Attention and memory bias for positive emotional words

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ATTENTION AND MEMORY BIAS FOR

POSITIVE EMOTIONAL WORDS

by

Gregory P. Strauss

Bachelor of Science
University of Georgia
2002

A thesis submitted in partial fulfillment
of the requirements for the

Master of Arts Degree in Clinical Psychology
Department of Psychology
College of Liberal Arts

Graduate College
University of Nevada, Las Vegas
December 2004
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ABSTRACT

Attention and Memory Bias for Positive Emotional Words

by

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The current study examined the relationship between attention and memory for emotional words. Theories of “basic emotion” divide emotions into positive and negative classifications, and propose that discrete categories exist within the larger positive negative dichotomy. Previous research on emotion has yet to investigate the areas of attention and memory by dividing positive/negative words into discrete emotional categories. Participants included 30 undergraduate students between the ages 18-40. Attention and Memory were examined using an Emotional Stroop task, The Emotional Verbal Learning Test, and the California Verbal Learning Test-II, respectively. Stimuli for emotional tasks are divided into five emotional word categories of: happiness, sadness, anger, anxiety, and disgust. Results support the existence of the Pollyanna Principle in memory and attention; however, attention and memory were not significantly correlated within discrete emotion conditions.
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ACKNOWLEDGMENTS

I would like to thank my major professor, Dr. Daniel Allen, as well as Drs. Karen Kemtes, Christopher Heavey, and Alice Corkill for their support in the completion of this study. I would specifically like to thank Dr. Allen for assisting me in undertaking such a major project, for having faith in my abilities to see it through to completion, and for his guidance along the way. In addition, I would like to thank research assistants working in the Neuropsychology Research Program’s Emotion Research Group for their dedication to research related to this project. I would also like to thank fellow graduate students Brandon Park, Danielle Knatz, and Sylvia Ross for their contributions to emotion research and input regarding this study. Finally, I would like to thank Amy Lykins for her constant support, love, and understanding during the many hours of work that I devoted to this study and other projects over the past 2 years.
CHAPTER 1

INTRODUCTION

Emotion has been defined in numerous ways throughout the past century. Some researchers describe emotion as adaptive functions that have allowed for individual survival throughout the evolutionary process (Plutchik, 1980; Izard, 1971). Others regard emotion as dimensions or states of consciousness (Tellegen, 1985), complex interactions of self-concept and the environment (Arnold, 1960), products of cognitive arousal and the appraisal of the situation that elicited that arousal (Schacter, 1966), and principal motivational systems that influence cognition and action (Tomkins, 1962). These views are seen as complimentary, with each theory representing different aspects of emotion. Regardless of how one defines emotion, the ability to experience emotion is undeniably important. Without the ability to experience emotions like happiness, sadness, fear, and guilt, existence would be limited to simple instincts and reflexes, mere actions and reactions that would determine major life functions.

Recent research on cognitive processes, such as memory, categorizes emotions as positive or negative; however, basic emotion literature suggests that such a classification may not account for the existence of discrete emotions that fall within positive and negative categories. For example, word lists using negative emotion classifications generally include words that are related to emotions like anger, sadness, fear, and disgust. These emotions have proven to be distinctly different with regard to subjective
experience and adaptive functioning. Additionally, emotions such as anger, fear, or disgust cannot necessarily always be categorized as negative. For example, anger is correlated with survival value, defense and maintenance of self image, and the preservation of social order (Izzard, 1991). Thus, anger contains adaptive as well as negative characteristics. Similarly, emotions commonly classified as positive (e.g. happiness, joy, and surprise) have also been shown to be distinctly different. The current study attempts to determine whether the cognitive processing of emotional words differs among discrete basic emotions (i.e. happiness, sadness, fear, anger, and disgust) that are commonly included in positive and negative classifications.

Current trends in classifying emotions as positive or negative may be related to the seminal works of Boucher and Osgood (1969) and Matlin and Stang (1978), who proposed the existence of a “Pollyanna Principle”. The Pollyanna Principle affirms that positive information is processed more accurately and efficiently than neutral or negative information. The Pollyanna principle is proven to exist in numerous domains. For example: Positive words occur more frequently in language, people are more accurate in recalling and learning pleasant than unpleasant words, and people consider the majority of events in their lives to be pleasant (Matlin and Stang, 1978). The tendency to attend to positive stimuli is thought to exist, due to our limited capacity to deal with emotional information compared to the incredible amount of emotional information presented in the environment. The Mobilization-Minimization hypothesis (Taylor, 1991), according to which negative events and stimuli occupy more cognitive resources, provides additional theoretical support for why the existence of the Pollyanna Principle may be beneficial, as the ability to filter out negative emotional information allows our limited cognitive
capacity to function more efficiently and effectively. Research on memory supports the existence of the Pollyanna Principle, suggesting that experimenter generated lists of positive words are recalled more than negative or neutral words. These findings have been consistently replicated in sound methodological studies; however, research has yet to explore whether these findings differ when words are divided into discrete basic emotion categories, rather than the broad classifications of positive and negative.

Similar to research conducted on emotion and memory bias, research on attention bias has also yet to investigate differences among individual basic emotions that make up positive and negative categories. Sensitivity to or preoccupation with emotionally relevant stimuli in the environment is referred to as attention bias. A number of psychological disorders are associated with aberrant emotional processing, which is maintained by attention bias. For example, individuals with disorders like schizophrenia, antisocial personality disorder, and alexithymia are thought to have less inner-experience of emotion, while individuals with anxiety, mood, and eating disorders are believed to have high inner-experiences of emotion. It is thought that the emotional processing differences exhibited in these disorders are the result of an attention bias for emotionally relevant stimuli in the environment. Although research has established the existence of a relationship between attention and memory bias for emotional information in individuals with psychological disorders, research has yet to investigate such a relationship in nonclinical populations. Additionally, those studies which have investigated attention and memory bias in nonclinical populations restricted their categorization of emotions to that of positive and negative.
The current study attempts to determine whether there is a significantly stronger relationship between attention and memory for positive emotional words than for neutral or negative words in a nonclinical population, and whether this relationship differs among discrete basic emotions commonly included in positive and negative dichotomies. To accomplish this purpose, differences in memory and attention for the basic emotions of happiness, sadness, anger, and anxiety will be evaluated.
CHAPTER 2

LITERATURE REVIEW

In the following sections, literature relevant to the current proposal is reviewed. These sections include: 1) Theories of Basic Emotion, 2) Positive Emotions, 3) Memory and Emotion 4) Attention Bias and Emotion.

Basic Emotion

Basic emotions are considered by most theorists to be those emotions that are universally experienced. However, the number of emotions held to be “basic” varies from one theorist to another (Ortony and Turner, 1990). Some theorists classify basic emotions into only two categories, pain and pleasure (Mowrer, 1960), while other theorists propose the existence of six basic emotions: surprise, anger, fear, sadness, disgust, and contempt (Ekman, 1984), or as many as eight to eighteen, including additional emotions like shame, guilt, arrogance, and indifference (Izard, 1971; Plutchik, 1980; Frijda, 1986). One theorist even noted that lust, should be considered a, if not the, basic emotion (Mandler, 1997). Currently, most theories divide emotions into positive and negative categories, yet differ in regard to which emotions make up these categories (Izard, 1991). Although investigations have not resulted in a discrete number and list of positive and negative basic emotions, fear, disgust, anger, and sadness are included in most negative classifications, and happiness and joy are included in most positive classifications.
There is also some discrepancy regarding what makes an emotion “basic”. Ekman (1984) considers an emotion to be basic if it can be linked to an identifiable facial expression and facial movement. Ekman (1984) posits that: 1) there are a number of separate emotions that differ from each other in basic ways, and 2) evolution shaped the unique and common features displayed by basic emotions, and determined their functions. Thus, Ekman concludes that emotions evolved to assist in dealing with fundamental life-tasks, such as reacting quickly during important interpersonal encounters (Ekman, 1992). Ekman (1992) also lists nine characteristics which distinguish basic emotions: 1) Distinctive universal signals, 2) presence in other primates, 3) distinctive physiology, 4) distinctive universals in antecedent events, 5) coherence among emotional response, 6) quick onset, 7) brief duration, 8) automatic appraisal, and 9) unbidden occurrence. The most important of these is the existence of distinct universal signals. Ekman (1986, 1992) proposes that distinct universal facial expressions exist in both literate and preliterate cultures, and that these expressions reflect distinct inner-experiences and predict behavior. Thus, emotions are considered basic if they correspond to identifiable and producible facial expressions that exist across cultures.

Another theory posits that an emotion can only be basic if it has its own hardwired neural circuitry (Izard, 1977). Izard (1977) asserts that basic emotions have the same expressions and experimental qualities across cultures. These emotions are maintained by “innate neural programs”, which are derived from genetically based mechanisms, which develop based upon evolutionary and motivational factors. These genetically based mechanisms are represented by hardwired responses such as facial expressions and physiological responses, which are subsequently modified through experience. Thus,
innate programming that exists for how to express an emotion may be inhibited and modified to fit culturally specific circumstances, which accounts for cultural variations in the experience or expression of basic emotion (Izzard, 1991).

Plutchik (1962, 1980) defines emotion as a patterned physiological reaction that corresponds to an underlying adaptive biological process, and proposed that what makes an emotion basic is that it cannot be reduced to any combination of other emotions. Thus, a set of basic emotions exists, and these basic emotions mix with each other to form secondary emotions, similarly to the way in which primary colors mix to form new colors. These emotions which are considered "basic" are therefore those that can not be reduced to a mixture of other emotions. In sum, basic emotions represent coherent patterns of feelings, outward expression, internal physiological changes, and behavior that are hardwired, adaptive, automatic, and the result of natural selection (Mowrer, 1960; Plutchik, 1980; Frijda, 1986; Ortony and Turner, 1990; Izard, 1991; Ekman, 1992; Mandler, 1997).

Another approach to understanding emotion emphasizes cognitive processes involved in the evaluation of complex emotions. Early theories proposed that complex emotions are simply mixtures of several basic emotions, but more recent research has shown that complex emotions involve processes that entail in depth social conditions (Kahneman and Miller, 1986; Kahneman and Tversky, 1982). Unlike basic emotions, complex emotions can be distinguished by the level of symbolic processing they require. Thus, complex emotions like pity, guilt, and regret entail a complex cognitive appraisal of why we or someone else failed or succeeded in some endeavor (Gilovich and Medvec, 1995). One might conclude that complex emotions are considered to be as discrete as basic
emotions, yet not as biologically ingrained; however, a comprehensive conclusion regarding the nature of complex emotions may never reach fruition, due to the heterogeneity of complex emotions. It should be noted, however, that because complex emotions are not mixtures of more basic emotions, the notion that some emotions truly are basic is questionable.

The issue of how emotions are experienced across cultures also undermines the universality of basic emotions. If emotions truly are basic and universal, one would expect all cultures to share the same categorization of emotions. However, emotion lexicons (the vocabularies available to describe emotions) have been shown to differ across cultures. For example, people of the Pacific island of Ifaluk lack a word for surprise, yet feel an emotion called “fago” which involves a mixture of compassion, love, and sadness experienced in relationships that involve dependence (Lutz, 1986; Lutz, 1988). The fact that one culture lacks a word for an emotion that is considered basic, prompted further research that resulted in finding similar circumstances for other emotions considered to be basic.

Although no single theorist’s list of basic emotions has been shown to exist across cultures, emotions have been shown to be experienced similarly across cultures. For example, investigations have reported similar bodily reactions to fear and anger across several cultures (Frijda, 1986). The homogeneous experience of emotions across cultures lends support for the existence of basic emotion despite the fact that all emotions are not universally acknowledged, because those emotions that are acknowledged cross culturally are experienced similarly. With these issues in mind, the current investigation will focus exclusively on basic emotions, specifically: happiness, sadness, anxiety, anger,
and disgust. These emotions are included in the current study as they are considered basic in most investigations and are both acknowledged and similarly experienced across nearly all cultures.

Positive Emotions

Throughout the history of scientific inquiry in psychology, investigations of basic emotion have primarily focused on negative emotions like anger, anxiety, sadness, and fear. Significantly less attention has been devoted to explorations of positive emotions like joy, love, interest, and contentment (Fredrickson & Branigan, 2001). Several explanations exist for why negative emotions have been the focus of emotion research. First, negative emotions generate extreme levels of distress within individuals and society, distress that necessitates significant attention by mental health professionals and researchers. In contrast, positive emotions tend to be less problematic within society, although they can at times cause problems (e.g., mania, substance abuse) (Fredrickson & Branigan), and therefore do not require the same level of attention as negative emotions. Although negative emotions require substantial investigation due to their impact on mental health, theorists have argued that this attention should not come at the expense of research on positive emotions, as positive emotions provide solutions to the problems that negative emotions emanate (Fredrickson & Branigan, 2001, Seligman, 2004).

A second explanation for why positive emotions receive less attention is because theorists postulate that there are fewer discrete positive emotions than negative emotions (Fredrickson & Branigan, 2001; Seligman, 2004). Since many theories of basic emotion require a distinct biological pattern of behavior for an emotion to be considered basic,
and it is apparent that many negative emotions have distinct behavioral patterns (e.g., specific facial expressions and physiological reactions), while positive emotions do not, positive emotions have received less theoretical attention. Theorists have also confused positive emotions with pleasant affective states, such as sensory pleasure. As some forms of sensory pleasure share many characteristics with positive emotional states, such as physiological change and subjective experience, pleasurable sensory experiences are sometimes equated with positive emotion (Fredrickson & Branigan, 2001). While pleasant sensory experiences can be seen as the result of fulfilling bodily needs, positive emotions cannot be generated by changing one's physical state or environment. Positive emotions require the initiation of cognitive appraisal and the evaluation of a given situation. Recent theorists have posited the existence of several discrete positive emotions, which require the initiation of cognitive appraisal. Fredrickson & Branigan (2001) propose the existence of four distinct positive emotions: joy, interest, contentment, and love. These emotions are thought to have corresponding cognitive and/or physical response patterns.

A final explanation for why positive emotions receive less attention is because many emotion theories focus on the idea that basic emotions have corresponding “fixed action tendencies” (Ekman, 1992; Frijda, 1986; Izzard, 1991; Lazarus, 1991), which is true for many negative, but not positive emotions. For example, the emotion fear may have evolved due to its survival value and ability to activate a mobilization response during a threatening situation; however, the same is not true with regard to positive emotions, like joy, which is associated with aimless activation (Frijda, 1986). Subsequently, positive
emotions have received less theoretical attention because they do not correspond with general models that include a biological or evolutionary perspective.

The Pollyanna Principle

Few theorists have postulated that positive emotions have significant survival value. In 1974, Erdelyi proposed that all cognitive processes are selective processes that favor the processing of some kinds of information over that of others. This selectivity is necessary due to our limited capacity to deal with information compared to the incredible amount of information presented in the environment (Erdelyi, 1974). Erdelyi suggests that most incoming information must be discarded, during the early stages of perception, since little information can be processed by the succeeding stage. Matlin and Stang (1978) furthered Erdelyi's hypothesis and proposed that information is retained for further processing based upon pleasantness/unpleasantness characteristics. Matlin and Stang (1978) propose that selecting pleasant information and avoiding unpleasant information possesses a survival value, as it allows for needs to be met; however they do not explain why this may be so or hypothesize how this selective process may have developed.

It may be the case that attending to positive stimuli allows for needs to be met in most situations (which are not negative) because it occupies less resources and allows for more efficient cognitive processing and more effective functioning; whereas negative information occupies more cognitive resources than positive information, and therefore significantly impairs cognitive performance, which could impede adaptive life functioning. This explanation is supported by Taylor (1991) who proposed the Mobilization-Minimization hypothesis, according to which negative events and stimuli
occupy more cognitive resources. It may also be the case that individuals select information based upon the situation at hand. For example, individuals may be just as likely to selectively process negative information when confronted with a negative/threatening situation since it would be adaptive to do so. Research on priming (described in the attention bias section) confirms the fact that individuals do in fact attend to emotional information that is relevant to the situation at hand. The current study proposes that situational factors influence emotional selectivity processes, and that the tendency to selectively attend to positive information may be evident because most life situations are either neutral or positive, but not negative in nature.

Matlin and Stang (1978) refer to the tendency to select positive information over neutral or negative information as the “Pollyanna Principle”. The Pollyanna Principle states that pleasantness predominates and pleasant items are processed more accurately and efficiently than unpleasant or neutral items. The Pollyanna Principle was originally postulated by Boucher and Osgood (1969) who applied the term “Pollyanna Hypothesis” to the higher frequency of pleasant than unpleasant words in language, selecting the name “Pollyanna” to reflect the optimistic qualities found in the Disney character with that name (Matlin and Stang, 1978). More recently, this tendency has been renamed the “Pollyanna Principle”, as it has been demonstrated in nearly every area of cognitive psychology. For example: pleasant stimuli are judged larger in size than unpleasant or neutral stimuli, pleasant items appear earlier in “spew” order than unpleasant, people are more likely to respond with a pleasant than unpleasant word in a free association task, people are more accurate in recalling and learning pleasant than unpleasant words, and
people consider the majority of events in their lives to be pleasant (Matlin and Stang, 1978).

Matlin and Stang (1978) also propose the existence of an “Intensity Principle”, which suggests that intense or highly polarized items are processed more efficiently than neutral or unpolarized items. Thus, intensely pleasant or unpleasant items are processed equally, and more efficiently and accurately than neutral items. A few instances are proposed in which the Intensity Principle outweighs the Pollyanna Principle, causing unpleasant items to be processed more efficiently than pleasant items. Such instances include displaying a perceptual vigilance (perceiving certain items more readily than others) for unpleasant items, language frequency studies that show an equal frequency for positive and negative words in the English language, and information processing in individuals with psychological disorders who process negative information more readily than positive information. Apart from these select instances, contrary findings are believed to result from methodological problems related to valence intensity of stimuli, where unpleasant stimuli are more intense than pleasant stimuli. The current study attempts to account for the issue of intensity by controlling for word intensity across basic emotion conditions.

*Memory and Emotion*

Despite evidence suggesting that memory for emotional events significantly impacts daily life functioning, memory has traditionally received little attention in the history of emotion theories. Early emotion theorists first conceptualized the activation of emotional experience as resulting from the paired association of conditioned and unconditioned stimuli, and conditioned and unconditioned responses (Cannon, 1927; James, 1884).
These theories propose that an external stimulus engenders a set physiological response, which is then perceived as an emotional experience. Although these first theories of emotional experience implicate the effects of physiological arousal, they neglect the influence of cognitive appraisal on memory. Arnold (1950, 1960, 1970a, 1970b) was among the first theorists to propose a relationship between memory and emotional experience. In contrast with early theories, Arnold (1950, 1960, 1970a, 1970b) proposed an "excitatory theory of emotion", which implicates memory, rather than associative conditioning, as the basis of emotional appraisal. Arnold's excitatory theory suggests that external stimuli received via the senses excite memories for previously stored information, which subsequently activates the previously experienced corresponding emotion. However, Arnold postulates that an additional factor, imagination, interacts with memory and sensory experience to create an emotional occurrence.

To experience emotion, one must anticipate how future life outcomes will relate to the situation at hand (Arnold, 1970a). The anticipation of such outcomes is ostensibly dependent upon the activation of relevant memories. In other words, an external stimulus is initially received via the senses, which activates previously stored memories and corresponding affect. Then, an appraisal is made to determine how that external stimulus will affect the current situation, and whether that effect will be maladaptive. Arnold termed this type of appraisal "imagination" (Arnold, 1970a). The theory therefore proposes that the appraisal of emotional information is dependent upon an interaction between imagination and memory. Arnold (1970a) derived the term "preliminary appraisal" to describe the interaction between imagination and memory. According to Arnold (1970a), the preliminary appraisal of a situation promotes an impulse to approach
or avoid the stimulus being appraised. The experience of this impulse activates the transfer of neural transmission from cortical to subcortical areas of the brain (i.e., hypothalamus, thalamus, hippocampus, amygdala), which initiates the internal experience and external expression of emotion.

Later theorists furthered Arnold's (1950, 1960, 1970a, 1970b) original conjectures to incorporate the involvement of the autonomic nervous system (ANS). (Mandler, 1980, 1984). Mandler (1980, 1984) asserts that emotional experience results from ANS activation, which initiates once directed cognition and behavior becomes disrupted. However, ANS activity alone is not enough to induce an emotional experience (Mandler, 1980, 1984). Like Arnold (1950, 1960, 1970a, 1970b), Mandler (1980, 1984) suggests that emotional experience results from physiological arousal, and the subsequent appraisal of the environmental situation the elicited that arousal. According to Mandler (1980, 1984), memory is the basis of emotional appraisal since ANS activity disrupts normal cognitive processes, resulting in the connection of the ANS response and its precipitating stimulus. In this regard, emotion is experienced as the result of sensory/perceptual activation caused by an external stimulus, as well as the activation of similar events in memory. Thus, Mandler (1980, 1984) and Arnold (1950, 1960, 1970a, 1970b) propose that emotional experience, and the significance of that experience, is dependent upon an appraisal that occurs when we encounter a situation that activates an autobiographical memory of a similar event.

Although these early theories of memory and emotion provide the basis of future theories, they do not consider issues such as: whether emotional memories are activated during subjective emotional experience, the role of emotional memories in the evaluation
of emotionally charged situations, whether emotion can be experienced without activating emotional memories, and how emotional experiences are stored (Mayne & Bonnano, 2001). Several recent models of emotional memory explore these issues.

**Bower's Associative Semantic Network Model**

Bower (1981) was one of the first theorists to propose a model that integrated knowledge of memory with modern theories of emotion. In Bower's associative semantic network model, memory for emotional items functions in an overall network consisting of nodes and their associated links. Bower (1981) proposes that individual nodes that function within a larger memory network represent discrete basic emotions, while secondary emotions (e.g., shame) result from the concomitant activation of several nodes representing basic emotions. Basic emotion nodes are also thought to have associative links with other nodes that represent either semantic knowledge or physiological response patterns. An emotional experience therefore occurs when an individual node is triggered, and subsequent nodes are triggered through spreading activation to engender a complete emotional response. For example, when the node for fear is activated, associated nodes like heightened blood pressure, hypervigilance, and pupil dilation are also activated, along with semantic knowledge stemming from previous life experiences that are associated with fear. Thus, Bower's (1981) theory proposes that the activation of a discrete emotion results in not only the activation of a set of inherent responses, but also the activation of previous events that have elicited that emotion.

From this model, Bower (1981) developed subsequent theories related to emotion and memory. Among the most prominent of those theories are the notions of "mood-congruent" and "mood-dependent" memory. Mood-congruent memory refers to the
phenomenon where individuals are able to encode information more easily when the material being encoded is consistent with that individual’s mood state at the time of encoding. For example, when negatively valenced material is to be encoded, that material will be encoded more easily if the individual encoding that material is in a negative mood. The phenomenon can be explained by the idea that when an individual is experiencing a particular emotion (e.g., happy), the node representing that emotion is already activated, which subsequently causes information being encoded to be activated more strongly. Bower also proposed that when an individual encodes information in a particular mood state, that individual will be better able to recall that information if they are in a similar mood at the time of retrieval. He termed this phenomenon “mood-dependent memory”. Mood-dependent memory is explained by the notion that when an individual experiences a given emotion while encoding information, the experience of that emotion activates corresponding nodes, and subsequently creates links with those nodes that were activated during encoding. If an individual is in a similar mood state at the time of retrieval to what they were at the time of encoding, those links that were formed during encoding are very accessible for retrieval due to the strength of their activation.

Although Bower’s model has several substantiated elements, recent theorists have questioned specific aspects of his associative semantic network model. One of the largest criticisms is that his theory assumes a singular representation for individual emotions, where various components of emotion (e.g., neural activity, facial-expressions, autonomic response, subjective experience) are all represented by a singular unified system. Other theorists have proposed that it is unlikely that the multifaceted and distinct
components that contribute to an emotional experience are represented by a single system (Philippot & Schafer, 2001). A second critique of Bower’s (1981) model is that it does not account for differences in semantic and episodic memory, but rather assumes that both processes fall under a similar memory store. Recent studies have suggested that episodic and semantic memory stores are separate processes that involve varied structures (Wheeler, Stuss, & Tulving, 1997). Bower’s model also assumes that emotional experience and emotional knowledge are the same, and that the activation of a particular emotion automatically activates all semantic knowledge associated with a given emotion, which implies that one cannot think about emotion without having an emotional response. This poses a problem for differences in what researchers term “hot emotion”, which refers to the active experience of emotion, and “cold emotion”, which involves semantic knowledge related to emotion without an emotional experience.

*Teasdale’s Integrated Cognitive Subsystems Model*

Teasdale proposed an integrated model of memory that incorporates multiple cognitive subsystem stores, and addresses several issues neglected by Bower’s (1981) model. The integrated cognitive subsystem model implements several memory stores that served unique functions and code information in different forms. One of these stores, the implicational subsystem, encodes habitual information of multiple types (e.g., sensory, physiological, etc.), and conveys information in a general sense. It is thought to be influential in emotional memory, as it transfers general information into a form that contains personal significance and emotional implications. The implicational system is thought to connect cognition with “hot” emotional processing, which allows emotion to be actively experienced in conjunction with sensory and physiological memory stores.
Teasdale, 1999). For example, the sight of a spider would likely arouse the autonomic nervous system, and subsequently cause a “hot” emotional experience when sensory and physiological stores associated with spiders are activated in memory.

Teasdale’s model also incorporates general semantic knowledge regarding emotion (i.e., “cold” cognition). Cold cognition is thought to be governed by a propositional subsystem that encodes information related to general knowledge and factors associated with that knowledge. For example, the propositional store would encompass knowledge associated with the statement “My dog was hit by a car”. Associated with this thought are specific meanings tied with each component in the statement. The meanings are encoded in factual and rational forms, and activated associated knowledge that is semantically related. Although the propositional system in itself does not allow emotional experience, it operates in conjunction with the implicational system to foster complete emotional experiences. Following with the example of “my dog was hit by a car”, factual knowledge related to the statement’s meaning is integrated with “hot” emotions that develop from associated sensory and physiological knowledge. Thus, emotional memories incorporate “cold” semantic knowledge and “hot” emotional cognition by integrating propositional and implicational subsystems, respectively.

Neuropsychological Models of Emotion and Memory

Neuropsychological models of emotional memory attempt to incorporate knowledge of brain functioning and cognition. Animal and human studies suggest that emotion is primarily regulated by a region of the brain known as the limbic system (Philippot & Schaffer, 2001). The limbic system contains several structures, including: the hypothalamus, pituitary gland, hippocampus, thalamus, and amygdala. Animal studies
conducted by LeDoux (1992, 1993, 1996) implicate the amygdala as the central structure involved in emotion processing. The amygdala is a subcortical structure located within the temporal lobe. It is thought to play an active role in the encoding and retrieval of emotional information in memory. Emotional information is encoded within the amygdala after an appraisal is ascribed to a given event and the emotional meaning given to the event is associated with other memories. Emotional memories are thought to be governed by the thalamo-cortical and thalamic circuits (Philippot & Schaffer, 2001). Emotional experience is facilitated by these circuits when elements of an event activate similar events and associated emotional experiences. Physiological responses are also triggered from emotional memories due to connections between the amygdala and various physiological systems (e.g., pituitary gland) (Philippot & Schaffer, 2001).

Additionally, studies conducted on humans with lesions to the amygdala have shown that these persons are unable to experience some emotions, particularly fear (Labar, LeDoux, Spencer, & Phelps, 1995; Adolphs, Tranel, Damasio, & Damasio, 1995). Cantill et. al (1996) also found evidence for amygdala activation while individuals were given a negatively valenced story and asked to encode that information. These findings suggest that the amygdala has a potentially important role in the processing of emotion in memory, particularly with regard to negative emotions. However, it is currently unclear as to whether these findings are true with regard to the encoding of positively valenced material in memory.

Phillips and LeDoux (1992) hypothesize that limbic system connections between the amygdala and hippocampus explain why we can experience emotion while thinking about the past. As the hippocampus is primarily involved in the retrieval of declarative
memories, and several neural pathways connect the hippocampus and amygdala, it is
postulated that there are connections between emotional experiences and declarative
memories (Phillips & LeDoux, 1997). Other researchers have suggested that several other
structures are involved in the processing of emotions in memory. Damasio (1994)
investigated neurologically impaired individuals and found evidence for the influence of
the amygdala and the anterior cingulated cortex. It is possible that these subcortical
structures are activated when certain aspects of an object or event signal threat, and cause
the experience of a basic emotion that has specific physiological response patterns
(Damasio, 1994). In contrast, complex emotions are thought to involve the medial
prefrontal cortex, and necessitate the activation of past memories to be experienced;
however, the amygdala, anterior cingulated cortex, and medial prefrontal cortex are
thought to be simultaneously active during the processing of complex emotions. Damasio
(1994) proposes that when the aforementioned structures are activated, an association is
formed between a current event and previous events that have been appraised to have a
given emotional label, which results in the experience of a complex emotion (e.g., guilt,
shame, pride). For example, the amygdala, anterior cingulated cortex, and medial
prefrontal cortex may become activated when an individual performs an immoral act,
which is subsequently appraised as shame when the event activates similar events that
were also labeled as “shame” experiences. It seems possible that such an occurrence
would also incorporate the declarative memory processes, and the hippocampus, since the
label “shame” would be ascribed to an event (e.g., immoral act) after it is appraised in
relation to previous complex situations.
Positive Emotions and Memory

Several investigations have compared memory for positive, negative, and neutral items. These investigations show support for the Pollyanna Principle in free recall and recognition measures of long-term memory. Research has indicated the existence of a memory bias for positive information in the recall of daily experiences, participant generated-lists, and experimenter-generated lists. As the current study involves only experimenter-generated lists, only this literature will be discussed. An early study conducted by Lynch (1932) presented participants with pleasant, unpleasant, and neutral words, while testing immediate recall and long-delayed recall after one and three week delays. Results showed slight evidence for greater recall of pleasant words in the immediate recall condition, and significantly greater recall of pleasant words in the long-delay condition. Recall for unpleasant and neutral words was statistically similar across recall conditions. Similar results were found by Silverman and Cason (1934), Barret (1938), Amster (1964), Shillace and Dragon (1971), Rychlak and Saluri (1973), and Lishman (1972a; 1972b).

In a more recent study, Colombel (2000) studied the processing of emotionally positive words in long-term memory, in a format similar to the current experiment. Participants included 240 undergraduate students, and the study manipulated the processing level of stimuli during encoding (low-level and deep-level processing) and the stimulus retrieval type (free-recall or recognition). An interference task followed a learning phase and preceded a retrieval phase. The results show an emotional valence effect in the condition characterized by low-level processing and free recall. Participants were found to recall more positive words than neutral words when few retrieval cues
were available. This result was confirmed by a qualitative analysis that revealed organized recall according to emotional intensity only for the low-level processing condition. These results provide further support for the existence of the Pollyanna Principle.

Matlin, Stang, Gawron, Freedman, and Derby (1979) found additional evidence for the existence of the Pollyanna Principle in an investigation of evaluative spew position. Matlin et al. (1979) systematically manipulated different list types, which consisted of positive, negative, and neutral words, and measured the order in which items were listed in free recall. Results showed that positive words were not only recalled at a higher rate than negative or neutral words, but were also recalled earlier in the list than neutral or negative words. These findings suggest that positive words are stored more accessibly in LTM, and also indicate that they may be stored as a separate semantic category than either negative or neutral information.

Research by Hayward and Strongman (1987) directly addressed the idea that positive emotional words are stored differently than negative or neutral words. The study required 48 healthy individuals to learn lists of emotional and neutral words. Participants were then tested with either cued or free recall conditions. Results showed that cued recall was superior to free recall, and memory for emotional words was superior to that for neutral words. Differences were not found between pleasant and unpleasant words. Evidence for greater memory during cued recall suggests that emotionally salient information is stored differently that neutral information. These findings indicate that emotionally salient words may be stored in semantic categories that are distinct from those of neutral words. The findings of Hayward and Strongman (1987) and Matlin et al.
provide evidence for the notion that emotional information is stored differently than neutral information, and further suggest that pleasant and unpleasant information may or may not contain distinct semantic stores; however, it has yet to be investigated whether emotional categories that are more discrete than simple positive/negative classifications also have distinct semantic stores.

Evidence for greater recall and recognition after a long-delay have been shown in studies by Silverman and Cason (1934), Barret (1938), Amster (1964), Shillace and Dragon (1971), Rychlak and Saluri (1973), Lishman (1972a; 1972b), and Colombel (2001). In a meta-analysis conducted by Matlin and Stang (1978), results showed that long-delay conditions produced greater selective recall for positive words than did immediate recall conditions. Specifically, immediate recall conditions evidenced the selective recall of positive words in 45% of studies examined, while 75% of studies examined evidenced selective recall after a long delay was introduced (even if the delay was only a few minutes). Matlin and Stang (1978) propose that these findings reflect the fact that pleasant words are more accessible than neutral and negative words in LTM. Research conducted on “spew order” reflects this notion, as positive words are recalled first after a long delay, indicating that they are more accessible. Thus, unpleasant and neutral words are believed to be “locked away”, while pleasant words are readily accessible. These findings are explained by the fact that pleasant material is more easily retrieved due to the nature in which it is encoded into memory.

Some studies have found no evidence for the selective recall of positive words, however. The majority of these studies included methodological flaws such as not accounting for word valence, frequency, or word length (Lanier, 1940; Baron, 1962;
Routh and Ellis, 1975). For example, an early study conducted by Anisfeld and Lambert (1966), categorized numerous words as positive, which are actually neutral (ex: cushion, ginger, zenith). The lack of sufficient contrast in the valence of emotional and neutral words is believed to account for the lack of significant findings. Other studies using sound methodology have also found results contradicting the Pollyanna Principle. For example, McNulty and Isnor (1967) reported equal recall for pleasant and unpleasant words, which was superior to recall for neutral words. Boglarsky (2000) conducted both free recall and recognition testing while manipulating the emotional intensity of positive and negative emotional words. Results indicated that intensity did not have an effect on word recall, but did have an effect on word recognition. Specifically, high intensity emotional words were recognized more than low intensity emotional words. Differences were not found between positive and negative words for either recall or recognition testing conditions, signifying that intensity may be more influential than pleasantness. These findings contradict those of Colombel (2000), who used a similar recall vs. recognition paradigm. Although studies comparing recognition and recall paradigms have found discrepant findings across memory condition (explicit/implicit), results consistently support the finding that memory for high intensity emotional words is greater than memory for low intensity emotional or neutral words. These findings are believed to reflect that emotional words are more salient than neutral words.

Recent findings have also suggested that emotional salience may exist when individuals are presented with words from emotional categories other than those that are simply pleasant or unpleasant. In a study conducted by Kulas, Cogner, and Smolin (2003), forty 17-24 year old individuals participated in a free recall memory task that
manipulated emotionally threatening and neutral words. Participants reported their subjective fear of spiders and were subsequently tested for their recall of "spider," and the word following it in a list. Results indicated that participants recalled the word "spider" at a much higher rate than neutral words, and recalled the word following it at a much lower rate, independent of subjective fear ratings. Although comparisons were not made with positive words, these findings suggest that the salience of threatening words produce a greater memory bias than neutral words. These findings suggest that words from emotional categories reflecting basic emotions can evidence results similar to studies that compare only pleasant vs. unpleasant dichotomies.

In summary, research using experimenter-generated lists provides evidence for the existence of both the Pollyanna Principle and the Intensity Principle in nonclinical populations. Studies that evidence contrary findings commonly show poor methodology regarding word usage. Furthermore, recent research has provided support for additional investigations that directly evaluate words from emotional categories that are more complex than simple pleasant/unpleasant dichotomies. Investigations also suggest that emotionally salient words are stored in distinct semantic categories, however, it has yet to be investigated whether such distinctions exist when classifications include more complex emotional categories, such as fear, anger, sadness, disgust, and happiness.

Attention Bias

It is well documented that numerous psychological disorders process emotional information abnormally and have aberrant inner-experiences of emotion. Various Mood and Anxiety disorders are believed to have intense inner-experiences of emotion, while
disorders like schizophrenia and alexithymia are believed to have inhibited inner-experiences of emotion and process emotional information irregularly. Although these disorders with emotional abnormalities are very different, they are believed to share a common feature: heightened sensitivity to and preoccupation with emotional information in the environment that represents their unique concerns. It is believed that heightened sensitivity and preoccupation result from a cognitive process known as “attention bias”.

It is assumed that attention bias does not occur due to the existence of an emotional disorder, but rather that attention bias causes and maintains relevant symptomatology (Williams, Matthews, and MacLeod, 1996). Thus, attention bias interacts with a dysfunctional cycle, where increases in emotional experience cause disorder specific stimuli to become more salient, causing a biased estimate of threat, which heightens the presence of the initial emotional experience. For example, individuals with panic disorder experience an increased saliency of physical sensations, which is interpreted to indicate collapse or death, causing increased anxiety and further attention bias for physical sensations (Williams, Matthews, and MacLeod, 1996).

Attention bias is primarily measured using the Emotional Stroop Task (E-Stroop). The E-Stroop is one of numerous variants of J.R. Stroop’s original color naming task, which has proven to be a reliable measure of automatic processing. More recently, a modified version of J.R. Stroop’s (1935) original color-naming task, which involves the naming of the color of ink in which an emotional word is printed, has proven useful in analyzing various components involved in the processing of emotional information. The theory behind the Emotional Stroop task states that emotional words create more interference (longer reaction times) than neutral words. In this regard, words that produce
significant interference are regarded as being automatic (read quickly and without effort). Word recognition is described as automatic when reading is fast, obligatory, and when cognitive processes can be devoted to tasks other than word recognition (Logan, 1978). Automaticity has proven to play an integral in the processing of emotional information in populations that evidence psychopathology by enabling researchers to investigate attention bias in relation to disorder specific concerns.

Although an abundance of literature has examined attention bias for disordered populations, few published studies have examined attention bias for positive and negative words in nonclinical populations. In 1996, White measured attention bias in a sample of 54 undergraduate students, while manipulating pleasant, unpleasant, and neutral words using an Emotional Stroop task. Results showed longer reaction times for negative than positive or neutral words. Similar findings were shown by Pratto and John (1991), who found longer reactions times for "undesirable" than "desirable" words in a color-naming Emotional Stroop task. Results from these two studies contradict the conjectures of Matlin and Stang (1978), who propose that positive information is processed more accurately and efficiently than negative or neutral words. One would expect that positive words would be more automatic, and therefore produce greater interference, if the Pollyanna Principle were supported. The findings of Pratto and John (1991) and White (1996) may be explained by methodological problems, as emotional intensity was not accounted for in word list development. The studies successfully controlled for pleasantness ratings by using pleasant and unpleasant word lists that significantly differed, however, words from the pleasant category seem more neutral in intensity than do the negative words. For example, the positive categories included words like "sunrise,
diamond, easter, and diploma”, which differed greatly in intensity from unpleasant category words like “poison, failure, obesity, and suicide”. The current study addresses this limitation by using emotional word lists that do not statistically differ with regard to intensity among emotional word conditions.

Recent studies have also examined attention bias for individual emotions. Smolin (2001) investigated attention bias for “anger” related words using an emotional Stroop task. It was hypothesized that the selective processing of anger may be different than that of other negative emotional states. Results showed significantly greater interference for anger related words than words from a general “negative” category. These findings suggest that further investigations of other basic emotion categories may be warranted.

Other attention bias studies investigating nonclinical populations have included priming tasks to affectively orient participants to specific emotions. While testing a nonclinical population, Dahl (2001) found significantly prolonged response latencies for negative words compared to positive ones in a word detection task, when participants were affectively oriented using a negatively valenced story. Charash and McKay (2002) primed nonclinical participants with a disgust story, and measured response latencies for disgust words, as compared to fear and neutral words. Results showed that nonclinical individuals had longer reaction times for disgust words than anger or neutral words. Participants were also tested for recall of emotional words following the presentation of the Emotional Stroop task. A positive correlation was found between attention and memory bias for disgust words. These findings provide further evidence for investigating differences in attention bias for emotions while using word lists that are believed to represent basic emotions, rather than positive/negative word list classifications.
Although studies of attention bias in nonclinical samples have shown findings contrary to the Pollyanna Principle, these studies have contained methodological flaws, included priming conditions, or have failed to include a positive list comparison. The current study attempts to correct for methodological flaws while making direct comparisons between happiness, sadness, anger, fear, and disgust, as well as words from pleasant and unpleasant categories, without the influence of priming. The word list comparisons used may allow for a direct examination of whether the Pollyanna Principle exists when compared to basic emotion categories, and whether emotions are automatically processed as distinct “basic emotion” categories or positive/negative categories.

If the Pollyanna Principle was soundly examined with regard to attention bias, several expectations could be made. With regard to reaction time, Matlin and Stang (1978) proposed that a large number of pleasant responses are likely to be generated for pleasant stimuli, and fewer responses will be generated for unpleasant stimuli. Due to a larger amount of potentially pleasant than negative options to respond from, individuals are more likely to respond quickly to positive stimuli and more slowly to negative stimuli. Matlin and Stang (1978) hypothesize that such an occurrence would indicate that positive stimuli are very accessible for retrieval. However, research has yet to adequately test this hypothesis.

Unlike Matlin and Stang (1978), the current study proposes that individuals will evidence a delayed response to positive (happiness) stimuli and a faster response (shorter RTs) to negative stimuli (sadness, anger, fear and disgust stimuli). Such an occurrence would reflect that positive stimuli are more interfering, and therefore more automatic,
rather than simply being more accessible for retrieval. Rather than explaining the existence of the Pollyanna Principle in attention bias as a result of having a larger number of positive than negative responses to choose from, the current study believes that the tendency to focus on positive information occurs because we are exposed to more positive information than negative information, and that this exposure has caused the processing of positive information to become more automatic (done quickly and without effort) than negative information. This process can be likened to the means by which reading becomes automatic due to practice (extended exposure). Positive stimuli can also be expected to produce greater interference than neutral stimuli, even though we encounter more neutral than emotional stimuli, because emotional information is more salient than neutral information, and therefore has more “grabbing power”.

Summary

The means by which individuals process emotional information plays a significant role in daily life functioning. Current emotional theories suggest the existence of a set of “basic” emotions, which exist across all cultures. These emotions are currently divided into positive and negative categories, yet are believed to be represented as differential feelings and expressions, which are more diverse than what categorizations of positive and negative allow. Debate exists regarding which characteristics make an emotion “basic”, the number of basic emotions that exist, and what those basic emotions are. However, there is a general consensus that the emotions of happiness, sadness, anger, fear, and disgust are universally experienced. Research on cognition has shown that learning and memory are benefited by the salience of emotional words. More specifically,
positive emotional words are typically processed more accurately and efficiently than neutral or negative words. This tendency has been named the Pollyanna Principle. The rationale explaining why the Pollyanna Principle occurs may be questionable, however, its existence is widely supported. Research has yet to account for current emotional theories that dichotomize emotions into positive and negative categories, which are each then further divided into more discrete basic emotions, and investigate whether the Pollyanna Principle is affected when comparisons are made to discrete basic emotions.

Investigations of clinical populations (i.e. mood disorders, alexithymia, schizophrenia) have consistently found that individuals with emotional processing abnormalities have a heightened sensitivity to and preoccupation with emotionally relevant stimuli. Such occurrences are referred to as attention biases. Very few attention bias studies have been conducted on nonclinical samples, and the few that have, contained methodological flaws, and excluded a “positive” emotion comparison condition. Attention bias studies using priming methods have also found greater attention bias for words from basic emotion categories that are more complex than simple positive/negative dichotomies. These findings suggest that an investigation of attention bias that does not use priming methods may be warranted to determine if such a relationship exists in a comparison of basic emotion categories vs. pleasant/unpleasant categories.

Research has also shown a correlation between attention and memory biases for individuals with psychological disorders; however, this relationship has yet to be examined for emotional information processing in nonclinical populations. The current study attempts to examine the relationship between attention and memory bias for
emotional words in a nonclinical population, while accounting for current theories of basic emotion. Differences among words from the basic emotion categories of happiness, sadness, anger, anxiety, and disgust will be examined in relation to attention and memory.

Hypotheses

Based on the literature review, the following hypotheses were made for the current study:

1. Participants will evidence statistically significant overall differences in attention bias across emotional word conditions. Specifically, greater Stroop interference will be displayed for words from the happiness condition than for words from sadness, anger, anxiety, disgust, neutral, pleasant, and unpleasant conditions.

2. Participants will evidence statistically significant overall differences in memory bias across emotional word conditions. Specifically, greater recall and recognition will be displayed for words from the happiness condition than for words from sadness, anger, and anxiety conditions. Individual recall and recognition conditions will not significantly differ with regard to memory performance.

3. A positive linear relationship between memory and attention bias will be evident across emotional word conditions. Statistically significant overall differences will occur among the four emotional word conditions of: happiness, sadness, anger, and anxiety. Additionally, the correlation between attention bias and memory will not differ with regard to recall and recognition.
CHAPTER 3

METHODS

Participants

Participants included 35 undergraduate students who volunteered to take part in the study, for which they were compensated with course credit. Participants were men and women between the ages of 18 and 40. Individuals were excluded from the study if they spoke English as a second language, had a speech impediment, reported a current psychiatric or neurological diagnosis, had inadequate corrected vision or hearing, or exhibited severe psychopathology based on routine screening. Individuals were also excluded if they had a history of psychiatric disorder or treatment, or a history of neurological disorder including traumatic brain injury. Based on these inclusion and exclusion criteria, four participants were excluded, one that evidenced severe psychopathology on screening, and three that evidenced inadequate effort on tasks. The remaining 30 participants were an average of 20 years old, and had 14 years of education. Right handed individuals composed 76.7% of the sample, 70% of the sample was composed of females, and 56.7% were Caucasian, 23.3% Asian, 10% Hispanic and 10% African American. All participants provided written informed consent prior to the completion of any study procedures. See Appendix C for Subject Pool research description.
Procedures

UNLV student participants learned of the study by searching on-line research postings advertised on the Psychology Department Subject-Pool website. Students were recruited via on-line advertisements of the study, which listed completion time as approximately 2.0 hours and included a description of procedures and methods that were used. Individuals willing to participate in the study scheduled an appointment and received 2.0 research credits upon completion. Prior to the initiation of study procedures, informed consent and demographic information was obtained from all participants (see appendix F).

All testing was conducted by the primary author, and occurred in a quiet setting (laboratory office) located on UNLV campus. The research battery was individually administered to all participants in one sitting that lasted approximately 2.0 hours. The research battery included a demographic and medical history questionnaire (See Appendix E), the California Verbal Learning Test-II (CVLT-II; Delis et. al, 2000), the Emotional Verbal Learning Test (EVLT), a picture-word emotional Stroop Task (E-Stroop), the Revised Dimensions of Temperament Survey (DOTS-R), and the Symptom Checklist 90 Revised (SCL-90-R). Detailed descriptions of these procedures are provided in the measures and stimulus development section. The SCL-90-R and the DOTS-R are standardized assessments that measure psychological symptoms and temperament, respectively. These measures were included to determine whether individuals expressing different patterns of temperament and psychological symptoms evidence greater attention and memory bias for words related to their levels of psychological symptomatology or unique temperament profiles. Additionally, the SCL-90-R was included as a means of
excluding participants evidencing clinically significant psychopathology, as indicated by a global index score greater than 63.

Order of task administration was designed to control for possible carry-over effects and occurred in one of the following two formats: 1) Demographic and medical history questionnaire, CVLT-II, SCL-90-R, CVLT-II Long Delay Recall, EVLT, DOTS-R, EVLT Long Delay Recall, E-Stroop, 2) Demographic and medical history questionnaire, EVLT, SCL-90-R, EVLT Long Delay Recall, CVLT-II, DOTS-R, CVLT-II Long Delay Recall, E-Stroop. An equal number of subjects received each order. There were several reasons for presenting tasks in these sequences. First, the EVLT and CVLT-II each contain 20 minute delay intervals during which verbal testing cannot take place. During these 20 minute break intervals, two tests (SCL-90-R and DOTS-R) which do not include verbal testing, and take approximately 20 minutes to complete, were administered. Second, presenting the E-Stroop last eliminated the possibility of priming individuals to remember words from various neutral word categories, as a result of previous exposure to pictures that represent those categories. Additionally, the E-Stroop task was presented after the EVLT because the E-Stroop measures automatic processing, and is therefore unlikely to be affected by priming effects as a result of previous exposure to EVLT emotional words. Third, the order of memory task administration was also counterbalanced to control for biasing effects across tasks. The task administration procedures described above allow for the most efficient use of time and an effective presentation of tasks that controls for carry-over effects.
After testing was complete, time was allotted for participant questions, and all participants were given a debriefing form containing experimenter contact information and information regarding the nature of the study (See Appendix G for debriefing form).

Measures

Measures used in the current study included: The California Verbal Learning Test-II (CVLT-II), The Emotional Verbal learning Test (EVLT), and a Modified Picture-Naming Emotional Stroop Task (E-Stroop). A description of the format of each test, including reliability and validity, and procedures is provided below. Score calculations and descriptions for the CVLT-II and EVLT are detailed in Appendices A and B, respectively.

California Verbal Learning Test-II

The CVLT-II (CVLT-II; Delis et al., 2000) is an individually administered clinical instrument designed to quantify various aspects of verbal learning and memory. The CVLT-II is an updated version of the first edition of the CVLT (Delis et al., 1987), which was one of the first clinical instruments to utilize theories of cognitive psychology to measure multiple facets of learning and memory with clinical populations. It has been used in studies of numerous clinical disorders including schizophrenia (Paulsen et al., 1994), dementia of the Alzheimer’s type (Kramer et al., 1989), Parkinson’s disease (Massman et al., 1990), head injury (Crosson et al., 1988), Alcohol Korsakoff syndrome (Delis et al., 1987), temporal lobe epilepsy (Hermann et al., 1987), human immunodeficiency virus (Peavey et al., 1994), and major affective disorders (Dupont et al., 1990).
The task first requires the experimenter to orally present 16 words (List A) over five immediate-recall trials. The list consists of 4 words from each of four categories (furniture, vegetables, ways of traveling, and animals). Individual words of the same category are never presented successively, to allow for the assessment of semantic clustering, which is regarded as the most efficient strategy for learning verbal information. Following administration of the five trials, a second 16 word “interference list” (List B) is presented for a single trial. Immediately following List B, a short delay free recall trial and a category cued recall trial of List A are conducted. Twenty minutes later, long delay free recall, category cued recall, and recognition trials occur for List A. Recognition of List A is measured using a yes-no recognition format immediately in which List A is presented with 28 distractors consisting of: List B words semantically related to List A words, List B words semantically unrelated to List A words, novel words that are prototypical of semantic categories presented in list A, and novel words semantically unrelated to List A words.

The CVLT-II (Delis et al., 2000) was standardized on a sample of 1,087 individuals between the ages of 16 to 89. Administration time for individuals under 60 years is approximately 47 minutes, while administration time for individuals over 60 years is approximately 51 minutes. Numerous aspects of verbal memory can be studied using the CVLT-II, including: total recall and recognition, primacy-recency effects in recall, stability of item recall across trials, proactive and retroactive interference, differences in retention after short and long delays, intrusion error recall, repetition errors in recall, and an analysis of false-positive types in recognition testing. Measurements of learning can also be obtained, including measures of learning strategies (semantic, serial, and
subjective clustering) and the amount of new learning per trial over the first five presentations of List A.

Five relevant measures of learning (semantic clustering, serial clustering, learning slope, proactive interference, and retroactive interference) and 6 measures of memory (level of correct recall on List A Trial 1, Level of correct recall on List A Trials 2-5, overall level of correct recall on list A trials 1-5 Total, Primacy/recency recall, percentage of recall consistency, List B trial and Proactive Interference, Short-delay free-recall trial and retroactive interference, Short-delay cued-recall trial, Long-delay trials, and yes/no recognition) were selected for use in the current study. The primary CVLT-II scores, and the cognitive domains they assess, are described in Appendix A.

*Emotional Verbal Learning Test*

The Emotional Verbal Learning Test (EVLT) was developed for this study and is a measure of learning and memory for emotional words. All procedures, parameters, and score calculations are modeled after the CVLT-II (Delis, 2000), allowing for a direct comparison between learning and memory performance for emotional and neutral words. The EVLT is a standardized procedure, however, its reliability and validity have yet to be established.

The task first requires the experimenter to orally present 16 words (List A) over five immediate-recall trials. The list consists of 4 words from each of four “basic emotion” categories (Happiness, Sadness, Anger, and Anxiety). Individual words of the same category are never presented successively to allow for the assessment of semantic clustering (See List A construction under Test Development for a description of List A). Following the administration of the five trials, a second “interference” list (List B) is
presented for a single trial (See List B construction under Test Development for a
description of List B). Immediately following List B, a short delay free and category cued
recall of List A is conducted. A 20 minute delay then occurs between the presentation of
the short-delay and long-delay free recall assessments. Long delay free and cued recall is
then assessed. Recognition of List A is measured using a yes-no recognition format
immediately proceeding the administration of the long delayed recall. In the test of
recognition, there are 28 distractors consisting of: List B emotional words semantically
related to List A words, List B emotional words semantically unrelated to List A words
(disgust category), novel words that are prototypical of semantic categories presented in
list A, and emotional words semantically unrelated to List A words.

Administration time is anticipated to be approximately the same as that of the CVLT-
II (Delis et al., 2000), ranging from approximately 37 minutes for individuals under 60
years of age, to 41 minutes for those over 60 years. These time estimates include a 20
minute delay interval in-between short and long-delayed recall sections. Unlike the
CVLT-II, the EVLT does not contain a Long-delay forced choice recognition test section,
which subsequently results in a shorter administration time since the 10 minute delay
interval is not included.

The EVLT measures both recall and recognition of two separate word lists,
comprised of emotional words, in several short and long-delayed memory trials. As such,
the test can measure a number of different aspects of learning and memory for emotional
words, including: total recall and recognition, primacy-recency effects in recall, proactive
and retroactive interference, differences in retention after short and long delays, and
recognition memory. Measurements of emotional word learning can also be obtained,
including measures of learning strategies (semantic, serial, and subjective clustering) and
the amount of new learning per trial over the first five presentations of List A.

**Stimulus Development**

The testing format used in the EVLT is modeled directly after the CVLT-II (See
Appendix E for EVLT administration form). EVLT testing materials were designed to
approximate those of the CVLT-II, while changing minor variables within the
demographic variable section to include information that is relevant to emotional
processing, including measures of mood congruent memory. In developing the EVLT
word lists, the same parameters as those applied to the CVLT-II were used to allow for a
direct comparison between emotional and neutral words. A comprehensive description of
word list development is described in the sections that follow.

Words used in EVLT List A, List B, and the Long-delay yes/no recognition testing
section were derived by first collecting word lists used in other studies of memory and
attention bias for emotion. The majority of the words used were obtained from
emotionality rating and free association norms of emotional words developed by Carolyn
John (1988). Additional words were acquired from studies examining emotional
processing in healthy individuals with an attentional bias for disgust (Charash and
McKay, 2002). Thus, all word lists used were taken from studies involving healthy
individuals, rather than individuals with psychological disorders. Normative emotional
intensity ratings were also determined for all neutral words used in the CVLT-II. Based
on these selection procedures, a total of 308 emotional and neutral words were selected
for possible inclusion on the EVLT.
In order to select words for the EVLT, an on-line study was conducted to further determine the reliability of emotional intensity ratings obtained from John (1988), as well as the additional emotional words for which intensity rating norms are not available. A total of 389 undergraduate students recruited from the Psychology Department subject pool participated. The study was approved by the UNLV institutional review board and all participants provided informed consent.

Prior to the development of the on-line study, the 308 emotional and neutral words were separated into various categories of basic emotion (happiness, sadness, anger, fear, disgust, neutral). This preliminary categorization was accomplished to ensure that enough words were included for each emotional category and that words from the same emotional category were distributed throughout the word lists. The 308 words were then divided into four lists so that any participant would only have to rate a maximum of 125 words. This step was taken to avoid fatigue effects. Individual words were selected to be repeated within word lists and across word lists, to establish the reliability and validity of ratings. The order of word presentation was consistent for each subject, and all words were randomized to control for order effects prior to the development of the online form.

Participants completed two separate questionnaires that contained the same set of one of four word lists. Participants first performed emotional intensity ratings, followed by emotional categorization ratings of the same words. All participants read the following instructional set:

"For each of the following words, please rate by selecting the appropriate number on the scale, the extent to which you think the average person would consider that the word has some emotional content. If you
think that NEARLY EVERYBODY would agree that a word has some emotional content, then rate it "7", or if you think that PRACTICALLY NOBODY would find it emotional then rate it "1". If you think that they would be equally divided in opinion, then rate it "4". If any word is unfamiliar to you so you cannot rate it, please select the option for UNFAMILIAR.”

These instructions were patterned after those used by John (1988). Participants then proceeded to rate each emotional word by selecting one of seven boxes that corresponded with the numbers 1 through 7.

Participants then completed the second questionnaire for the same word list, which required them to determine the emotional category that best represented each of the individual words. All participants received the following instructions:

“For each of the following words, please select from the drop down menu the emotional category that you think the word most closely resembles. If you think that a word has NO emotional content, select ‘neutral’ from the drop down menu. If you think that a word does not fit with any of the categories available to chose from, please type the category that you think it most closely resembles in the text box labeled ‘other’.”

Participants responded to each item by selecting a given emotion from the drop-down menu, or by typing a category into a text box if the category they deemed appropriate was not available.
Once intensity and categorization ratings were obtained, participants and data considered outliers were then removed from the data set, and means were calculated for each rating type. An average of 50 participants rated the emotional intensity and categorization of all 308 words. Mean intensity ratings were derived by taking the average intensity score for all participants rating that word. Mean categorization ratings were obtained by calculating the percentage of participants (out of 50) who categorized an emotion as being represented as a given category. Once means were calculated, words were then divided into lists according to each of five basic emotion categories (happiness, sadness, fear, anger, and disgust) and two pleasantness categories (pleasant and unpleasant) and ordered according to each item’s mean valence rating. Emotional intensity ratings obtained by John (1988) and the on-line study were highly reliable ($r = .91$). Individual words were then chosen in the construction of List A, List B, and Long-Delay recognition testing sections.

**List A Construction**

Four words were first chosen from each of four emotional categories (happiness, sadness, anger, and anxiety) and included in List A. These conditions were designed to assess emotions regarded as “basic”. Each emotional category of List A consisted of 4 target words presented in a nonconsecutive format, such that no two words from the same emotional category appear successively.

Univariate analyses of variance were conducted to ensure that List A emotional word categories were similar with regard to emotional intensity, word frequency, word categorization, and word length. List A word conditions were statistically similar with regard to emotional intensity, $F (3, 12) = 1.487, p = .268$, word frequency $F (3, 12) = \ldots$
1.43, \( p = .282 \), word categorization, \( F(3, 12) = .601, \ p = .627 \), and word length \( F(3, 12) = 1.72, \ p = .216 \). Thus, emotional words used in EVLT List A were statistically similar with regard to emotionality and word variables known to effect memory. Words included in EVLT list A are presented in Table 1, along with the category means and standard deviations in relation to emotional intensity, word categorization, word frequency, and word length.

**List B Construction**

Two words from each of the four targeted emotional categories were included in List B. The additional eight words included in List B relate to “disgust”, a basic emotion not included in List A. The use of disgust words for the remaining eight words is consistent with the List B construction of the CVLT-II, as these words fall in the List B nonshared (BN) by List A category. Thus, disgust words are similar to other words included in List A, in that they related to a basic emotion, yet differ from List A words, as List A does not include disgust as a targeted emotion. Ostensibly, this allows for List B to serve as a distractor word list. Similar to List A, each target word (words with emotional categories shared by List A) is presented in a nonconsecutive format so that no two words from the same emotional category appear successively.

Normative word frequency, word categorization, word length, and emotional intensity were also examined to control for confounding influences across List B. Univariate analyses of variance were conducted to examine word variables related to list B. Word conditions were statistically similar with regard to word length \( F(4, 11) = .798, \ p = .551 \), and word categorization \( F(4, 11) = .727, \ p = .592 \). Word categories significantly differed with regard to emotional intensity \( F(4, 11) = 7.04, \ p < .01 \), and word frequency, \( F(4, 11) \)
such that disgust words were significantly less emotionally intense and less frequent than other emotional words. Disgust words were selected to be less frequent and intense to allow for a unique assessment of proactive and retroactive interference, and to determine the semantic similarity of disgust words and other words representing negative categories (i.e., anger, anxiety, and sadness). However, other emotional word categories (happiness, sadness, anger, and anxiety) did not statistically differ with regard to emotional intensity $F(3, 7) = 1.77, p = .291$. List B words sharing the same emotional category of list A words were designed to be statistically similar to each other to ensure that list B served as an adequate distraction list.

**List A Long-Delay Yes/No Recognition Test Construction**

The format of the long-delay recognition testing section is modeled after the CVLT-II long-delay recognition test section. Recognition testing consists of a yes/no format presentation of the 16 target words (List A) and 32 distractor words. Like the CVLT-II, the distractor words fall into one of four conditions: 1) List B shared words (BS), which are eight words from List B that are from categories found on both List A and List B, 2) List B nonshared words (BN), which are eight words from list B that are from categories on List B, but not List A (disgust words), 3) Prototypical words (PR), which are eight words that are not found on List A or B, but are prototypical words from List A (i.e. happiness, sadness, anger, or fear words), and 4) Neither List Unrelated words (UN), which are eight words that are not found on List A or B and do not correspond with basic emotions found on either of the Lists (i.e. emotional words not related to happiness, sadness, anger, fear, or disgust).
Target words used in Long-delay Yes/No Recognition testing are those used in List A, and therefore do not differ with regard to word frequency, word length, word categorization, or emotional intensity. Individual scores and score calculation procedures are taken directly from those used in the CVLT-II. The primary EVLT scores, and the cognitive domains they assess, are described in Appendix B.

**Emotionality Ratings for CVLT-II Words**

To determine whether semantic categories used in the CVLT-II were comparable with regard to emotionality and variables known to effect memory, univariate analyses of variance were conducted to investigate emotional intensity, word frequency, word length, and word categorization. CVLT-II list A words, which were included in the on-line emotional intensity rating experiment, did not significantly differ from each other with regard to emotional intensity, $F(3, 15) = 1.48, p = .274$. Additionally, no significant differences were present between the CVLT-II and EVLT words with regard to word categorization, $F(3, 15) = 2.56, p = .11$, word frequency, $F(3, 15) = 2.36, p = .13$, and word length, $F(3, 15) = .078, p = .970$. Analyses suggest that CVLT-II words are statistically similar with regard to variables known to effect memory, and that words used are sufficiently neutral to serve as a neutral learning comparison to the EVLT words in the current study.

**Emotional Stroop Task**

The current study uses a commonly employed variant of J. R. Stroop’s (1935) original color-naming task, which involves the naming of a picture with an interfering word superimposed onto the picture. This modified Stroop task is referred to as the picture-word Stroop task. The Picture-word Stroop has been widely used in analyzing
various components involved in the development of early reading, and is believed to assess the same cognitive processes as the color-word version. The task involves naming a simple line-drawing (of a familiar object), while ignoring a word that is written overtop of the picture. The theory behind the picture-word Stroop task states that more influential words will cause longer picture naming latencies, due to the interfering qualities of the word. An emotional version of the picture-word Stroop task was used in the current study because it allowed for more complex manipulations of stimulus conditions (i.e. comparing picture control, letter string, and nonwords with emotional and neutral words), and because it has proven to be a reliable measure of emotional processing (Strauss, Allen, Jorgensen, & Cramer, unpublished manuscript).

The emotional picture-word Stroop task (E-Stroop) required participants to name a picture (simple black and white line drawing) while ignoring an emotional word that had been superimposed onto the picture. Picture stimuli were taken from a normative sample of stimuli depicting various animals, shapes, and objects taken from the Snodgrass and Vanderwart (1980) stimulus set and words were taken from the on-line study described above. E-Stroop apparatus, stimulus materials, and procedures are described in the sections that follow.

**E-Stroop Apparatus**

The E-Stroop task was created using E-Prime software (Psychology Software Tools). Stimuli were prepared as slides and presented by means of a Dell Inspiron (8200) laptop computer. The slides were projected onto a 15” laptop computer screen, with a viewing distance of approximately two feet. Verbal response was measured by a voice-operated microphone (Audio-Technia Cardioid low Impedance model # ATR 20C), which was
connected to a serial response box (Psychology Software Tools, Inc., model # 200A) that relayed the stimulus response interval to E-Prime Data-Aid software (Psychology Software Tools, Inc., Version 5.0) on the computer.

E-Stroop Stimulus Materials

The pictures were 100 digitized line drawings of various animals, shapes, and objects obtained from Snodgrass and Vanderwart (1980). All pictures were exact duplicates of those developed by Snodgrass and Vanderwart (1980), and were provided by those researchers with consent to be used in this study. The pictures were designed for adults, and have nameability ratings of ninety percent or higher. The information printed within the pictures was prepared by means of Adobe Photoshop 7.0. Each word was written in lowercase, Arial Black font regular, size 8 points, in black color, and saved in bitmap format. Words printed within the pictures appeared on the computer screen as black line drawings against a white background, and each stimulus appeared on the computer screen for five seconds or until a word was spoken into the microphone.

There were 167 stimuli, with 159 experimental, and 9 practice stimuli. Practice stimuli consisted of emotional and neutral words not included in the experimental stimuli. Two trials of all experimental stimuli of interest were presented to ensure that results were reliably produced by word interference, rather than difficulties in picture naming. Pleasant and unpleasant stimulus conditions were included for purposes not to be analyzed in the thesis, and were therefore only presented once. Thus, a total of 86 individual words and nonwords were presented. All words were randomly assigned to individual pictures, where words appeared on different pictures in trials one and two. Interference words were three to eight letters long, with letter string stimuli also ranging

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from three to eight letters. Six words were chosen from each of the following emotional conditions: Anger, Anxiety, Disgust, Fear, Happiness, Neutral, and Sadness. Each of the six words from these conditions was presented twice on two separate pictures. Fourteen pleasant and 13 unpleasant stimuli were also presented, where each word was only presented once. Twelve stimuli from a picture-control condition were also presented, such that 12 separate pictures were each presented once. Six words from a letter-string condition, 6 words from a neutral-nonword condition, and 6 words from an emotional-nonword condition were also included, such that each word was presented twice on two separate pictures.

The picture-control condition consisted of twelve pictures that were not altered from their original formats. Thus, stimuli appeared as simple black and white line drawings, with no word superimposed on top of the picture. Words from the letter string condition consisted of a random presentation of letters and syllables designed to produce a target that approximates the appearance of a word, yet has no meaning (ex: Gseoq). Two nonword conditions were included to assess semantic influences in emotional and neutral words. Semantic influences were assessed by contrasting neutral-nonwords with neutral words and emotional-nonwords with emotional words. Emotional-nonwords consisted of words taken from the six emotional categories, which were modified by changing the first letter of the target word in a way that causes it to no longer have meaning. For example, the word “despair” was changed to “jespair”. Neutral-nonwords consisted of six words similar to the six neutral words, which were modified by changing the first letter of the target word in a way that caused it to no longer have meaning. Letter string and nonword conditions were implemented to allow for the evaluation of semantic influence in the
automatic processing of emotional words. Word stimuli included in the E-Stroop task are presented in Table 2.

Univariate ANOVAs were conducted to control for the influence of variables known to effect automatic processing. Real word conditions (happiness, anger, anxiety, disgust, fear, neutral, sadness) included in the E-Stroop task did not differ with regard to word frequency, $F(6, 34) = 2.04, p = .087$ (Francis and Kucara, 1982) and word categorization, $F(6, 34) = 1.49, p = .212$. Emotional intensity ratings significantly differed across the real word conditions of happiness, sadness, anger, fear, anxiety, neutral, and disgust, $F(6, 34) = 22.26, p < .001$, as well as emotional word conditions (happiness, sadness, anger, fear, and disgust), $F(6, 34) = 8.60, p < .001$. The four emotions central to analyses of the current study (happiness, sadness, anger, and anxiety) did not differ with regard to emotional intensity, $F(6, 34) = 2.25, p = .114$. Word length also differed across emotional word conditions, $F(6, 34) = 3.40, p = .01$; however, it has been reported that word length does not significantly effect Stroop interference (MacLeod, 1991). As such, differences in word length were not expected to affect comparisons of emotional processing.

No attempt was made to include or exclude pleasant and unpleasant words according to emotional intensity or other word variables. Pleasant and unpleasant words were taken directly from normative word lists developed by Bellezza, Greenwald, and Banaji (1986). This was done to allow for a direct comparison between pleasant and unpleasant words, as presented in previous studies, with words from other basic emotion conditions. It was found that pleasant and unpleasant words did not statistically differ with regard to emotional intensity, $F(1, 24) = 0.00, p = .986$, word frequency, $F(1, 14) = 1.39, p = .262$,
and word length, F (1, 27) = 1.75, p = .198. Analyses were not conducted for word categorization, since basic emotions, rather than pleasant and unpleasant categorization, were examined in the development of E-Stroop words. Overall, pleasantness control analyses suggested that pleasant and unpleasant words did not statistically differ with regard to emotional intensity, although they have been shown to differ with regard to valence (i.e., pleasantness) (Bellezza, Greenwald, & Banaji, 1986).

Additionally, word frequency, word categorization, emotional intensity, and word length were examined across all tasks used in the study to allow for a direct comparison of word conditions from various measures. Emotional categories analyzed included: happiness, sadness, anger, and anxiety. Analyses were made using EVLT and ES task words from these categories alone, as other categories were not compared across tasks in subsequent analyses. With regard to word categorization, EVLT and E-Stroop words did not significantly differ for the category X test interaction, F (3, 32) = 1.21, p = .947. With regard to word frequency, EVLT and E-Stroop words did not significantly differ for the category X test interaction, F (3, 32) = .062, p = .979. With regard to word length, EVLT and E-Stroop words did not significantly differ for the category X test interaction, F (3, 32) = .012, p = .998. With regard to emotional intensity, EVLT and E-Stroop words did not significantly differ for the category X test interaction, F (3, 32) = .123, p = .946. Thus, EVLT and E-Stroop measures did not differ in the normative frequency, word length, or intensity of emotional words. Several emotional words were included in both EVLT and E-Stroop tasks, because it was not expected that word repetition would impact either memory or attention in these tasks, as E-Stroop words are automatically processed, and therefore not consciously evaluated and the E-Stroop was administered after the
EVLT. Overall, analyses suggest that a valid comparison may be made between emotional and neutral words across measures.

_E-Stroop Procedures_

Each participant was first seated in front of the computer screen, while the experimenter read aloud a set of instructions. The experimenter then read a set of directions which state:

“Welcome to the Picture Naming Task. In this task, you will first see a little cross in the middle of the computer screen like this: (+). Then, you will see a word printed on top of a picture. For instance, you might see the word ‘happy’ printed on the picture of a Zebra. Your task is to name the picture that is presented and ignore the written word. Just name the picture. You will respond by saying the name of the picture into the microphone. Can you tell me what you are supposed to do in this task?”

The experimenter then asked each participant if he or she understood the directions and requested that the participant say that he or she is to name the picture and ignore the printed word. If the participant responded incorrectly, the experimenter repeated the directions until the participant could correctly state that the purpose of the experiment was to say the name of the picture and ignore the written word. Once the participant responded correctly, the experimenter administered the practice stimuli.

Twelve practice stimuli were then presented, including one stimulus from each condition. Feedback was given for each practice stimulus by displaying “Correct!” in the color blue and “Incorrect” in the color red. After responding to the nine practice stimuli,
a sentence was presented stating “The previous trials were practice. The following trials will not include feedback. Press the Space Bar when you are ready to continue.”

For the initial trial, the first stimulus was triggered when the participant pressed the space-bar, causing the fixation point (+) to appear, followed shortly by the picture-word stimulus. Participants then named each picture-word stimulus by saying the name that corresponded to the appropriate target. Each participant was then given 159 experimental trials.

Data Entry and Analyses

Data Entry and Screening

Two examiners scored all CVLT-II and EVLT test protocols. When there were differences between scorers, tests were reviewed and scored again by both examiners. Raw data were entered into data form templates using Microsoft Access. Following data entry, descriptive statistics were calculated for individual tests and emotional categories, including frequency counts and skewness and kurtosis statistics. Descriptive statistics and box plots for each of the variables were examined in order to detect mechanical errors in the E-Stroop task, evaluate the presence of outliers, and inspect the distribution of each of the major variables. In cases where E-Stroop mechanical errors were present, these data were eliminated from analyses. All outliers (±2.5 SDs) in the raw data were examined to ensure that outliers were not the result of data entry error. Data considered to be outliers were removed from analyses, as these data typically reflected difficulty in picture naming rather than word interference.
Evaluation of Main Hypotheses

Several statistical procedures were used to evaluate the hypotheses for the current study.

Hypothesis 1

In order to test hypothesis 1, repeated measures ANOVA was used to evaluate differences across emotional word conditions. Dependent variables in the analysis included measures of reaction time (ms) and error rate (incorrect responses). Planned orthogonal comparisons were used to examine differences among word conditions for each of the dependent variables.

Hypothesis 2

In order to test hypothesis 2, a two-way repeated measures ANOVA was used to evaluate differences across emotional word conditions and individual memory conditions (recall and recognition). Dependent variables in the analysis included measures of recall (total number of words recalled) and recognition (correct responses). Planned orthogonal comparisons were used to examine differences among word conditions for each of the dependent variables.

Hypothesis 3

In order to test hypothesis 3, a Pearson product moment correlation coefficient was used to evaluate the relationship between attention and memory bias among the four emotional conditions. Dependent variables used in the analysis included mean reaction time (attention bias), mean recognition (memory), and mean recall (memory) measures taken per condition. Separate correlation matrixes were created to compare the
relationship between attention bias and recall with that of attention bias and recognition.

A multistage Bonferroni hypothesis test was used to account for inflated Type I error rates that resulted from conducting multiple correlations within a matrix.
CHAPTER 4

RESULTS

Preliminary Analyses

All participants evidencing psychopathology, as determined by an SCL-90-R global rating scale score above the clinical range were excluded from analyses. This was done to avoid potential biasing effects on the emotional Stroop and EVLT tasks. All individuals completing the experiment obtained an SCL-90-R global severity index scale score less than 63 (standard nonclinical population cut off score), with a range of 33 to 62, and a mean global index score of 50.61.

Subjects considered outliers were first removed from all analyses. To evaluate EVLT performance, skewness and kurtosis statistics were calculated. It was found that variables were approximately normally distributed. Accuracy analyses were then conducted on the Emotional Stroop task to ensure that there were no systematic errors among nontarget components of picture-word stimuli. It was found that four picture stimuli, the cloud (30% error), pen (33% error), toaster (30% error), and leaf (21% error), evidenced error rates greater than 20%. These stimuli were eliminated from all picture-word E-Stroop task analyses, as reaction time for stimuli containing these pictures was biased by the namability of the picture, rather than the interfering content of the word. Word and word-conditions were then analyzed for accuracy. This sequence was implemented to allow for
a comparison of the accuracy of conditions based upon the interfering effects of words, rather than the namability of pictures.

All E-Stroop reaction time trials associated with incorrect responses and mechanical errors were then eliminated from the data. Approximately 5% of the final E-Stroop data set was eliminated due to mechanical errors and incorrect picture naming. Next, reaction time trials greater than 2.5 standard deviations above each condition’s mean and less than 150 ms were removed from the data as outliers. This encompassed approximately 2.6% of the final data set. A total of 8% of individual RTs were eliminated from final E-Stroop analyses. Finally, for each participant, averages were calculated for reaction time and error rate for each task and condition. These averages formed the basic data for subsequent analyses. Reaction time was viewed as the primary dependent measure, particularly because picture and color naming accuracy approached ceiling.

**Evaluation of Main Hypotheses**

**Hypothesis 1.**

Participants will evidence statistically significant overall differences in attention bias across emotional word conditions. Specifically, greater Stroop interference will be displayed for words from the happiness condition than for words from sadness, anger, anxiety, disgust, neutral, pleasant, and unpleasant conditions.

In order to test hypothesis 1, a repeated measures ANOVA was used to evaluate differences across emotional word conditions. Dependent variables in the analysis included measures of reaction time (ms) and accuracy (correct responses). The Greenhouse-Geisser correction was implemented to eliminate the influence of error due
to repeated measures. Planned orthogonal comparisons were used to examine differences among word conditions for RT.

With reaction time as the dependent measure, the repeated measures ANOVA indicated statistically significant differences among the 8 target conditions (happiness, sadness, anger, anxiety, disgust, pleasant, and unpleasant), $F(7, 29) = 2.40, p < .03$. These findings suggest that emotional word conditions significantly differ with regard to attention bias (see Figure 1). Planned orthogonal comparisons were used to determine the nature of these differences. All orthogonal comparisons were nonsignificant. Results suggest statistical similarity in attention bias among emotional and nonemotional words, positive and negative words, emotionally intense and unintense words, happiness and pleasantness, disgust and intense negative words (sadness, anger, and anxiety), anger and other negative words (unpleasant anxiety, sadness), emotionally unintense negative words (disgust and unpleasant) and emotionally intense negative words (anger and sadness). Orthogonal analyses suggest that emotional intensity and word valence are not contributing to differences among emotional word categories. However, the pattern of means suggests a speed advantage for happiness words (See Figure 1). Results do not support hypothesis 1, but rather suggest the opposite pattern of results expected, as happiness words were processed more quickly than other word conditions.

A repeated measures ANOVA conducted with accuracy as the dependent variable indicates that emotional word conditions do not significantly differ with regard to error rate, $F(6, 29) = 1.14, p = .295$. Since the repeated measures ANOVA was nonsignificant, planned orthogonal comparisons were not calculated in relation to accuracy. Means and standard deviations for emotional conditions with accuracy serving
as the dependent variable are presented in Table 4. These findings suggest that pictures are highly namable across conditions, and that the degree to which errors are produced due to the emotional salience of words does not differ as a function of emotional category. Thus, emotional-word conditions included in analyses evidence similar levels of error.

Hypothesis 2.

Participants will evidence statistically significant overall differences in memory bias across emotional word conditions. Specifically, greater recall and recognition will be displayed for words from the happiness condition than for words from sadness, anger, and anxiety conditions. Individual recall and recognition conditions will not significantly differ with regard to memory performance.

Means and standard deviations of EVLT list A conditions are included in Table 5. A two-way repeated measures ANOVA was conducted with memory (recall and recognition) and emotion (happiness, sadness, anger, and anxiety) serving as within subjects factors. Findings suggest statistically significant differences for the main effects of memory, $F(1, 29) = 30.27$, $p < .001$, and emotion, $F(3, 29) = 3.26$, $p < .03$; however, the memory X emotion interaction was nonsignificant, $F(6, 29) = .093$, $p = .763$. Findings suggest significant differences between recall and recognition memory, and differences in memory among words representing the emotional categories of happiness, sadness, anger, and anxiety. The nonsignificant interaction suggests a similar pattern of results for emotional word conditions in both recall and recognition memory (See Table 5). Planned orthogonal comparisons were calculated for recall and recognition variables to determine the nature of these differences. With immediate free recall across trial 5
serving as the dependent variable, planned orthogonal comparisons suggest that recall is statistically similar for positive (happiness) and negative words (anger, anxiety, and sadness), negative words (anger, sadness, and anxiety), and sadness and anxiety. Although orthogonal comparisons were not significant, the pattern of results suggests that differences in condition can be attributed to a memory bias for happiness words, as participants recalled more happiness words than sadness, anger, and anxiety words (See figure 3 and Table 5). It is expected that orthogonal comparisons were nonsignificant due to ceiling effects in trial 5 immediate free recall, which occur due to increases in learning across trials 1-5.

To measure differences in emotional word recall while taking the influence of learning into account, a repeated measures ANOVA was conducted using total recall per condition across trials 1-5 as the dependent variable. Results suggest statistically significant differences among recall for emotional word categories across trials 1 through 5, $F(1, 29) = 30.27, p < .001$. To investigate these findings, simple contrasts were conducted using happiness as the contrast variable. Simple contrast analyses suggest statistically significant differences between happiness and sadness, $F(1, 29) = 9.31, p < .01$, happiness and anger, $F(1, 29) = 20.71, p < .001$, and happiness and anxiety, $F(1, 29) = 10.22, p < .001$. As hypothesized, findings support the existence of the Pollyanna Principle in recall.

Planned orthogonal comparisons were also calculated to investigate recognition memory. Orthogonal comparisons using recognition as the dependent variable evidence similar results to analyses conducted using immediate free recall trial 5 as the dependent variable. Orthogonal analyses suggest that recognition is statistically similar for positive
(happiness) and negative words (anger, anxiety, and sadness), negative words (anger, sadness, and anxiety), and sadness and anxiety. Emotional word conditions may be nonsignificant with regard to recognition due to ceiling effects related to total recognition across emotional word categories (See Table 5).

Results support several hypotheses made with regard to memory. First, the processing of emotional word conditions significantly differed with regard to memory. Differences in memory were found among memory for words representing happiness, sadness, anger, and anxiety categories. Second, happiness words were recalled to a greater extent than sadness, anger, or anxiety words. These findings support the existence of a Pollyanna effect in memory (See figure 3). However, results do not support hypotheses related to the existence of a Pollyanna effect in recognition memory, as emotional conditions did not significantly differ with regard to recognition performance.

Hypothesis 3.

A positive linear relationship between memory and attention bias will be evident across emotional word conditions. Statistically significant overall differences will occur among the four emotional word conditions of: happiness, sadness, anger, and anxiety. Additionally, the correlation between attention bias and memory will not differ with regard to recall and recognition.

Pearson product moment correlation coefficients for the correlation between E-Stroop RT and EVLT List A immediate Free recall across trials 1-5 are presented in Table 6. Findings suggest that there is no statistically significant linear relationship for the correlation of attention and recall for the four emotional word conditions of happiness, sadness, anger, and anxiety. These findings suggest that there is no statistically
significant linear relationship between attention and recall for emotional words within the same category in psychologically healthy individuals. However, findings do suggest a significant negative linear relationship between attentional interference for anger words and recall for happiness words ($r = -0.45, p < 0.01$) (See Table 6). The significant negative linear relationship implies that as recall for happiness words increases, RT for anger words becomes shorter (See Figure 5). Therefore, the greater the presence of the Pollyanna effect in memory, the less attention bias (preoccupation) an individual has for anger stimuli.

Pearson Product Moment correlation coefficients for the correlation between E-Stroop RT and EVLT long-delay yes/no recognition are presented in Table 7. A multistage Bonferroni hypothesis test was used to account for inflated Type I error rates that result from conducting multiple correlations within a matrix. Findings indicate that there is no statistically significant linear relationship for the correlation of attention and recognition within the four emotional word conditions of happiness, sadness, anger, and anxiety. These findings suggest that there is no statistically significant linear relationship between attention and recognition for emotional words in psychologically healthy individuals.

Results do not support predictions made in hypothesis 3. This is true for several reasons. First, the relationship between attention and memory bias was negative across recall and attention correlations, and mixed in direction across recognition and attention analyses. Thus, correlations between attention and memory were not consistently positive or negative across word conditions. Second, memory and attention were not significantly correlated within any of the 4 primary emotion conditions. Third, different patterns of
correlations were found across recall and attention and recognition and attention analyses, as there was a positive linear relationship between anxiety, anger, and happiness conditions, and a negative linear relationship among these conditions for the relationship between attention and recall. Finally, differences in the correlation between attention and memory were not found among the four basic emotion conditions of happiness, sadness, anger, and anxiety, as correlations within these conditions were all nonsignificant. Thus, attention and memory were not significantly correlated within individual emotions, and correlations were not positive, as would be expected based upon hypotheses designed to reflect current theories of cognition and emotion.

Additional Analyses

Attention Bias

A repeated measures ANOVA was conducted to evaluate differences in accuracy across all word categories used in the E-Stroop task. This analysis was conducted to investigate differences in emotional and control word conditions with regard to the nameability of pictures and the interfering effects of words. Accuracy analyses indicate that E-Stroop word categories do not differ with regard to accuracy rates, $F(12, 29) = 1.26, p = .343$. Additionally, subjects were highly accurate in naming pictures across all emotional word categories ($M = .95$, subject range $.81 - .99$). This suggests that differences observed in RT are reliably due to differences in emotional processing, rather than difficulty in picture naming.

An analysis of all interference conditions suggested that word conditions significantly differed with regard to interference (RT), $F(12, 29) = 4.48, p < .001$. The pattern of
means suggests a speed advantage to positive words, relative to other “real word” and nonword control conditions (See Figure 2). To evaluate differences in interference effects for emotional word conditions (happiness, sadness, anger, anxiety, disgust, fear, and neutral) simple contrasts were calculated using the happiness condition as the contrast variable. Happiness was chosen as a contrast variable, as it allows for a comparison of attention bias for positive and negative categories. Using a happiness contrast, findings indicated statistically significant differences between happiness and sadness, F (1, 29) = 16.53, p < .001, happiness and anger, F (1, 29) = 12.09, p < .01, happiness and anxiety, F (1, 29) = 5.40, p < .03, happiness and disgust, F (1, 29) = 9.32, p < .01, and happiness and neutral, F (1, 29) = 8.29, p < .01. Simple contrasts using a happiness comparison indicated that positive, negative, and neutral words are processed differently with regard to attention, such that happiness words were processed more quickly. To determine differences in the processing of emotional and nonemotional words, simple contrasts were also calculated using a neutral contrast. Analyses indicated statistically significant differences between happiness and neutral conditions, F (1, 29) = 8.29, p < .01; however differences were not found between neutral words and all other categories. Results indicated that attention bias did not differ between neutral words and words representing negative categories. Overall, simple contrast findings implicated a positive speed advantage for happiness words, rather than an attention bias for negative words, as happiness words are processed more quickly than negative and neutral words, and neutral words and negative words do not significantly differ with regard to Stroop interference.

A repeated measures ANOVA was conducted to examine differences in the processing of pleasant and unpleasant words. Results indicate that pleasant and
unpleasant words were statistically similar with regard to interference, $F(1, 29) = .224, p = .640$. These findings suggested that attention bias was similar for pleasant and unpleasant words, and that valence did not significantly impact interference in the E-Stroop task. When viewed in comparison to analyses conducted on basic emotion categories, the lack of difference between pleasantness conditions implies that the cognitive processing of emotional information is more complex than what pleasant and unpleasant categorization allows. Differences in the processing of pleasant/unpleasant and discrete emotional conditions may therefore support the existence of distinct basic emotions.

An analysis of variance was also calculated to investigate differences in interference among nonemotional control conditions (i.e., neutral, emotional nonword, neutral nonword, letterstring, and picture control). Results indicated that nonemotional control conditions significantly differed with regard to interference, $F(1, 29) = 7.53, p < .01$. Simple contrasts were used to evaluate differences between "real word" and nonword conditions. To evaluate differences in interference effects for control conditions, simple contrasts were calculated using a neutral word comparison. This contrast was used to allow for an investigation of differences between the processing of nonemotional "real words" and nonwords that have similar phonemic properties to nonemotional and emotional "real words". Significant differences were present between neutral words and picture control stimuli, $F(1, 29) = 17.31, p < .001$, and neutral words and emotional nonwords, $F(1, 29) = 5.55, p < .03$. All other contrasts were not significant. Picture control stimuli and emotional nonwords were significantly less interfering than neutral words. These findings indicate that the presence of a word significantly interferes with
picture naming, which confirms that interference effects in the picture-word Stroop task are due to the interfering qualities of words, rather than the namability of pictures. Differences in the processing of neutral words and emotional nonwords indicated that emotional nonwords that are phonemically similar to emotional "real words" are processed more quickly than neutral "real words", which ostensibly occurs due to emotional properties conveyed by these stimuli. It is expected that emotional aspects of emotional nonword stimuli contributed to these differences, rather than the fact that these stimuli are not real words, because neutral nonwords and neutral "real words" did not significantly differ with regard to RT, $F(1, 29) = 1.32, p = .260$.

Memory Bias

To determine whether differences observed among EVLT categories is truly the result of emotional processing in memory, rather than other semantic variables, comparisons were made between semantic categories included in the EVLT and CVLT-II. A Two-Way Repeated Measures ANOVA was conducted with test and semantic category serving as within subjects variables. Recall across trials 1-5 served as the dependent measure. Results indicate a significant test $X$ condition interaction, $F(1, 29) = 6.66, p < .03$. Findings suggest that the pattern of means observed between tests significantly differed as a function of semantic categories (See Figure 3). To further investigate these differences, a Repeated Measures ANOVA was calculated for CVLT-II conditions alone. Results indicated that CVLT-II categories did not significantly differ with regard to recall, $F(1, 29) = .186, p = .673$. Thus, recall did not differ among the four neutral semantic categories included in the CVLT-II (furniture, animals, ways of traveling, and vegetables); however, recall significantly differed among the four
emotional conditions included in the EVLT. The lack of difference among recall for neutral word conditions may substantiate that memory differences observed between emotional-word categories are due to aspects of emotional processing, rather than differences solely related to the presentation of four categories differing in semantic meaning.

Analyses of the serial position effect were also calculated to further delineate the cause of differences found in the recall of emotional words. To determine the effects of emotionality on emotional word learning and memory, composite scores were calculated for primacy, recency, and middle portions of List A. Scores were calculated for CVLT-II and EVLT variables following primacy/recency memory score calculation procedures developed for the CVLT-II (See Appendix A). A two-way repeated measures ANOVA was calculated using the Greenhouse-Geisser correction with test and serial position condition serving as within subjects variables. Results indicated significant differences in the main effect of serial position, $F(2, 29) = 13.50, p < .01$, and a test X serial position interaction, $F(2, 29) = 5.15, p < .04$. The main effect of test was not significant, $F(2, 29) = .409, p = .553$. These findings suggest that the pattern of word learning observed in CVLT-II neutral words significantly differed from EVLT neutral words. Figure 4 presents serial position curves for the 16 words included in the CVLT-II and EVLT. An analysis of the patterns of words recalled in primacy, middle, and recency list sections suggests that recency effects are greater for EVLT words, and that words in the middle of the list are recalled to a greater extent in the EVLT. These findings may be explained by the fact that EVLT middle words being recalled are either positive (glory and honor), which lends further support to the Pollyanna Principle, or semantically similar to their
designated category name (anxious and sad). High percentages of recall for the words sad and anxious may be explained by the fact that these words are strongly activated by nearby list words of the same emotional category, which allows them to be recalled easily, despite their position in the middle of the list. These words are also highly associated with the emotions they represent, and therefore contain a large number of associations with their given emotional nodes due to the similarity between these words and their designated category names (i.e., anxious is similar to anxiety; sad is similar to sadness). Findings lend support to an associative semantic network in emotional memory.
DISCUSSION

The current study measured the relationship between attention and memory for words representing discrete emotional categories. Overall, memory and attention were not significantly correlated for words representing the same emotional category; however, a significant negative linear relationship was found between recall of happiness words and attention bias for anger words. Additionally, differences were found among the processing of emotional words in attention, as well as emotional words in memory. Results provide support for the Pollyanna Principle in the learning and memory of emotion, and implicate a speed advantage for the processing of happiness words in attention. These findings implicate differential roles of the amygdala and basal ganglia in the processing of negative and positive words.

Memory and Emotion

Several predictions were made with regard to the current study. In relation to memory, it was hypothesized that participants would evidence statistically significant overall differences in memory bias across emotional word conditions. Specifically, greater recall and recognition were expected to be displayed for words from the happiness condition than for words from sadness, anger, and anxiety conditions. Individual recall and recognition conditions were not expected to significantly differ
with regard to memory performance. Results support several assumptions made regarding memory and emotion.

First, findings suggest significant differences in the learning and recall for emotional word categories, such that happiness words are learned more quickly and recalled to a significantly greater extent than anger, anxiety, and sadness words. The pattern of results supports previous findings reporting the existence of the Pollyanna Principle in recall (Amster, 1964; Barret, 1938; Colombel, 2000; Lishman, 1972a; 1972b; Lynch, 1932; Rychlak and Saluri, 1973; Shillace and Dragon, 1971; Silverman & Cason, 1934). The majority of previous research presented participants with pleasant, unpleasant, and neutral words, and tested immediate and long-delay recall. Results from previous studies show some evidence for greater recall of pleasant words in immediate recall memory, and significantly greater recall of pleasant words in long-delay recall memory. Recall for unpleasant and neutral words has been shown to be similar across immediate and long-delay recall conditions. Results of the current study provide further support for the existence of the Pollyanna Principle in recall, and suggest that the memory bias is not limited to pleasantness, but extends to more intense words representing a happiness category. Thus, the Pollyanna Principle may encompass a more general realm of positivity, rather than the specific factor of pleasantness.

Results do not support hypotheses related to recognition memory, as happiness, sadness, anger, and anxiety words did not significantly differ with regard to long-delay recognition. Recognition findings support studies reporting the lack of a memory bias for positive words in recognition (Colombel, 2000). Findings do not support studies reporting the existence of a Pollyanna effect in emotional processing for recognition.
memory (Amster (1964), Barret, 1938; Boglarsky, 2000; Rychlak and Saluri, 1973; Shillace and Dragon, 1971; Silverman and Cason, 1934). However, recognition findings of the current study may be effected by learning effects relative to the presentation of five immediate recall trials, which could potentially result in ceiling effects in relation to long-delay recognition testing. Additionally, hypotheses predicting similarity among recognition and recall memory were not supported, as recall and recognition significantly differed between trial 5 immediate free recall and long-delay yes/no recognition memory. However, recall and recognition memory evidenced a similar pattern of results with regard to the processing of emotional words. This suggests that even though ceiling effects may have precluded a finding of significant differences between happiness and other emotional categories, recall and recognition memory conditions are relatively similar with regard to the extent to which individual emotions are remembered.

Memory findings observed in the current study can be explained by theories postulated by Matlin and Stang (1978) and Matlin (2003), which propose the existence of the Pollyanna Principle. The Pollyanna Principle refers to the tendency to select positive information over neutral or negative information. The Pollyanna Principle is thought to occur because pleasantness predominates and pleasant items are processed more accurately and efficiently than unpleasant or neutral items. Findings of the current study support the existence of a Pollyanna Principle in recall memory, as happiness words were recalled to a significantly greater extent than negative words. The greater level of recall for happiness words suggests that these words are encoded and stored differently than negative words, which may occur because positive information is encoded more accurately and efficiently, and subsequently is more accessible for retrieval from
memory. Thus, results support the conjectures of Matlin and Stang (1978) and Matlin (2003), and provide further support for theories postulating that the accurate and efficient processing of positive information allows positive information to be more accessible for recall, resulting in a memory bias for positive information.

Findings may also be explained by some of the widely accepted models of emotion and memory. Theories postulated by Bower (1981) may explain results related to the Pollyanna effect in recall, as well as the disruption in serial position evident in emotional word learning. Evidence for the Pollyanna Principle in recall, where happiness words are recalled to a greater extent than other emotional categories, may be partially explained by theories of mood-congruent memory. Mood-congruent memory refers to the phenomenon where individuals are able to encode information more easily when the material being encoded is consistent with that individual's mood state at the time of encoding. The theory of mood-congruent memory may explain the Pollyanna effect in recall because psychologically healthy individuals are often in a positive mood state, which would cause the node for happiness to be active in memory during the encoding process, and subsequently allow happiness words to be encoded more easily in memory. Recently, Matlin (2003) also posited that mood-congruent memory significantly contributed to the Pollyanna effect in memory, and described how the phenomenon may transcend into areas other than experimenter generated-lists, including recall for personal information and recall for daily events.

Differences in recall for emotional words may also be explained by the disruption of word learning that occurs for emotional, but not neutral words. Serial position effect findings suggest differences in the pattern of word learning between emotional and
neutral words. These differences may be explained by Bower’s (1981) associative semantic network theory. With regard to the Pollyanna effect findings, Bower’s (1981) theory would suggest that happiness words may be recalled to a greater extent because they are strongly associated with the node for the emotion “happiness”, which allows happiness words to be retrieved more easily from memory due to the high degree to which those words are activated. This is particularly evident in happiness words falling in the middle of list A (glory and honor), which evidence higher rates of recall than neutral words occupying the same list position. According to Bower’s (1981) associative semantic network theory, happiness words in the middle of the list are recalled to a higher extent than their neutral word counterparts because these words have strong associations with the node for happiness, which overrule serial order effects that otherwise apply to words in the middle of a list. A similar explanation can be drawn for findings related to the words “sad” and “anxious”, which also evidence higher rates of recall than neutral words occupying the same position in the middle of CVLT-II list A. The disruption of the serial position effect in relation to the words “sad” and “anxious” may be explained by the fact that the high correspondence between these words and their category names allows the words to be highly associated with their representative emotional nodes.

It is likely that highly representative words (like sad and anxious) are more strongly associated with their given emotions than less associated words, which causes stronger activation and facilitates retrieval. Therefore, the high percentage of recall for the words “sad” and “anxious” may be explained by high association between these words and their designated categories, which causes disruption in the normal “U” shaped serial position effect. For example, “sad” is a word highly representative of the verbal category sadness,
and ostensibly has a very strong association with the node for the emotion sadness. Therefore, recall for the word “sad” is less affected by its list position than other words less associated with their emotional nodes. Thus, Bower’s (1981) associative semantic network model provides explanation for why only happiness words and words that are highly representative of their emotional categories significantly disrupt the normal serial position curve, by positing that these words have strong associations with the emotional nodes to which they are connected.

**Attention Bias and Emotion**

With regard to attention, it was hypothesized that participants would evidence statistically significant overall differences in attention bias across emotional word conditions. Specifically, longer RTs were expected to be displayed for words from the happiness condition than for words from sadness, anger, anxiety, disgust, neutral, pleasant, and unpleasant conditions. This hypothesis was primarily based upon psychological theories of attention bias, which suggest that emotional words that produce significant interference (longer RTs) are regarded as having greater “attention grabbing” power (White, 1996), and are thought to reflect an “attention bias” toward a particular emotion or mood state (Williams, Matthews, & MacLeod, 1996). The existence of an attention bias is generally thought to reflect that words causing interference are processed automatically in the brain. Following this notion, it was hypothesized that individuals evidencing a preoccupation with positivity or a general positive mood, would be more likely to display an attention bias toward positive words. Since most individuals are thought to exhibit a Pollyanna tendency, which involves a preoccupation with
pleasantness, it seems logical to expect that psychologically healthy individuals would evidence an attentional bias toward positive words, if the emotional Stroop task, which was used to measure attention bias, is able to adequately assess the automatic processing of positive words. It was hypothesized that the tendency to focus on positive information occurs because individuals are exposed to more positive information than negative information, and that this exposure has caused the processing of positive information to become more automatic (done quickly and without effort) than negative information. In the emotional Stroop task this would be reflected by longer latencies in RT that occur because emotional words processed automatically draw attention away from the target naming process more so than words that are not processed automatically. Positive stimuli were also expected to produce greater interference than neutral stimuli, even though we encounter more neutral than emotional stimuli, because emotional information is more salient than neutral information, and therefore has more “grabbing power” (Matlin & Stang, 1978; White, 1996). However, findings were contrary to hypotheses made regarding attention bias and emotion processing.

Results from the picture-word E-Stroop task provide support for a speed advantage for happiness words, rather than an attention bias for negative or positive words. This is true because RT for neutral words was similar to words from negative categories (i.e., anxiety, sadness, and anger), which were all significantly more latent than happiness words. Additionally, the positive word speed advantage may be specific to emotionally intense words that are representative of the discrete emotion happiness, as pleasant words evidenced similar RTs to words from negative, neutral, and unpleasant categories. Differences in interference between pleasant words and happiness words suggests that
emotional intensity significantly impacts the processing of positive words, and that pleasant words may be processed similar to neutral words due to their lack of emotional intensity. Results from the preliminary study designed to develop emotional intensity and categorization ratings for emotional words confirms this hypothesis, as pleasant words were not very emotionally intense (M = 4.58) and often categorized as neutral, while happiness words were very emotionally intense (M = 5.86) and highly representative of the basic emotion happiness.

In a novel facial-word ES task, which used a picture-word format, Stenberg, Wiking, and Dahl (1998) also found evidence for a positive word advantage. Strauss, Allen, Jorgensen, and Cramer (unpublished manuscript) conducted a study investigating the test-retest reliability of picture-word and color-word variants of Stroop and emotional Stroop tasks, which used a picture-word format identical to the current study. Results of Strauss et al. (unpublished manuscript) suggest that the picture-word E-Stroop test is a reliable measure of emotional processing, and also support the existence of a speed advantage for positive words. The discrepancy between previous color-word E-Stroop tasks, which suggested an attention bias for negative words, and the current findings related to the picture-word E-Stroop task may be explained by two general theories, which postulate the underlying mechanism of ES interference. First, results obtained in previous color-word studies (Pratto & John, 1992; Strauss et al., unpublished manuscript; White, 1996) may indicate that the ES task measures automatic processes, which are critical for detecting potential threats. Therefore, results of previous studies may suggest that healthy individuals evidence greater interference for negative words because negative words are processed automatically, and therefore draw attention away from the
targeted color-naming process. This may be explained by biological theories, which postulate the survival value inherent in having an attention bias for negative information. Alternatively, picture-word results may be explained by the fact that positive words are more accessible for retrieval. Matlin and Stang (1978) proposed that in a RT task, few responses will be generated for negative stimuli, while a large number of responses will be generated for positive stimuli. Due to a larger amount of potentially positive than negative options to respond from, individuals are more likely to respond quickly to positive stimuli and more slowly to negative stimuli. Matlin and Stang (1978) further hypothesize that such an occurrence would indicate that positive stimuli are processed accurately and efficiently, which causes them to be very accessible for retrieval in a RT task. Picture-word findings in the current study and those of Stenberg, Wiking, and Dahl (1998) and Strauss et al. (unpublished manuscript), which suggest a speed advantage for positive words, may therefore be explained by the fact that positive words are processed more accurately and efficiently than negative and neutral words.

The positive word speed advantage may also occur because happiness words are not automatized like negative and neutral words, and therefore do not significantly disrupt target (picture) naming. Negative words may disrupt picture-naming due to the fact that they are automatized and "grab attention" to signal threat in relation to a negative stimulus. The automatization of negative stimuli serves an adaptive function as it promotes survival. Neutral words may also become automatized due to processes inherent in word reading. The automatization of neutral words is a key element in text comprehension, and therefore promotes learning in literate individuals (Schwanenflugel, Strauss, Meisinger, Kuhn & Stahl, unpublished manuscript). Factors related to word
reading may therefore explain why neutral words also evidence RTs that are significantly longer than happiness words. Additionally, pleasant words may evidence RTs more similar to neutral than happiness words because pleasant words are less emotionally intense than happiness words, and therefore emotionally similar to neutral words.

It may also be the case that emotional words used in previous studies were not highly representative of their designated emotional categories. The current study developed normative ratings for each of the emotional words used, both in terms of emotional intensity, as well as emotional category. Prior studies that have not utilized this procedure may present conclusions that are biased by differences in emotional intensity that exist between positive and negative words. Therefore, results of the current study may be a more accurate representation of attention bias for emotional words, as word lists were equated for variables known to effect Stroop interference, as well as emotional intensity and word categorization.

Although findings suggest differences in attention for positive, negative, and neutral words, these findings do not support the existence of an attentional bias for positive words because positive words were not significantly more interfering than negative or neutral words. Rather, happiness words evidenced significantly faster RTs than negative or neutral words, which may be explained by the fact that highly intense positive (happiness) words are processed more accurately and efficiently than negative or neutral words. This pattern of results suggests that happiness words are not processed automatically because they do not significantly interfere with target naming. In relation to current theories of emotion, the lack of interference for positive words may not directly contradict the idea that the Pollyanna Principle is influential in attentional processes, but
rather that positive words are not automatized like negative or neutral words. Results may therefore support the existence of the Pollyanna Principle in attention, and specify that this tendency does not occur due to the automatization of positive words (as hypothesized), but rather because positive words are processed more accurately and efficiently than negative or neutral words. Findings support the conjectures of Matlin and Stang (1978) and Matlin (2003) who proposed that positive words are processed more accurately and efficiently than negative or neutral words. However, results from the current study extend current theories regarding the Pollyanna Principle in attention by finding evidence that the Pollyanna effect is specific to emotionally intense happiness words, rather than words representing a general pleasant category that vary in intensity.

**The Relationship Between Attention and Memory**

With regard to the correlation between attention and memory for emotional words, findings do not support hypotheses. It was hypothesized that there would be a significant positive linear relationship between memory and attention bias within emotional word categories. Additionally, differences in correlations were expected among the four emotional word conditions of happiness, sadness, anger, and anxiety. However, the relationship between attention and recall and attention and recognition was not expected to differ. These hypotheses were made based upon the results of studies on individuals with psychological disorders who evidenced increased memory and attentional biases for words related to their concerns or mood states (e.g., PTSD). It was expected that cognitive processes underlying these functions would be similar in psychologically healthy individuals, who tend to be optimistic by nature, and that healthy individuals
would also evidence a bias toward their given mood state of happiness. However, in healthy individuals, results suggest a nonsignificant relationship between attention and memory within word categories representing the same emotion. For example, within the emotional condition happiness, recall and attention for happiness words, and recognition and attention for happiness words were not significantly correlated. This may be consistent with the apparent dissociation between memory and attention biases. Negative stimuli have attention grabbing power, but positive stimuli are more easily encoded. So while we are always on the look out for threats and our survival instincts are exquisitely tuned to detect and respond to threats, there must be a natural mechanism that inhibits the encoding of such threat based information. To encode this information would naturally lead to depression or anxiety based disorders, which in themselves are not adaptive. Rather, while attentional processes are tuned for threat based information, positive information is quickly learned and remembered. This dissociation presents certain adaptive advantages resulting from avoidance of harmful situations, combined with the potential benefits of optimism. However, in order for this dual emotion system to occur, two systems would be required, one to attend to, learn and respond to threat based information, and the other to attend to, encode and respond to positive information. Recent evidence exists supporting such a dual system. Threat based information may rely on implicit memory systems for encoding, while positive information is encoded through explicit or declarative processes.

These findings may best be explained by neurological theories of emotion processing, as automatic and controlled processes and positive and negative emotions, are thought to involve different brain regions. Recent research on emotion has focused on differentiating
the roles of automatic and controlled processed, and attempted to delineate brain structures involved in these processes in relation to the processing of positive and negative information. Cognitive processes are described as automatic when information processing is fast and does not require conscious attention (Logan, 1978). Automatic processes can be viewed as working in a bottom-up sequence. Previous studies have suggested that individuals are able to processes emotional information automatically, and make fast and accurate judgments regarding the valence of information they are presented (e.g., is this word positive or negative?) (Quigley & Feldman Barret, 1999; Robinson, 1998). Recent neuropsychological studies suggest that the automatic processing of negative information is primarily governed by a small subcortical brain structure known as the amygdala. In contrast, controlled processes necessitate conscious cognitive processing, and are thought to be governed by several brain structures, including: the lateral prefrontal cortex, orbital frontal cortex, and the ventromedial frontal cortex (Ochsner & Feldman Barret, 2001). Controlled cognitive processes include those processes that are directed and effortful, and require focused attention to be completed (Ochsner & Feldman Barret, 2001). The retrieval of emotional information in memory is one example of a controlled cognitive process. It is likely that the retrieval of emotional information in memory includes the aforementioned brain structures, as well as other subcortical structures involved in memory processes (e.g., hippocampus, thalamus, amygdala); however, the activation of these structures may depend upon the valence of information to be retrieved from memory.

Recent studies have implicated differential roles of the amygdala and basal ganglia in the processing of negative and positive emotional information, respectively. The
amygdala, which is known to involve automatic processes, is also thought to be active in the processing of negative emotional information. A major role of its functioning is to detect potential threatening information, and relay signals to other structures, which stimulate an appropriate flight or fight response. Recent neuroimaging studies have also confirmed the role of the amygdala in controlled emotional processes, such as learning and recall, in relation to negative stimuli (LaBar, LeDoux, Spencer, & Phelps, 1995; LaBar, Gatenby, Gore, LeDoux, & Phelps, 1998). Although, the amygdala is thought to play a central role in the processing of automatic information, it is unknown whether the amygdala is active in detecting only negative information, or whether it is also involved in the automatic processing of positive information. However, it is well established that the amygdala is involved in the processing of negatively valenced stimuli during both automatic and controlled processes.

In contrast to the amygdala, the basal ganglia is thought to be involved in cognitive emotional processes that engrain patterns of action and response that have consistently lead to the attainment of reward or positive outcome (Ochsner & Feldman Barret, 2001). The basal ganglia are a group of large nuclei located in the central region of the left and right hemispheres. Although the basal ganglia are involved in several cognitive processes, they are thought to be central to the processing of emotional information (especially in relation to memory), due to their involvement with dopamine activity and circuits that connect their structures with other regions involved in memory and emotion (e.g., amygdala, orbital frontal cortex, anterior cingulate cortex). As individuals with basal ganglia dysfunction have been shown to experience less positive emotions (Robinson & Paradisio, 1996), and the region regulates dopamine activity, it is expected
that the basal ganglia plays a central role in the processing of positive emotions (Ochsner & Feldman Barret, 2001). Although the basal ganglia is known to play a crucial role in controlled processes, such as encoding and retrieval, it is unexpected that the basal ganglia is the primary structure involved in the processing of automatic positive information because basal ganglia activation requires directed attention. Currently, researchers have yet to identify a structure central to automatic processing and positive information.

Results of the current study may be explained by the complex interactions of controlled and automatic processes, and the interaction of brain regions that differentially regulate these processes while evaluating positive and negative emotional information. The significant negative relationship between recall for happiness words and attention for anger words may suggest that as positivity increases, preoccupation with anger decreases. This occurrence may be explained by the differential roles of the basal ganglia and amygdala with regard to the cognitive processing of emotion. Findings indicate that individuals evidencing a Pollyanna effect recall more positive words, which may be due to the proper functioning of the basal ganglia in encoding and retrieving positive information. Concurrently, the amygdala may not be activated by the automatic processing of anger words in healthy individuals because healthy individuals evidence positive mood states and are primarily preoccupied with positive information. Therefore, individuals who evidence the Pollyanna Principle may exhibit less preoccupation with anger words because automatic attention toward anger words conflicts with the processing of positive information in memory. This explanation may support the notion that different brain areas are involved in the automatic processing of positive and
negative information, and suggest that the amygdala is not involved in the processing of automatic positive information.

The causes of the nonsignificant relationship between attention for happiness words and memory for happiness words may provide further clarification for why the amygdala is not involved in the automatic processing of positive information. It is established that the amygdala governs automatic processes and is active in the processing of negative emotions; however, it is unknown whether the amygdala is active in the processing of positive emotions. If positive emotions are not governed by the amygdala, it is possible that positive information is not automatized by the amygdala, or that positive emotions are not automatized at all. This notion may be supported by evidence suggesting that the amygdala regulates the automatic processing of emotion, but that no evidence has been shown to support the fact that the amygdala is sensitive to detecting positive information in a quick fashion. An explanation of current findings may therefore indicate that even though individuals have a bias toward recalling happiness words, happiness words may not disrupt focus in the E-Stroop task because they are not automatized like negative words, which are regulated by the amygdala. Current findings indicating a nonsignificant relationship between attention and memory for happiness words may not signify that persons evidencing Pollyanism do not have an attention bias toward positive information, but rather that brain areas taxed by tasks used do not allow for an investigation of attentional preoccupations related to happiness. The E-Stroop task may therefore only be sensitive to detecting biases toward negative emotions because it measures automatic processes governed by the amygdala. This explanation seems possible since healthy
individuals evidencing a Pollyanna effect in memory also evidence decreased attention bias toward anger words, which are known to be regulated by the amygdala.

Conclusions

Results of the current study provide support for the existence of the Pollyanna Principle in memory and attention. However, the pattern of results observed differs from several hypotheses made regarding attention, memory, and the correlation between attention and memory. With regard to memory, it was hypothesized that psychologically healthy individuals would evidence significantly greater recall and recognition for happiness words than for words related to anger, sadness, and anxiety conditions. Results suggest that psychologically healthy individuals evidence a memory bias for happiness words in recall, but not recognition testing. Differences in results observed for recall and recognition may be explained by ceiling effects related to overall recognition across all emotional conditions. Thus, findings support the existence of the Pollyanna Principle in recall, but not recognition memory. These findings may be explained by theories postulating an associative semantic network of emotion and memory and the effects of mood-congruency on recall.

With regard to attention, it was expected that happiness words would be processed more automatically than neutral or negative words, and therefore evidence significantly greater interference effects (longer RTs). Support of this hypothesis would suggest that healthy individuals evidence a tendency to attend to positive information, which would occur because positive information is processed automatically in the brain, and subsequently cause healthy individuals to have an attentional bias toward positive
information. Emotional Stroop task results do not support hypotheses made regarding the automatic processing of positive words, but rather propose the opposite pattern of results. E-Stroop RT findings suggest the existence of a speed advantage for happiness words. These findings indicate that positive words are processed differently than negative and neutral words; however differences are not attributed to automatic processing and suggest that happiness words are not automatized. Findings may be explained by the fact that highly intense positive (happiness) words are processed more accurately and efficiently than negative and neutral words. Thus, findings do not support the existence of an attention bias for positive words, as happiness words are not processed automatically; however, findings support the existence of the Pollyanna principle in attentional processes because happiness words are processed more accurately and efficiently than negative or neutral words.

Hypotheses were also made regarding the relationship between attention and memory for emotional words. It was expected that psychologically healthy individuals would evidence a positive linear relationship with regard to memory and attention, and that this relationship would be most significant for happiness words. Results do not support hypotheses, and suggest that attention and memory are not significantly correlated within individual emotions. However, correlational analyses do suggest a significant negative linear relationship between attentional interference for anger words and recall of happiness words. The negative linear relationship between attention for anger words and recall of happiness words implicates differential roles of brain regions involved in controlled and automatic cognitive processes, and the processing of positive and negative information. Previous studies have found evidence for the role of the amygdala in the
automatic processing of emotional information, however it is unclear whether the amygdala regulates the automatic processing of positive information. Results of the current study imply that the amygdala is primarily active in the processing of automatic negative information, but not the automatic processing of positive information. Findings also suggest that positive emotions may not be automatized, or that the emotional Stroop task used in the current study is not sensitive to detecting the automatic processing of positive words. Additionally, results suggest that the basal ganglia are primarily active in the controlled processing of positive information.

Although the present study provides support for existence of the Pollyanna Principle in memory and attention, findings may be subject to several confounds. First, although the Snodgrass and Vanderwart (1980) stimuli used in the E-Stroop task include various images that are presumably of nonemotional content, the emotional intensity and valence of those stimuli have yet to be tested. Although words and pictures were randomly paired and words were presented twice within the E-Stroop task, RT data may be unexpectedly biased throughout the picture-word ES task. Additionally, several emotional words were repeated between EVLT and E-Stroop tasks, which may have unexpectedly biased E-Stroop results. However, this occurrence is unexpected because the E-Stroop task measures automatic processes that are presumably not effected by previous exposure to words since the words are experienced automatically.

Findings of the current study are limited to psychologically and neurologically healthy populations. Therefore, results of the current study can not be applied to clinical populations. Future studies may assess differences in memory and attention using the EVLT and E-Stroop to determine the relationship between memory and attention for
words representing pathological concerns. Results are also limited to individuals represented in the sample, who were primarily right handed, Caucasian, and female. It is possible that emotional processing may differ as a function of any of these demographic variables. Future E-Stroop task investigations may also benefit from using emotional words that are not repeated in memory tasks, and by ensuring that picture stimuli included in the E-Stroop task are empirically proven to be emotionally neutral. Literature on the Stroop task may also benefit from methodological comparisons, using color-word and picture-word tasks, as task versions may vary with regard to emotional processing. Future studies may also attempt to delineate brain areas implicated to be involved in the controlled and automatic processing of positive and negative information using Neuroimaging techniques.
APPENDIX A

CVLT-II SCORE DESCRIPTIONS

Learning

Semantic Clustering

The CVLT-II consists of two word lists (A and B) comprised of words taken from semantic categories. This allows for an assessment of a strategy known as semantic clustering, the extent to which words are actively organized according to shared semantic features (Bousfield, 1953). The implementation of semantic clustering strategies allows for information to be retrieved more efficiently from LTM (Craik, 1981). Use of semantic clustering strategies has been shown to significantly improve memory performance (Delis et al., 1988). As the current study focuses on age related differences, it important to note that healthy aging older individuals exhibit accelerated age-related decline in semantic clustering abilities (Craik, 1984).

The CVLT-II follows neuropsychological theories of learning which view semantic clustering as occurring during the learning process, rather than after target words have been retrieved from memory. By subscribing to this model, Delis et al. (1999) created a correction factor that utilized the number of categories given on the target list, rather than the number of categories given in the participant’s recall. The computation of semantic clustering involves three steps: 1) Calculating an observed semantic clustering score, 2)
Calculating a chance-expected semantic clustering score, and 3) Calculating a chance-adjusted semantic clustering score.

The observed semantic clustering score includes awarding a point for a correct word after another correct word from the same semantic category. To obtain this score, one totals the number of correct clusters. The maximum semantic cluster score for each trial is 12.

Calculating a chance-expected semantic clustering score corrects for the overall number of words recalled and the occurrence that greater clustering scores occur from greater overall recall. The formula of: \((\#C-1)/5\), where \#C is the number of correctly recalled words on a trial, is used to find the chance-expected semantic clustering score for each trial.

The chance-adjusted semantic clustering score evaluates the participant’s observed score relative to the chance-expected score given the number of words recalled. The formula for the chance-adjusted semantic clustering score in individual trials is: semantic clustering observed minus semantic clustering expected. The adjusted score for trials 1-5 or 1-4 is: Sum the chance adjusted scores for each individual trial and divide by the number of trials that had at least 2 or more correct responses. These scores can range from a high of 9 (perfect clustering when all 16 words are recalled) to a low of -3 (no semantic clustering when all 16 words are recalled).

**Serial Clustering**

The ability to recall words in the same order they are presented is known as serial clustering. Serial clustering strategies are generally inefficient means of remembering
information, as this entails focusing on the temporal sequence of a list, which does not allow for semantic reorganization (Delis et al., 1987).

Similarly to the semantic clustering score, the serial clustering score calculates an observed score, chance expected score, and a chance adjusted score. The observed score is derived by giving a single point for each instance an examinee recalls two words in the matching successive order that was presented on the list. To obtain the total serial clustering score per trial, the number of correct serial clusters must be totaled. The maximum serial cluster score possible for each trial is 15 (since there are 15 pairs of words that can be serially clustered). The serial clustering expected score for individual trials is calculated with the formula: (#of correctly recalled words for a particular trial-1)/16. The serial clustering chance adjusted score for individual trials is calculated the formula: Serial clustering observed minus serial clustering expected. The chance adjusted score for trials 1-5 is calculated by summing the chance adjusted score for each individual trial and dividing by the number of trials that had at least 2 or more correct responses. Chance adjusted raw scores can range from a high of 14.06 (all sixteen words are recalled and perfect serial clustering) to a low of -.93 (all sixteen words are recalled and no serial clustering).

**Learning Slope**

Learning slope refers to the average number of new words per trial that an individual is able to recall over the five immediate recall trials. For example, a learning slope of 2 would occur when an individual recalled 4 words on trial 1 and 12 words on trial 5. This learning slope score would indicate that the individual learned an average of two new words per trial. The formula for calculating the learning slope for trials 1-5 is as follows:
Proactive Interference

Proactive interference is the detrimental effect of previous learning on the retention of subsequently learned material (Postman, 1971). On the CVLT-II, proactive interference may be evidenced by a lower immediate recall score on List B than List A, which occurs due to interference from learning List A words over the five immediate recall trials. Proactive interference may also be exhibited by poorer recall of words from the shared category than the nonshared category on List B, which is due to the similarity of these words to those of List A.

A release from proactive inhibition occurs when previous learning is no longer an impediment to material that is learned later (Butters and Cermak, 1980). In the CVLT-II, release from proactive inhibition occurs when the recall of words from nonshared categories is superior to the recall of words from shared categories in List B. Cognitively healthy individuals commonly exhibit the proactive interference effect by having lower raw scores on List B than on trial 1 of List A. Two measures of List B are calculated and normed: 1) the number of correctly recalled words on List B, and 2) the standardized score on List A trial 1 subtracted from the standardized score on the List B trial. The later score indicates a participant’s degree of vulnerability to proactive interference.

Retroactive Interference

Retroactive interference is defined as the detrimental effect of recently learned information on previously learned material (Postman, 1971). On the CVLT-II this is measured by the presentation of a single trial of List A (without re-reading the list) that is given after the free recall trial of List B. Thus, retroactive interference occurs when
recall on this trial is less than that of trial 5 of list A. Two measures are calculated to determine retroactive interference: 1) The number of words recalled on the short-delay List A free recall trial, and 2) a retention score that is calculated by subtracting the standardized score on List A trial 5 from the short-delay recall trial standardized score. This retention score indicates how much information is retained from List A trial 5 to the List A short-delay trial.

Memory

Level of Correct Recall on List A Trial 1

It is well established that an individual’s ability to recall information falls between five to nine pieces of information, with an average of seven (Miller, 1956). Analyses of the level of correct recall on the CVLT-II list A trial one have yielded results affirming Miller’s findings, indicating that individuals recall an average of 6.62 target words (Delis, 2000). The ability to successfully recall target words on List A trial one is thought to be highly related with auditory attention span ability, as List A trial one is highly correlated with the Digit Span Forward Task from the Wechsler Scales (Delis et al., 1988). The level of correct recall on List A trial one is calculated by summing the number of correctly recalled target words.

Level of Correct Recall on List A Trials 2-5

When cognitively healthy individuals are presented additional opportunities to learn a word list, their level of recall generally increases with each subsequent trial. Healthy individuals also evidence consistent patterns of recall over the four immediate recall trials. This occurrence indicates that each subsequent trial of the same list plays a
progressively larger role in determining how information is encoded into and retrieved from LTM. The total level of recall for List A trials two through five is examined by summing the total number of target words recalled for each trial, and then qualitatively comparing the level of recall from each subsequent trial.

Overall Level of Correct Recall on List A Trials 1-5 Total

The overall level of correct recall for List A trials 1-5, is regarded as "a global index of verbal learning ability" (Delis et al., 2000). Analyses are performed by summing the total number of correct target responses for each trial, and comparing the recall level of each subsequent trial and the overall number of words recalled to normative data obtained for each individual trial and the total number of words recalled across the five trials.

Primacy/Recency Recall

The CVLT-II also provides the opportunity to measure an individual's primacy (beginning of the list) and recency (end of the list) recall tendencies. Research has shown that healthy individuals recall a greater proportion of words from the beginning and end of lists, and less words from the middle. This tendency has been termed the "primacy/recency effect". The Primacy effect occurs because beginning words are given significantly more rehearsal time than words presented later on this list. The Recency Effect occurs because words presented at the end of the list can be actively "echoed" back from Working Memory. The words presented in the middle of the list are more difficult to recall due to the effects of proactive interference from words presented at the beginning of the list and retroactive interference from words presented at the end of the list. The CVLT-II measures primacy and recency by analyzing the first and last four
words on the list, respectively. Consequently, the middle region is defined as the middle eight words. High levels of recall on the primacy and middle regions of the list are thought to reflect superior learning ability, and have been shown to correlate highly with superior LTM performance (Delis et al., 1988). Individuals who primarily recall words from the recency region are thought to evidence poorer encoding ability, and commonly have working memory deficits (i.e., Disorders like Alzheimer's disease and Korsakoff's syndrome) (Delis et al., 1991).

Primacy, middle, and recency indices are calculated to determine the percentage of words recalled across trials 1-5 from the three regions. These indices use standard scores to evaluate the degree to which an individual's primacy/recency recall corresponds to the general population, which is made possible because of an adjustment that corrects for the total number of words recalled across the five trials (Delis et al., 2000). The percentage of recall from each region of the list is calculated by: summing the total number of words correctly recalled from each region for each individual trial, and then dividing the total for each region by the total correct score for that individual trial. The percentage of words recalled per region is then obtained by multiplying each calculation by 100.

**Short-Delay Cued-Recall Trial**

The short-delay cued recall trial entails the recall of List A words in each of the four categories, after the short-delay free recall trial has been administered. Memory is assisted by providing examinees with category names and additionally requiring the use of semantic clustering to recall target words. The use of clustering words into categories can either facilitate or impede recall performance. When clustering facilitates recall, this suggests that a significantly greater amount of words were encoded into memory than
could be recalled in free-recall, and that retrieval was assisted through clustering
techniques. Individuals with learning disabilities (both adults and children) evidence
impeded performance on cued recall compared to free recall (Shear et al., 1992). This
finding is believed to result from deficient verbal learning capacities that are further
hindered by the task of recalling words in semantic categories. Short-delay cued recall
scores are obtained by totaling the amount of target words recalled from each individual
semantic category, summing the scores of each category, and finally comparing the total
number of words recalled in cued recall to the total amount of words recalled in the short
delay free recall trial.

Long-Delay Trials

In Long-Delayed recall, “Long Delay” is defined as a 20 minute interval comprised of
nonverbal testing. The benefits of the long delay trial are twofold: 1) it provides an
accurate estimate of retention without the confounding influence of retroactive
interference, and 2) it provides an assessment of forgetting rates over a prolonged time
span.

The Long-delay recall trials provide three distinct scores: 1) The amount of correct
recall on long-delay free recall, 2) the amount of correct recall on long-delay cued recall,
and 3) a contrast score that indicates the amount of information retained from short-delay
free recall to long-delay free recall. The contrast measure score is derived by calculating
Z-scores for earlier and later trials and subtracting the earlier trial Z-score from the later
trial Z-score. Most individuals evidence similar performance on short and long-delay
recall trials (Delis, 2000).
Yes/No Recognition

The CVLT-II utilizes recognition testing (in a yes/no format) to evaluate both encoding and retrieval features of memory. Recognition testing consists of a yes/no format presentation of the 16 target words (List A) and 32 distractor words. The distractor words fall into one of four conditions: 1) List B shared (BS), which are eight words from List B that are from categories found on both List A and List B, 2) List B nonshared (BN), which are eight words from list B that are from categories on List B, but not List A, 3) Prototypical (PR), which are eight words that are not found on List A or B, but are prototypical words from List A, and 4) Neither List Unrelated (UN), which are eight words that are not found on List A or B and do not share semantic features with words from either of the Lists.
APPENDIX B

EVL T SCORE DESCRIPTIONS

Learning

Semantic Clustering

The EVLT consists of two word lists (A and B) comprised of words taken from five “basic emotion” categories. This allows for an assessment of semantic clustering strategies applied in the learning of emotional information. As previously stated, the implementation of semantic clustering strategies allows for information to be retrieved more efficiently from LTM (Craik, 1981). Research has yet to investigate whether semantic clustering strategies are implemented in the learning of emotional information, and whether the use of such strategies allows for information to be retrieved from LTM more efficiently. Understanding how semantic clustering strategies are used in the learning of emotional information may prove beneficial since emotional information is more salient and processed differently than nonemotional information (E-Stroop reference here). As previously mentioned, healthy aging older individuals exhibit accelerated age-related decline in semantic clustering abilities for nonemotional information (Craik, 1984). It is expected that healthy aging older individuals will exhibit a similar semantic clustering pattern for emotional words, although emotional information should receive significantly greater amounts of semantic clustering than
neutral words, across the life-span. Specifically, words from the “Happiness” condition will evidence significantly greater amounts of semantic clustering than other emotions. This is expected to occur in accordance with the Polyanna Principle.

Serial Clustering

As previously stated, the ability to recall words in the same order they are presented is known as serial clustering. This strategy is generally an ineffective means of remembering information (Delis et al., 1987). In the EVLT, serial clustering will be analyzed to determine whether the use of this strategy is more beneficial than that of semantic clustering in remembering emotional words. If semantic clustering strategies are not used in learning emotional words, this may reflect the presence of the Pollyanna Principle or that emotional words are so salient that semantic learning strategies are not necessary.

Learning Slope

Learning slope refers to the average number of new words per trial that an individual is able to recall over the five immediate recall trials. This score is included to allow for a direct comparison of neutral (as measured by the CVLT-II) and emotional word learning rates. It is expected that the EVLT will result in a significantly steeper learning slope than the CVLT-II for trials 1-5.

Proactive Interference

Proactive interference is the detrimental effect of previous learning on the retention of subsequently learned material (Postman, 1971). On the EVLT, proactive interference is evidenced by a lower immediate recall score on List B than List A, which occurs due to interference from learning List A words over the five immediate recall trials. Proactive
interference may also be exhibited by poorer recall of words from the shared category than the nonshared (disgust) category on List B, which is due to the similarity of these words to those of List A. It is expected that significantly greater proactive interference will occur in the EVLT than the CVLT-II, which would ostensibly occur due to the prominent influence of words from the happiness condition.

A release from proactive inhibition occurs when previous learning is no longer an impediment to material that is learned later (Butters and Cermak, 1980). In the EVLT, release from proactive inhibition occurs when the recall of words from nonshared (disgust) category is superior to the recall of words from shared categories in List B. The proactive interference effect is evident when participants display lower raw scores on List B than on trial 1 of List A. Thus, if meaning impacts the learning of emotional words, recall should depend upon the semantic similarity of words from various emotional categories. If participants evidence a release from proactive interference, this would suggest that words from various basic emotion categories are distinct. If release from proactive interference does not occur, this would suggest that emotional words are inherently similar, regardless of category.

_Retroactive Interference_

Retroactive interference is defined as the detrimental effect of recently learned information on previously learned material (Postman, 1971). On the EVLT this is measured by the presentation of a single trial of List A (without re-reading the list) that is given after the free recall trial of List B. Thus, retroactive interference occurs when recall on this trial is less than that of trial 5 of list A. The occurrence of retroactive interference would possibly suggest that disgust words are more influential than other
categories of basic emotion, and/or that disgust words are distinctly different than happiness, sadness, anger, and fear words. If retroactive interference is not stable across participants, this would suggest that memory and learning for words from different basic emotion categories is inherently similar. This comparison of semantic similarity between emotional categories is possible because disgust words are included in list B, but not List A, and would subsequently be more influential than List A emotional categories if recall on the single trial of List A (presented after the List B trial) is less than that of List A trial five.

Memory

*Level of Correct Recall on List A Trial 1*

George Miller’s (1956) seminal paper titled “the magical number seven, plus or minus two: Some limits on our capacity for processing information” proved that an individual’s ability to recall information falls between five to nine pieces of information, with an average of seven. It is well established that the capacity to recall emotional information is greater than that of neutral information, and that positive words are remembered more than negative words (Matlin and Stang, 1978). However, research has yet to directly compare recall rates for individual basic emotions (i.e. happiness, sadness, disgust, anger, fear). The level of correct recall on List A trial one is calculated by summing the number of correctly recalled target words.

*Level of Correct Recall on List A Trials 2-5*

Measures of recall for neutral words (Delis et al., 2000) and emotional words (Matlin and Stang, 1978) over numerous trials have shown that recall generally increases with
each subsequent trial. It is expected that EVLT free recall scores of trials 2-5 will
evidence a similar pattern. The total level of recall for List A trials two through five is
examined by summing the total number of target words recalled for each trial, and then
qualitatively comparing the level of recall from each subsequent trial.

*Overall Level of Correct Recall on List A Trials 1-5 Total*

Research investigating recall of emotional words over five immediate recall trials has
indicated that positive emotional words are recalled more than negative or neutral words
in measures of total recall and on recall of each individual trial (Matlin and Stang, 1978).

*Primacy/Recency Recall*

The EVLT also provides the opportunity to measure an individual’s primacy
(beginning of the list) and recency (end of the list) recall tendencies. Similarly to the
recall of neutral words, it is expected that individuals will recall a greater proportion of
words from the beginning and end of lists, and less words from the middle. Measures of
primacy and recency are determined by analyzing the first and last four words on the list,
respectively. Consequently, the middle region is defined as the middle eight words.
Primacy, middle, and recency indices are calculated to determine the percentage of words
recalled across trials 1-5 from the three regions.

*Short-Delay Cued-Recall Trial*

The short-delay cued recall trial entails the recall of List A words in each of the four
basic emotion categories, after the short-delay free recall trial has been administered. In
measures of neutral words, memory is assisted by providing examinees with category
names and additionally requiring the use of semantic clustering to recall target words. It
is expected that memory for emotional words will also benefit from semantic clustering,
as emotional words are more salient than neutral words. The CVLT-II demonstrates that clustering words into categories can either facilitate or impede recall performance. If clustering according to emotional categories facilitates recall, this may suggest that the encoding and retrieval of emotional information is assisted through clustering techniques. If the use of semantic clustering impedes performance on cued recall compared to free recall, this may suggest that emotional words are inherently similar across categories and subsequently not divided into discrete units.

*Long-Delay Trials*

In the EVLT, the Long Delay interval is comprised of a 20 minute period of nonverbal testing. The Long-delay recall trial provides an estimate of whether emotional words are transferred into LTM as efficiently as neutral words.

*Yes/No Recognition*

The EVLT utilizes recognition testing (in a yes/no format) to evaluate both encoding and retrieval features of memory for emotional words. Recognition testing consists of a yes/no format presentation of the 16 target words (List A) and 32 distractor words. The distractor words fall into one of four conditions: 1) List B shared (BS), which are eight words from List B that are from categories found on both List A and List B, 2) List B nonshared (BN), which are eight words from list B that are from categories on List B, but not List A (disgust words), 3) Prototypical (PR), which are eight words that are not found on List A or B, but are prototypical words from List A, and 4) Neither List Unrelated (UN), which are eight emotional words that are not found on List A or B and are not related to basic emotions from either of the Lists. Recognition testing is included to
provide an additional assessment of memory, as recall and recognition often evidence varied memory patterns and presumably reflect different aspects of memory.
APPENDIX C

SUBJECT POOL RESEARCH DESCRIPTION

Gregory Strauss from the Department of Psychology is seeking participants for a study that examines the cognitive processing of emotional words. If you volunteer to participate in this study, you will be administered one computerized experiment and asked to recall two lists of words. These assessments are noninvasive and should not induce distress of any kind. Written instructions concerning how to behave during the examination will be provided. Part of the research time will involve remembering lists of words and naming pictures of black and white images. Participation time in this study is expected to be approximately one and a half hours. By participating in this study, you will gain one and a half research participation credits. You will also receive increased understanding of typical research conducted in cognitive psychology. If you experience mental fatigue during the testing, the researcher will allow breaks as necessary for your comfort. Although it is not expected to occur, should you feel uncomfortable answering any questions or performing any of the tasks, you may withdraw from the study at any time without penalty or consequence. You are encouraged to discuss concerns with the researcher who will be happy to discuss them with you in more detail.
APPENDIX D

DEMOGRAPHIC AND MEDICAL HISTORY QUESTIONNAIRE

Name: ____________________________

Email Address: _______________ Student Number: ____________

Birth date: _____ Date of Testing: _________ Gender: M F

Education Level:

4th grade (4) _______

8th grade (8) _______

High School/GED (12) _________

Some College (give #) _________ Major: ______________

Completed College (16) _________ Major: ______________

Graduate Work (give #) _________ Major: ______________

1. Do you have diabetes? Y N

2. Vision

A) Is your vision corrected (glasses/contacts)? Y N

B) Are you wearing them now? Y N

3. The next questions ask about difficulty with vision. Do you have difficulty....

A) Reading ordinary print in newspapers?

No difficulty ___ A little difficulty ___ Moderate difficulty ___ Extreme difficulty ___
B) Seeing print in dim light (such as restaurants)?

   No difficulty ___ A little difficulty ___ Moderate difficulty ___ Extreme difficulty

C) Doing work or hobbies that require you to see close up such as cooking, sewing, fixing things around the house?

   No difficulty ___ A little difficulty ___ Moderate difficulty ___ Extreme difficulty

4. Do you have severe visual impairments such as cataracts or glaucoma? Y N

5. Do you have any hearing loss (hearing aid)? Y N

6. Have you ever or do you now have seizures? Y N

7. Have you ever had a head injury (Motor vehicle accident/fall out of tree)? Y N

8. Consciousness-

   A) Have you ever been unconscious? Y N

   B) If so, how long? ______________

9. Psychological Disorders

   A) Have you ever been treated for any psychological condition?

   B) Have you ever been to therapy or seen a psychiatrist? Y N

   C) What for? ________________

10. Do you have any medical conditions? Y N   What ______________

11. Do you have any neurological disorders? Y N

12. Do you have a learning disability? Y N

13. Has this been formally diagnosed? Y N   diagnosis: ______________

14. Do you have an attention deficit? Y N

15. Has this been formally diagnosed? Y N   diagnosis: ______________

16. ADHD-
A) Are you taking medications for the attention deficit? Y N

B) What? _______

C) Take it as prescribed today? Y N

17. Medication-
   A) Presently taking any other medications? Y N

   B) What? ____________________________________________

18. Substance Abuse-
   A) Do you have problems with consuming alcohol or any other substances? Y N

   B) What? _______

   C) How often? _______

   D) How much? _______

   E) Have you used this in the past 6 months? Y N

19. Do you consider yourself: left Handed, Right Handed, or Ambidextrous?
   L _____ R _____ Ambidextrous _________

20. Is English your Primary language? Y N

21. What is the first language you learned? ___________________________
APPENDIX E

INFORMED CONSENT

Introduction: Gregory Strauss and Daniel Allen, Ph.D., from the Department of Psychology at UNLV, are seeking participants for a study that examines cognitive aspects of the processing of emotion. You are invited to participate in this research study.

Procedure: If you volunteer to participate in this study, you will be interviewed and then be administered four examinations designed to test temperament and thinking ability. For these examinations, you will be asked to complete a number of different tasks such as remembering lists of words and naming pictures. During the interview, the examiner will ask you general questions such as your age and years of education, along with questions regarding your medical history. At the beginning of the study, you will be provided with instructions that will tell you how to complete the tests. The total time needed to complete this research project is approximately 2.0 hours, although it may take less time for you to complete the study.

Benefits of Participation: By participating in this study, you will gain a research participation credit for every hour of research participation. Participation time in this study is expected to be approximately 2.0 credits.
Risks of Participation: There is a chance you may experience some mental fatigue during the assessments. To decrease the chance of fatigue, the researcher will allow breaks as necessary for your comfort. Although it is not expected to occur, should you feel uncomfortable answering any of the questions or performing any of the tasks, you are encouraged to discuss concerns with the researcher. Your participation is voluntary and you may refuse to answer questions or withdraw from the study at any time.

Contact Information: If you have questions about the study, or if you experience any harmful effects because of participation in this study, you are encouraged to contact Gregory Strauss or Daniel Allen at 895-0295.

For questions regarding the rights of research subjects, you may contact the UNLV Office for the Protection of Research Subjects at 895-2794.

Voluntary Participation: Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Confidentiality: All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for at least 3 years after completion of the study. After this three-year period, all test materials will be destroyed.
Participant Consent:

I have read or have had read to me all of the above information. I have had all of my questions answered and understand the purpose, procedures, risks and benefits of the study. I agree to participate in this study. I certify that I am at least 18 years of age. A copy of this form has been given to me.

Name __________________________  Date ____________

Signature __________________________  Witness ____________
APPENDIX F

DEBRIEFING FORM

OUR STUDY

The purpose of this study is to determine whether certain types of emotional words are remembered more and selectively attended to more than other words, by individuals with certain temperament characteristics.

The basic idea is that, a current subfield of Cognitive Psychology research focuses on emotional processing. Thus, studies are conducted on healthy individuals that measure the ability to memorize, learn, and selectively attend to different types of emotional words. These studies commonly uses research methodology that calls for individuals to perform tasks that require reading emotionally charged words or naming a picture and ignoring a written word. Current research on Basic emotions suggest that there are several distinct emotions that are universally experienced (happiness, sadness, disgust etc.), and that these emotions are more complex than simple positive/negative classifications. Past research has not accounted for theories of basic emotion, however, and continues to measure memory and attention for emotion by using positive and negative word lists. The current study attempted to account for theories of basic emotion while measuring the emotions of happiness, sadness, fear, anger, and disgust.
The tasks that you perform today are called the California Verbal Learning Test, the Emotional Verbal Learning Test, the Continuous Performance Test, the Emotional Stroop task, Revised Dimensions of Temperament Survey, and the Symptom Checklist-90-Revised. These studies measure verbal learning and memory, sustained attention, selective attention, temperament, and psychological symptoms, respectively.

If you want to learn more about memory and attention for emotional words see:


Thank you for participating in our study.

If you have any further questions about this study, please email me at straussg@unlv.edu.
APPENDIX G

TABLES
Table 1.
EVLT and CVLT Means and Standard Deviations for Word Variables

<table>
<thead>
<tr>
<th>Category</th>
<th>Anger</th>
<th>Anxiety</th>
<th>Happiness</th>
<th>Sadness</th>
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</thead>
<tbody>
<tr>
<td>Words</td>
<td>Angry</td>
<td>Anxious</td>
<td>Joy</td>
<td>Sad</td>
</tr>
<tr>
<td></td>
<td>Rage</td>
<td>Nervous</td>
<td>Honor</td>
<td>Cry</td>
</tr>
<tr>
<td></td>
<td>Mad</td>
<td>Uneasy</td>
<td>Love</td>
<td>Hopeless</td>
</tr>
<tr>
<td></td>
<td>Enemy</td>
<td>Tense</td>
<td>Glory</td>
<td>Gloom</td>
</tr>
<tr>
<td>M</td>
<td>6.08</td>
<td>5.50</td>
<td>6.06</td>
<td>5.91</td>
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<tr>
<td>SD</td>
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<td>.42</td>
<td>.43</td>
<td>.48</td>
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<tr>
<td>Freq.</td>
<td>55.75</td>
<td>21.5</td>
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<td>Len.</td>
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<td>6.25</td>
<td>4.25</td>
<td>4.75</td>
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<tr>
<td>% Cat.</td>
<td>90.98</td>
<td>83.63</td>
<td>90.6</td>
<td>86.6</td>
</tr>
</tbody>
</table>

Note. Int. = Emotional Intensity; Freq. = Word Frequency; Len. = Word Length; % Cat. = The average percent that a word is categorized to represent a given emotional category.
Table 2.

Words Included in Emotional Stroop Task.

<table>
<thead>
<tr>
<th>Anger</th>
<th>Anxiety</th>
<th>Disgust</th>
<th>Fear</th>
<th>Happiness</th>
<th>Neutral</th>
<th>Sadness</th>
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<td>Angry</td>
<td>Anxious</td>
<td>Decompose</td>
<td>Afraid</td>
<td>Glory</td>
<td>Boat</td>
<td>Cry</td>
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<td>Enemy</td>
<td>Nervous</td>
<td>Diarrhea</td>
<td>Danger</td>
<td>Honor</td>
<td>Closet</td>
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<td>Hatred</td>
<td>Restless</td>
<td>Filth</td>
<td>Fearful</td>
<td>Joy</td>
<td>Fork</td>
<td>Grief</td>
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<td>Horror</td>
<td>Lively</td>
<td>Grass</td>
<td>Hopeless</td>
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<td>Stinking</td>
<td>Rattlesnake</td>
<td>Love</td>
<td>Lawn</td>
<td>Sad</td>
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<td>Stern</td>
<td>Urgent</td>
<td>Vomit</td>
<td>Terror</td>
<td>Smile</td>
<td>Saxophone</td>
<td>Tragic</td>
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</table>
Table 3.

Emotional Stroop Reaction Time Means and Standard Deviations

<table>
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<tr>
<th>Interference Condition</th>
<th>Mean</th>
<th>SD</th>
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<td>Anger</td>
<td>908</td>
<td>233</td>
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Table 4.

Emotional Stroop Task Accuracy Means and Standard Deviations

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### Table 5.
EVLT Means and Standard Deviations

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Table 6.

Correlation Coefficients for EVLT Immediate Free Recall Trials 1-5 and E-Stroop Conditions

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<tr>
<th></th>
<th>Hap. Trials 1-5</th>
<th>Sad. Trials 1-5</th>
<th>Ang. Trials 1-5</th>
<th>Anx. Trials 1-5</th>
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<td>Anx. Trials 1-5</td>
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<td>-.13</td>
<td>-.33</td>
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<td>Ang. E-Stroop</td>
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<td>.62**</td>
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</tr>
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</table>

Note. Hap. Trials 1-5 = Mean number of happiness words recalled across trials 1-5; Sad. Trials 1-5 = Mean number of sadness words recalled across trials 1-5; Ang. Trials 1-5 = Mean number of anger words recalled across trials 1-5; Anx. Trials 1-5 = Mean number of anxiety words recalled across trials 1-5; Hap. E-Stroop = Mean RT (ms) of E-Stroop happiness words; Sad. E-Stroop = Mean RT (ms) of E-Stroop sadness words; Ang. E-Stroop = Mean RT (ms) of E-Stroop anger words; Anx. E-Stroop = Mean RT (ms) of E-Stroop anger words. * = p < .01, ** = p < .001.
Table 7.

Correlation Coefficients for EVLT Recognition and E-Stroop Conditions

<table>
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<tr>
<td>Anx. Recog.</td>
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<td>.65**</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Note. Hap Recog. = Mean number of happiness target words recognized; Sad. Recog. = Mean number of sadness target words recognized; Ang. Recog. = Mean number of anger target words recognized; Anx. Recog. = Mean number of anxiety target words recognized; Hap. E-Stroop = Mean RT (ms) of E-Stroop happiness words; Sad. E-Stroop = Mean RT (ms) of E-Stroop sadness words; Ang. E-Stroop = Mean RT (ms) of E-Stroop anger words; Anx. E-Stroop = Mean RT (ms) of E-Stroop anger words. * = p < .01; **
Figure 1.

Emotional Stroop Mean Reaction Time for Primary Conditions
Figure 2.

Emotional Stroop Mean Reaction Time for All Interference Conditions
Figure 3.

EVLT and CVLT-II Mean Number of Words Recalled Across Trials 1-5
Figure 4.

EVLT and CVLT-II Trial 1 Immediate Free Recall Serial Position Effect
Figure 5.

Correlation Between E-Stroop Anger Words and EVLT Happiness Trials 1-5.
REFERENCES


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