantly with brain reactivity to positive images in the brain regions of the amygdala ($r = 0.79$), middle frontal gyrus ($r = 0.79$), caudate ($r = 0.84$), and putamen ($r = 0.86$). Neuroticism correlated significantly with brain activity to negative images in the brain regions of the middle frontal gyrus ($r = 0.75$) and middle temporal gyrus ($r = 0.79$). The described

correlations were relative to positive pictures (for extraversion) and negative pictures (for neuroticism), as no neutral images were presented to the participants.

Personality has been demonstrated to be correlated with attention. Using an fMRI Amin, Constable, and Canli (2004) examined participants' performance in a dot-probe task. The dot-probe task presents participants with two images, where one of the images hides a dot-probe that is revealed as both images are removed. A fast response time indicates that participants were attending to the image associated with the hidden stimulus while a slow response time indicates that participants were attending to the other image. Personality was measured personality using the *NEO-Five Factor Inventory* (*NEO-FFI*; Costa & McCrae, 1992) and images were selected from the IAPS and included positive, negative, and neutral items. Amin et al. (2004) found that people with high Extraversion scores had faster response times when the stimulus was placed behind a neutral stimulus rather than a negative stimulus. They surmised that elevated extraversion scores are associated with an aversion to negative stimulus. The area of the brain active for high E individuals was the right fusiform gyrus; which the authors explained as an increased effort in visual search. Amin et al. reported that Neuroticism was not correlated with any findings at the chosen level of statistical significance of $p < 0.001$. Amin et al. conjectured that this may have been due to their participant sample (11 people, 5 who had the same neuroticism score). When the authors examined relationships at a $p < 0.01$ they found other regions were related to E was associated with greater anterior cingulate and amygdala activation when the dot-probe was hidden by the positive item of a positive/neutral pair. At a $p < 0.01$ level they also found that Neuroticism was associated with anterior cingulate activation when the dot-probe was

hidden by the negative item of a negative/neutral pair. These additional findings, while not significant a-priori, suggest that people high in Neuroticism attend more to negative information and that people high in Extraversion attend more to positive information.

Norris, Larsen, and Cacioppo (2007) measured skin conductance reactivity as a function of neuroticism and extraversion for emotionally evocative pictures. Norris et al. (2007) used the 40 items from Goldberg's (1992) *Big 5 Personality Dimensions* scale that measured neuroticism and extraversion. Norris et al. then presented 66 pictures from IAPS – 22 most negative pictures, 22 neutral pictures, and 22 most positive pictures. Neuroticism was correlated with skin conductance but extraversion was not. Participants with higher neuroticism scores demonstrated greater skin reactivity to both positive and negative images. Further, the duration of skin reactivity was longer for people high in neuroticism indicating that their physiological arousal from both positive and negative images was more prolonged.

Summary

The big five personality variables have been used to demonstrate how individual traits are related to performance. These previous studies have demonstrated that Neuroticism is correlated with changes in outcome when presented with negative stimuli while Extraversion is correlated with positive stimuli. The studies in the section have confirmed that personality traits can influence mood and memory. The inclusion of personality traits may provide additional information regarding an individual's memory for images.

Hypotheses

Anderson (2005) wrote that "if the focusing of attention represents a prioritizing of information processing, then the allocation of resources should be tightly coupled with information of biological or motivational import to the organism" (p. 258). The aims of this study include the replication and extension of findings by Stones and Bygate (2009). These authors reported that while experiencing a negative mood at the time of study, (1) more negative images were later recalled than non-negative images, (2) high arousal images were recalled more frequently than low arousal images, and (3) participants who had experienced an anxious mood induction rated the images more negatively and recalled more unpleasant than pleasant images. The present study included measurement of personality traits, which are hypothesized to affect valence and arousal ratings of images and moderate the effects of mood induction. The previous literature suggests the following model (Figure 4) of recall for images.

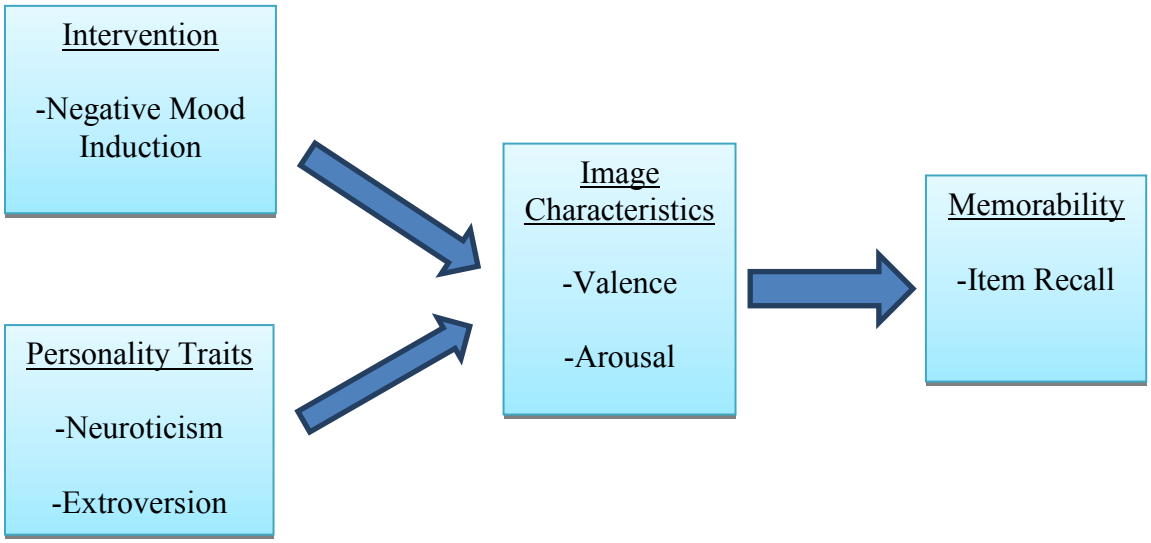

Figure 4. A model of the expected effects of intervention, personality traits, and image characteristics upon recall.

This model hypothesises four general areas that influence the dependent variable, item recall. Based on this model, developed from the findings of the literature review, the following main hypotheses and secondary hypotheses were tested.

Image Characteristics

1. The hedonic valence of the images will be correlated with image recall. Stones and Bygate (2009) found that recall correlated with the hedonic valence of the IAPS images. Specifically, they found a "J-shaped" curve for the negative mood induction group where images with a negative hedonic valence were recalled with greater frequency than images with a positive hedonic valence, which in turn were recalled with greater frequency than images with a neutral hedonic valence. Stones and

Bygate found a "U-shaped" curve for recall of images in the control group (negative and positive IAPS items were recalled equally well and superior to neutral IAPS items).

2. Images described as having higher levels of arousal will be more likely to be recalled, replicating one of the findings from the Stones and Bygate (2009) study.

Intervention

3. Participants who undergo a negative mood induction will rate all images with a more negative hedonic valence. These findings are expected to follow similar findings from the previous study by Stones and Bygate (2009).

4. Participants in the negative mood induction condition will recall negative images better than positive images. This hypothesis is supported by evidence that mood congruent events are better remembered (e.g., Haas & Canli, 2008; Rusting and DeHart, 2000). For example, the study by Stones and Bygate (2009) demonstrated that participants who had experienced a negative mood induction recalled more unpleasant images followed by pleasant images and finally neutral images.

Personality Traits

5. The 45° counter clockwise rotation of the circumplex model provides measures of positive and negative affect. Negative affect has been correlated with Neuroticism (Watson & Clark, 1994). Research has demonstrated the enhanced memorability of negative images

(e.g., Stones & Bygate, 2009) and negative affect is experienced more frequently by people with high Neuroticism (Bienvenu et al., 2004; Cox et al., 1999); consequently, it is hypothesised that participants with high neuroticism scale scores will report higher negative ratings to the IAPS images in the negative induced mood condition than in the control condition. This hypothesis is related to the personality construct that describes people with high neuroticism scale scores as being more emotionally labile.

6. Further, participants with high neuroticism scale scores will recall unpleasant photographs with a greater frequency in the negative mood induction condition than participants with low neuroticism scale (Canli et al, 2002; Hooker et al., 2008).

7. Extroversion has been correlated with positive affect as measured by the PANAS (Watson & Clark, 1994). Accordingly, participants with high extroversion scale scores will report positive pictures as more positive than participants with low extraversion scores. Extraversion has long been linked to the experience of positive emotions.

8. Research has demonstrated that people with high extraversion scale scores may also have higher base arousal rates (Amin et al., 2004; Canli et al., 2002). If extraverts do have higher base arousals rates it could be that participants scoring high in extroversion will demonstrate enhanced memory for high arousal images irrespective of hedonic valence relative to participants scoring low in extroversion; whereas people with high

neuroticism may recall high arousal high negative hedonic valence images with a greater frequency than individuals with low neuroticism scale scores.

Memorabilitiy

9. Recall rates tested 24 hours and 1 week after testing will demonstrate robustness to memory decay in the experimental condition. This reduced memory decay for images is expected to be positively correlated with scale score for neuroticism in both conditions for images rated as negative and arousing. Individuals with higher neuroticism are expected to have attention to negative information and therefore may display greater memory consolidation for negative and arousing images (Hooker et al., 2008).

Method

All procedures used were approved by the Lakehead University Ethics Board. Bonus points for Introductory Psychology students were approved by the Lakehead University Psychology Department.

Participants

Participants included university students enrolled in psychology courses (51 women and 24 men; mean age = 22.37 years) and people from the community (17 women and 9 men; mean age = 30.58 years). Students enrolled in a first year psychology course were awarded two extra percentage marks of extra credit for participation in the study. All other participants were entered into a draw for a $100 gift certificate from Walmart.

Materials

The NEO Five-Factor Inventory

The *NEO Five-Factor Inventory* (*NEO-FFI*; Costa & McCrae, 1992) is a 60 item questionnaire that measures five broad domains of personality functioning. The *NEO-FFI* is a shortened form of the *NEO Personality Inventory – Revised* (*NEO-PI-R*, Costa & McCrae, 1992), which is a 240 item questionnaire. The *NEO-FFI* measures the personality factors of neuroticism (N), extraversion (E), openness to experience (O), agreeableness (A), and conscientiousness (C). The *NEO-FFI* takes approximately 10 to 15 minutes to complete. The global factors are independently assessed with five 12-item scales. There have been some criticisms of the NEO-FFI by Deary et al. (1996) who found that the N scale of the NEO-FFI correlated with Extraversion and Conscientiousness. However, by December 2006 it was used in over 615 scientific studies (McCrae & Costa, 2007). The median internal consistency was reported as .80 (Costa & McCrae, 1992).

The *NEO-PI* was developed with six principles in mind. The first principle was the idea that there is a hierarchical structure to personality traits. The second was that the basis for the development of the personality traits was from the psychological literature. The third principle was that items were generated using a rational scale construction. The fourth principle was to develop the scale using psychometric principles. The fifth principle was to develop a parallel form to avoid the reliance on self-report. The sixth principle was of construct validation. Costa and McCrae (1992) examined the validity of the *NEO-FFI* by comparing results to *NEO-PI-R* responses obtained three years earlier by the same participants. They found that the correlations for the between the two measures over a three year period was .62 (N), .60 (E), .56 (O), .57 (A), and .61 (C).

The International Affective Picture Study

Fifty-seven images were selected from the International Affective Picture Study (IAPS; Lang, Bradley, & Cuthbert, 2008) for use in this study. The pictures chosen were the same as those used by Stones and Bygate (2009) who demonstrated that mood induction affected picture recall. The pictures consist of 19 unpleasant, 19 pleasant, and 19 neutral images (see Appendix A for description of the images and their respective mean ratings for hedonic valence and arousal level). Participants viewed images from one of two laptops monitors. Images were displayed from a distance of 50 to 75 cm from a 17" monitor displaying images at 1440x900 pixels or from an 11.6" monitor at 1376 x 768 pixels.

The hedonic valence and arousal ratings of the images were rated on 9-point Likert-type scales. The norms were developed in 14 separate studies involving 60 pictures each. Norms were developed for each picture 1) averaged across all subject, 2) averaged across male subjects, and 3) averaged across female subjects. Appendix A contains the averaged norms for all subjects, male and female. These norms were used to choose the images for the study and were not be used in the analyses. Participants were be asked to rate each image and those ratings were used for the analyses.

Procedure

Session 1. Prior to participation people were provided information regarding the nature of the experiment (see Appendix B). Participants were then asked to read and sign the consent form (Appendix C). Next, participants were asked to complete the *NEO-FFI*. Half of the participants (N = 51) were randomly assigned to the mood induction condition and the other half (N = 50) were assigned to the control condition.

The mood induction procedure was the same as the method used by Stones and Bygate (2009). The mood induction was the imagination-type, which was previously described as being efficacious. Stones and Bygate (2009) demonstrated that it was an effective procedure for producing differences in mood induction. Participants who were randomly assigned to the mood induction condition were asked to complete two open ended questions: 1) "What will physically happen to you when you die?" and 2) "What emotions did the thoughts of dying elicit?" Participants in the control condition were asked to think about the same questions in regards to their thoughts about their next meal, a relatively neutral topic, as a substitute of for thoughts of their death. These questions were derived from a study by Landau et al. (2006) who asked participants to rate pieces of art. Participants were randomly assigned to a death salience condition or the control condition (asking them to write about their next exam). Landau et al. found that participants rated art work as less attractive than people in the control condition.

Participants were then provided instructions (Appendix D) that described the computer presentation of images and how to rate each image. Participants were provided with the instructions to read as they were being read aloud by the experimenter, which took approximately five minutes. The text for the instructions was taken from the IAPS instructions for rating images. Participants were informed that for each image they would be asked to rate the level of valence they experienced from viewing the image and the level of arousal they experienced from viewing the image. Following the reading of instructions participants were asked to rate their current mood using a 1 to 9 Likert-type scale, with the anchors of unpleasant, neutral, and pleasant. They were also asked to rate

their level of arousal using a 1 to 9 Likert-type scale, with the anchors of calm and excited (see Appendix E for the mood and arousal rating scales).

Having participants rate their moods using a Likert-type scale following instructions was deliberate. Rather than taking mood ratings immediately following mood induction, ratings were recorded following the instructions to examine how participants felt after a few minutes of instruction, an event with an assumed neutral hedonic valence. The use of a Likert-type measure for mood and arousal following instruction to participants was to reduce the formation of demand characteristics which could diminish the external validity of the study (Westermann et al., 1996). Additionally, asking participants their mood and arousal levels prior to seeing images provided participants with a practice in how to use the Likert-type scales to rate the images that were to follow. Using this method to identify mood will also replicate the procedure used by Stones and Bygate (2009).

Participants were then shown 59 images from the International Affective Picture Survey (IAPS) library over a computer monitor one at a time. The first two images were examples meant to accustom participants to the experiment. It took participants approximately 30 minutes to complete this section of the experiment. There were three orders of image presentation; one order was randomly selected for each participant. The first two practice example images were identical in each presentation order and they were not included in the final analyses. Each order of image presentation consisted of 19 sets of three images for a total of 57 images. The three images in each set were comprised of IAPS images from each of the standardized hedonic valence categories; one image from the negative hedonic rating set of images, one image from the positive hedonic rating set

of images, and one image from the neutral hedonic rating set of images. Presenting the images in this manner was done to ensure that images from each hedonic valence category were displayed equally throughout the experiment. This minimized any potential confounding effects that could arise due to a succession of negative or positive images, which could have exaggerated the effects of hedonic rating. This presentation also minimized any confounding effects that could occur due to having a preponderance of positive or negative items at the beginning or end of the experiment, which could have influenced recall via serial position effect (Ebbinghaus, 1885).

Each IAPS image was displayed for six seconds after which time the image was removed. Two questions then appeared on the screen and participants were asked to rate the image on a 9-point Likert-type scale. Participants were asked to rate the images with the questions "How pleasant was the image you just saw?" and "How arousing was the image you just saw?" (See Appendix E). The questions were displayed for 14 seconds before the questions were removed from the screen and the experiment proceeded with the following image. The participant indicated their answers to these questions on a separate piece of paper, identified by their participant group (1 = control group, 2 = mood induction group), the presentation order (a, b, or c), and participant number (01 to 103). Each image was displayed for six seconds and was followed by a request for the participants to rate the hedonic valence and arousal of the preceding image. This continued until all images have been displayed. This technique of rating images immediately after presentation is standard procedure for rating IAPS images and it was also the procedure used by Stones and Bygate (2009); therefore, it was not expected to affect the mood induction effectiveness. Further, immediately rating the images could

provide information regarding the strength and duration of mood induction, by comparing the image ratings between the mood induction group and the control group as the experiment progresses over the 57 images.

Following the presentation of images, participants were asked to rate their mood and level of arousal using the questions in Appendix E. This rating was used to examine any effects of the mood induction that may have remained by the end of the experiment. Next, participants were asked to recall as many photographs as they could remember by providing written descriptions of the images. Participants were given the opportunity to submit their names and addresses for a mailed summary of the findings from the experiment, which were kept separate from their experimental responses so as to maintain anonymity.

Participants were then invited to participate in two more sessions that were to be done online from any computer with an internet connection. They were informed that each session would take approximately 15 minutes and that they were free to decline the participation without prejudice if they wish. They were informed that if they chose to participate further they would receive two emails. The first email would be sent to them approximately 24 hours after the initial session and would provide a link to follow for the online website where they would be asked a few questions about the experiment. The second email would be sent one week after the initial session and would have a similar link with similar questions. If participants instead chose to decline further participation, they were thanked for their time and provided with a debriefing form (see Appendix G). All but one participant agreed to partake in the second and third sessions, and they

submitted their email addresses to be contacted with further information. Total time of participation for Session 1 was approximately one hour.

Session 2. Twenty-four hours after participants have completed session 1, an email was sent to the 100 participants who agreed to take part in the second experiment. Of the initial 101 people who participated in Session 1, 92 people (91.1%) completed session 2. The email provided participants with a link to an individualized webpage to answer a few questions at www.surveymonkey.com. The survey asked participants for their participant number, which was included in the email to them and was used as a double check to verify the identity of the respondent. They were then asked to rate their current mood and arousal levels using the questions in Appendix E. Next, participants were asked to recall as many of the 57 images as they could. Finally, participants were asked if they wish to participate in the third and final questionnaire. If they choose not to participate in Session 3, no further email was sent, the person will be thanked for their participation, and the person was provided with debriefing information that could be printed (see Appendix G). This took participants approximately 10 minutes.

There were a few reasons to use SurveyMonkey to capture responses rather than asking participants to reply in an email. First, the use of SurveyMonkey allowed for anonymity of responses, as compared to an email response that would include identifying information. Second, SurveyMonkey allows for contingencies management. For example, if a participant declined further participation then the survey tool provided participants with the debriefing form (Appendix G) which was printable. The survey tool also prevented participants from accessing the questionnaire twice; the link provided brought them to a unique webpage which could only work once. Finally, SurveyMonkey

provided a time of start and time of completion for the questionnaire. The completion time was used to calculate the time lapse between initial presentation and the following two sessions.

Session 3. One week after participants completed Session 1, an email was sent to them asking them to visit a webpage to answer a few questions. This only occurred if they have agreed to continued participation at the end of session 2. Of the 92 people who completed session 2 and who elected to proceed, 75 people (81.52%) completed Session 3. Therefore, 74.25% of the original 101 participants in Session 1 completed all three sessions. In Session 3 the email link directed participants to their own unique page on SurveyMonkey that captured the same information as Session 2, which included mood, arousal, and their recollection of as many of the 57 images as they could remember. Finally, participants were thanked for their contribution and provided with debriefing information that could be printed out (see Appendix G). This took approximately 10 minutes.

Results

Demographic Profile

There were 101 people who completed Session 1, of which 68 were females and 33 were males (67.33% female). Of the 92 people who completed Session 2 there were 62 females and 30 males (67.39% female). For Session 3, 77 individual competed the study, 52 individuals were females and 25 were males (68% female). Therefore, attrition was similar for females and males.

Participants were randomly assigned to the groups so that 51 were in the Experimental condition and 50 were in the Control condition. For Session 2, 49 of the

participants were from the Experimental condition and 43 were from the Control condition. For Session 3, 39 participants were from the experimental group and 38 from the control group.

Groups were compared using a General Linear Univariate Model for differences in base rates for Age, Sex, and Picture Order (Table 1). There were no significant differences between groups for Age (F[23,100] = 1.195, p = 0.301), Sex (F[1,101] = 0.001, p = 0.979), and Picture Order (F[2,101] = 0.126, p = 0.634).

Table 1.

General Linear Univariate Model to examine for Group differences for Sex, Age, and Picture Order

Effect	Type III Sum of Squares	*df*	*F*	Sig.
Corrected Model	13.764	58	0.868	0.695
Intercept	129.255	1	472.748	<0.001
Sex	0.000	1	0.001	0.979
Age	7.514	23	1.195	0.301
Picture Order	0.252	2	0.461	0.634
Sex x Age	2.941	9	1.195	0.323
Sex x Picture Order	0.747	2	1.367	0.266
Age x Picture Order	1.961	14	0.512	0.912
Sex x Age x Picture Order	0.120	4	0.110	0.978
Error	11.483	42		
Total	254.000	101		
Corrected Total	25.248	100		

Personality Profile

The mean scale scores for the personality traits are presented in the Table 2, these scores are similar to the *NEO-PI-R* reported means.

Table 2.

Mean Personality Scale Scores for Participants

Personality Scale	N	Minimum	Maximum	Mean	Std. Deviation
Neuroticism	101	4	40	21.00	8.142
Extraversion	101	14	42	30.80	5.503
Openness to Experience	101	18	42	30.23	6.278
Agreeableness	101	14	43	31.00	5.769
Conscientiousness	101	12	47	30.96	7.155

Personality traits were examined using a General Linear Multivariate Model for differences in Sex, Group, and Picture Order (Table 3). There was a significant difference in Sex (F[5,85] = 4.093, p = 0.002); the between subject factors being significant for Agreeableness (F[1,89] = 5.88, p = 0.017) and Conscientiousness (F[1,89] = 4.02, p = 0.048). Women had higher Agreeable and Conscientious scale scores than men, M = 32.00 versus M = 28.94 and M = 31.93 versus M = 28.97 respectively. Personality sex differences are expected due to the naturally occurring mean differences (Costa & McRae, 1992). Further, there was a marginally significant interaction between Sex, Grouping, and Neuroticism (F[1,89] = 4.49, p = 0.037).

Table 3.

General Linear Multivariate Model to examine for Group differences for Sex, Age, and Picture Order

Effect	F	Hypothesis df	Error df	Sig.
Intercept	2165.092	5	85	<0.001
Sex	4.093	5	85	0.002
Group	2.008	5	85	0.086
Picture Order	1.095	10	170	0.369
Sex x Group	1.522	5	85	0.192
Sex x Picture Order	1.360	10	170	0.203
Group x Picture Order	0.951	10	170	0.488
Sex x Group x Picture Order	0.497	10	170	0.890

Note. Wilks' Lamba statistic was used for calculations

Figures 5 to 9 present histograms of the scale score values of the personality traits to demonstrate the variability of distributions for each of the traits.

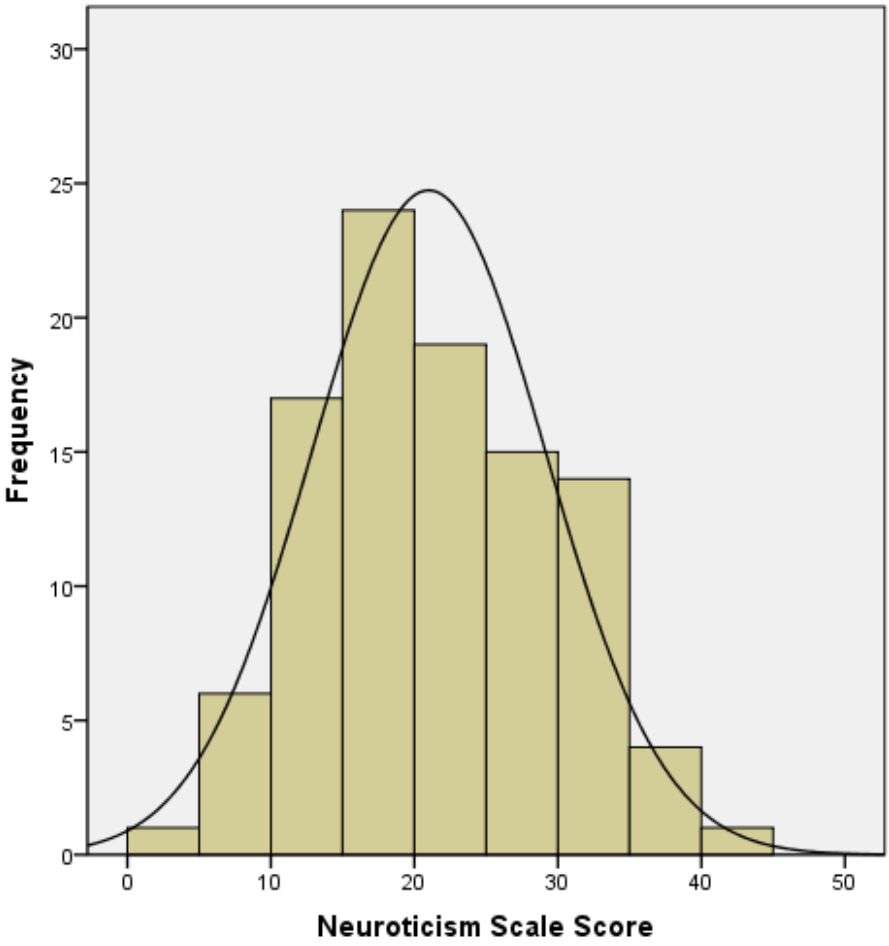

Figure 5: Distribution of participant scale scores for Neuroticism measured using the *NEO-FFI*.

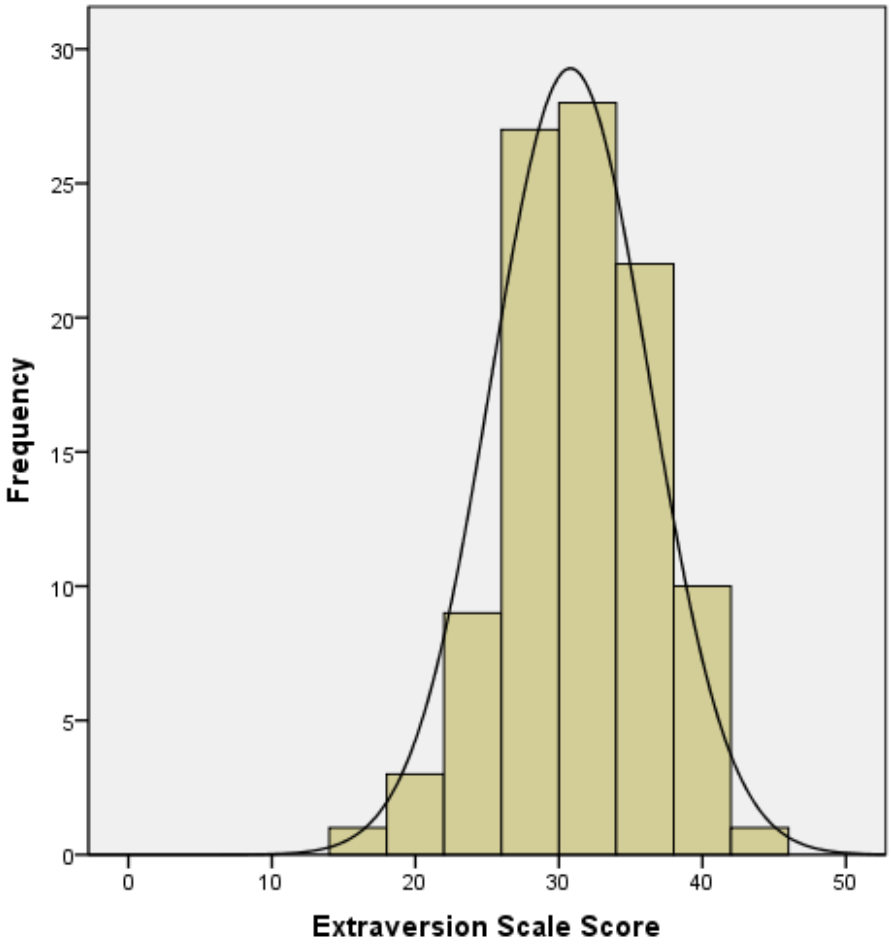

Figure 6: Distribution of participant scale scores for Extroversion measured using the *NEO-FFI*.

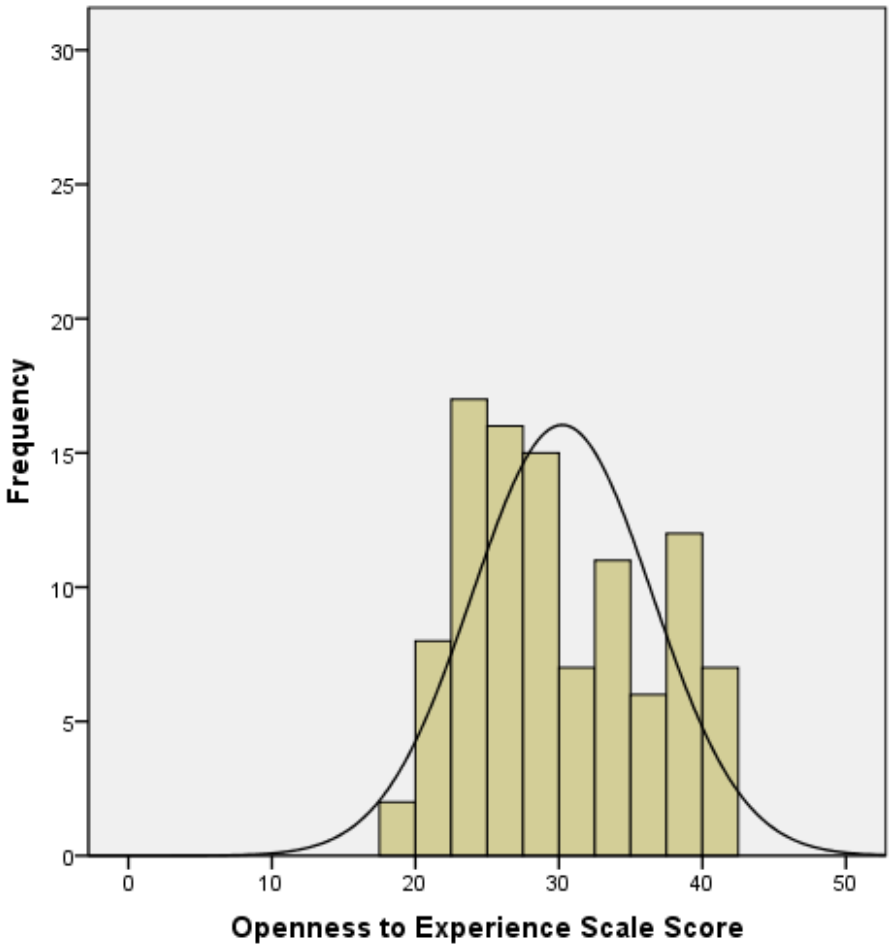

Figure 7: Distribution of participant scale scores for Openness to Experience measured using the *NEO-FFI*.

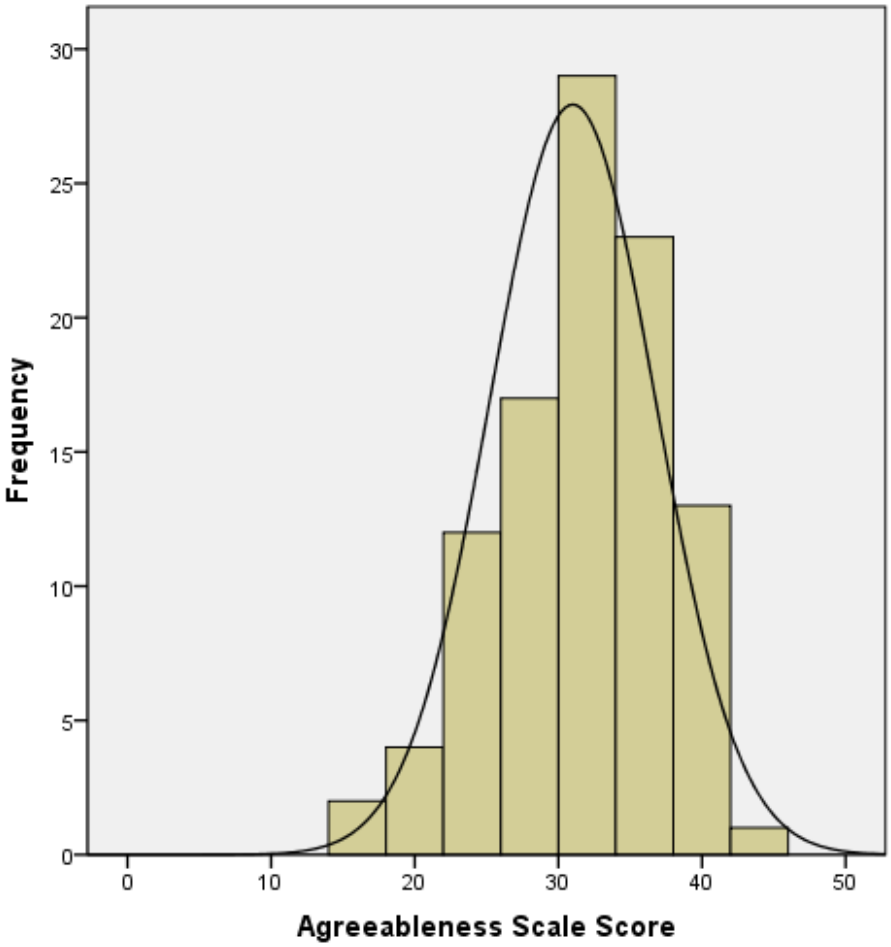

Figure 8: Distribution of participant scale scores for Agreeableness measured using the *NEO-FFI*.

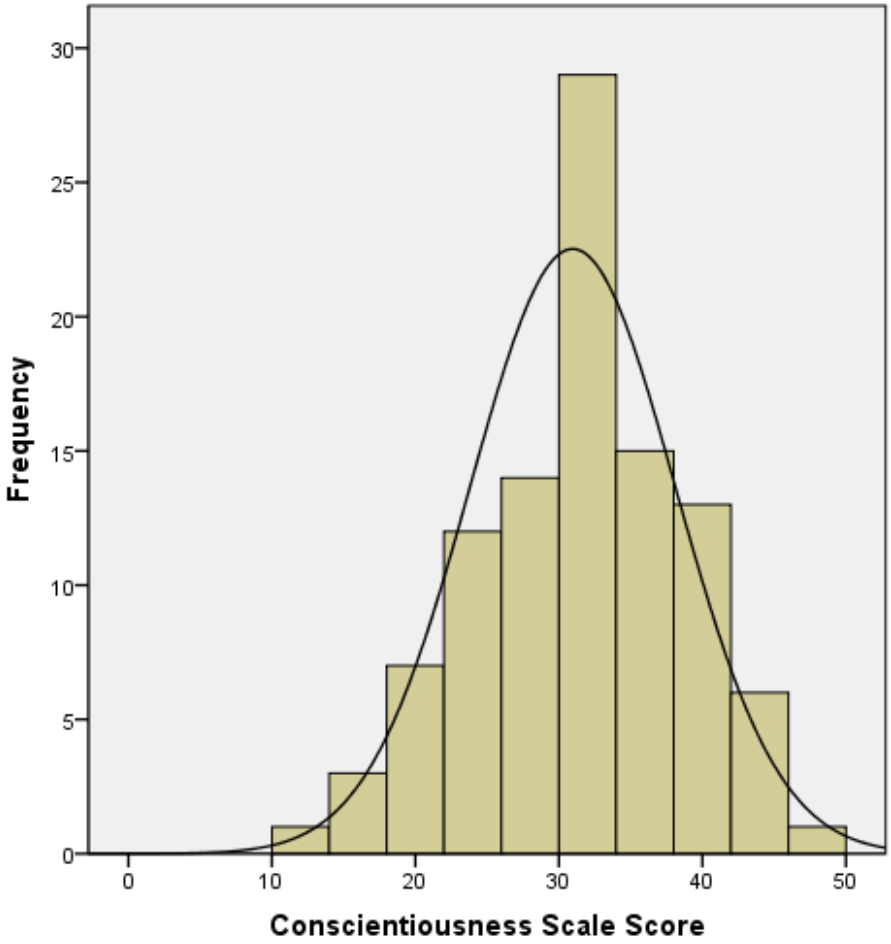

Figure 9: Distribution of participant scale scores for Conscientiousness measured using the *NEO-FFI*.

Valence and Arousal

The participants' report of IAPS image hedonic valance and arousal levels were analyzed. The mean hedonic rating for IAPS images was 4.77 (*SD* 2.37) mood and the mean arousal rating was 4.55 (*SD* 2.32). See Figure 10 and 11 for illustration of the distributions. The ostensibly flat distributions in the hedonic ratings support the choice of 57 images from the complete set of IAPS images. That is, each hedonic valence and arousal rating were adequately represented by the choice of images.

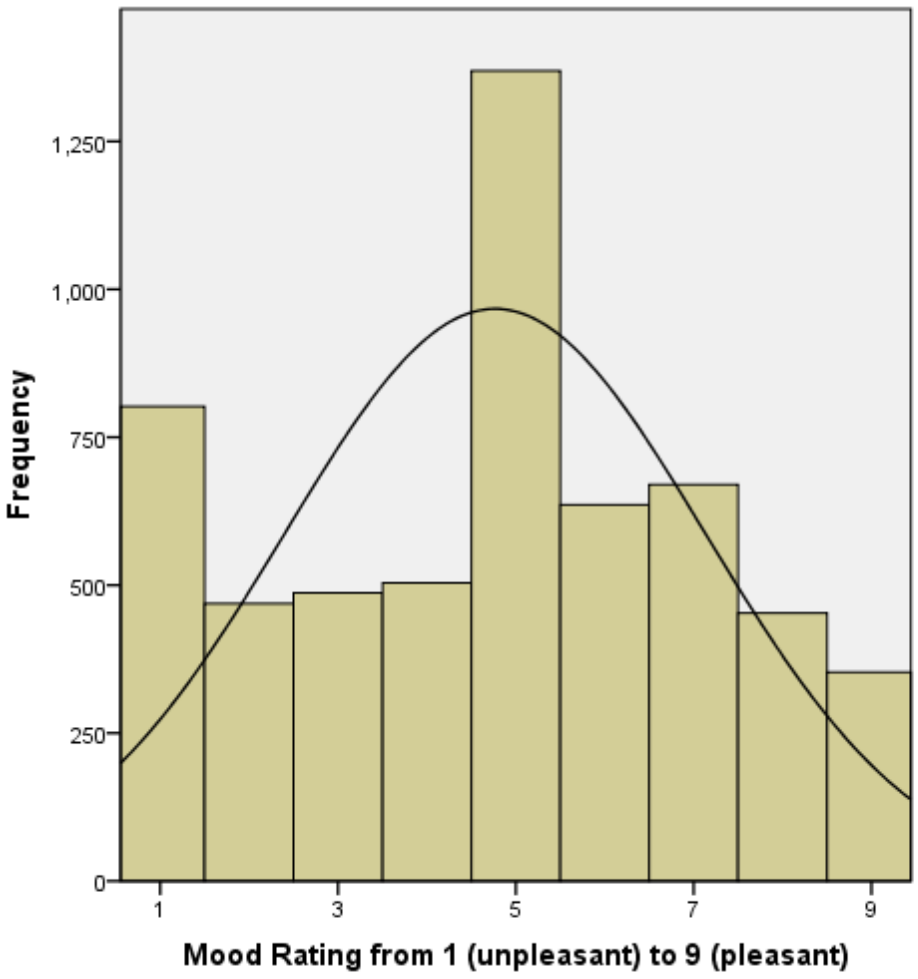

Figure 10. Frequency of Hedonic Valence ratings given by the 101 participants for the 57 images.

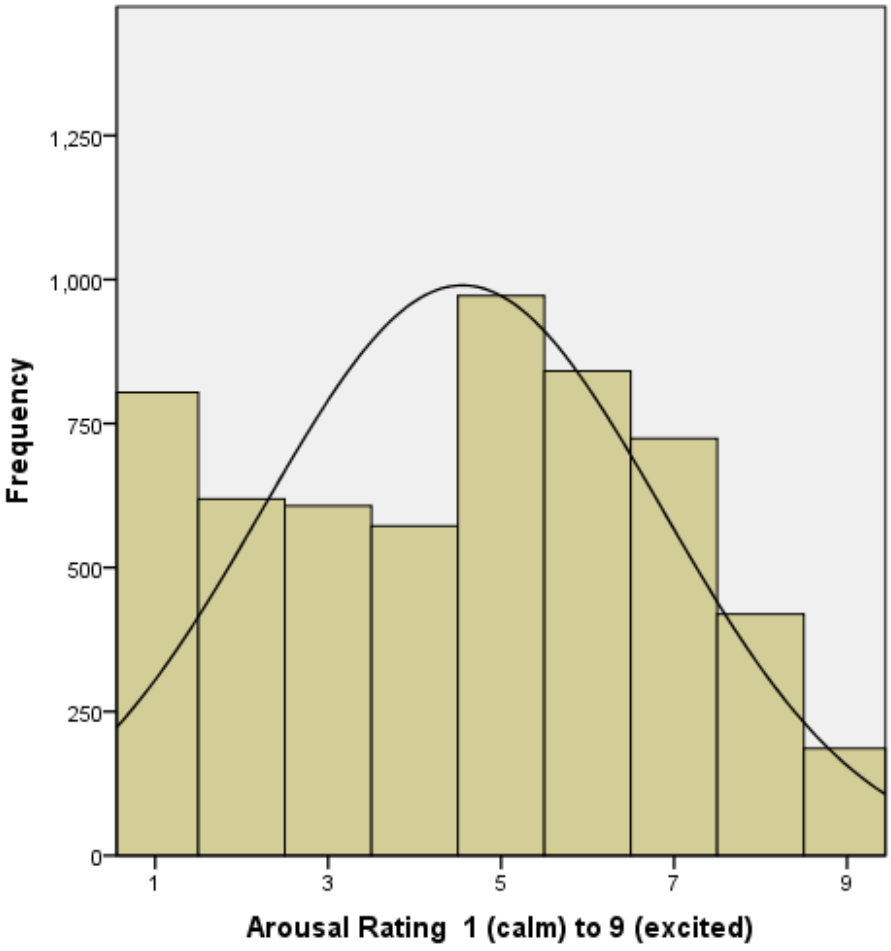

Figure 11. Frequency of Arousal ratings given by the 101 participants for the 57 images

Memory Recall

Prior to the analysis of the participants' recall information, two judges independently examined the recalled items to determine if the description provided by the participants matched one of the 57 experimental images. The independent judges agreed on 1367 recollections and disagreed on 48 of the recollections (agreement 96.61% of the time). The 48 recollections that were not agreed upon were not used in the analyses. Participants also often recalled the practice items that had been presented to accustom them to the experiment. Recollections of practice items were also not used in the analyses. The degree of inter-rater agreement is similar to the one by Stones and Bygate (2009) who demonstrated a very high inter-rater reliability for items recalled or not recalled (reliability of .95).

There were a total of 57 images that could be recalled for each of the three time periods. The mean number of items recalled in Session 1 was 23.37 (*SD* 26.22), in Session 2 was 17.67 (*SD* 26.22), and in Session 3 was 13.11 (*SD* 23.94). See Table 4 for a listing of the items recalled by condition and session.

Table 4.

Successful Recall of the 57 Images over the Three Sessions

Session	Group	N	Mean	Standard Deviation	Min	Max
Session 1	Control	50	22.48	7.54	7	38
(immediate)	Experimental	51	24.71	8.51	4	46
	Total	101	23.60	8.04	4	46
Session 2	Control	45	17.24	9.59	0	35
(two days)	Experimental	49	19.88	9.32	2	43
	Total	94	18.62	9.49	0	43
Session 3	Control	38	16.71	8.65	1	32
(nine days)	Experimental	39	17.79	9.39	2	41
	Total	77	17.26	8.99	1	41

Although Session 2 emails were sent out 24 hours after the completion of session one there was great variance in responding to the online questionnaire (M = 2.20 days, SD = 1.98 days). The average time of response for Session 3 participants was also varied (M = 9.07 days, SD = 6.90 days). The issue of a variable response time is important because memory is known to decay over time. Memory decay is understood to proceed quickly at first and then become more gradual over time. Therefore, it would be expected that any effects of time of responding would be more pronounced during Session 2 in comparison to Session 3.

A bivariate correlation analysis was conducted to examine for any effects of the responding time following the presentation of items. Included in the analysis were number of hours till Session 2, number of hours until Session 3, number of images recalled at Session 1, number of images recalled at Session 2, and number of images recalled at Session 3. Time of response for Sessions 2 and 3 were not significant contributors to the number of items recalled during those sessions. There was a slightly negative correlation during Session 2 between time of recall and number of recalled, which was expected, but it was not significant. Therefore, the recall of images was not affected by the variation in response timing for Sessions 2 and 3. As expected, the number of items recalled during Sessions 1, 2, and 3 were all significantly correlated with each other. There was a significant correlation of number of items recalled at Session 1 and 2 (r = 0.771, df = 101, $p < 0.001$), between number of items recalled at Session 1 and Session 3 (r = 0.806, df = 77, $p < 0.001$), and between number of items recalled at Session 2 and Session 3 (r = 0.936, df = 77, $p < 0.001$). See Table 5 for the complete list

of correlations. These findings demonstrate that even though memory is generally understood to decay over time and although participants responded to the emails at different times, the variation in response times was not enough to significantly affect the number of items recalled. The number of items recalled during each session was highly correlated with the number of items recalled at later sessions providing some support that the individuals provided good effort to the study even when doing Sessions 2 and 3 from locations that were convenient to them.

Table 5.

Correlations between time of recall and number of items recalled

	S1 images recalled	Elapsed time before S2	S2 images recalled	Elapsed time before S3	S3 images recalled
S1 images recalled					
Pearson Correlation	1				
Sig. (2-tailed)					
N	101				
Elapsed time before S2					
Pearson Correlation	.068	1			
Sig. (2-tailed)	.514				
N	94	94			
S2 images recalled					
Pearson Correlation	.771	-.179	1		
Sig. (2-tailed)	.000	.085			
N	94	93	94		
Elapsed time before S3					
Pearson Correlation	.059	-.048	.131	1	
Sig. (2-tailed)	.607	.672	.249		
N	79	79	79	79	
S3 images recalled					
Pearson Correlation	.806	-.145	.936	.092	1
Sig. (2-tailed)	.000	.208	.000	.428	
N	77	77	77	77	77

Note. S1 = Session 1, S2 = Session 2, S3 = Session 3

Influences on Hedonic and Arousal

The Generalized Linear Model (GLM) function is being used with increasing frequency for many sciences where there is interdependence between variables. One advantage of GLM is that there is greater flexibility in the number of observations and greater flexibility for the variance of the observations for each subject. GLM is particularly appropriate because it can take account of missing data without casewise deletion. Further, using GLM there is an assumption that observed variables at times 1, 2, and 3 are related rather than independent. Given this experimental design, GLM was used. The covariates of Sex, Intervention, Mood, Arousal, and personality variables were centred on grand means, the order of presentation was used as a repeated term, and order categories a factorial term. Mood and Arousal refer to the individual's ratings of each of the 57 IAPS images.

Hedonic Ratings

The initial GLM analysis examined how hedonic rating was affected by Intervention, Sex, Age, and Picture Order (see Table 6). Picture Order was used were included in all GLM analyses due to the expected effect of image on hedonic rating, arousal rating, and recall for all time periods. Across all analyses Picture Order was significant and due to space concerns the inclusion of 57 images they are not reported in the tables. There was a significantly ($p = 0.011$) higher level of moods in males (coefficient of 0.1993) and a significantly ($p = 0.036$) higher mood in the Experimental condition (coefficient of 0.1659).

Table 6.

Generalized Linear Model to examine for differences in Hedonic Levels for Intervention, Sex, Age, and Picture Order

			95% Wald Confidence Interval		Hypothesis Test		
Effect	*B*	Standard Error	Lower	Upper	Wald Chi-Square	*df*	Sig.
Intercept	6.133	0.1882	5.7637	6.5013	1062.0311	1	>0.001
Intervention	0.166	0.0790	0.0111	0.3208	4.4130	1	0.036
Sex (Male)	0.199	0.0782	0.0460	0.3527	6.4927	1	0.011
Sex x Intervention	0.099	0.1570	-0.2088	0.4065	0.3965	1	0.529
Age	0.007	0.0052	-0.0036	0.0169	1.6335	1	0.201

Note. Dependent variable: Mood Rating from 1 (unpleasant) to 9 (pleasant)

In the second analysis, Personality Traits were added to the list of variables to determine any effects they might have. Sex was again significant ($p = 0.018$) with a higher level of mood in males (coefficient of 0.204). A higher level of Openness was also significantly ($p = 0.002$) related to hedonic ratings (coefficient of 0.016). However, with the addition of personality traits, Group was no longer a significant predictor of hedonic rating (see Table 7). Given that Sex was significant for the first set of analyses with hedonic ratings, a GLM using a Sex x Group interaction was included as well as the arousal ratings for items. For the effects on hedonic ratings (Table 8), Sex continued to be significant ($p = 0.031$, estimated coefficient of 0.195) as did Openness ($p = 0.001$, estimated coefficient of 0.018).

Table 7.

Generalized Linear Model to examine for differences in Hedonic Ratings for Intervention, Sex, Age, and Picture Order for the five personality traits

			95% Wald Confidence Interval		Hypothesis Test		
Effect	*B*	Standard Error	Lower	Upper	Wald Chi-Square	*df*	Sig.
Intercept	6.132	0.188	5.764	6.501	1064.889	1	>0.001
Intervention	0.142	0.082	-0.018	0.302	3.037	1	0.081
Sex (Male)	0.204	0.087	0.035	0.374	5.567	1	0.018
Sex x Intervention	0.154	0.164	-0.168	0.476	0.880	1	0.348
Age	0.002	0.005	-0.008	0.012	0.176	1	0.675
Neuroticism	-0.003	0.006	-0.014	0.009	0.224	1	0.636
Extroversion	-0.011	0.007	-0.024	0.001	3.010	1	0.083
Openness	0.016	0.005	0.006	0.027	9.416	1	0.002
Agreeableness	0.007	0.008	-0.007	0.022	0.970	1	0.325
Conscientiousness	0.009	0.006	-0.003	0.020	2.308	1	0.129

Note. Dependent variable: Mood Rating from 1 (unpleasant) to 9 (pleasant)

Table 8.

Generalized Linear Model to examine for differences in Hedonic Ratings for Intervention, Sex, Sex x Intervention, Item Arousal, Age, and Picture Order for the five personality traits

			95% Wald Confidence Interval		Hypothesis Test		
Effect	*B*	Standard Error	Lower	Upper	Wald Chi-Square	*df*	Sig.
Intercept	6.130	0.190	5.758	6.501	1045.311	1	>0.001
Intervention	0.140	0.081	-0.020	0.300	2.947	1	0.086
Sex (Male)	0.195	0.090	0.018	0.372	4.671	1	0.031
Sex x Intervention	0.149	0.165	-0.173	0.472	0.822	1	0.365
Arousal	-0.023	0.041	-0.103	0.057	0.323	1	0.570
Age	0.003	0.005	-0.007	0.012	0.273	1	0.601
Neuroticism	-0.002	0.006	-0.014	0.009	0.158	1	0.691
Extroversion	-0.011	0.007	-0.024	0.002	2.680	1	0.102
Openness	0.018	0.006	0.007	0.029	10.185	1	0.001
Agreeableness	0.008	0.008	-0.007	0.023	1.019	1	0.313
Conscientiousness	0.009	0.006	-0.002	0.021	2.408	1	0.121

Note. Dependent variable: Mood Rating from 1 (unpleasant) to 9 (pleasant)

Arousal Ratings

The next set of analyses examined Arousal Ratings for Intervention, Sex, and Age and there were no significant relationships (see Table 9). When Personality Traits were added to the GLM analysis, a higher level of Openness was significantly ($p > 0.0001$) related to arousal ratings (estimated coefficient of 0.034) (Table 10). For Arousal ratings (Table 11), Openness was again significant ($p > 0.001$, estimated coefficient of 0.064).

Table 9.

Generalized Linear Model to examine for differences in Arousal Ratings for Intervention, Sex, Age, and Picture Order

			95% Wald Confidence Interval		Hypothesis Test		
Effect	*B*	Standard Error	Lower	Upper	Wald Chi-Square	*df*	Sig.
Intercept	4.436	0.227	3.991	3.881	381.874	1	>0.001
Intervention	-0.004	0.203	-0.402	0.393	0.000	1	0.984
Sex (Male)	-0.387	0.237	-0.852	0.077	2.672	1	0.102
Sex x Intervention	-0.093	0.473	-1.020	0.834	0.039	1	0.844
Age	0.028	0.145	0.000	0.057	3.760	1	0.052

Note. Dependent variable: Arousal Rating from 1 (calm) to 9 (excited)

Table 10.

Generalized Linear Model to examine for differences in Arousal Ratings for Intervention, Sex, Age, and Picture Order for the five personality traits

			95% Wald Confidence Interval		Hypothesis Test		
Effect	*B*	Standard Error	Lower	Upper	Wald Chi-Square	*df*	Sig.
Intercept	4.436	0.226	3.993	4.878	386.329	1	>0.001
Intervention	-0.094	0.198	-0.481	0.293	0.226	1	0.634
Sex (Male)	-0.202	0.450	-1.085	0.681	0.201	1	0.654
Sex x Intervention	-0.394	0.237	-0.859	0.071	2.753	1	0.097
Age	0.023	0.016	-0.008	0.053	2.082	1	0.149
Neuroticism	0.020	0.012	-0.004	0.043	2.738	1	0.098
Extroversion	0.018	0.018	-0.017	0.054	1.022	1	0.312
Openness	0.064	0.015	0.034	0.093	17.517	1	>0.001
Agreeableness	0.009	0.019	-0.028	0.047	0.226	1	0.634
Conscientiousness	0.012	0.012	-0.011	0.035	0.997	1	0.318

Note. Dependent variable: Arousal Rating from 1 (calm) to 9 (excited)

Table 11.

Generalized Linear Model to examine for differences in Arousal Ratings for Intervention, Sex, Sex x Intervention, Item Mood Rating, Age, and Picture Order for the five personality traits

			95% Wald Confidence Interval		Hypothesis Test		
Effect	*B*	Standard Error	Lower	Upper	Wald Chi-Square	*df*	Sig.
Intercept	4.472	0.228	4.025	4.918	385.698	1	>0.001
Intervention	-0.090	0.199	-0.479	0.299	0.207	1	0.649
Sex (Male)	-0.198	0.451	-1.081	0.685	0.193	1	0.660
Sex x Intervention	-0.388	0.237	-0.852	0.075	2.695	1	0.101
Mood	-0.026	0.040	-0.104	0.052	0.437	1	0.509
Age	0.023	0.016	-0.008	0.053	2.097	1	0.148
Neuroticism	0.020	0.012	-0.004	0.043	2.706	1	0.100
Extroversion	0.018	0.018	-0.017	0.053	0.983	1	0.321
Openness	0.064	0.015	0.034	0.094	17.775	1	>0.001
Agreeableness	0.009	0.019	-0.028	0.047	0.236	1	0.627
Conscientiousness	0.012	0.012	-0.011	0.035	1.038	1	0.308

Note. Dependent variable: Arousal Rating from 1 (calm) to 9 (excited)

Recall in Relation to Demographic Variables and Personality

A Multivariate General Linear Model was run to examine how the dependent variables of items recalled during Session 1, Session 2, and Session 3 were related to the fixed factors of Sex, and Group, for the covariates of the five raw scores representing personality variables. There were no significant effects for Sex or for Group. There was a significant effect for Neuroticism ($F = 3.20$, $df = 65$, $p = 0.029$). Interestingly, the effect of Neuroticism was more pronounced in Session 1 ($F = 8.67$, $p = 0.004$) not present in Session 2 ($F = 2.59$, $p = 0.113$) and again significant in Session 3 ($F = 4.07$, $p = 0.048$). Extraversion was also related to the number of images recalled, although only for Session 2 ($F = 5.63$, $p = 0.021$) and Session 3 ($F = 4.68$, $p = 0.034$). Similarly, Agreeableness was significantly related to the number of items recalled for Session 2 ($F = 6.20$, $p = 0.015$) and Session 3 ($F = 7.43$, $p = 0.008$).

Recall of Images

GLM analyses were then conducted to examine the dependent variable of Recall. In the first analysis, Group, Mood, a Quadratic Mood, Arousal, Sex, Age, and Personality Traits were examined for their effects on Recall at Session 1, recall immediately following the presentation of items (see Table 12). A quadratic function was used for mood because there is a hypothesized greater recall for items with a negative hedonic valence and items with a positive hedonic valence when compared to items with neutral hedonic valence. There was a significantly ($p < 0.001$) lower level of Mood (estimated coefficient of -0.339) and a significantly ($p < 0.001$) higher level of Mood Quad

(estimated coefficient of 0.038). There was also a significantly ($p = 0.001$) lower level of Neuroticism (estimated coefficient of -0.023).

Table 12.

Generalized Linear Model to examine for differences in Session 1 Recalled Items for Group, Mood, a quadratic Mood function, Arousal, Sex, Age, and personality traits

			95% Wald Confidence Interval		Hypothesis Test		
Effect	*B*	Standard Error	Lower	Upper	Wald Chi-Square	*df*	Sig.
Intercept	-0.375	0.211	-0.788	0.038	3.163	1	>0.001
Intervention	0.153	0.123	-0.088	0.393	1.544	1	0.214
Mood	-0.339	0.056	-0.449	-0.229	36.166	1	>0.001
Mood Quad	0.038	0.006	0.027	0.050	45.376	1	>0.001
Arousal	0.041	0.015	0.012	0.071	7.686	1	0.006
Sex	0.049	0.132	-0.210	0.308	0.137	1	0.711
Age	-0.001	0.007	-0.014	0.012	0.015	1	0.903
Neuroticism	-0.023	0.007	-0.038	-0.009	10.740	1	0.001
Extroversion	-0.017	0.011	-0.038	0.004	2.428	1	0.119
Openness	0.014	0.009	-0.003	0.031	2.729	1	0.099
Agreeableness	0.020	0.013	-0.006	0.046	2.323	1	0.127
Conscientiousness	-0.005	0.009	-0.023	0.012	0.371	1	0.542

Note. Dependent variable: Session 1 recall of images

Next Recall during Session 2, approximately 2 days after item presentation, was examined using the same variables (see Table 13). Recall during Session 2 was significantly related to lower Mood ($p < 0.001$, estimated coefficient of -0.0277), higher Mood Quad ($p < 0.001$, estimated coefficient of 0.033), and lower Extraversion ($p = 0.022$, estimated coefficient of -0.040), and higher Agreeableness ($p = 0.022$, estimated coefficient of 0.041).

Table 13.

Generalized Linear Model to examine for differences in Session 2 Recalled Items for Group, Mood, a quadratic Mood function, Arousal, Sex, Age, and personality traits

			95% Wald Confidence Interval		Hypothesis Test		
Effect	*B*	Standard Error	Lower	Upper	Wald Chi-Square	*df*	Sig.
Intercept	-0.790	0.222	-1.226	-0.355	12.637	1	>0.001
Intervention	0.232	0.181	-0.123	0.587	1.642	1	0.200
Mood	-0.277	0.056	-0.387	-0.166	24.019	1	>0.001
Mood Quad	0.033	0.006	0.021	0.044	32.438	1	>0.001
Arousal	0.043	0.016	0.011	0.075	6.968	1	0.008
Sex	0.080	0.202	-0.317	0.476	0.154	1	0.694
Age	-0.002	0.014	-0.029	0.026	0.015	1	0.901
Neuroticism	-0.021	0.011	-0.043	0.001	3.625	1	0.057
Extroversion	-0.040	0.017	-0.074	-0.005	5.134	1	0.023
Openness	0.012	0.015	-0.018	0.042	0.584	1	0.445
Agreeableness	0.041	0.018	0.006	0.076	5.273	1	0.022
Conscientiousness	0.008	0.012	-0.014	0.031	0.500	1	0.479

Note. Dependent variable: Session 2 recall of images

Lastly, a GLM was used to see how Recall at Session 3 was affected by Group, Mood, Mood Quad, Arousal, Sex, Age, and personality traits (see Table 14). Recall during Session 3, approximately 13 days after the presentation of times, was significantly related to lower Mood ($p < 0.001$, estimated coefficient of -0.216), Mood Quad ($p < 0.001$, estimated coefficient of 0.025), and lower Neuroticism ($p = 0.019$, estimated coefficient of -0.039).

The GLM analyses of hedonic ratings indicates higher levels for males and higher levels for people with higher levels of Openness personality trait. The GLM analyses for arousal ratings indicated higher levels of arousal for people with higher degree of the

Openness trait. After the inclusion of the alternative measure of Sex x Intervention Openness continued to positively correlate to mood and arousal ratings.

Table 14.

Generalized Linear Model to examine for differences in Session 3 Recalled Items for Group, Mood, a quadratic Mood function, Arousal, Sex, Age, and personality traits

			95% Wald Confidence Interval		Hypothesis Test		
Effect	*B*	Standard Error	Lower	Upper	Wald Chi-Square	*df*	Sig.
Intercept	-1.436	0.254	-1.935	-0.937	31.859	1	>0.001
Intervention	0.207	0.219	-0.221	0.635	0.898	1	0.343
Mood	-0.216	0.059	-0.331	-0.101	13.500	1	>0.001
Mood Quad	0.025	0.006	0.013	0.037	17.018	1	>0.001
Arousal	0.029	0.015	-0.001	0.058	3.507	1	0.061
Sex	-0.026	0.278	-0.571	0.519	0.009	1	0.925
Age	-0.020	0.019	-0.058	0.018	1.107	1	0.293
Neuroticism	-0.039	0.017	-0.072	-0.006	5.487	1	0.019
Extroversion	-0.029	0.022	-0.072	0.014	1.705	1	0.192
Openness	0.004	0.021	-0.037	0.044	0.031	1	0.859
Agreeableness	0.024	0.023	-0.021	0.069	1.098	1	0.295
Conscientiousness	0.041	0.017	0.008	0.075	5.856	1	0.016

Note. Dependent variable: Session 3 recall of images

The GLM analyses for recall of items at the over the three sessions provided some findings that a lower mood rating was related to a greater recall across all time periods. Participant's self-report ratings of arousal also predicted recall during Sessions 1 and Session 2, but not Session 3. Perhaps the most surprising finding is that recall was negatively correlated with levels of Neuroticism during Session 1 (immediate recall) and Session 3 (recall after 13 days). Taken together, negative items were recalled with greater frequency and people with higher levels of neuroticism recalled fewer items.

Discussion

This study examined the effects of mood and personality traits upon memory over three time periods. The first set of analyses examined demographic and personality differences between groups following random assignment to the Experimental or Control conditions. Findings indicate that (1) there were no significant differences between the two groups for the measures of age, sex, personality, and order of presentation (three orders of item presentation were used to control for the serial position effect); (2) that attrition was as similar across the groups and sexes; and (3) there were differences between men and women for their mean levels of Agreeableness and Conscientiousness and sex differences are reported by the *NEO-PI-R* manual (Costa & McCrae, 1992). Overall, these results indicated that the groups were similar in composition and that random assignment was successful in producing groups of similar people.

Recall was assessed at three time periods – immediately following the experiment, approximately two days following the experiment, and approximately nine days following the experiment. Session 2 requests were sent out approximately 24 hours completing Session 1, and Session 3 requests were sent out approximately seven days after Session 1. Participants exhibited considerable variation in the number of hours it took them to participate in Sessions 2 and 3. In spite of the variable time of response following the initial item presentation, there was no significant effect for the number of items recalled. Fewer items were recalled as time progressed from Session 1 ($M = 23.37$, $SD = 26.22$) to Session 2 ($M = 17.67$, $SD = 26.22$) to Session 3 ($M = 13.11$, $SD = 23.94$), suggesting that forgetting occurred over time. Also interesting was that although the mean recalled items changed, the variance in recalled means was large and remained

similar, with a very high correlation between items recalled in Sessions 1, 2, and 3. These results suggest that although individual differences in recall ability are highly variable, recall rates diminish similarly over time. These innate differences in ability may be important when studying the memory for images by creating floor and ceiling effects associated with personality traits. For example, it may be that people with low levels of memory ability are more affected by personality traits for filtering important data for recall. It would be interesting to examine various facets of memory (e.g., auditory, visual, immediate, short-term) and personality for any interactions.

Initially, there was apprehension that Sessions 2 and 3 may produce dissimilar outcomes because they were not conducted in a controlled laboratory environment; during Sessions 2 and 3 subjects participated at locations of their choosing, wherever they had an internet connection and the time to answer the questions. This apprehension was upheld, in part, by the variation in response times for Sessions 2 and 3. However, the high degree of correlation between the numbers of items answered between all three sessions provides support that participants genuinely participated with good effort. Further, the differences in correlations between Sessions 1 and 2 and between Sessions 1 and 3 (r = .771 and r = .806 respectively) and the strong correlation between Sessions 2 and 3 (r = 0.936) are to be expected given how memory decays over time. The strong correlations in recall between the three sessions are consistent with the Ebbinghaus (1885) forgetting curve (see Figure 12). This curve describes a greater decay in memory after the first two days in comparison to the next 7 days, between Sessions 2 and 3. Further, the act of recalling the images in Session 2 may reinforce those memories so that they are more likely to be remembered during Session 3. Finally, the very high degree of

correlation between remembered items in Session 2 and Session 3 could represent the expected level of decay for the stimulus provided (M = 17.67 to M = 13.11), recalling on average 4.56 fewer items.

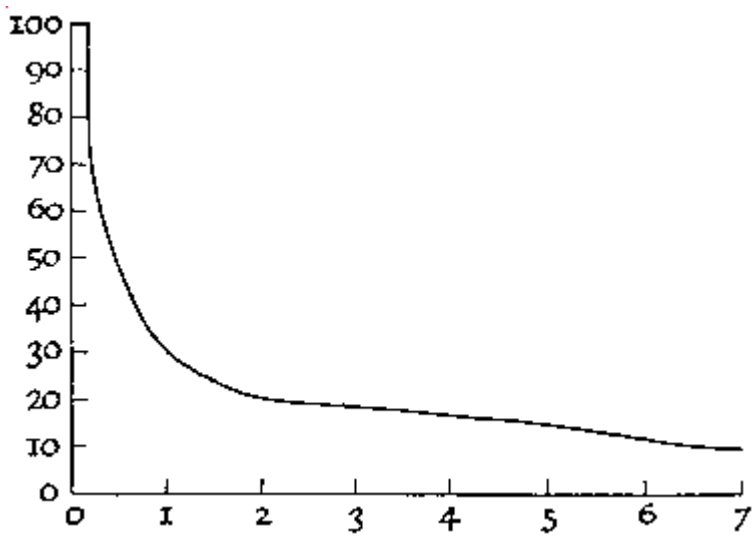

Figure 12: Ebbinghaus memory curve. The y-axis represents the number of retained words and the x-axis represents the number of days after learning the words.

The successful random assignment between groups and the recall correlation data provide evidence to support the internal validity of the study. The results of from this study are summarized in Figure 13 and deviate from the hypotheses presented in Figure 4. The hypotheses will be reviewed and reasons for the deviation will be considered.

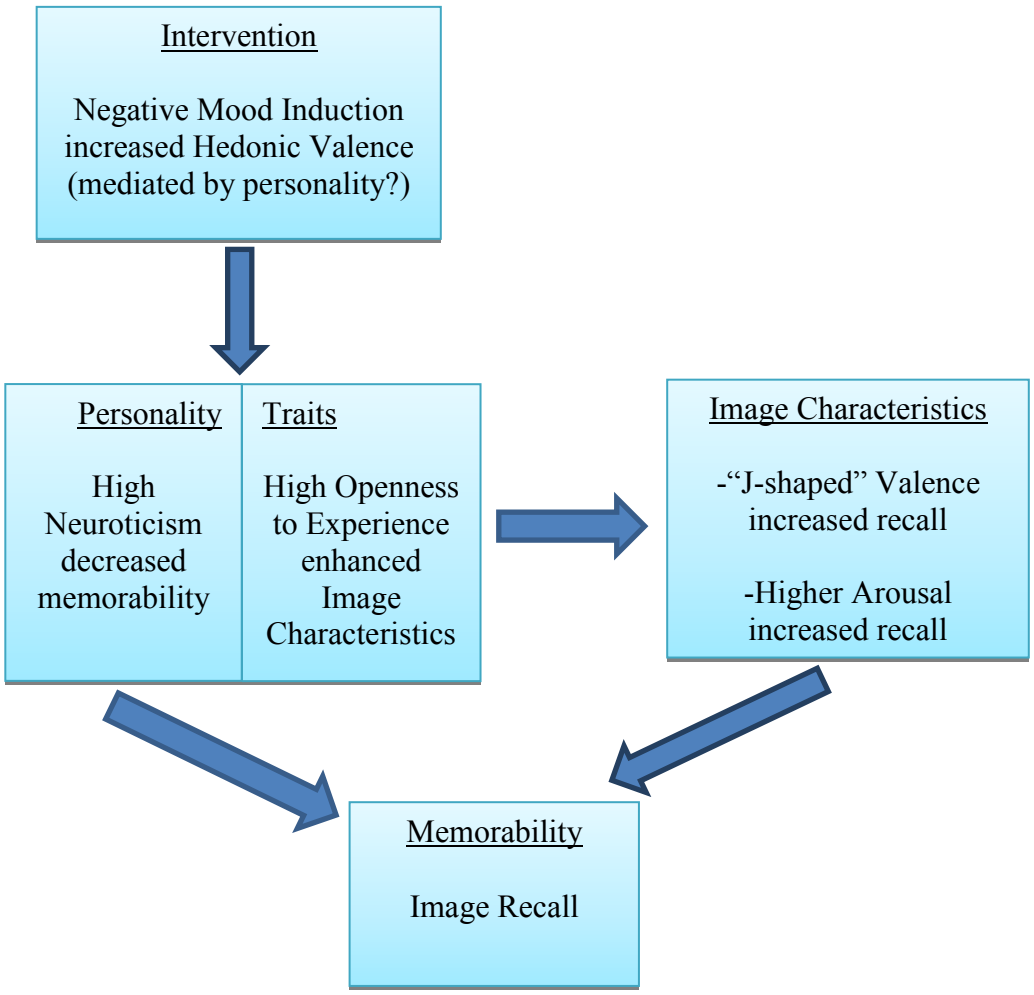

Figure 13. A model of recall demonstrating the interaction of mood induction, personality traits and image characteristics.

Image Characteristics

Hypothesis 1. The hedonic valence will be correlated with image recall.

The prominent finding from the current study was that the hedonic valence of the images was a negatively correlated with recall. That is, items judged to have a negative hedonic rating were more likely to be recalled in Session 1 (B = -0.339, SE = 0.056).

Further, a quadratic function for hedonic rating was significantly correlated with recall (*B* = 0.038, *SE* = 0.006). This suggests that while images with a positive hedonic valence were not recalled as frequently as images with a negative hedonic valence, they were recalled with greater frequency when compared to items with a neutral hedonic valence. This pattern continued in Session 2 where the hedonic rating was significant (*B* = -0.277, *SE* = 0.056) and the quadratic function for hedonic rating was also significant (*B* = 0.033, *SE* = 0.006) and continued in Session 3 for hedonic rating (*B* = -0.216, *SE* = 0.219) and the quadratic function (*B* = 0.025, *SE* = 0.006). These results indicate that negative items are recalled with greater frequency of positive items which are recalled with greater frequency than neutral items. Stones and Bygate (2009) also found that the hedonic valence of the images were correlated with recall and followed a "U-shape" for the control group and a "J-shape" for the intervention group with negative images having a greater probability of recall than positive images, which had a higher probability of recall than neutral images. In contrast, this study indicated a "J-shape" for all participants.

The emotional perception of an image is a primary determinant in the success of recalling that image immediately after presentation, a couple of days after presentation, and over a week after seeing the items. As other researchers have indicated, emotions are deeply tied to our ability to recall an image and this study provides further evidence of this effect. Further, this study demonstrates that the effects of image hedonic valence continue on when participants were asked to recall in information over three time periods.

This study was designed to closely follow the procedure employed by Stones and Bygate (2009) in order to compare results across the two studies. Their study examined participants at one point in time (immediately after presentation) and did not include

personality variables. In their study, participants recalled on average 26.22 of the 57 images that were presented, which is similar to the recall rate in this study of 23.37 images for Session 1. One potential difference in the two studies is that for this study, image presentation was on a 20-second cycle, 6 seconds of image presentation with the image removed for the following 14 seconds. Stones and Bygate presented items in quicker succession; images in their study were presented without a mandatory 14-second pause. Participants were able to immediately view the next image after they had completed rating the valence and arousal level of the current image. The use of a 14-second duration of image withdrawal between IAPS item presentations likely increased the duration of the experiment and could have contributed to the decreased recall rate (M= 26.22 for Stones & Bygate vs. M = 23.57 for this study).

Hypothesis 2. High arousal images will have higher levels of recall. Stones and Bygate (2009) reported that Arousal affected the probability of recall, with images with higher arousal levels being recalled more frequently; this was also confirmed by our study for Sessions 1 and 2 but not 3. This suggests that the level of arousal generated by an image is less stable over time when compared to the hedonic valence of an image. Previously described research by Sharot and Phelps (2004) concluded that level of word arousal decreased the rate of memory decay. They had found that memory of high arousal items remained robust after 24 hours. These results are consistent with Sharot and Phelps while further proposing that arousal is less important for memory after a one week period. These results suggest that long term memory has a stronger hedonic valence than arousal component. To improve long term recall it is more important that information be meaningful than it be shocking. Stones and Bygate, however, found a

difference between levels of arousal ratings between the treatment condition and the control condition, whereas there was no significant effect of arousal between groups in this experiment.

Intervention

Hypothesis 3. Participants in the Experimental condition will rate all images with a more negative hedonic valence. Stones and Bygate also demonstrated that for participants in the intervention condition, images were rated as more negative, while the results of this study demonstrated that images were rated as more positive for people in the intervention condition. The initial GLM analyses demonstrated that images were given higher hedonic rating if participants were in the intervention group ($B = 0.142$) and if the participants were male ($B = 0.199$). It had been hypothesized that hedonic valence ratings would be lower in the intervention group but the opposite was true. There are two immediate explanations for this finding. First, it is possible that participants who experienced a negative mood induction were briefly desensitized to negativity thereby rating all images more positively. This may be the result of natural mechanisms for self-protection. There is some recent evidence to demonstrate that this might be possible, Wu and Thierry (2012) presented words that had either positive or negative hedonic valence to participants who spoke fluent English and whose native language was Chinese. They found that a negative word presented in a second language inhibits access to that word in the participant's native language. In the present study, a negative mood induction could have insulated or desensitized individuals from the negative images.

One potential issue with the desensitization explanation for mood differences between groups is the short duration for general mood induction effects. Mood induction

does not last long and is highly susceptible to changes in perception. The Velten procedure, for example, was demonstrated to last less than 30 minutes (Eich & Metcalfe, 1989). There is no evidence to suggest that the Imagination task used for mood induction in this study is a longer-lasting technique than the Velten mood induction. Additionally, as part of the procedure for Session 1, mood induction occurred and then participants read instructions for five minutes (Appendix D), prior to providing a self-rating of their current mood level. Participant self-rating of current mood, after mood induction (or control task), and prior to viewing images was not different between groups. It is possible that the mood induction technique produced a result that was an artifact of the experiment. However, it is also likely that the negative mood induction desensitized participants to negative experiences and that this detail was not able to be capture by the single question "please rate your current mood".

Participants in the Experimental condition rated images more positively than people in the Control condition. This is counter to our expectations and previous literature which stated that people who experience a negative mood induction would rate images as more negative. Additionally, the effect of the intervention was not significant when personality traits were added into the GLM function.

Hypothesis 4. Participants in the Experimental condition will recall negative images better than positive images. Across all three periods of recall, the Experimental condition was not correlated with recall. In contrast to these findings, Stones and Bygate demonstrated that recall was affected by the intervention. They demonstrated a mood congruent memory effect for participants in their intervention condition because they were more likely to recall images with a negative hedonic valence.

The type of mood induction used in this experiment was unlikely to produce a consistent effect throughout the presentation of items as compared to other techniques. This is due to the general transient characteristics of mood induction, an induced mood dissipates readily. The transient nature of mood inductions is very good for working with volunteer students who may be participating during personally busy times. Further, the addition of a 14-second delay in the procedure increased the length of the experiment further affecting the mood induction procedure. It is plausible that alternate methods of mood induction that have longer lasting effects would have demonstrated group differences and these differences may resemble more intense real-life situations (e.g., a state of depressed mood, attending a sad event). The continuous music technique used by Eich and Metcalfe (1989) would likely demonstrate more prominent mood effects.

Personality Traits

Hypothesis 5. People with high neuroticism scale scores will report more negative ratings to the IAPS images. This hypothesis was generated from the definition of neuroticism. It was thought that because people with higher levels of neuroticism experience mood more frequently and intensely, that they would identify the IAPS images are more intense. This assumption was not supported by these findings.

Hypothesis 6. People with high neuroticism scale scores will recall unpleasant photographs with greater frequency. Perhaps the most interesting finding was that Neuroticism was correlated with recall but opposite to what had expected. Initially, it was predicted that higher levels of Neuroticism would be correlated with higher recall ability for images with negative hedonic valence. Instead, Neuroticism was negatively correlated with recall in Session 1 (B = -0.023, SE = 0.007) and Session 3 (B = -0.039, SE

= 0.017) and although Session 2 was not significant (p = 0.057) the coefficient was in the same direction (B = -0.021, SE = 0.011) demonstrating the same trend. Neuroticism describes an individual's emotional stability; high levels of the Neuroticism traits identify individuals who are prone to psychological distress. For the full version of the *NEO-PI-R*, from which the *NEO-FFI* was developed, the subscales of Neuroticism include the facets of Anxiety, Angry Hostility, Depression, Self-Consciousness, Impulsiveness, and Vulnerability. People with lower levels of Neuroticism are thought to be emotionally more stable and calm. People with lower levels of Neuroticism recalled more images in Sessions 1 and 3. From our initial findings, it is clear that hedonic ratings were not correlated with Neuroticism. That is, people with high levels of Neuroticism did not rate images differently. This finding is parallel to the finding by Anderson and Phelps (2001) who found that individuals with left amygdala lobectomy were able to provide normal Likert-type scale ratings to aversive stimuli indicating that they had understood the affective meaning of words presented. Individuals with left amygdala lobectomy were not protected from an attentional blink with arousing word targets. Nonetheless, images with positive and negative hedonic ratings were recalled with a greater frequency than images with neutral hedonic ratings.

Remarkably, even though the people with high and low levels of Neuroticism ratings the hedonic valences of the image similarly, and even though people generally remembered images with negative or positive hedonic valence with greater success, people with high levels of Neuroticism, people more emotionally expressive, recalled fewer images. The perception and understanding of each image, while generally important, was not the driving factor for the outcome of increased recall for people with

high Neuroticism. People with high Neuroticism trait scores were affected by a process other than hedonic judgement of the image even though the hedonic valence would be the most obvious target for impact. Moreover, this outcome occurred immediately after item presentation and was not a process involved in the later stages of memory; for example, rehearsal of the images would be a process more available in Sessions 2 and 3 and is unlikely to be a factor in Session 1. One potential explanation for this outcome would be that attention levels differed among participants with higher and lower neuroticism scale scores; it is possible that people with lower levels of Neuroticism were more attentive to the experiment. Items were displayed for six seconds and it is possible that for negative items, people with higher levels of the neuroticism trait were more likely to protect themselves from the image by attending less to the image. In this way people with high and low levels of Neuroticism both agreed upon the image's hedonic valence but people with higher levels of Neuroticism attended less to the image. This account would fit with the research by Wu and Thierry (2012) who demonstrated that a self-protective mechanism in language. This explanation may also fit the definition of hedonic rating provided by Lang et al. (1998), who developed the IAPS. They asserted that a negative hedonic valence creates a defensive motivation. It may be that that people with high Neuroticism, people who experience emotion more freely, accurately follow the urge for defensive motivation, that is, they are motivated to "move away" from the image or to disengage from viewing the image. However, people with low levels of Neuroticism, stable people who are less likely to experience emotional shifts, are more likely to engage in "rubbernecking". It may be that people with low levels of Neuroticism wish to "study" the negative images because of the perceived importance of the image. On the other

hand, people with high levels of Neuroticism engage in self-protection, recognizing the image's qualities but avoiding further "study" of the image to protect themselves from becoming overwhelmed.

Contrary to the notion of a reduced attention to the negative images are findings from previously described studies that demonstrated that memory for images is robust to varying levels of attention (e.g., Cuthbert et al., 1998; Sharot & Phelps, 2004; Talmi et al., 2007). Another possible explanation to reconcile these differences is by examining the behaviours during testing. A person engaged in a divided attention study is still attending to images but has their attention divided and the images are displayed quickly, not for a full 6 seconds like in this experiment. The hypothesis presented stated that people with high levels of Neuroticism are more sensitive to negative images, which causes them to engage in self-protective behaviour and attend less to the image. Alternatively, it is possible that people with high Neuroticism are less sensitive to images due to desensitization, due from the more common experience of both positive and negative emotions, which may lead to placing less importance on emotional information. It would be feasible to test the hypotheses of reduced attention versus desensitization in future studies.

Hypothesis 7. People with high levels of extraversion will rate positive images as more positive. There was no support for the effect of extraversion on the rating of images.

Hypothesis 8. People with higher levels of extraversion will have higher levels of base arousal rates. Extraversion was not correlated with the reporting of arousal rates.

Additional personality findings – Openness to Experience. The effect of the intervention was not significant when personality traits were added into the GLM function, although the Openness trait became a significant factor in how items were rated ($B = 0.016$, $SE = 0.005$). Openness represents an individual's propensity for fantasy, aesthetics, feelings, actions, ideas, and values. It has also been correlated to intelligence. This set of characteristics gives the impression that the openness trait would allow people to have a more visceral experience and to rate the images more positively than people who had low scores for the Openness trait.

It is also curious that although the Openness trait was positively correlated with hedonic ratings and to arousal ratings (images were viewed as more positive and more arousing) that the Openness trait was not correlated with Recall. This may have been because recall was generally more affected by unpleasant images and Openness was correlated with positive images. It may also be that the Openness trait may have merely shifted the hedonic ratings and the arousal ratings in a positive manner (e.g., adding +1 to all ratings) so that the differences in rating items remained relatively similar to the differences in ratings items from people with a low Openness trait.

Arousal Ratings were also positively correlated with the Openness trait ($B = 0.064$, $SE = 0.015$) and were unaffected by Sex, Intervention, and Age. GLM functions were conducted with a Sex x Intervention interaction to examine for potential interactions effects for Hedonic ratings and Arousal ratings. There were no significant effects for the interaction, which suggests that men and women were not differently affected by the negative mood induction.

Additional personality findings – Extraversion, Agreeableness, and Conscientiousness. GLM analyses also demonstrated that personality traits were correlated with recall in unexpected ways. In session 2, Extraversion was negatively correlated with the ability to recall images (B = -0.040, SE = 0.017) and Agreeableness was positively correlated with the recall of images (B = 0.041, SE = 0.018). A low level of Extraversion is described as being introverted. High Agreeableness is related to trust, straightforwardness, altruism, compliance, modesty, and tender-mindedness. It is curious to see that these factors were relevant in Session 2 and did not even trend in the other two Sessions. One explanation is that compliant introverts were more likely to provide a strong effort after a couple of days while responding at their leisure.

In session 3, Conscientiousness was positively correlated with recall (B = 0.041, SE = 0.008). Conscientiousness is related to order, deliberation, self-discipline, and duty. It is interesting to note that mean score for Conscientiousness for Session 3 completers (N = 77) was 31.32 versus 30.96 for Session 1 completers (N = 101), demonstrating that people who completed the third session were not necessarily more conscientious. In spite the high correlations between image recall for all sessions, it is possible that people with higher levels of Conscientiousness provided more effort in the third session, on average nine days after the initial experiment. In addition, the lack of any correlations for Extraversion and Agreeableness may mean that those personality traits become less important with the passage of time for the recall of images.

Limitations and Future Research

A potential limitation of memory is the division of recall from recognition. It is difficult to separate recognition tasks from recall tasks due to participants' association of

similar themed items. It is possible that some of the images that were recalled were primed by the hedonic valence of an alternative image, otherwise stated some images were recalled due to associations between images. For example, it may have been easy to recall a spider if the person had initially recalled a snake. The result of this effect may be noticeable recall ability for negative and positive images as they may be more associated than neutral images. Associations made between images would likely occur in real life in so doing assisting the recall of information, which would increase the external validity of these recall findings. This experiment was designed to reduce potential associations between items by the method of image presentation. This experiment used 57 images, 19 with a negative hedonic valence, 19 with a positive hedonic valence, and 19 with a neutral hedonic valence. The distribution of the images throughout the experiment was such that there was a balance of hedonic valences throughout the experiment. Further, there were 14 seconds between image presentations to minimize the influence in recall or impression of hedonic valence from one picture to the next. This gap in time allowed for at least some temporal and attentional distance between items with negative hedonic valence. As noted, the mean number of recalled items for Session 1 was 23.37 with a standard deviation of 26.22 and a very high correlation of recalled items between sessions. Between Sessions 1 and 2, approximately 2 days after initial presentation, people forgot an average of 5.7 images. Between Sessions 2 and 3, after an additional seven days, people forgot on average another 4.56 images from Sessions 2 to 3. The associations between items may be remedied using a larger number of images. For example, participants can be tested using 120 images rather than 57, which may also assist with the large variation in individual ability.

Mood inductions experiments produce transient states that dissipate quickly. The transient nature of mood inductions is very good for working with volunteer students who may be participating during personally busy times. It may be beneficial for future studies to examine other mood induction techniques. Alternate methods of mood induction that have longer lasting effects would be more robust over the duration of the experiment and may resemble more intense real-life situations (e.g., a state of depressed mood, attending a sad event). Future studies should consider using the continuous music technique (e.g., Eich & Metcalfe, 1989) over the duration of the study in an effort to elicit prominent group differences. Further, this type of prominent mood induction may demonstrate greater interactions between recall and personality traits.

It may also be different results may be obtained by varying the type of induced mood. In terms of the degree of recall, Eich and Macauley (2000) have stated that participants who had a sad mood induction often recalled positive and negative items equally well, while participants who had experienced a happy mood induction recalled more positive than negative items. This study demonstrated that although the sad mood induction procedure created an asymmetric interpretation of the images, more negative items were recalled in both groups without any influence from the mood induction. The study by Eich and Macauley (2000) concluded that simulated moods may produce distinctly different profiles of mood congruent recall. Future studies could examine simulated versus genuine mood.

Emotion has been defined as a temporary state while mood has been described as diffuse and enduring (Larsen et al., 2008). It would be interesting to examine how personality differences and mood induction interact to affect people experiencing a

genuine depressive mood versus people not experiencing a depressive mood. Groups could be compared using the *Beck Depression Inventory – 2* (Beck, Steer, & Brown, 1996) to establish a general level of depressive symptomatology. This would provide information to describe how people experiencing a genuine mood state, like major depressive disorder, are affected by a negative mood induction.

Regarding the use of personality traits, the use the full version of Costa and McCrae's personality inventory, the *NEO-PI-R* or the newest version, the *NEO-PI-3*, may be helpful in isolating specific characteristics important to memory. Each personality trait consists of five or six facets and by using the full inventory researchers could examine specific trait facets for their influence on memory. For example, it is conceivable that for the personality trait of Neuroticism that the facet of "vulnerability" is more important than the facet of "impulsiveness" in describing how a person is affected by the mood induction as well as by the hedonic rating of an image. Alternatively, the facet of "impulsiveness" may provide insight as to why items are recalled to a greater or lesser degree. For example, "impulsiveness" may be more correlated with how well someone attends to the images. Despite the fact that these facets are highly correlated with one another it may be possible to isolate the facets of Neuroticism to gain more knowledge about how Neuroticism affects memory.

Generally, this study successfully demonstrated that a recall task can be provided to participants outside of a formal laboratory. Results demonstrated that most participants continued to participate at times even if it was two weeks after the initial presentation of items. Future studies may wish to explore the use of the internet as an administration medium. For example, participants could be randomly assigned to either

participate for all three sessions at home or all three sessions in a laboratory. This may approximate current real world scenarios more faithfully. Allowing people to participate in the study at their own convenience and without having to find and travel to a laboratory would likely increase the likelihood of participation. Using an online design may make it feasible to extend the length of the experiment to examine recall after one month.

This study demonstrated that images perceived as having negative hedonic valence were recalled with greater frequency over three time periods. Asking participants to recall the same information over three time periods improves the participants' memory at each successive stage due to the recollection and repetition of the images. With such a large set of IAPS images to choose, this study could be designed use the remember-know procedure (Tulving, 1985), which would ask participants to view images and to state whether the image is new, remembered (considered to be recall memory), or known (considered to be recognition memory). In this manner, recognition memory and recall memory could be examined for differences. Participants may also find the remember-know design to be preferable to complete due to simplicity of their responses in comparison to having them spend time recalling and writing (or typing) descriptions of the images. This might reduce attrition rates in future sessions. Further, researchers could explore using the Faces subtest from the *Wechsler Memory Scale – IV* to gain a baseline of recognition memory that could then be compared to any recognition results using a mood induction experiment with a measurement of personality variables. Mood induction studies have found that any advantage due to mood induction is less

consistently demonstrated with recognition memory compared to recall memory (Christianson, 1992).

Atienza and Cantero (2008) described findings that demonstrated how recall is affected by reduced sleep, while recognition was not affected by the lack of sleep. Although general levels of sleep may be evenly distributed between groups by means of random assignment, it may be helpful, especially when working with university students, to identify current sleep patterns using a sleep diary.

Summary

This study examined the recall ability over three time periods for participants viewing 57 IAPS images – immediately after presentation, two days after presentation, and nine days after presentation. There were 101 participants in Session 1, 92 people in Session 2, and 77 in Session 3. Participants were randomly assigned to either a negative mood induction group or a control group. Participants' hedonic ratings and arousal ratings of the images were recorded and their personality traits were measured using the *NEO-FFI*.

The most prominent finding was that the perceived mood rating of the image predicted whether that image was recalled. More specifically, negative images were recalled more frequently than positive images, which were recalled more frequently than neutral images. The idea that negative and positive images are recalled with greater facility than neutral image can be explained in terms of an evolutionary perspective; it is good to pay attention to positive things, and it is very good to remember negative things. Higher arousal was correlated with a higher frequency of recall during Sessions 1 and 2 but not for Session 3. It is hypothesized that arousal is more useful for immediate

information and that arousal is not sustained over time. Personality variables were also related to recall, most noticeably the trait of Neuroticism. People with lower levels of Neuroticism were more likely to recall images. It was hypothesized that people with higher levels of Neuroticism may be engaging in a form of self-preservation. Alternatively, the results may have been the result of desensitization for people with higher levels of Neuroticism. Examining attention levels during the viewing of images could distinguish these two hypotheses. Self-perseveration would require a diminished attention while desensitization would not.

It was surprising that even though images were given higher hedonic rating if participants were in the intervention group and if the participants were male, there was no effect on recall for being in the intervention group or for being male. This may have been due to the notion that images were rated as relatively more "pleasant" and that there was less of an effect demonstrated for positive images than there was for negative images.

This study is one of the first to examine how mood induction can interact with personality variables and the hedonic valence of the images to influence recall over three time periods. Future research should continue to examine personality factors in more detail and continue to use the internet and smartphones for experiment modalities.

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Appendix A

Pictures Chosen from the International Affective Picture Study (Lang, Bradley, & Cuthbert, 2008). Hedonic Valence and Arousal represent standardized response ratings, which range from 1 to 9 with a mean of 5.

Image Description	Slide	Hedonic Valence	Arousal
Snake	1050	3.46	6.87
Spider	1200	3.95	6.03
Horse	1600	7.37	4.05
Rabbit	1610	7.82	3.08
Coyote	1640	6.27	5.13
Woman on Beach	2030	6.71	4.54
Angry Woman	2130	4.08	5.02
Man and Baby	2150	7.92	5.00
Neutral Man	2493	4.82	3.34
Elderly Man	2500	6.16	3.61
Elderly Woman	2510	6.91	4.00
African Woman	2830	4.73	3.64
Mutilated Face	3051	2.30	5.62
Mutilated Body	3061	2.32	5.28
Burn Victim	3110	1.79	6.70
Bloody Finger	3150	2.26	6.55
Surgery	3210	4.49	5.39
Woman in Water	4250	6.79	5.16
Man in Bed	4530	6.19	5.31
Man on Beach	4531	5.81	4.28
Romantic Couple	4599	7.12	5.69
Couple in Bed	4666	6.24	6.10
Mountains	5600	7.57	5.19
River	5820	7.33	4.61
Beach at Sunset	5830	8.00	4.92
Gun Pointed Away	6200	3.20	5.82
Gun Pointed Toward	6230	2.37	7.35
Missile Range	6930	4.39	4.88
Bomber Aircraft	6900	4.76	5.64
Rolling Pin	7000	5.00	2.42
Hair Dryer	7050	4.93	2.75
Garbage Bin	7060	4.43	2.55
Umbrella	7150	4.72	2.61

Lightbulb	7236	5.64	3.79
Cake	7250	6.62	4.67
Chocolate Soda	7270	7.53	5.76
Wine	7280	7.20	4.46
Turkey Dinner	7291	6.35	4.81
Urban Building	7500	5.33	3.26
City Landscape	7570	6.97	5.54
Ski Jumper	8030	7.33	7.35
Sailing	8080	7.73	6.65
Gymnast	8090	7.02	5.71
Pole Vaulter	8130	6.58	5.49
Tennis Player	8350	7.18	5.18
War Graves	9000	2.55	4.06
Barbed Wire	9010	3.94	4.14
Starving Child	9040	1.67	5.82
Airplane Crash	9050	2.43	6.36
Solemn Boy	9070	5.01	3.63
Electrical Wires	9080	4.07	4.36
Car Exhaust	9090	3.56	3.97
Cow	9140	2.19	5.38
Soldier	9160	3.23	5.87
Dead Seals	9180	2.99	5.02
Animal Carcass	9182	3.52	4.98
Dirty Puddle	9341	3.38	4.50

Appendix B

Dear Potential Participant,

My name is Derick Cyr, I am a Doctoral student in the Clinical Psychology program at Lakehead University. I am working under the supervision of Dr. Michael Stones. I am writing this letter to request your participation in my study entitled **The Influence of Personality Traits on Mood Induction and Memory**. This study has been approved by the Lakehead University Research Ethics Board (see contact information below).

Our mood states can alter our perceptions and interpretations of everyday events. We wish to examine how personality traits affect our moods and cognitions. Current research has demonstrated that moods can affect cognitions. In addition, research has demonstrated that personality traits can affect mood states. Specifically, we plan to extend research findings that moods affect cognitions by further identifying individual differences in personality traits affect this process.

Should you agree to participate, you will be asked to provide consent. You will be asked to complete a brief questionnaire that identifies your personality traits. Following this, you will sit in front of a computer screen to identify some cognitive processes. The entire session will last approximately one hour. After the session is complete, you will be asked to participate in two more sessions. These extra two sessions will ask a few questions online and can be completed from a computer with access to the internet. The extra sessions will take approximately 15 minutes each.

For your participation you will receive up to two bonus credits. One bonus credit will be awarded after the first session and the second bonus credit will be awarded after session 3. All information you provide will be confidential. Once the data is collected, identifying information will be removed from the forms that contain the data. In compliance with the Ontario Personal Health Information Protection Act and the Personal Information Protection and Electronic Documents Act, documents will be stored in a locked filing cabinet. Electronic data will be stored on a secured computer during data collection. You are free to withdraw consent at any time without prejudice. You may choose not to answer any questions that are asked throughout the study, and this will have no bearing on the bonus credits you receive. At your request, results will be mailed to you at the address you provide.

Your participation in the study will enable us to better understand individual differences in cognitive processes. The intent is to develop new insights that will be published in a peer reviewed journal. The identity of participants will always remain confidential and information will be published in aggregate form.
If you have any further questions regarding the research, please do not hesitate to contact us by phone or email.

Thank you,

_____

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Appendix C

CONSENT FORM

The Influence of Personality Traits on Mood Induction and Memory

I, _____, the undersigned, hereby consent to participate as a subject in the research project entitled **The Influence of Personality Traits on Mood Induction and Memory** conducted at Lakehead University under the direction of Derick Cyr (Student Investigator) and Michael Stones (Principal Investigator). The procedures in this research project have been explained to me via an introductory statement, and are as follows:

- This study examines how personality interacts with moods to affect cognitions. The study will examine how individual differences can lead to differences in cognitions.
- There are no known physical or psychological risks associated with this project.
- The study will consist of three sessions. The first session will be approximately one hour in duration. In the first session a standardized personality inventory will be administered to identify personality traits. Following the brief personality inventory, there will be a computer presentation of items and asked to respond to some questions from the computer display. The second and third session will ask participants a few questions about the experiment. The second and third sessions will take approximately 15 minutes each. I understand that the risks of this experiment are minimal and that I am free to withdraw at anytime.
- My consent is given of my own free choice without undue inducement or any element of force, fraud, deceit, duress, or any form of constraint or coercion. I understand that I am free to withdraw my consent at any time without prejudice to me. Furthermore, I understand that I may choose not to answer any questions that are asked of me throughout the study, and this will have no bearing on the credit that I receive. Participating in one stage of the study does not oblige me to participate in later stages.
- All information gathered will be kept strictly confidential.
- In any sort of report we might publish, we will not include any information that will make it possible to identify you.
- All results obtained from this research will be kept confidential and remain in secure storage at Lakehead University for five years.
- In return for my participation, I will be given up to two credits for participation. If I wish to have a summary of the results, I can request a copy from the investigators.

_____	_____	_____
Participant`s Name (Print)	Date	Signature
_____	_____	_____
Witness (Print)	Date	Signature

Appendix D

Instructions for Rating Images

We thank you for coming today and appreciate your participation in this experiment. In this study, we are interested in how people respond to pictures that represent a lot of different events that occur in life. For the next 30 minutes you will be looking at 57 different pictures on a computer display. You will be rating each picture in terms of how it made you feel while viewing it. There are no right or wrong answers, so simply respond as honestly as you can. All responses will be confidential and your name is not indicated on the answer sheet. Also, there may be other people also looking at images – however, they will be looking at a different order of image presentation.

If you'll look at the page provided, you will that it has two columns of numbers, each arranged along a continuum. This will be where you will rate how you felt while viewing each picture. There are spaces for image ratings, 2 practice images and 57 study images. You can see that each scale has a range of 1 to 9.

The first scale is the mood scale and it ranges from unpleasant to pleasant. At one extreme of the scale, you felt happy, pleased, satisfied, contented, hopeful. If you felt completely happy while viewing the image, you can indicate this by circling the number 9, which is located above the word pleasant at the far right of the scale. The other end of the scale is when you felt completely unhappy, annoyed, unsatisfied, melancholic, despaired, bored. You can indicate by circling the number 1, which is located above the word unpleasant at the far left of the scale. If you felt completely neutral, neither happy nor unhappy, circle the number 5, located above the word neutral in the middle of the scale. The scales also allow you to describe intermediate feelings of pleasure, by circling any of the other numbers on the scale. Please circle only one number per scale.

The second scale is the arousal scale and it ranges from calm to excited. At one extreme of the scale you felt stimulated, excited, frenzied, jittery, wide-awake, aroused. If you felt completely aroused while viewing the picture, circle the number 9 at located above the word excited at the far right of the

scale. On the other hand, at the other end of the scale, you felt completely relaxed, calm, sluggish, dull, sleepy, unaroused. You can indicate you felt completely calm by circling the number 1 located above the word calm at the far left of the scale. If you are not at all excited nor at all calm, circle the number 5 in the middle of the scale. As with the mood scale, you can represent intermediate levels by circling any of the other numbers.

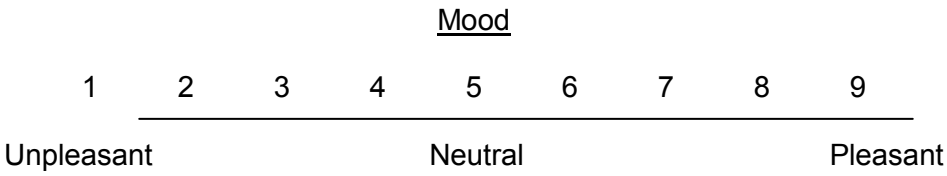
Some of the pictures may prompt emotional experiences; others may seem relatively neutral. Your rating of each picture should reflect your immediate personal experience, and no more. Please rate each one AS YOU ACTUALLY FELT WHILE YOU WATCHED THE PICTURE.

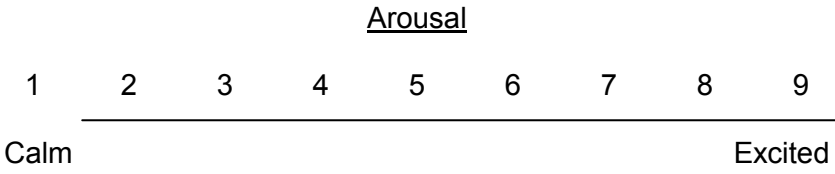
The procedure will be as follows: Before each of the pictures, which you will rate, there will be a warning slide that indicates the item number where you should use to rate the upcoming picture. At these times, you should always be certain that the picture number corresponds to the ratings page number. It is important that your eyes be directed towards the screen when the pictures to be rated are shown. You'll have only a few seconds to watch each picture. Please view the picture for the entire time it is on and make your ratings after the picture is removed. If, for some reason, you should miss viewing any picture, please leave that ratings page blank. It is very important not to dwell on your ratings of the pictures, since there will not be much time.

The first two pictures are just to help you get a feel for how the ratings are done. They are labeled P1 and P2 on the response sheet. After the picture is off, make your ratings on both dimensions as quickly as possible and get ready for the next picture. It is important that we have information from each of you on all of these pictures. There are no right or wrong answers; so rate every picture on all three dimensions. You will have an opportunity to ask questions again after the two practice items. Ready?

Appendix E

Please circle the number that best describes your emotion the following two scales:





Appendix F

How pleasant was the image you just saw?

Mood

1	2	3	4	5	6	7	8	9
Unpleasant				Neutral				Pleasant

How arousing was the image you just saw?

Arousal

1	2	3	4	5	6	7	8	9
Calm								Excited

Please indicate your responses on the answer sheet provided.

Appendix G

Debriefing Form

Dear Participant,

Thank you for taking the time to participate in our study: **The Influence of Personality Traits on Mood Induction and Memory**. Our study is investigating how personality traits influence moods and cognitions.

Current research strongly suggests that a person's current mood state affects which images people will later remember. Your participation in the study will enhance our ability to identify potential ways of improving memory for images. In public policy (e.g., drinking and driving campaigns), moods and images are often used to convey a message and it would be beneficial for people who create these images to understand how to maximize their effectiveness. This study may provide evidence to demonstrate how individual personality traits are related to mood induction and memory for images. By understanding the link between personality traits, mood induction, and memory, policy makers may be able to tailor their messages for particular populations. Positive findings from this study would be the first step to increased effectiveness of policy implementation.

If participating in this study or completing the questionnaires has distressed you or has raised personal issues that you would like to discuss, or if you just need someone to talk to, the following organizations are available: the Crisis Response Program, Canadian Mental Health Association (807-346-8282), the Lakehead University Counselling Centre (807-343-8361), and Lakehead University Chaplain (807-343-8002). For more information about mental health programs in Ontario, call the free, confidential, and anonymous line, available 24 hours – the Mental Health Service Information Ontario (1-866-531-2600).

Thank you,

_____

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