Hostility and Negative Emotion Induction: Implications for Verbal Learning and Cardiovascular Regulation.

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Abstract

Hostility is a multidimensional construct that has been extensively studied. It has been shown that hostility affects cognitive (Shimojima et al., 2003), behavioral (Prkachin & Silverman, 2002), visual (Herridge, Mollet, Harrison, & Shenal, in press), somatosensory (Herridge, Harrison, & Demaree, 1997a), auditory (Demaree & Harrison, 1997a), motor (Demaree et al., 2002) and pre-motor functioning (Williamson & Harrison, 2003). In order to extend and integrate the present literature on hostility and the effects of negative emotional state on cognition, the present investigation used a cold pressor to induce a negative emotional/pain state in high and low hostile participants and measured. The subsequent effects on the acquisition of the Auditory Affective Verbal Learning Test (AAVLT; Snyder & Harrison, 1997) were measured. Blood pressure (BP) readings were taken before and after the cold pressor to examine cardiovascular regulation in high and low hostiles. Further, before the first trial participants were asked to predict the number of words that they would be able to recall on the first trial. After completion of the experiment participants were asked to estimate their performance relative to other participants. The measures were used to assess self-awareness in high and low hostile participants, which may be impaired in high hostile individuals (Demaree & Harrison, 1997b).

As expected, high hostiles learned negative emotional words significantly better than they learned positive words. Additionally, high hostiles were impaired in their acquisition of verbal material relative to low hostile participants. Low hostile participants learned more words faster and reached asymptote sooner. A significant primacy effect for negative emotional words and an overall better recall of negative information was found.

Analysis on each of the four groups of the experiment indicated that participants in the cold pressor group performed similar to the high hostile participants. The cold pressor facilitated negative learning and also slowed verbal learning relative to the no cold pressor group.

It was predicted that high and low hostiles would differ on baseline measures of systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) and that they would demonstrate increased cardiovascular reactivity in response to the cold pressor. These hypotheses were not supported. Self-awareness measures also failed to produce significance.

These results support the purposal that high hostiles differ from low hostiles in a number of modalities. They demonstrate the persistence of negative emotional material. Future work should address what kinds of implications these factors have on high hostiles in daily interactions.

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The influences of negative emotion on health, behavior, and cognition have been investigated in a number of experiments (e.g., Shenal & Harrison, 2003; Sirois & Burg, 2003; Shimojima et al., 2003; Frasure-Smith, Lesperance, & Talajic, 1993). In the context of this research, hostility has emerged as one of the most extensively studied affective constructs and has been described in both behavioral and physiological terms. Behaviorally, hostility is an attitude that motivates aggressive behavior towards objects and people (Spielberger et al., 1985). Physiologically, hostility has been associated with the chronic over activation of the sympathetic nervous system (Keefe, Castell, & Blumenthal, 1986), leading to heightened arousal levels. The patterns of behavior and physiological activity in high hostile individuals have linked the construct to cardiovascular disease (CVD). While this link has been controversial, correlates of hostility suggest that hostility may play a role in the development of CVD. High hostile individuals demonstrate heightened cardiovascular liability (Davis, Matthews, & McGrath, 2000) and are more likely to engage in behaviors that put them at risk for CVD (Calhoun et al., 2001).

The hostile disposition has been described in terms of altered or dysfunctional right cerebral systems and right cerebral activation patterns to emotional/painful stressors (e.g., Demaree & Harrison, 1996, Demaree & Harrison, 1997a; Harrison & Gorelczenko, 1990). Using a neuropsychological approach, we may employ both behavioral and physiological indices to evaluate hostility and dynamic activation of the left and the right cerebrum. Previous models have suggested that overt levels of hostility result from a diminished capacity of the right frontal lobe to inhibit the right temporal and parietal lobes (Demaree & Harrison, 1996). Everhart and Harrison (1995) found support for the contention of oppositional anterior to posterior regulation of hostility using quantitative electroencephalography (QEEG) in a patient with hostility management problems. Anger episodes in the patient evidenced heightened sympathetic tone with a shift to increase delta magnitude over the right frontal region concurrent with increased beta magnitude over the temporal lobe (Everhart & Harrison, 1995). Shapiro et al. (2000) advocate that impaired function in the prefrontal cortex, be it from a lesion or as measured by regional cerebral blood flow (rCBF), is associated with hostile behaviors and abnormal modulation of cardiovascular activity.

More complex models of hostility are also present in the literature. A number of researchers suggest that the limbic system plays a role in the regulation and production of negative emotions. A regulatory role for anger and hostility has been found for the orbital-frontal cortex and its connections to the limbic system (Lieberman & Benson, 1977, Tonkonogy & Geller, 1992). The heightened level of arousal in hostility influences behavior responses and emotional interpretations through connections between the cortex and the amygdaloid bodies. Damasio & Anderson (1993) concluded that physiological changes which accompany anger and aggression are related to orbital-frontal disinhibition of the amygdala. Behavior systems and emotion response systems can be viewed as complex and integrated systems that require both feedback and feedforward circuits for efficient functioning (Thayer & Lane, 2000). Altered functioning in the right cortico-limbic system may produce chronically elevated levels of arousal interfering with the feedback system producing hostile behavior and an invalid perception of affective events.

Positron emission tomography (PET) and single-photon emission computed tomography (SPECT) studies produced conflicting results surrounding the right hemisphere's role in hostility. Gottschalk et al. (1992) found that hostility outward scores were positively correlated with heightened glucose metabolic rates in the right cingulum and right anterior cingulum during silent mentation using PET. However, Shapiro et al. (2000) found that high hostile participants showed higher rCBF in the left temporal and parietal cortices during control conditions and a decline in blood flow in the left frontal-temporal areas during mental arithmetic using SPECT scans. These results suggest that complex dynamic interactions in brain regions exists in hostility and that further study is needed to determine the neural substrates of hostility.

In experiments describing the effects of hostility on behavior, altered visual (Harrison & Gorelczenko, 1990, Larkin, Martin, & McClain, 2002, Herridge, Harrison, Mollet & Shenal, in press), auditory (Demaree & Harrison, 1997a), somatosensory (Herridge, Harrison, & Demaree, 1997), motor (Demaree et al., 2002), and pre-motor (Williams & Harrison, 2003) systems were found in individuals classified as high hostile by the Cook Medley Hostility Scale. In addition, behavioral investigations have shown distorted self-awareness in high hostile participants (Demaree & Harrison, 1997b). Distorted self-awareness is important due to the implications that it may have for future behavior. High hostiles may invalidly perceive events as threatening or stressful, thus increasing the chances of anger and physiological reactivity.

Although the self-awareness component of hostility has not been fully described, correlates of impaired right frontal functioning (which may be present in hostility) include disturbed self-awareness and self-regulation (Stuss & Alexander, 2000). Vilkki, Servo, and Surma-aho (1998) concluded that participants with right frontal lesions were less accurate in "feeling-of-knowing" judgments. In high hostiles, a negative relationship between hostility and self-awareness was observed (Demaree & Harrison, 1997b). In a study examining dissociative tendencies, hostility was a key factor in predicting their appearance (Irwin, 1998). Luu, Collins, and Tucker (2000) found that participants high in negative affect rated their performance as dissatisfactory and were less aware of mistakes. The authors attribute this effect to the fact that high negative affect participants are more likely to initially over-engage in a task and then to become dissatisfied with performance, leading to disengagement (Luu, Collins, & Tucker, 2000). Thus, Luu, Collins, and Tucker's (2000) explanation is based on personality characteristics associated with negative affect, such as coping style and agreeableness.

Physiological comparisons between high and low hostile individuals have shown heightened heart rate (HR) and blood pressure (BP) in high hostiles. Demaree and Harrison (1997a) found heightened HR and BP in high hostiles after the administration of a cold pressor. Though, commonly reported in the literature this has not been a unidimensional finding. Felsten (1995) reported that cynical hostility did not influence systolic blood pressure (SBP) responses. In a series of meta-analyses, Suls and Wan (1993) found that participants scoring high and low on most trait hostility scales do not consistently differ on measures of BP and HR reactivity to laboratory stressors.

In order to extend the established line of research in high hostiles as well as to integrate the effects of negative emotion on cognition, the current experiment used a functional cerebral systems model to describe interactions and intra-actions between the hemispheres which purportedly contribute to the dynamic nature of emotional processing. To test self-awareness in hostility the participants were asked to predict and to rate their performance.

The primary scope of this project is to examine how cognition in high and low hostiles would be affected by negative emotional/pain induction. Neuropsychological research on emotion has shown that both emotional states and emotional content in stimuli can affect cognition (Cahill et al., 1994; Adolphs et al., 1997; Erk et al., 1997). Damasio (1998) stated that memory and emotion are so closely related that they cannot be fully understood separately.

Research has suggested that emotional stimuli are more easily remembered (Cahill et al., 1994) and that negative emotional material may provide memory enhancing effects (Adolphs et al., 1997). In an investigation of the effects of emotional state on encoding, Erk et al. (2003) found that free recall for neutral material was better during a positive emotional state than during a negative emotional state or neutral state. In an evaluation of both an emotional trait and emotional stimuli, Harrison and Gorelczenko (1990) found a negative affective bias in high hostile individuals in the visual modality. Existing neuropsychological models of emotional processing explain these effects through examining lateralization of function, cognitive processes that mediate the emotional experience, and the existence of separate systems for cognition and emotion that are mutually interacting (Borod, 1992).

Additionally, the current experiment measured physiological responses to examine the links between emotion and the regulation of sympathetic tone. While some research suggests that emotion may be primarily processed within the right hemisphere (Heilman, 1997; Borod, 1992), others have shown a divergent lateralization for positive and negative emotion to the left and right hemispheres, respectively (Adolphs, Jansari, & Tranel, 2001; Tomarken et al., 1990; Davidson, 1993). Still others suggest more complex cerebral processing of emotion that includes both cortical and subcortical structures and that incorporates the autonomic nervous system (Damasio, 1998). Some physiological findings indicate that the right hemisphere is important for sympathetic tone regulation, while the left hemisphere may play a role in parasympathetic tone (Wittling, 1998). These implications and results demonstrate the importance of examining both behavior (performance on a task) and physiological regulation.

Neuropsychology of Emotional Processing

Neuropsychology has used several approaches to studying emotion. Early theories were based on the limbic system. This perspective was based upon evolutionary concepts explaining the difference in reasoning, memory, and thinking among mammals and other vertebrates. Only mammals were believed to have neocortex. Thus, the neocortex mediated cognition and newer aspects of mental life, while emotions or older aspects of mental life came to be thought of as mediated by the limbic system and the related older cortex (LeDoux, 2000). This theory lost credibility when it was discovered that damage to the limbic system produces deficits in learning and memory and with the discovery of an elementary neocortex in non-mammalian species. However, the incorporation of the limbic system into many theories of emotion is still prominent today. LeDoux (2000) suggests that this is due to the vague nature of both the anatomy and emotional function of the system. The author further argues that implicating the limbic system in emotional theories is grounded in tradition rather than data.

The lack of data surrounding the limbic theory and the inability to predict specific emotional processing from the theory (LeDoux, 2000) has led to the development of more tangible systems and ideas. Among these, the principle of lateralization or asymmetry of function among the right and left hemispheres has emerged as a central tenant in most theories of emotion processing. Paul Broca's initial description of the lateralized processing for language in the left hemisphere opened the doors for new routes of studying cerebral processing. When Kimura (1961) demonstrated that left hemisphere specialization for language could be examined through presentation of stimuli to each hemisphere, studies of lateralization of function flourished. Emotion researchers quickly adapted this methodology, producing two hypotheses based on lateralization. The first is that the right hemisphere is specialized for all emotional expression and perception, regardless of the affective valence. The second maintains that there is lateralization between the hemispheres, such that the right hemisphere is specialized for negative emotion and the left hemisphere is specialized for positive emotion (Borod, 1992).

Support for both models is evident in the literature. Heilman, Bowers, and Valenstein (1993) implicated the right hemisphere in the reception, expression, and regulation of negative emotion. Studies of patients with brain damage have found the right hemisphere to be crucial for emotional processing (Kucharska-Pietura et al., 2003; Borod et al., 2002; Mandal, Asthana, & Maitra, 1998). Research among non-brain damaged individuals indicates a right hemisphere advantage in emotional processing across a number of modalities. Using dichotic listening, Bryden and MacRae (1989) found a left ear advantage (LEA) for the identification of emotion. A LEA for the emotional quality of tonal sequences was also found (Bryden et al., 1982). Harrison and Gorelczenko (1990) found faster affect perception by the right hemisphere. Nagae and Mascovitch (2002) found that memory for emotional words was more dependent on the right hemisphere. Borod (1992) suggests that the strategies used in emotional processing, such as nonverbal, integrative, and pattern perception, are functions for which the right hemisphere is specialized giving rise to its advantage in emotional processing.

The valence hypothesis, suggesting lateralization of emotional processing, has produced more controversy in the literature, but still has received validating support. In an investigation of patients with unilateral cerebral damage, Adolphs, Jansari, and Tranel (2001) concluded that the perception of negative valences relies primarily on the right hemisphere, whereas positive valences are processed by both the right and the left hemispheres. EEG data suggest that there is greater right frontal activation during negatively valenced stimuli relative to left frontal activation and that positively valenced stimuli increase activation in the left frontal lobe (Tomarken et al., 1990; Davidson, 1993). Using emotional faces, Harrison & Gorelczenko

(1990) found an overall processing advantage for the right hemisphere; however the advantage was most prominent during the presentation of angry faces. Symmetry in the visual perception of happy faces was found using tachistiscopic presentation to the left and to the right visual fields (Harrison & Gorelczenko, 1990). In a population of temporal lobe epilepsy patients, Lee et al. (2002) found support for the valence model by measuring skin conductance and heart rate in response to positive and negative photographs. Increased glucose metabolism in the right orbitofrontal region was seen during the perception of angry faces in a neuroimaging experiment (Blair et al., 1999). Davidson (1993) concluded that the right hemisphere is associated with negative, withdrawal related emotions, while the left hemisphere is associated with positive, approach related emotions. Data examining subcortical structures also indicates lateralization. Morris et al. (1991) found that the right amygdala was important for arousal activation associated with negative emotions while the left amygdala was influential in positive emotions.

While both the right hemisphere hypothesis and the valence hypothesis can explain some of the findings from the research, neither model can fully account for the multitude of emotional processing effects. Perhaps a better explanation of the findings can be produced by looking at the type of stimuli involved and the type of cognitive processing involved. For example, experiments in the auditory modality generally produce support for the right hemisphere hypothesis (Bryden & MacRae, 1989; Bryden et al., 1982), while investigations in the visual modality favor the valence theory (Lee et al., 2002, Harrison & Gorelczenko, 1990). Cognition-emotion interactions are evident (Gray, Braver, & Raichle, 2002; Hartikainen, Ogawa, & Knight, 2000) and their existence warrants further investigation. Stimulus delivery was also found to influence emotion interpretation and physiological reactivity. Simons et al. (1999) demonstrated that moving images were related to an increase in both valence and arousal as measured by self-report, electromyography (EMG), and HR. Models that integrate emotional disposition, physiological arousal, valence and cognitive processing can account for these effects better than the right hemisphere hypothesis and the valence hypothesis alone.

Kinsbourne (1970) suggested that the hemispheres are asymmetrically activated by processes that favor one hemisphere over the other. Activation may produce facilitation (Kinsbourne, 1970) or interference effects (Kinsbourne & Hicks, 1978) depending on the nature of the task. Interference or facilitation effects are based on functional cerebral space, such that tasks performed concurrently that demand resources in close proximity may interfere with each other. However, hemispheric priming or activation may produce performance facilitation. This can be exemplified by the fact that the left hemisphere advantage for words can be increased when participants are instructed to direct attention to the right ear (Bryden, Munhall, & Allard, 1983). These principles are important for emotional processing because they demonstrate the effects that task selection and instruction can have on patterns of laterality.

Compton (2003) suggested that in order to produce more “fruitful” research, scientists should move beyond the dichotomies of emotion and cognition. Instead, Compton (2003) argued for a two stage model based on top-down and bottom-up influences, whereby processes of emotion and cognition are interacting and not mutually exclusive. Kinsbourne (2000) argues that the dynamic and multidirectional flow of information in the brain supports a neural model that is based on the horizontal transfer of information. Organization of the cortex along with bidirectional influences between modality specific processors suggests that the traditional model of unidirectional transfer of information is too simplistic (Kinsbourne, 2000). Tucker, Derryberry, and Luu (2000) describe a vertical integration system for emotional processing, whereby interactions occur between the brainstem, subcortical, and cortical structures. From this position, it is thought that emotion is processed and then reprocessed at each level of the nervous system.

Other researchers have placed more emphasis on the connection between physiological systems and emotion. Davidson and Sutton (1995) argued that physiological predictors and individual differences in behavior patterns in response to emotional arousal are more significant in understanding emotion than the lateralization of emotion. This is consistent with the Easterbrook hypothesis which states that physiological arousal results in a narrowing of attention that alters performance patterns (Easterbrook, 1959). Thayer and Lane (2000) described a combined neurovisceral and emotion regulation system. Within this presentation they integrate three previously proposed models for autonomic processing, attention, and emotion. Thayer and Lane (2000) noted that the systems include many of the same anatomical structures and propose that they compose a network of central nervous system (CNS) structures that are important in physiology, attention, and emotion. Additional researchers have also supported an integrative approach to the study of emotion (e.g. Damasio, 1998; Cacioppo & Gardner, 1999; Heller, Etienne, & Miller, 1995).

Neuoranatomical evidence demonstrating the rich interconnections between all brain areas favors an integrative approach to the understanding of cerebral processing. While specialized systems within the right and left cerebrums are present (e.g. the language processing system in the left hemisphere), they do not operate independently, but rather parallel to and in conjunction with other systems. In a meta-analytical review of the studies examining both the right hemisphere and the valence hypotheses, Wager et al. (2003) found that on a whole no hemisphere differences in emotional processing existed and that no hemisphere-valence interactions appeared. However, when considering gross brain structures more complex lateralization patterns emerged (Wager et al., 2003).

Hostility and Cardiovascular Regulation

Cerebral regulation of cardiovascular tone is a difficult area to study because of the complex interactions between the sympathetic and parasympathetic nervous systems. However, several authors argued that cerebral regulation of sympathetic tone may be a manifestation of the right hemisphere (Oppenheimer et al., 1992, Heller et al., 1990, Hachinsky et al., 1992; Wittling, 1998). Lateralization for parasympathetic regulation and sympathetic regulation is also evidenced in the literature. Wittling (1998) presented emotionally negative and positive films to the right and left cerebrums and found an increase in SBP during right cerebral presentations and a decrease in SBP during left cerebral presentations, suggesting a right hemisphere dominance in sympathetic control and a left hemisphere dominance for parasympathetic control.

Within the framework of the presented model of hostility, right cerebral regulation of sympathetic tone can help explain some of the increased physiological responses noted in high hostiles. Thayer and Lane (2000) suggest that relative sympathetic activation in anxiety disorders may be a result of faulty inhibitory mechanisms. This concept may also be applicable to hostility, as hostile behavior is associated with a diminished capacity of the right frontal lobe (which plays an inhibitory role) and increased sympathetic activation. In a dual task evaluation of hostility, Williamson and Harrison (2003) found differences in cardiovascular reactivity on tasks reported to tap either the right or left frontal lobe in high and low hostile individuals. On a right frontal mediated nonverbal fluency task, high hostiles demonstrated heightened SBP, whereas decreased SBP was evidenced on a left frontal mediated verbal fluency task (Williamson & Harrison, 2003). The results support diametrically opposite effects on cardiovascular measures as a function of a left versus a right frontal challenge (stress).

Other studies have shown that high hostiles demonstrate lower initial vagal modulation of HR and a greater reduction of vagal tone during stress (Sloan et al., 1994; Shapiro et al. 1993). Vagal tone is associated with HR activity, such that a reduction in vagal tone increases HR reactivity. In a paper on the central nervous system (CNS), sympathetic tone regulation and emotion, Lane and Schwartz (1987) suggest that individuals who demonstrate more cerebral lateralization for emotion may also experience more lateralized imbalance of sympathetic input to the heart. Lane et al. (1992) further this hypothesis by noting that right hemisphere stroke is associated with a greater number of supraventircular tachycardia. The authors suggest that right hemisphere infarction is associated with a decrease in cardiac parasympathetic activity causing a rise in sympathetic tone. Within the hostility construct, high hostiles may demonstrate higher sympathetic tone as a result of both an imbalance of sympathetic input and diminished parasympathetic tone due to a relative dysfunctional right hemisphere.

Current Experiment

The current experiment tested verbal learning of neutral, positive, and negative word lists in response to a cold pressor among high and low hostile participants. The experiment sought to describe the effects of an induced negative emotional/pain state on learning within the neuropsychological framework of interference and facilitation. An existing line of research has demonstrated differential neuropsychological processing and lateralized activation patterns to stress within high and low hostile participants (Williams & Harrison, 2003; Demaree & Harrison, 1997a; Herridge, Harrison, & Demaree, 1997; Harrison & Gorelczenko, 1990).

The current investigation is an extension of the research into the cognitive domain by looking at how hostility affects verbal learning. The inclusion of the cold pressor created a negative emotional/pain state in participants. QEEG studies examining the effects of the cold pressor indicate that cold pressor stimulation produces Alpha 2 desynchronization over the contralateral parietal electrodes of the stimulated hand and that this effect lasts longer over the right hemisphere (Ferracuti, 1994). Di Piero et al. (1994) reported that the cold pressor not only produced severe pain in participants but also activated contralateral frontal and bilateral temporal regions as measured by single-photon emission tomography (SPET). The pattern of activation suggests that painful stimuli are able to activate cortex via somatosensory pathways (Di Piero et al., 1994). Submerging the participants' left arm in the cold pressor should have activated right brain regions that are associated with negative emotion. This induction allows for the testing of interference and facilitation models by giving participants two concurrent variables to respond to, emotional processing and a cognitive task. Further, the cold pressor typically creates physiological changes that may be regulated by the right hemisphere. Physiological changes in arousal may also create differences in cognitive functioning.

Research has previously indicated that hostility has negative effects on cognition (Shimojima et al., 2003). However, it is not known how cold pressor presentation will interact with the different cerebral dynamics that exist in high and low hostiles to produce changes in cognitive functioning.

The experiment used a cold pressor and no cold pressor group and consisted of three phases. The same procedure was used in both conditions, except that in the no cold pressor condition participants placed their left hand in an empty cooler. In the first phase participants were asked to learn a neutral word list, in the second and third phases they were asked to learn either a negative or a positive word list. The added variable of affect to the stimuli in the second and third phases of the experiment created an opportunity to evaluate how affect can influence learning and memory. Bower and Forgas (2000) propose that participants should show an advantage in processing emotional stimuli congruent with their current emotional state. This can also be explained in terms of facilitation, whereby the negative emotion induced by the cold pressor primes the right hemisphere to process negative affect. However, the right hemisphere hypothesis for emotional processing would predict that both the positive and the negative list will be learned faster in the context of right hemisphere priming and facilitation.

To evaluate the self-awareness components of hostility participants were asked to predict the number of words that they would be able to recall on the first trial. At the end of the experiment they were also asked to rate their performance in comparison to other participants. Hertzog and Dixon (1994) describe performance predictions as knowledge about tests, cognitive abilities, self-efficacy, and self-monitoring. If high hostiles display a limited capacity for self-awareness, they should show less accurate predictions relative to low hostiles.

Initial investigations of the Auditory Affective Verbal Learning Test (AAVLT) suggest that the positive and negative lists are similar to the neutral list of the Rey Auditory Verbal Learning Test (RAVLT; Rey 1964; Synder & Harrison, 1997). Results in high and low hostile participants indicate that the negative list increases BP and right cerebral activation (Shenal & Harrison, 2003). These results lend support to the idea that the addition of affect activates the right hemisphere. Significant primacy and recency effects have also been noted in the negative and positive lists of the AAVLT (Snyder & Harrison, 1997; Everhart, Demaree, & Wuensch, 2003; Shenal & Harrison, 2003), such that there is a greater primacy effect during recall of the negative list and a greater recency effect in the recall of the positive list. These results were considered in the analysis.

In order to increase the homogeneity of the experiment, only men were recruited for participation. Considerable evidence suggests that sex differences in emotional processing and laterality exist between men and women (e.g., Ley & Bryden, 1979; Harrison, Gorelczenko, & Cook, 1990; Crews & Harrison, 1994; Hiscock et al, 2001). To avoid the confounding results secondary to these differences, the exclusion of women was necessary.

Hypotheses

1. Low hostile participants in the cold pressor condition will perform better than low hostiles in the no cold pressor condition on the neutral and positive lists as a result of left hemisphere activation.
2. High hostiles in the cold pressor condition will demonstrate the most impaired performance on the neutral and positive lists in comparison to all the low hostile and high hostile participants in the no cold pressor condition as a result of right hemispheric activation.
3. Overall, high hostiles in the no cold pressor condition will perform better than high hostiles in the cold pressor condition.
4. Because high hostiles have shown a negative emotional bias in the visual system (Harrison & Gorelczenko, 1990), it is expected that they will show a negative emotional bias in the auditory system and recall more items on the negative list relative to the low hostile group.
5. High hostiles in the cold pressor condition will experience a larger increase in HR, and SBP as a result of the cold pressor relative to low hostiles.

6. Participants in the no cold pressor condition will not experience significant changes in HR, SBP, or diastolic blood pressure (DBP) as a result of placing their hand in the empty cooler.
7. Participants in the cold pressor condition will experience significant changes in HR, SBP, or DBP as a result of placing their hands in ice water.
8. High hostiles will be more likely to over or under predict and over and under rate their performance, while low hostiles will produce predictions and performance ratings that are closer in value to their actual performance, regardless of stress.

Method

Participants

Participants were recruited from the undergraduate psychology pool. Criteria for inclusion included: between the ages of 18 and 25, right handedness, and no prior or current major neurological or medical issues. A brief medical history questionnaire (Appendix A) was given to assess prior neurological damage and illnesses. Participants who reported current or historical neurological damage/problems, current or prior cardiovascular disorders, current or prior diagnosed mental illnesses, a history of cognitive impairment, arthritis, or Reynaud's disease were excluded. Participants who smoke were also asked to complete the Smoking Habits and History Questionnaire (Appendix B). Participants were screened for handedness using the Coren, Porac, and Duncan laterality test (Appendix C; Coren et al. 1979). The Cook Medley Hostility Scale (Cook-Medley, 1954) was used to classify high and low hostile participants. A score of 28 or above was required for inclusion in the high hostile group and a score of 20 or below was required for inclusion in the low hostile group.

A total of 58 men completed the experiment. Eight participants were excluded for not meeting scoring criteria on Cook Medley Hostility Scale on the testing day. One participant was excluded from the high hostile group for reporting a head injury. One participant scored in the low hostile range during pre-screening and in the high hostile range on testing day. This participant was also excluded from the final analysis. This resulted in 12 low hostile participants in the cold pressor group, 12 low hostile participants in the no cold pressor group, 12 high hostiles in the cold pressor group, and 12 high hostiles in the no cold pressor group.

Self-Report Questionnaires

Medical History Questionnaire

The medical history questionnaire is a 33 item self-report questionnaire assessing current and prior medical issues that may affect the outcome of the experiment. Participants who answered "yes" to any of the questions were asked to explain their answers and were contacted by the experimenter to assess whether or not they were eligible for continued participation.

Smoking History and Habits Questionnaire

This is a 6 item self-report questionnaire assessing current and prior smoking habits. Participants who reported smoking on the medical history questionnaire were asked to complete the questionnaire. The smoking history and habits questionnaire was included to keep track of smoking across groups.

Coren, Porac, and Duncan Laterality Test

This self-report, behaviorally validated questionnaire measures left or right hemibody preference. The questionnaire consists of 13 items assessing lateral preference for hand, foot, eye, and ear. Items are scored +1 for right, -1 for left, and 0 for both. Scores range from +13 to

-13, indicating extreme right or left handedness. A score of +7 was required for further participation in the experiment.

Cook Medley Hostility Scale

The Cook Medley Hostility Scale is a self-report questionnaire purported to tap cynicism, anger, suspiciousness, and resentment in the hostility construct (Smith & Frohm, 1985). The scale consists of 50 true false items. Individuals who scored 28 or above on the test were placed in the high hostile group, while those who scored 20 or below were classified as low hostile. This grouping criterion has been used previously in our lab (Harrison & Gorelczenko, 1990; Harrison, 1991; Demaree & Harrison, 1997a; Demaree et al., 2002; Williams & Harrison, 2003) and found to be successful. The general nature of the questions make it a trait, rather than state indicator of hostility (Demaree & Harrison, 1997a). Its validity as a predictor of medical and psychological outcomes has made it one of the more commonly used measurements of hostility (Contrada & Jussim, 1992). Although the scale has been criticized as lacking the internal structure to predict psychological traits (Contrada & Jussim, 1992) its success in measuring hostility in previous research (Demaree & Harrison, 1997a; Herridge, Harrison, & Demaree, 1997; Harrison & Gorelczenko, 1990; Davis et al., 2000, Larkin, Martin, & McClain, 2002; Shapiro et al., 2000) demonstrates that it is a valid measure. Some example questions from the scale include "I have sometimes stayed away from another person because I feared saying or doing something that I might regret afterwards." "I feel that I have often been punished without cause." "I have often had to take orders from someone who did not know as much as I did."

Apparatus

Affective Auditory Verbal Learning Test (AAVLT)

The AAVLT (Appendix D) is composed of three word lists differing in affective valence: positive, negative and neutral (Snyder & Harrison, 1997). The lists were derived from an index of word norms established by Toglia and Battig (1978). The negative word list is comprised of words that were rated as the lowest in pleasantness, while the words that received the highest pleasantness ratings make up the positive word list. The neutral list is taken from the original Rey Auditory Verbal Learning Test (RAVLT; Rey, 1964). Examples of the negative words are “morgue,” “murder,” and “kill.” Examples of the positive words are “sunset,” “garden,” and “beach.” The neutral list consists of words such as “drum,” “curtain,” and “bell.” Instructions for completing the AAVLT and the three word lists were read by a woman speaker and recorded on compact disc. The word lists were recorded so that participants heard approximately one word per second.

Cold Pressor

Ice water for the cold pressor was maintained at 0-3 degrees Celsius using a small ice cooler. Water temperature was measured using a standard mercury thermometer. The cooler was located next to the participant’s left arm.

Physiological Measures

Heart rate, SBP, and DBP were measured using a Korotkoff automated digital blood pressure/ pulse meter with cuff (Model # SD-700 A, IBS Corporation). Inflation was set to 20 mmHg above the individual’s expected SBP. Exhaust rate was preset to 3 mmHg to provide a range of error of ± 3 mmHg. The accuracy of blood pressure measurement is reported to be ± 3 mmHg of those auscultated, while the accuracy of heart rate readings is reported to be within 2% of those gauged (approx. 1 beat / min.). The procedures adhered to the basic requirements of the American National Standard Institute (ANSI), the Association for the Advancement of Medical

Instrumentation (AAMI), and the American Heart Association (Harrison & Edwards, 1988; Harrison, Gorelczenko, & Kelly, 1988). Readings were taken from the participants left arm. The arm was partially extended, supported, and positioned at the level of the fourth intercostal space with the palm facing up. The cuff was placed on the left upper arm with the cuff connector located over the brachial artery about 2.5 cm above the antecubital space. Arterial location was determined by palpation. Each reading was repeated to ensure stability. A third reading was taken if HR readings differ by 10 beats per minute or 20 mmHg for either SBP or DBP. The reading taken immediately prior to cold pressor or no cold pressor presentation and immediately following presentation were used in the final analysis.

Procedure

An online screening was used to identify eligible participants. Participants completed an Informed Consent Form (Appendix E), the Medical History Questionnaire, the Smoking History and Habits Questionnaire, the Coren, Porac, and Duncan Laterality Test, and the Cook Medley Hostility Scale online. Individuals who met the inclusionary criteria of the Medical History Questionnaire, the Coren, Porac, and Duncan Laterality Test, and the Cook Medley Hostility Scale were invited to the lab for participation in the experiment.

Qualifying participants were randomly assigned to either the cold pressor or no cold pressor conditions. Upon arrival in the lab, participants were seated in a sound attenuated lab (see Appendix G for a flow chart of procedures). They completed the Informed Consent Form (Appendix F) and were instructed to familiarize themselves with the surroundings and relax. The female experimenter then fitted the participant with the BP cuff and left the room. Participants heard all instructions and the verbal learning test through a speaker located at midline directly behind them. To begin the experiment the participants were told the following:

> You will be hearing lists of words and asked to learn the lists. Before the lists are presented, your BP will be taken, and you will be asked to put your hand in some water. More specific instructions will be given at the beginning of each task. Before you hear the first list, I want you to try and predict how many words you will be able to remember from a list of 15 words on the first trial.

The experimenter recorded the prediction. Baseline SBP, DBP, and HR were then recorded. Participants in the cold pressor condition then heard the following instructions:

> When instructed, please place your left hand in the water to a point about one inch above your wrist. Please keep you hand in the water until instructed to remove it. This may be uncomfortable or painful, but please try and keep your hand in the water for the entire time. Do you have any questions? Begin.

Participants in the no cold pressor condition heard the following instructions:

> When instructed, please place your left hand in the cooler to a point about one inch above your wrist. Please keep your hand in the cooler until instructed to remove it. Do you have any questions? Begin.

Participants kept their hand in the ice water or cooler for 45 seconds. Upon completion, SBP, DBP, and HR were again recorded. The participants then completed the first trial of the verbal learning test with the neutral list. Participants were given the following instructions to begin the first trial:

> You are going to hear a list of words. Listen carefully to the words. When the list is finished, I want you to tell me as many words as you can remember. You may say the words in any order. Just try to remember as many as you can.

The experimenter recorded all responses on a data sheet. When the participant ceased to recall words the trial ended. Trial 1 was followed by trials 2, 3, 4, and 5. The following instructions were given for trials 2-5:

> You are going to hear the same list of words. Again, listen carefully to the words. When the list is finished I want you to tell me as many words as you can remember, including the words you told me before. You may say the words in any order. Just try to remember as many as you can.

Responses were recorded in the same manner as in trial 1. The entire procedure was repeated with the other two lists. Half of the participants in each group (high and low hostile) received the negative list first and the other half received the positive list first. The order of assignment was counterbalanced among groups. The neutral list was always given first. Upon completion, participants were asked to give their performance a percentile rank in comparison with all other participants of the experiment. They then re-took the Cook Medley Hostility Scale to ensure proper grouping. Participants were debriefed and allowed to leave the lab. The experiment took about 50 minutes to complete.

Results

Self Report Questionnaire Analysis

Separate t-tests were used to compare the group scores from the Coren, Porac, and Duncan Laterality Questionnaire and the Cook Medley Hostility Scale. On the Coren, Porac, and Duncan Laterality Questionnaire the high hostile group (M = 10.67, SD = 2.18) did not differ from the low hostile group (M = 11.13, SD = 2.11) (t (46) = -.740, $p > .463$). On the Cook Medley Hostility Scale, the high hostile group (M = 34.00, SD = 4.19) scored significantly higher than the low hostile group (M = 14.58, SD = 3.52) (t (46) = 17.37, $p < .0001$).

AAVLT Analysis

A five factor mixed design ANOVA was used to analyze the verbal learning data. The following factors were included in the ANOVA: fixed effects of group (high and low hostile) and condition (cold pressor and no cold pressor) and repeated measures of affective valence (neutral, positive, and negative), trial (verbal learning trials 1-5), and word location (beginning, middle, and end). All post hoc pairwise comparisons among the means were made using Tukey's HSD test (Winer, 1971) with the a priori $p \leq .05$. Table 1 lists a summary of the significant and non-significant effects.

A significant main effect was found for list ($F(2,88) = 5.90$, $p < .004$) (see Figure 1). Negative words (*M* = 3.58, *SD* = 1.38) were recalled significantly more than positive words (*M* = 3.36, *SD* = 1.26). Recall of neutral words (*M* = 3.47, *SD* = 1.29) did not differ significantly from negative or positive words.

A main effect was found for location ($F(2,88) = 77.44$, $p < .0001$) (see Figure 2). Recall was significantly different at each location. Recall at the beginning of the list (*M* = 3.95, *SD* = 1.08) was significantly higher than recall at the middle of the list (*M* = 2.98, *SD* = 1.47) and recall at the end of the list (*M* = 3.48, *SD* = 1.18), indicating a reliable primacy effect. Recall at the middle of the list was also significantly lower than recall at the end of the list in support of a recency effect for verbal learning.

Trial also produced a significant main effect ($F(4,176) = 395.46$, $p < .0001$) (see Figure 3). Each trial was significantly different from the others (Trial 1: *M*= 2.20, *SD* = 1.19, Trial 2: *M*= 3.16, *SD* = 1.21, Trial 3: *M* = 3.71, *SD* = 1.13, Trail 4: *M* = 4.02, *SD* = 1.00, Trial 5: *M* = 4.25, *SD* = .94). The results are consistent with a gradually accelerating acquisition or improvement in recall across trials.

List by location (F (4,176) = 13.79, p < .0001) (see Figure 4) was significant. Post hoc comparisons revealed that negative words at the beginning of the list (*M* = 4.36, *SD* = .86) were recalled significantly more than neutral (*M* = 3.90, *SD* = 1.05) or positive words at the beginning of the list (*M* = 3.60, *SD* = 1.19). Recall at the middle of the list was not significantly different by list. For words at the end of the list, neutral (*M* = 3.52, *SD* = 1.19) and positive (*M* = 3.58, *SD* = 1.09) words recalled did not differ significantly, however, neutral and positive words at the end of the list were recalled significantly more than words at the end of the negative list (*M* = 3.33, *SD* = 1.26). Comparisons of the different locations revealed that recall at the beginning and end of the list was significantly higher than recall at the middle (negative: *M* = 3.03, *SD* = 1.57, positive: *M* = 2.91, *SD* = 1.36, neutral: *M* = 2.98, *SD* = 1.45) for all three lists. Recall at the beginning of the negative and neutral lists was significantly different from recall at the end, indicating a greater primacy than recency effect for those lists. For the positive list, words recalled at the end and beginning did not differ significantly.

Location by trial (F (8,352) = 9.28, p < .0001) (see Figure 5) was significant. Post hoc analysis revealed that each trial was significantly different within each location. The beginning location (Trial 1: *M* = 2.90, *SD* = 1.12, Trial 2: *M* = 3.77, *SD* = 1.01, Trial 3: *M* = 4.22, *SD* = .86, Trial 4: *M* = 4.38, *SD* = .80, Trial 5: *M* = 4.49, *SD* = .74) was significantly higher than the middle or end location across all five trials indicating a robust primacy effect. Words at the end of the list (Trial 1: *M* = 2.29, *SD* = .95, Trial 2: *M* = 3.27, *SD* = 1.00, Trial 3: *M* = 3.64, *SD* = 1.09, Trial 4: *M* = 3.99, *SD* = .88, Trial 5: *M* = 4.19, *SD* = .96) were recalled significantly more than words at the middle of the list (Trial 1: *M* = 1.40, *SD* = .93, Trial 2: *M* = 2.44, *SD* = 1.19, Trial 3: *M* = 3.28, *SD* = 1.21, Trial 4: *M* = 3.70, *SD* = 1.15, Trial 5: *M* = 4.06, *SD* = 1.03) indicating that a recency effect was also present, though not as strong as the primacy effect.

A three-way interaction was present for group by list by trial ($F(8,352) = 2.47$, $p < .02$) (see Figure 6 and Table 2). Post-hoc comparisons revealed that both groups recalled significantly more words within each list across the trials, indicating a learning curve with repeated exposure to the words. Within the high hostile group negative words (Trial 1: *M* = 2.30, *SD* = 1.35, Trial 2: *M* = 3.24, *SD* = 1.23, Trial 3: *M* = 3.78, *SD* =1.18, Trial 4: *M* = 4.18, *SD* = 1.01, Trial 5: *M* = 4.33, *SD* = 1.03) were recalled significantly more than positive (Trial 1: *M* = 2.29, *SD* = .97, Trial 2: *M* = 3.01, *SD* = 1.18, Trial 3: *M* = 3.40, *SD* =1.17, Trial 4: *M* = 3.71, *SD* = 1.01, Trial 5: *M* = 4.00, *SD* = .87) words on trials 2-5. Neutral words (Trial 1: *M* = 2.14, *SD* = 1.15, Trial 2: *M* = 3.04, *SD* = 1.22, Trial 3: *M* = 3.71, *SD* =1.09, Trial 4: *M* = 3.90, *SD* = .98, Trial 5: *M* = 4.18, *SD* = .91) were also recalled significantly more than positive words, on trials 3-5. Neutral words were recalled significantly less than negative words, except on trial 3.

For the low hostiles, negative words were recalled significantly more than positive words on the first through third trials (Negative: Trial 1: *M* = 2.16, *SD* = 1.33, Trial 2: *M* = 3.22, *SD* = 1.24, Trial 3: *M* = 3.89, *SD* = 3.89; Positive: Trial 1: *M* = 2.01, *SD* = 1.05, Trial 2: *M* = 3.10, *SD* = 1.19, Trial 3: 3.65, *SD* = 1.01), however no significant differences were found for positive words and negative words in the fourth and fifth trials. Neutral learning was significantly greater than positive learning in trial 1 (Neutral: *M* = 2.26, *SD* = 1.16; Positive: *M* = 2.01, *SD* = 1.05), trial 2 (Neutral: *M* = 3.38, *SD* = 1.17; Positive: *M* = 3.01, *SD* = 1.19), and trial 3 (Neutral: *M* = 3.84, *SD* = 1.07; Positive: *M* = 3.65, *SD* = 1.00). However, positive learning was significantly higher than neutral learning in trial 4 (Neutral: *M* = 4.00, *SD* = .97; Positive: *M* = 4.13, *SD* = .93) and trial 5 (Neutral: *M* = 4.20, *SD* = 1.08; Positive: *M* = 4.33, *SD* = .86). A similar pattern was present for neutral and negative learning. In trials 1 and 3, low hostiles did not significantly differ on neutral and negative lists. On trial 2, neutral words (*M* = 3.38, *SD* = 1.17) were recalled significantly more than negative words (*M* = 3.22, *SD* = 1.23), this pattern was reversed on trials 4 (Neutral: *M* = 4.00, *SD* = .97; Negative: *M* = 4.20, *SD* = .98) and 5 (Neutral: *M* = 4.20, *SD* = 1.08; Positive: *M* = 4.33, *SD* = .86) with negative words being recalled significantly more than neutral words.

Between groups comparisons show that by trial 5, low hostiles outperformed high hostiles on all three lists, with the most marked difference in the positive list. Low hostiles were significantly better at learning the positive list on trials 1-2 and 4-5. On the neutral list, groups differed significantly on trials 1-3, with low hostiles outperforming high hostiles. The only significant difference on the negative list was on trial 1, where high hostiles recalled more negative words than low hostiles. The results indicate that low hostiles are able to learn better than high hostiles, except when negative information is involved.

List by location by trial ($F(16,704) = 4.01$, $p < .0001$) (see Figure 7 and Table 3) was significant. Post hoc comparisons revealed that the negative list exhibited a robust primacy effect. Words recalled at the beginning of the negative list (Trial 1: *M* = 3.56, *SD* = .92, Trial 2: *M* = 4.15, *SD* = .87, Trial 3: *M* = 4.69, *SD* = .59, Trial 4: *M* = 4.66, *SD* = .69, Trial 5: *M* = 4.73, *SD* = .49) were significantly higher than that of the neutral (Trial 1:*M* = 2.87, *SD* = 1.12, Trial 2: *M* = 3.79, *SD* = .94, Trial 3: *M* = 4.10, *SD* = .78, Trial 4: *M* = 4.27, *SD* = .82, Trial 5: *M* = 4.44, *SD* = .77) or positive (Trial 1: *M* = 2.25, *SD* = .91, Trial 2: *M* = 3.38, *SD* = 1.08, Trial 3: *M* = 3.88, *SD* = .98, Trial 4: *M* = 4.19, *SD* = .81, Trial 5: *M* = 4.31, *SD* = .85) lists across all five trials. A less clear pattern of recall was found for words at the middle of the list. For trial 1 neutral (*M* = 1.60, *SD* = .92) and positive lists (*M* = 1.56, *SD* = .97) did not significantly differ, however recall for neutral and positive words in the middle of the list was significantly higher than recall of negative words (*M* = 1.04, *SD* = .82). For trial 2, negative words at the middle of the list (*M* = 2.58, *SD* = 1.25) were recalled significantly more than neutral words (*M* = 2.31, *SD* = 1.09). Recall of positive words (*M* = 2.44, *SD* = .1.24) at the middle of the list on trial 2 did not differ significantly from recall of neutral or negative words. On trial 3 negative words (*M* = 3.54, *SD* = 1.20) at the middle of the list were recalled significantly more than neutral (*M* = 3.27, *SD* = 1.33) and positive words (*M* = 3.02, *SD* = 1.06). Neutral words at the middle of the list were also recalled significantly higher than positive words for trial 3. On trial 4, negative words (*M* = 3.92, *SD* = 1.15) were again recalled significantly more than neutral (*M* = 3.67, *SD* = 1.17) and positive words (*M* = 3.52, *SD* = 1.13). No significant difference existed between neutral and positive words on trial 4. No significant differences were found for recall of words at the middle of the list for trial 5. These results show a trend for negative words to be recalled more and support the main effect of list, were negative words were recalled significantly more than neutral and positive words. Comparisons of words at the end of the list for trial 1 revealed that positive words (M = 2.65, SD = .89) were recalled significantly more than negative words (M = 2.10, SD = .81) and neutral words (M = 2.13, SD = 1.06). For trials 2 and 3 neutral words (Trial 2: *M* = 3.52, *SD* = 1.01, Trial 3: *M* = 3.96, *SD* = .87) were recalled significantly more than positive (Trial 2: *M* = 3.33, *SD* = 1.00, Trial 3: *M* = 3.69, *SD* = 1.07) and negative words (Trial 2: *M* = 2.96, *SD* = .94, Trial 3: *M* = 3.27, *SD* = 1.20) at the end of the list. Positive words at the end of the list for trials 2 and 3 were recalled significantly more than negative words. On trial 4, no significant differences existed for words at the end of the list. On trial 5, negative words (*M* = 4.33, *SD* = .92) were recalled significantly more than neutral words (*M* = 4.08, *SD* = .99), however, no differences existed between recall of positive (*M* = 4.17, *SD* = .86) and negative words, or neutral and positive words. Overall, the negative word list results seem to coincide with previous research (e.g. Snyder & Harrison, 1997) that has shown an increased primacy effect for the negative list.

No other main effects or interactions effects were significant.

Separate more refined ANOVAs were performed using only the participants in the low hostile group and using participants in the high hostile group only (see Tables 4 and 5 for a summary). The analyses revealed a main effect for list in the high hostile group ($F(2,44) = 5.55$, $p < .01$) (see Figure 8). However, in the low hostile group the main of list effect was not significant. The high hostile group differed significantly in their recall of negative (*M* = 3.57, *SD* = 1.37) and positive words (*M* = 3.28, *SD* =1.21). Neutral word recall (*M* = 3.39, *SD* = 1.29) was not significantly different from positive or negative word recall. In the low hostile group list by trial was significant ($F(2,44) = 2.05$, $p <.04$) (see Figure 9). Post hoc comparisons revealed significant differences in recall on trial 1 for neutral (*M* = 2.26, *SD* = 1.16), positive(*M* = 2.01, *SD* = .85), and negative (*M* = 2.16, *SD* = 1.33) lists, with neutral words being recalled significantly more than positive words and negative words being recalled significantly more than positive information. Neutral words (*M* = 3.37, *SD* = 1.16) were recalled significantly more than positive (*M* = 3.08, *SD* = 1.19) and negative words (*M* = 3.22, *SD* = 1.23) on trial 2. On trial 3, negative (*M* = 3.88, *SD* = 1.22) and neutral words (*M* = 3.84 *SD* = 1.07) were recalled significantly more than positive words (*M* = 3.08, *SD* = 1.19). Recall of positive and neutral words did not significantly differ on trials 4 (Neutral: *M* = 4.00, *SD* = .98; Positive: *M* = 4.13, *SD* = .93) and 5 (Neutral: *M* = 4.20, *SD* = 1.08; Positive: *M* = 4.33, *SD* = .86). However, negative words on trial 4 (*M* = 4.20, *SD* = .98) and 5 (*M* = 4.43, *SD* = .78) were recalled significantly more than both positive and neutral words. These results in combination with the group by list by trial interaction indicate that low hostiles recall more negative information with repeated presentation. However, in the high hostile group it seems that negative learning is superior irrespective of trial.

The main effect of trial was significant for both low (F (4, 88) = 218.93, p < .0001) and high hostiles (F(4, 88) = 177.53, p < .0001). However, differential effects were found in post hoc comparisons. The low hostile group differed significantly on trials 1-4 (Trial 1:*M* = 2.15, *SD* = 1.19, Trial 2: *M* = 3.23, *SD* = 1.20, Trial 3: *M* = 3.80, *SD* = 1.11, Trial 4: *M* = 4.11, *SD* = .96). However trial 4 and trial 5 (*M* = 4.32, *SD* = .92) were not significantly different. For the high hostile group post hoc comparisons showed that each trial was significantly different from the other (Trial 1:*M* = 2.24, *SD* = 1.20, Trial 2: *M* = 3.10, *SD* = 1.22, Trial 3: *M* = 3.63, *SD* = 1.15, Trial 4: *M* = 3.93, *SD* = 1.02, Trial 5: *M* = 4.17, *SD* = .96). The results demonstrate that low hostiles reach asymptote sooner than high hostiles. No additional differential effects were found.

Separate exploratory ANOVAs were also performed for only the cold pressor and the no-cold pressor groups (see Tables 6 and 7 for a summary). The analyses revealed a main effect for list in the cold pressor group (F(2,44) = 5.52, p < .01) (see Figure 10), but not in the no cold pressor group. Recall of negative words (*M* = 3.68, *SD* = 1.34) was significantly different from recall of neutral (*M* = 3.45, *SD* = 1.30) and positive words (*M* = 3.40, *SD* = 1.31). The analyses support the idea that the cold pressor activated the right brain and produced negative emotion in the participants.

The main effect of trial was also different by group. In the cold pressor group, the post hoc comparisons for trial (F(4, 88) = 204.83, p <.0001) revealed that each trial was significantly different from the other (Trial 1: *M* = 2.22, *SD* = 1.12, Trial 2: *M* = 3.19, *SD* =1.22, Trial 3: *M* = 3.77, *SD* = 1.14, Trial 4: *M* = 4.05, *SD* = 1.00, Trial 5: *M* = 4.33, *SD* = .97). For participants in the no cold pressor group trial was also significant (F(4, 88) = 190.95, SD, p < .0001). Post hoc comparisons resembled those of the low hostile group. Trials 1-4 were significantly different (Trial 1: *M* = 2.17, *SD* = 1.27, Trial 2: *M* = 3.14, *SD* = 1.20, Trial 3: *M* = 3.65, *SD* = 1.12, Trial 4: *M* = 3.99, *SD* = .99), but trial 4 and trial 5 (*M* = 4.19, *SD* = .91) were not significantly different. No additional differential effects were found.

Physiological Analysis

Separate four factor ANOVAs were prepared on each physiological measure – SBP (in mmHg), DBP (in mmHg), and HR (in BPM). Tables 8, 9, and 10 list a summary of the ANOVAs for each dependent measure. The following factors were included in each ANOVA: fixed effects of group (high hostile, low hostile) and stress (cold pressor, no cold pressor) and the repeated measures of condition (pre-cold pressor, post cold pressor) and trial (first, second, third).

For SBP significant main effects were found for condition ($F(1,44) = 11.25$, $p < .002$) and trial ($F(2,90) = 33.58$, $p < .0001$) (see Figures 11 and 12). Post-hoc comparisons on the means for condition revealed that SBP was significantly higher at the post measurement (*M* = 123.26, *SD* = 12.06) compared to the pre measurement (*M* = 120.36, SD = 11.40). For trial, SBP significantly decreased at each recording (Trial 1: *M* = 125.57, *SD* = 11.36 Trial 2: *M* = 121.00, *SD* = 11.78, Trial 3: *M* = 118.86, *SD* =11.02) indicating an habituation effect. A stress by condition interaction effect ($F(1,44) = 17.42$, $p < .0001$) (see Figure 13) was also present. Post-hoc comparisons indicated that the participants in the cold pressor increased their SBP from the pre (*M* = 119.19, *SD* = 10.40) to the post (*M* = 125.71, *SD* = 12.21) measurement, while participants in the no cold pressor group maintained their SBP from the pre (*M* = 121.53, *SD* = 12.28) to the post (*M* = 120.82, *SD* = 11.56) measurement. No other effects were significant.

No significant effects were found for the DBP measurement. For HR, significant main effects were found for condition ($F(1,44) = 9.99$, $p < .03$) (see Figure 14) and trial ($F(2,90) =$

9.13, p < .0002) (see Figure 15) were found. HR was significantly higher during the pre condition (*M* = 78.65, *SD* = 13.93) than it was during the post condition (*M* = 75.88, *SD* = 14.26) measurement. Participant HR significantly decreased from the first (*M* = 79.31, *SD* = 14.65) to the second (*M* = 76.67, *SD* = 13.58) trial. Trial 3 (*M* = 75.81, *SD* = 13.04) was not significantly different from trial 2. The results reveal an habituation effect similar to that found for SBP. No other effects were significant for HR.

Prediction of Recall Analysis

For prediction of recall, the actual number recalled was subtracted from the number predicted to obtain difference scores. A constant was added to the difference scores to produce all positive numbers. A three-way ANOVA was then preformed with the fixed effects of group (high or low hostile), stress (cold pressor or no cold pressor) and the repeated measure of trial (prediction at lists 1, 2, and 3). No effects were found. An additional ANOVA was performed using the number predicted (see Table 11) as the dependent variable. A main of effect of trial was found (F(2,88) = 3.84, p < .03) (see Figure 16). Participant predictions on the first trial were significantly higher (*M* = 6.90, *SD* = 1.66) than predictions on the second trial (*M* = 6.33, *SD* = 1.34). Trial 3 (*M* = 6.54, *SD* = 1.25) did not differ significantly from the first or second trials.

Percentile Rating Analysis

A two-way ANOVA (see Table 12) with the fixed factors of group (high or low hostile) and stress (cold pressor or no cold pressor) was performed using the participants' rating of their performance. No significant effects were found.

Discussion

The current experiment was designed to evaluate the effects of a negative emotional/pain stressor and hostility level on affective verbal learning. Participants were assigned to one of four groups (low hostile, cold pressor; low hostile, no cold pressor; high hostile, cold pressor; high hostile, no cold pressor) and completed the AAVLT, a verbal learning test that varies in emotional valence (neutral, positive, and negative).

Results revealed that negative words are recalled significantly more than positive words irrespective of hostility level or level of stress. This finding is congruent with previous research (Abele, 1985; Dahl, 2001) suggesting that negative emotional words possess a characteristic that positive words do not. It is thought that negative information is analyzed more closely than positive or neutral information (Abele, 1985). Dahl (2001) stated that negative words were obtrusive and of greater importance to an individual. Taylor (1991) concluded that negative events are more taxing to individuals, such that they require additional responding. Friedman, Thayer, and Borkovec (2000) found a bias for threat word recall in participants with generalized anxiety disorder. An additional finding in the current experiment lending support to the notion that negative emotion is processed more intimately is the fact that a robust primacy effect of the negative list was present. This indicates that the negative information heard first persisted the longest. This effect did not occur in the positive list, but rather a trend for the positive list to produce a significant recency effect was found in post hoc comparisons of the list by location by trial interaction.

The data suggest that negative emotional learning may be influenced by traits or states. Only the high hostile men and men in the cold pressor group showed a main effect of list, with negative words being recalled more frequently. This effect was not evident in the low hostile men or men in the no cold pressor group. High hostile men may have more associations with negative words, thus facilitating learning in this category. Further, the significant interaction of group by list by trial indicates that hostility level influences learning, particularly learning of positive information. The three-way interaction showed that high hostiles were most impaired in learning the positive list but were able to learn the neutral and negative lists at a level equivalent to the low hostile participants. The interaction also revealed that low hostile participants learned faster than did high hostile participants. Low hostiles recalled significantly more words than did high hostiles on trials 1-3 of the neutral list. However, on trials 4-5 groups performed at near equal levels. This suggests that high hostiles can learn neutral information at a level similar to low hostiles, however repeated exposure is needed. On the positive list, low hostiles recalled significantly more words than the high hostiles on trials 1-2 and 4-5. On the negative list high hostiles learned more words on the first trial, but no additional significant effects were found for the later trials. Comparisons between the affective lists show that high hostiles are most impaired in learning positive information, but can learn negative information relatively easy.

No support was found for hypotheses 1-3. The effect of the cold pressor on overall learning was seemingly not a factor. However, the exploratory ANOVAs on the just the cold pressor group and just the no cold pressor group did show a difference in the main effect of list. In the current experiment it seems that stress only served to increase learning in the negative emotional category. Although, this is conflicting with previous studies that have concluded that pain impairs memory regardless of affect (Kuhajda, Thorn, & Klinger, 1998; Kuhajda et al., 2002), it is in line with Seltzer and Yarczower's (1991) conclusion that acute pain facilitates the acquisition of negative emotional material and disrupts the encoding of positive material. The physiological data in the current experiment may help explain the weak effect of stress. The cold pressor group only increased their SBP by about 6mmHg. Moreover, no increase in DBP or HR was seen as a function of the cold pressor. An additional factor may have been the time between the cold pressor and the beginning of the AAVLT. Blood pressure was recorded twice after the hand was removed from the water and then list learning began, although, this procedure has been used before and reliably produced significant cold pressor effects (Demaree & Harrison, 1997; Shenal & Harrison, 2004).

Results also supported prior research using the AAVLT (Snyder & Harrison, 1997) in that the negative list produced a greater primacy effect than the neutral or positive lists. The three-way interaction of list by location by trial describes this relationship. The primacy effect for the negative list was heightened across all five trials. The proactive interference across all trials suggests persistence of the memory trace for negative information. This interference may influence the ability to learn subsequently presented information. For high hostiles the persistence of negative information was especially high as evidenced by the group by list by trial interaction and the main effect of list in the high hostile group. Both effects show a relationship between high hostiles and increased recall of negative information. Synder and Harrison (1997) also describe a significant recency positive list. In the current experiment, a recency effect was only found in the list by location by trial interaction on the first trial of the positive list. The recency effect of the positive list was greater than the recency effect of the neutral and negative lists at 3 of 5 trials. This suggests a trend for retroactive interference in learning positive information, indicating positive information may not persist as long as negative information.

Physiological data did not support hypothesis five or prior research indicating heightened sympathetic nervous system tone for high hostiles (Keefe, Castell, & Blumenthal, 1986) or higher cardiovascular reactivity for high hostiles (Davis, Matthews, & McGrath, 2000). Suls and Wan (1993) suggest that increased cardiovascular responses in high hostiles occur as a result of interpersonal stressors. The cold pressor used in the current experiment is classified as a passive stressor. The difference in type of stress may account for the lack of a relationship between stressor and hostility level. However, prior research (Demaree & Harrison, 1997a; Shenal & Harrison, 2003) has found differences in reactivity of high and low hostiles in response to a cold pressor stressor. Cardiovascular measures in the current experiment may have been confounded by the cardiovascular effects of the AAVLT. Previous work suggests the positive list lowers BP, while the negative list increases BP (Synder, Harrison, & Shenal, 1998). Additionally, the main effect of trial in the SBP and HR data also suggests that habituation was occurring throughout the experiment. SBP and HR were higher at trial 1 than they were at trials 2 and 3. The baseline measurement of HR, SBP, and DBP may have been heightened as a result of the prediction of recall. Participants made predictions before the baseline measurement and anticipation of a task could have increased the recording.

The prediction of recall and percentile rank analyses did not support the hypotheses that high hostiles would show a lower level of self-awareness. However, the prediction of recall analysis did show that participants lowered their predictions following the first list. In the current experiment no feedback was given, however, it may be interesting to examine this effect in future work with the addition of feedback. A potential confound for the prediction of recall analysis could have been that participants were recruited from undergraduate psychology classes. They would have been previously exposed to the 7 ± 2 rule for verbal list recall. The percentile ranking did not produce any significant effects. Participants seemed generally unwilling to rate their performance at the conclusion of the experiment and tended to label themselves as average.

Overall, it would appear that hostility impairs the ability to learn positive words but not the ability to learn negative material and that negative affect may be more demanding of attention and persistent. This pattern of findings is consistent with previous research on hostility and negative emotion. The previously proposed model of hostility suggests that hostility arises as a result of a dysfunctional right hemispheric system, such that there is decreased activation in the right frontal lobe and increased activation in the right posterior cerebral region. Models of emotional processing also suggest that the right hemisphere (Borod, 1992) and especially the right parietal lobe (Heilman, 1997) is integral for negative emotion. In the current experiment, a negative emotional bias in the auditory system was found for high hostiles. A negative emotional bias for facial affect has also been found in high hostiles (Harrison & Gorelczenko, 1990).

It is difficult to speculate why the negative emotional event (cold pressor) did not exert robust effects in the current experiment or interact with hostility level. It was hypothesized that low hostiles would activate the left hemisphere in response to the cold pressor and outperform high hostiles on the lists. The group by list by trial interaction partially supports this hypothesis, in that low hostiles did tend to perform better. However, low hostiles in the cold pressor group did not show superior performance as a result of left hemispheric activation. It was also hypothesized that the cold pressor would activate the right hemisphere in high hostiles and interfere with verbal learning. This effect is also partially supported by the fact that high hostiles were impaired on verbal learning of the positive list, but not the neutral or negative list. It may have been that the verbal and emotional nature of the tasks worked against the results. Verbal learning and expressing language are generally thought to be left hemisphere functions, while emotion is more associated with the right brain. The act of recalling and affective valence may have activated both the right and left hemisphere equally making it difficult to produce the hypothesized effects. Further, the first list was also the neutral list which may have primed the left brain.

The results of the current experiment may have important implications in the way high hostiles interact and respond in social situations. Negative emotional bias concurrent with impairments in verbal memory may lead to increased hostility and aggression. Hostiles may falsely recall situations or people as negative. The robust primacy effect of the negative list, also suggests that this negative material may be a persistent over time. High hostiles may also need to be repeatedly exposed to information before they learn it. The independent analysis of the cold pressor group suggests that the effects of hostility may be induced in a “normal” individual as a result of a negative emotional event or a pain state.

Future work in this area should further examine the negative bias in high hostiles across different functional systems. Additionally, research should also seek to understand the relationship between the recall of positive and negative stimuli as a function of state. Continual examination of hostility and its cardiovascular effects is also needed in the literature. The current experiment along with others (Suls & Wan, 1993; Felsten, 1995) found no effect of hostility on SBP, DBP, and HR. However, opposite effects are commonly reported (Demaree & Harrison, 1997; Sloan et al., 2001; Williamson & Harrison, 2003). A further understanding of the physiological component of hostility will help explain its correlation with CVD.

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Table 1. ANOVA Summary Table – AAVLT

ANOVA Summary Table – AAVLT

Source	***DF***	***SS***	***F Value***	***p-value***
Group	1, 44	6.122685	1.000	0.322
Stress	1, 44	4.004167	0.660	0.423
Group*Stress	1, 44	0.856019	0.140	0.710
List	**2,88**	**16.25833**	**5.900**	**0.004**
Group*List	2,88	2.195370	0.800	0.454
Stress*List	2,88	6.169444	2.240	0.112
Group*Stress*List	2,88	0.350926	0.130	0.881
Location	**2,88**	**342.3000**	**77.44**	**0.0001**
Group*Location	2,88	1.125926	0.250	0.776
Stress*Location	2,88	3.233333	0.730	0.484
Group*Stress*Location	2,88	5.114815	1.160	0.319
T	**4, 176**	**1159.1454**	**395.5**	**0.0001**
Group*T	4, 176	5.754630	1.960	0.102
Stress*T	4, 176	1.317593	0.450	0.773
Group*Stress*T	4, 176	0.900926	0.310	0.873
List*Location	**4, 176**	**63.35000**	**13.79**	**0.0001**
Group*List*Location	4, 176	4.551852	0.990	0.414
Stress*List*Location	4, 176	8.555556	1.860	0.119
Group*Stress*List*Location	4, 176	1.224074	0.270	0.899
List*T	8,352	5.232407	1.510	0.151
Group*List*T	**8,352**	**8.517593**	**2.470**	**0.013**
Stress*List*T	8,352	3.987963	1.150	0.326
Group*Stress*List*T	8,352	1.232407	0.360	0.943
Location*T	**8,352**	**62.10741**	**9.280**	**0.0001**
Group*Location*T	8,352	3.225926	0.480	0.869
Stress*Location*T	8,352	6.507407	0.970	0.458
Group*Stress*Location*T	8,352	4.440741	0.660	0.724
List*Location*T	**16, 704**	**50.38148**	**4.010**	**0.0001**
Group*List*Location*T	16, 704	9.818519	0.780	0.709
Stress*List*Location*T	16, 704	19.53704	1.550	0.076
Group*Stress*List*Location*T	16, 704	10.52593	0.840	0.644

Table 2. Summary of the Means and Standard deviations for the Group x List x Trial interaction.

Group x List x Trial

Tukey's HSD = .116

Group	*List*	*Trial*	*N*	*Mean*	*Std Dev*
HH	Neutral	First	72	2.14	1.15
HH	Neutral	Second	72	3.04	1.22
HH	Neutral	Third	72	3.71	1.09
HH	Neutral	Fourth	72	3.90	0.98
HH	Neutral	Fifth	72	4.18	0.91
HH	Positive	First	72	2.29	0.97
HH	Positive	Second	72	3.01	1.18
HH	Positive	Third	72	3.40	1.17
HH	Positive	Fourth	72	3.71	1.01
HH	Positive	Fifth	72	4.00	0.87
HH	Negative	First	72	2.31	1.35
HH	Negative	Second	72	3.24	1.23
HH	Negative	Third	72	3.78	1.18
HH	Negative	Fourth	72	4.18	1.01
HH	Negative	Fifth	72	4.33	1.03
LH	Neutral	First	72	2.26	1.16
LH	Neutral	Second	72	3.38	1.17
LH	Neutral	Third	72	3.85	1.07
LH	Neutral	Fourth	72	4.00	0.98
LH	Neutral	Fifth	72	4.21	1.09
LH	Positive	First	72	2.01	1.05
LH	Positive	Second	72	3.08	1.20
LH	Positive	Third	72	3.65	1.01
LH	Positive	Fourth	72	4.13	0.93
LH	Positive	Fifth	72	4.33	0.86
LH	Negative	First	72	2.17	1.33
LH	Negative	Second	72	3.22	1.24
LH	Negative	Third	72	3.89	1.23
LH	Negative	Fourth	72	4.21	0.98
LH	Negative	Fifth	72	4.43	0.78

Table 3. Summary of the means and standard deviations for List x Location x Trial interaction.

List x Location x Trial

Tukey's HSD = .18

List	*Location*	*Trial*	*N*	*Mean*	*Std Dev*
Neutral	Beginning	First	48	2.88	1.12
Neutral	Beginning	Second	48	3.79	0.94
Neutral	Beginning	Third	48	4.10	0.78
Neutral	Beginning	Fourth	48	4.27	0.82
Neutral	Beginning	Fifth	48	4.44	0.77
Neutral	Middle	First	48	1.60	0.92
Neutral	Middle	Second	48	2.31	1.09
Neutral	Middle	Third	48	3.27	1.33
Neutral	Middle	Fourth	48	3.67	1.17
Neutral	Middle	Fifth	48	4.06	1.17
Neutral	End	First	48	2.13	1.06
Neutral	End	Second	48	3.52	1.01
Neutral	End	Third	48	3.96	0.87
Neutral	End	Fourth	48	3.92	0.82
Neutral	End	Fifth	48	4.08	0.99
Positive	Beginning	First	48	2.25	0.91
Positive	Beginning	Second	48	3.38	1.08
Positive	Beginning	Third	48	3.88	0.98
Positive	Beginning	Fourth	48	4.19	0.82
Positive	Beginning	Fifth	48	4.31	0.85
Positive	Middle	First	48	1.56	0.97
Positive	Middle	Second	48	2.44	1.24
Positive	Middle	Third	48	3.02	1.06
Positive	Middle	Fourth	48	3.52	1.13
Positive	Middle	Fifth	48	4.02	0.91
Positive	End	First	48	2.65	0.89
Positive	End	Second	48	3.33	1.00
Positive	End	Third	48	3.69	1.07
Positive	End	Fourth	48	4.04	0.90
Positive	End	Fifth	48	4.17	0.86

List x Location x Trial (continued)

Tukey's HSD = .18

List	*Location*	*Trial*	*N*	*Mean*	*Std Dev*
Negative	Beginning	First	48	3.56	0.92
Negative	Beginning	Second	48	4.15	0.87
Negative	Beginning	Third	48	4.69	0.59
Negative	Beginning	Fourth	48	4.67	0.69
Negative	Beginning	Fifth	48	4.73	0.49
Negative	Middle	First	48	1.04	0.82
Negative	Middle	Second	48	2.58	1.25
Negative	Middle	Third	48	3.54	1.20
Negative	Middle	Fourth	48	3.92	1.15
Negative	Middle	Fifth	48	4.08	1.01
Negative	End	First	48	2.10	0.81
Negative	End	Second	48	2.96	0.94
Negative	End	Third	48	3.27	1.20
Negative	End	Fourth	48	4.00	0.92
Negative	End	Fifth	48	4.33	1.04

Table 4. ANOVA Summary Table – AAVLT (High Hostiles)

ANOVA Summary Table – AAVLT – High Hostiles

Source	*DF*	*SS*	*F Value*	*p-value*
Stress	1,22	4.281481500	0.6900	0.4145
List	**2, 44**	**14.6740741**	**5.5500**	**0.0071**
Stress*List	2, 44	4.674074100	1.7700	0.1824
Location	**2, 44**	**164.1796296**	**39.360**	**0.0001**
Stress*Location	2, 44	3.512963000	0.8400	0.4376
T	**4,88**	**508.2185185**	**177.53**	**0.0001**
Stress*T	4,88	1.42222220	0.5000	0.7381
List*Location	**4,88**	**30.1425926**	**7.9900**	**0.0001**
Stress*List*Location	8, 176	4.03148150	1.0700	0.3771
List*T	8, 176	6.52037040	1.9300	0.0585
Stress*List*T	8, 176	2.03888890	0.6000	0.7748
Location*T	**8, 176**	**32.2092593**	**5.1000**	**0.0001**
Stress*Location*T	8, 176	5.78333330	0.9200	0.5050
List*Location*T	**8, 176**	**36.7185185**	**2.4400**	**0.0016**
Stress*List*Location*T	16, 352	19.2555556	1.2800	0.2073

Table 5. ANOVA Summary Table – AAVLT (Low Hostiles)

ANOVA Summary Table – AAVLT – Low Hostiles

Source	***DF***	***SS***	***F Value***	***p-value***
Stress	1,22	0.57870370	0.1	0.7598
List	1,22	3.77962960	1.32	0.2778
Stress*List	2, 44	1.84629630	0.64	0.5299
Location	**2, 44**	**179.246296**	**38.39**	**0.0001**
Stress*Location	4,88	4.83518520	1.04	0.3635
T	**4,88**	**656.681482**	**218.93**	**0.0001**
Stress*T	4,88	0.79629630	0.27	0.8994
List*Location	**4,88**	**37.75925930**	**6.97**	**0.0001**
Stress*List*Location	4, 88	5.74814810	1.06	0.3806
List*T	**8, 176**	**7.22962960**	**2.05**	**0.0432**
Stress*List*T	16, 352	3.18148150	0.9	0.516
Location*T	**8, 176**	**33.1240741**	**4.68**	**0.0001**
Stress*Location*T	8, 176	5.1648148	0.73	0.6646
List*Location*T	**16, 352**	**23.4814815**	**2.32**	**0.0029**
Stress*List*Location*T	16, 352	10.8074074	1.07	0.3834

Table 6. ANOVA Summary Table – AAVLT – Cold Pressor Group

ANOVA Summary Table – AAVLT – Cold Pressor Group

Source	***DF***	***SS***	***F Value***	***p-value***
Group	1,22	1.2000000	0.17	0.6829
List	**1,22**	**16.938889**	**5.52**	**0.0072**
Group*List	2, 44	1.8722222	0.61	5476
Location	**2, 44**	**140.716667**	**35.89**	**0.0001**
Group*Location	2, 44	1.0166667	0.26	0.7728
T	**4, 88**	**605.709259**	**204.83**	**0.0001**
Group*T	4,88	4.7907407	1.62	0.1763
List*Location	**4,88**	**35.361111**	**7.15**	**0.0001**
Group*List*Location	4,88	1.4944444	0.3	0.8757
List*T	8, 176	4.5518519	1.29	0.2492
Group*List*T	8, 176	6.9148148	1.97	0.0532
Location*T	**8, 176**	**30.662963**	**5.03**	**0.0001**
Group*Location*T	8, 176	3.6037037	0.59	0.7846
List*Location*T	**16, 352**	**30.092593**	**2.2**	**0.005**
Group*List*Location*T	16, 352	9.2740741	0.68	0.8152

Table 7. ANOVA Summary Table – AAVLT (No Cold Pressor Group)

ANOVA Summary Table – AAVLT – No Cold Pressor Group

Source	***DF***	***SS***	***F Value***	***p-value***
Group	1,22	5.7787037	1.110	0.3040
List	1,22	5.4888889	2.250	0.1175
Group*List	2, 44	0.6740741	0.280	0.7600
Location	**2, 44**	**204.816667**	**41.63**	**0.0001**
Group*Location	2, 44	5.2240741	1.060	0.3545
T	**4,88**	**554.753704**	**191.0**	**0.0001**
Group*T	4,88	1.8648148	0.640	0.6340
List*Location	**4,88**	**36.544444**	**8.600**	**0.0001**
Group*List*Location	4,88	4.2814815	1.010	0.4078
List*T	4,88	4.6685185	1.380	0.2098
Group*List*T	8, 176	2.8351852	0.840	0.5722
Location*T	**8, 176**	**37.951852**	**5.210**	**0.0001**
Group*Location*T	8, 176	4.0629630	0.560	0.8117
List*Location*T	**16, 352**	**39.825926**	**3.470**	**0.0001**
Group*List*Location*T	16, 352	11.070370	0.960	0.4969

Table 8. ANOVA Summary Table – SBP

ANOVA Summary Table – SBP

Source	***DF***	***SS***	***F Value***	***p-value***
Group	1, 44	112.500000	0.19	0.6622
Stress	1, 44	117.55556	0.2	0.6552
Group*Stress	1, 44	1995.01389	3.43	0.0707
Condition	**1, 44**	**606.68056**	**11.25**	**0.0016**
Group*Condition	1, 44	174.22222	3.23	0.0791
Stress*Condition	**1, 44**	**938.88889**	**17.42**	**0.0001**
Group*Stress*Condition	1, 44	91.125000	1.69	0.2003
Trial	**2, 90**	**2255.14583**	**33.58**	**0.0001**
Group*Trial	2, 90	10.145830	0.15	0.86
Stress*Trial	2, 90	55.090280	0.82	0.4435
Con*Trial	2, 90	38.548610	0.71	0.4969
Group*Condition*Trial	2, 90	42.215280	0.77	0.4652
Stress*Condition*Trial	2, 90	71.381940	1.31	0.2763
Group*Stress*Condition*Trial	4, 86	129.52778	1.18	0.3233

Table 9. ANOVA Summary Table – DBP

ANOVA Summary Table – DBP

Source	*DF*	*SS*	*F Value*	*p-value*
Group	1, 44	401.38889	0.68	0.1436
Stress	1, 44	30.68056	0.05	0.8205
Group*Stress	1, 44	465.12500	0.79	0.3791
Condition	1, 44	45.12500	1.01	0.3200
Group*Condition	1, 44	33.34722	0.75	0.3919
Stress*Condition	1, 44	0.888890	0.02	0.8884
Group*Stress*Condition	1, 44	10.888890	0.24	0.6237
Trial	2, 90	63.145830	0.71	0.4961
Group*Trial	2, 90	3.0486100	0.03	0.9665
Stress*Trial	2, 90	185.50694	2.08	0.1315
Condition*Trial	2, 90	25.020830	0.35	0.7065
Group*Condition*Trial	2, 90	67.340280	0.94	0.3951
Stress*Condition*Trial	2, 90	65.798610	0.92	0.4035
Group*Stress*Condition*Trial	4, 86	41.361110	0.29	0.8849

Table 10. ANOVA Summary Table – HR

ANOVA Summary Table – HR

Source	*DF*	*SS*	*F Value*	*p-value*
Group	1, 44	88.888890	0.08	0.7739
Stress	1, 44	1128.1250	1.06	0.3087
Group*Stress	1, 44	10.125000	0.01	0.9227
Condition	**1, 44**	**550.01389**	**9.99**	**0.0028**
Group*Condition	1, 44	66.125000	1.2	0.279
Stress*Condition	1, 44	56.888890	1.03	0.3149
Group*Stress*Condition	1, 44	1.3888900	0.03	0.8745
Trial	**2, 90**	**639.36111**	**9.13**	**0.0002**
Group*Trial	2, 90	33.444440	0.48	0.6218
Stress*Trial	2, 90	0.2500000	.000	0.9964
Condition*Trial	2, 90	1.6944400	0.03	0.9681
Group*Condition*Trial	2, 90	44.333330	0.85	0.4321
Stress*Condition*Trial	2, 90	27.52778	0.53	0.5928
Group*Stress*Condition*Trial	4, 86	114.11111	1.09	0.3665

Table 11. ANOVA Summary Table – Prediction of Recall

ANOVA Summary Table – Prediction of Recall

Source	*DF*	*SS*	*F Value*	*p-value*
Group	1,44	0.0277778	0.01	0.9343
Stress	1,44	1.0000000	0.25	0.6212
Group*Stress	1,44	0.4444444	0.11	0.7416
Trial	**2, 88**	**9.0416667**	**3.84**	**0.0253**
Group*Trial	2, 88	1.2638889	0.54	0.5869
Stress*Trial	2, 88	4.0416667	1.71	0.186
Group*Stress*Trial	2, 88	0.5972200	0.25	0.7768

Table 12. ANOVA Summary Table for Percentile Rank

ANOVA Summary Table – Percentile Rank

Source	***DF***	***SS***	***F Value***	***p-value***
Group	1,44	0.08832252	0.99	0.325
Stress	1,44	0.11970019	1.34	0.2528
Group*Stress	1,44	0.05943169	0.67	0.4186

Figure 1. Mean words recalled for each list.

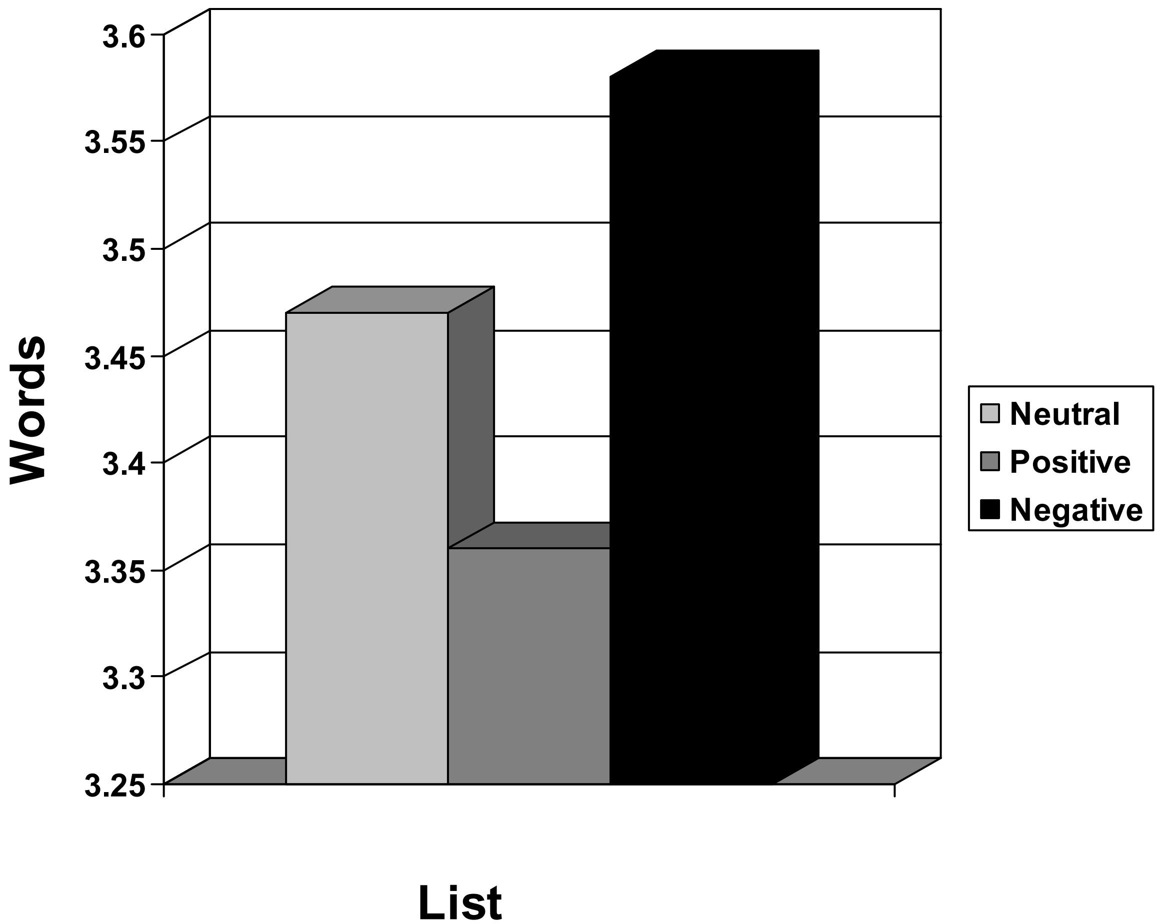


Figure 2. Mean words recalled for each location.

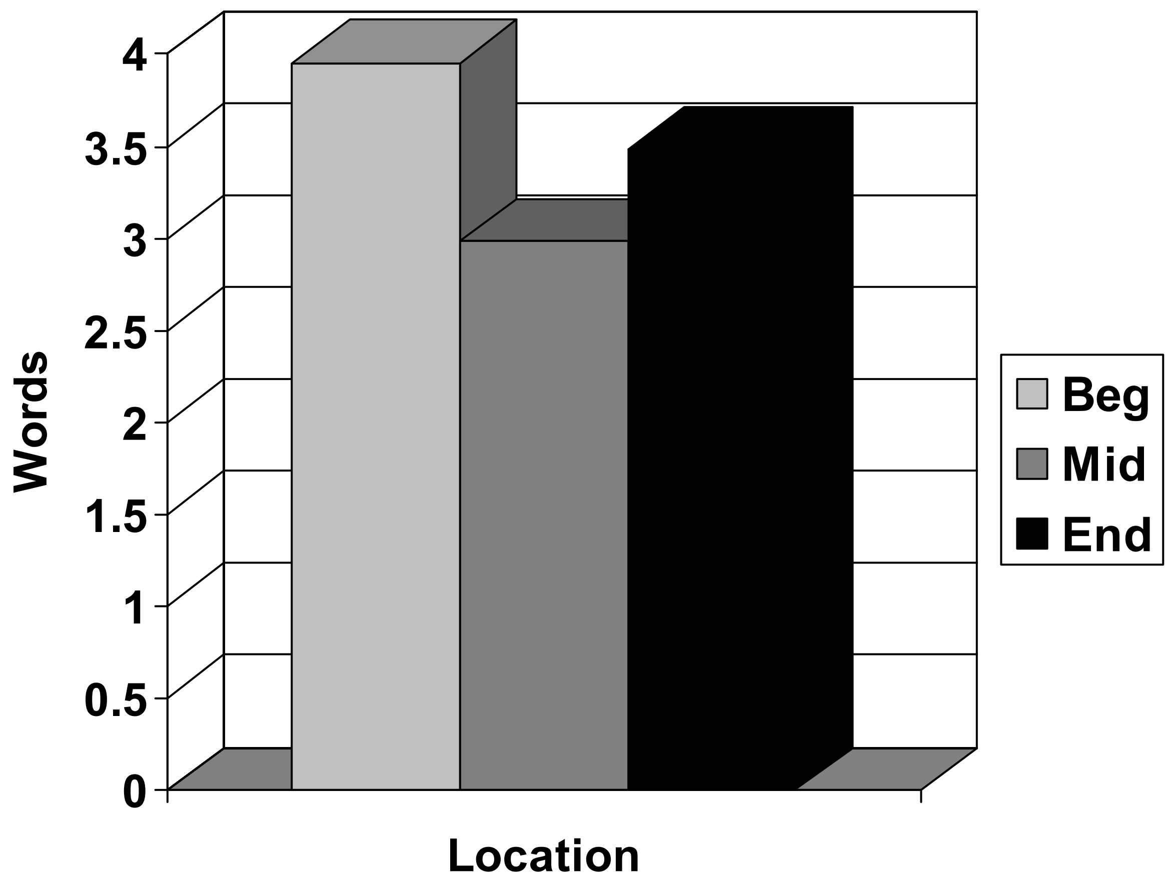


Figure 3. Mean words recalled by Trial.

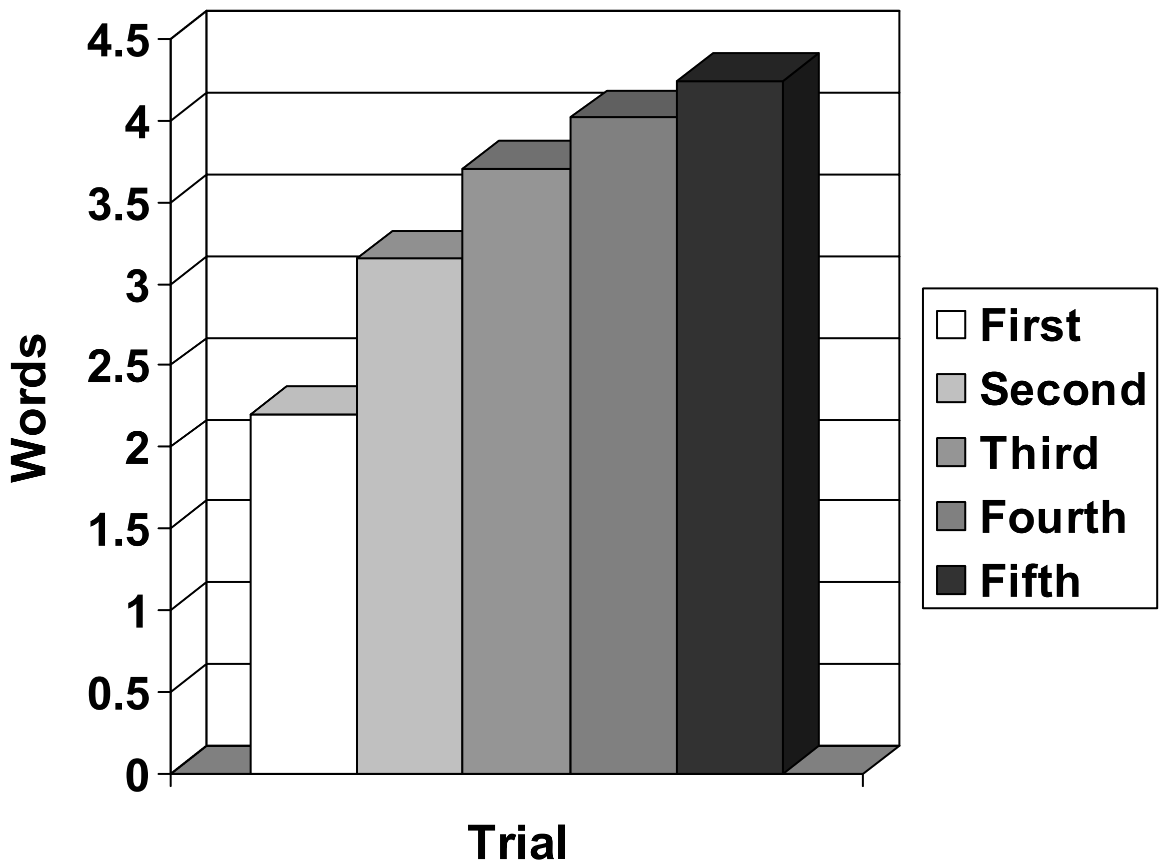


Figure 4. Number of words recalled at each location for each list. Negative words were recalled significantly more at the beginning, while neutral and positive words were recalled more at the end.

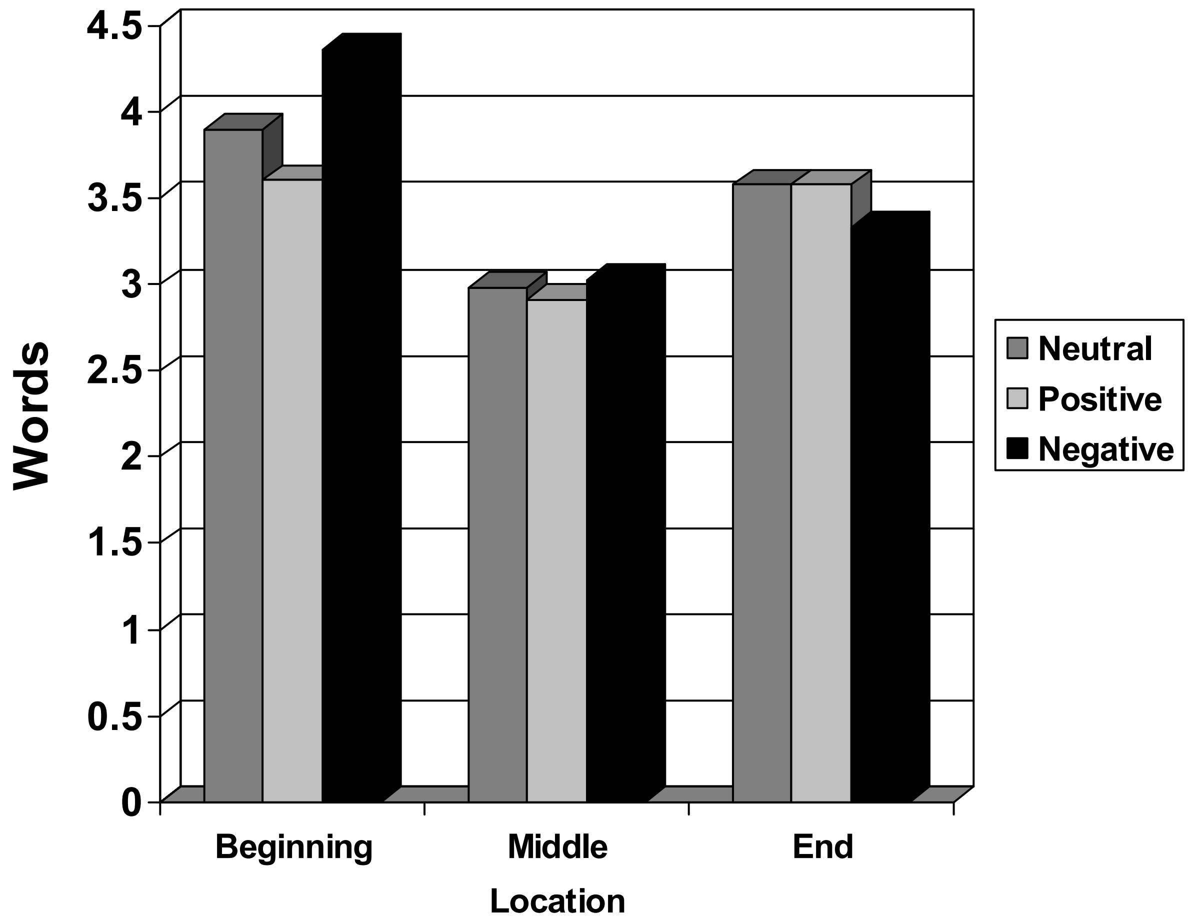


Figure 5. Mean number of words recalled at each location across the five trials. Significantly more words were recalled from the beginning of the list across all five trials.

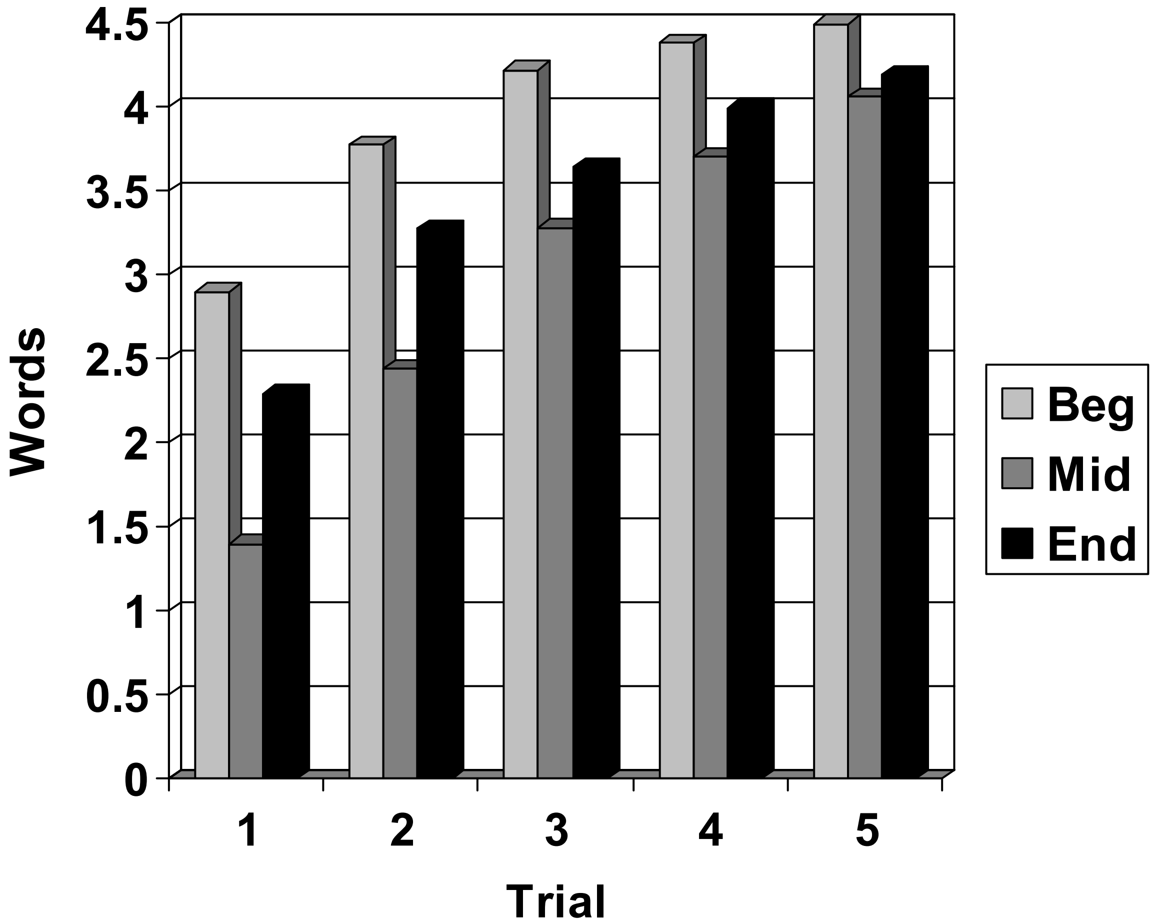


Figure 6. Mean number of words recalled at each trial for each list by high and low hostile participants. High hostiles learned fewer words and were most impaired on the positive list.

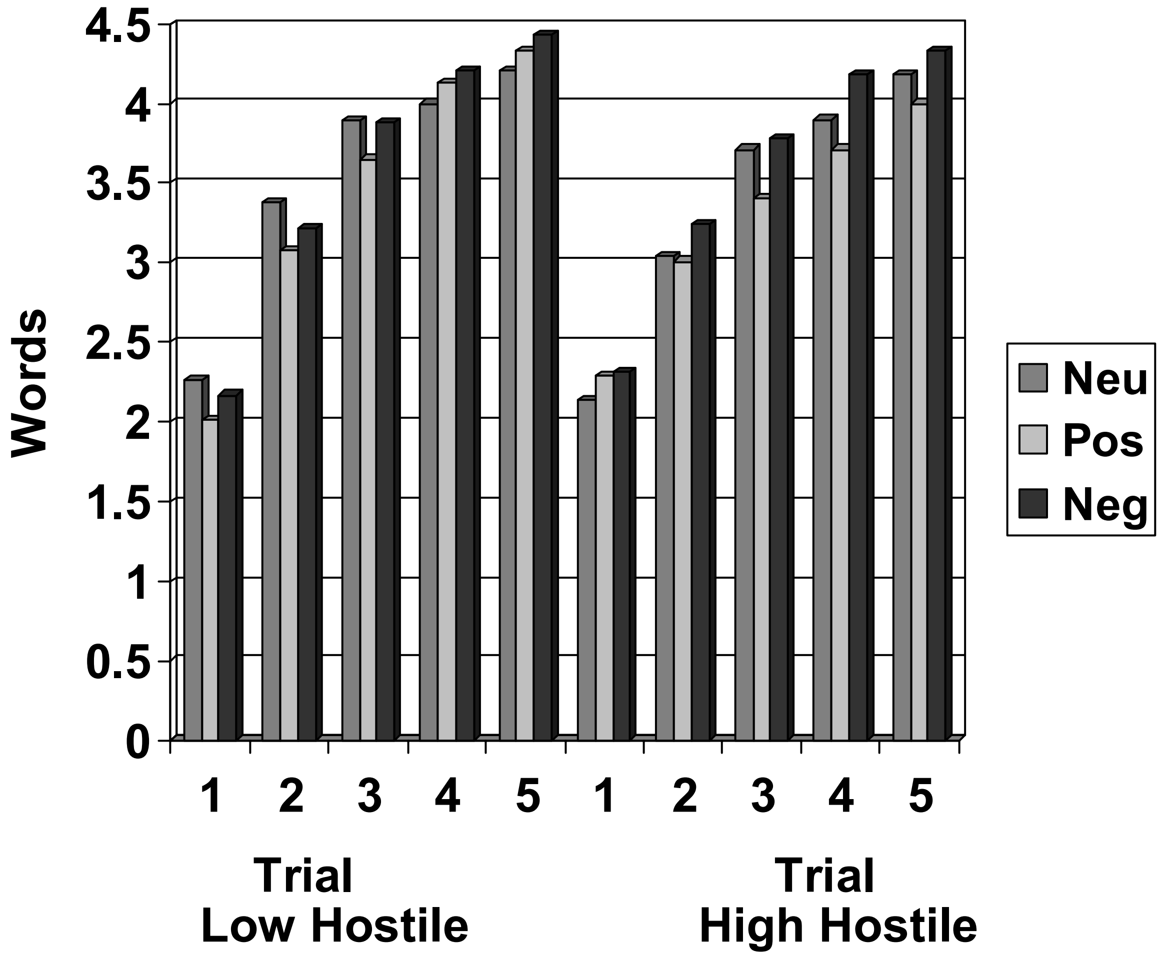


Figure 7. Mean number of words across the five trials at each location for each list. The negative list exhibited a higher primacy effect.

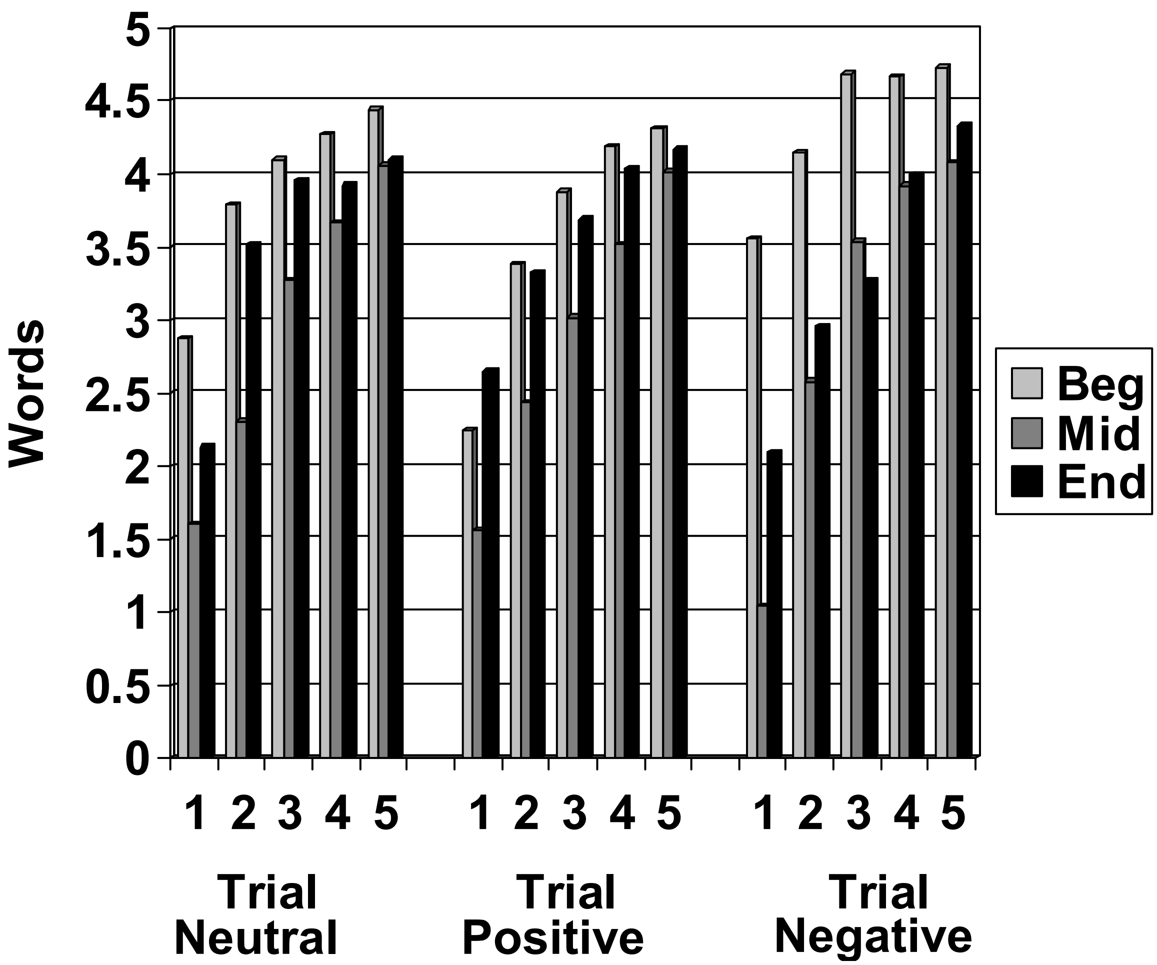


Figure 8. Mean number of words recalled by list for the high hostile group.

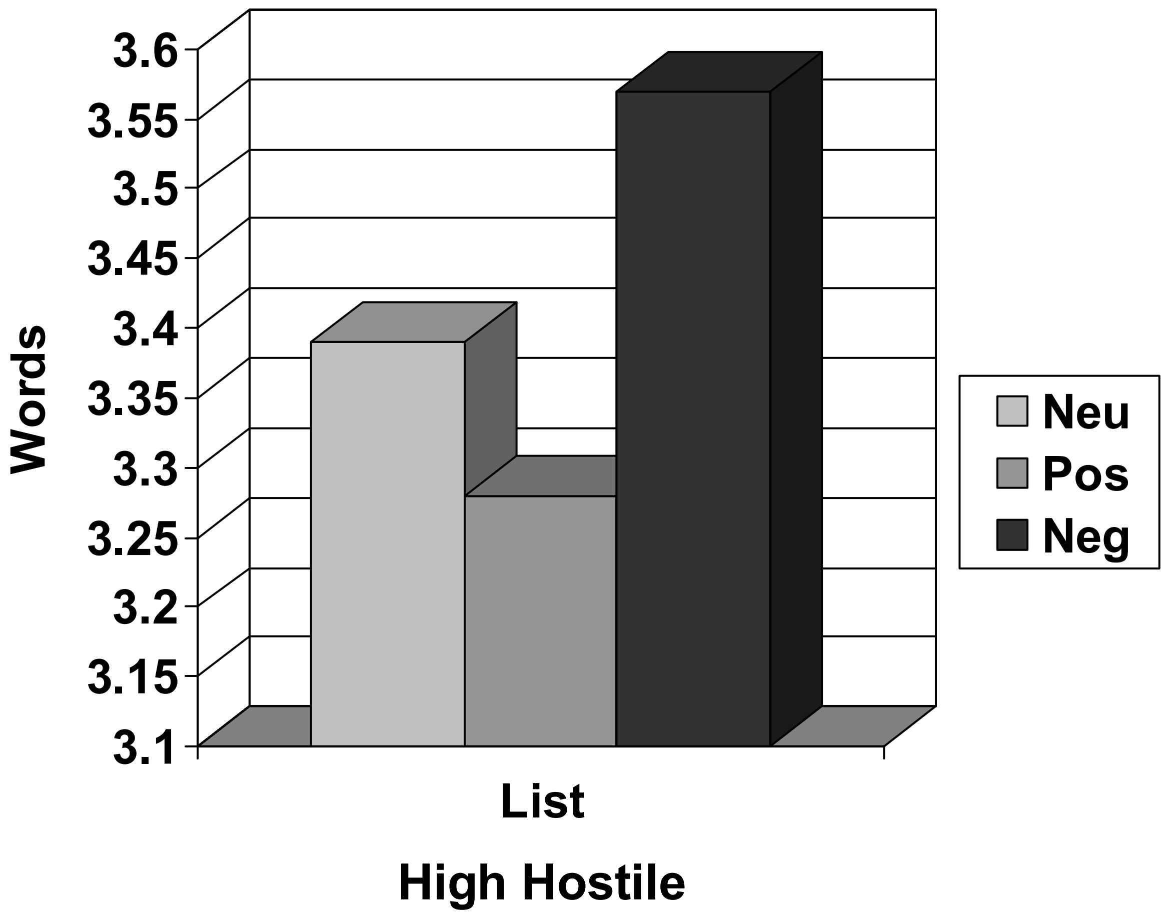


Figure 9. Mean number of words at each trial for each list recalled by the low hostile group.

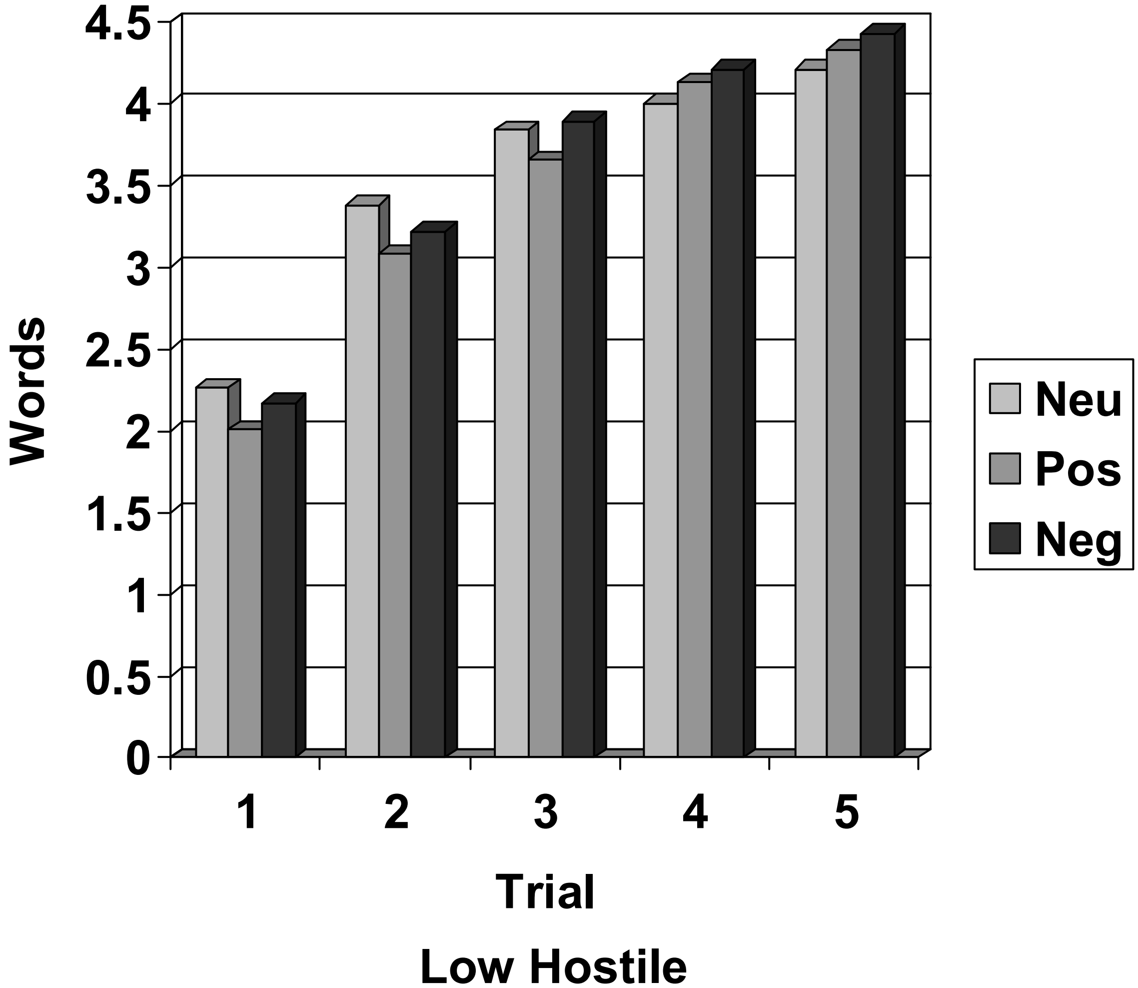


Figure 10. Mean number of words recalled by list for the cold pressor group.

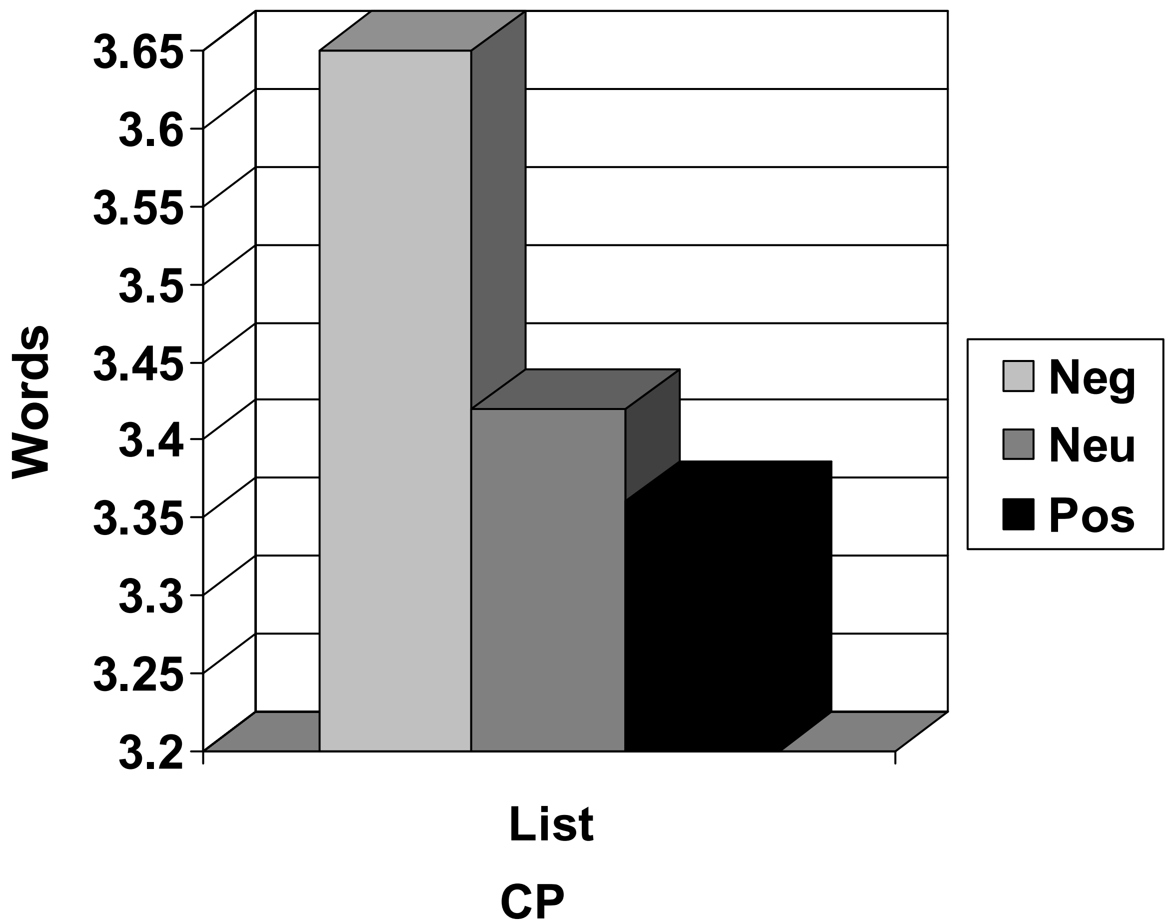


Figure 11. Mean SBP by condition.

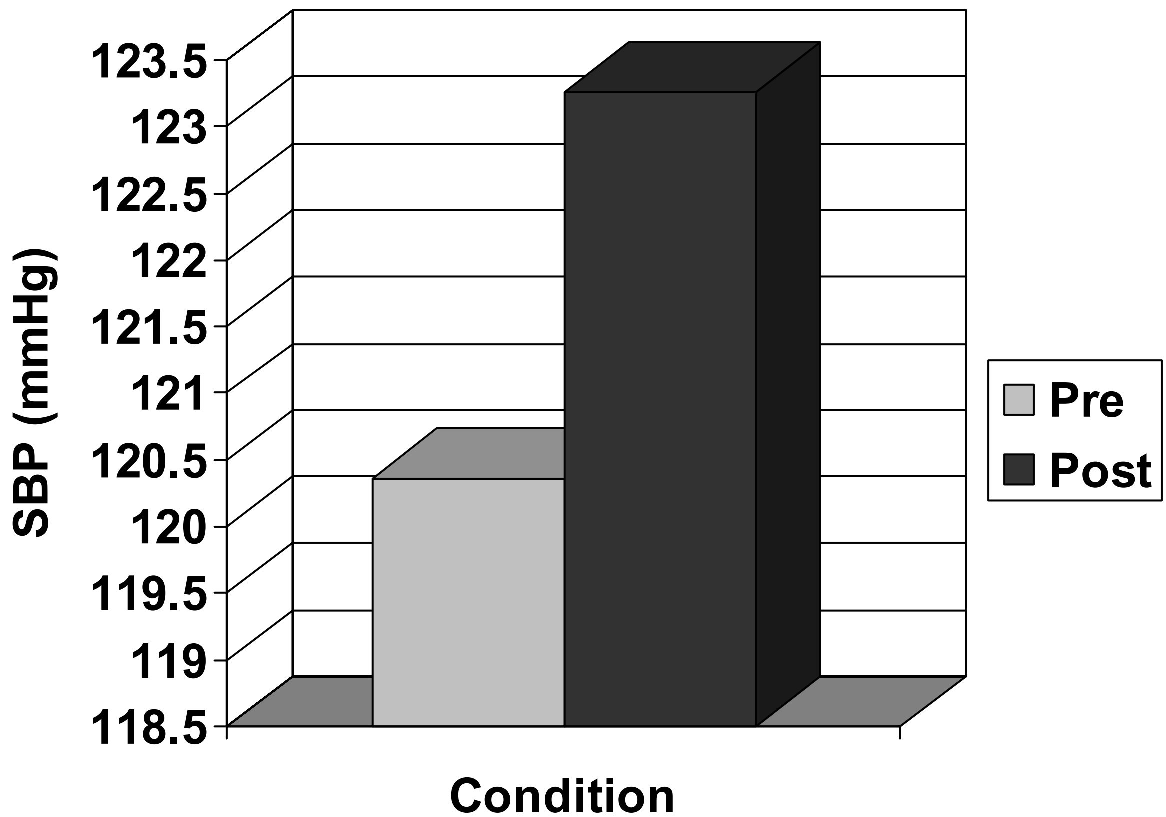


Figure 12. Mean SBP by trial.

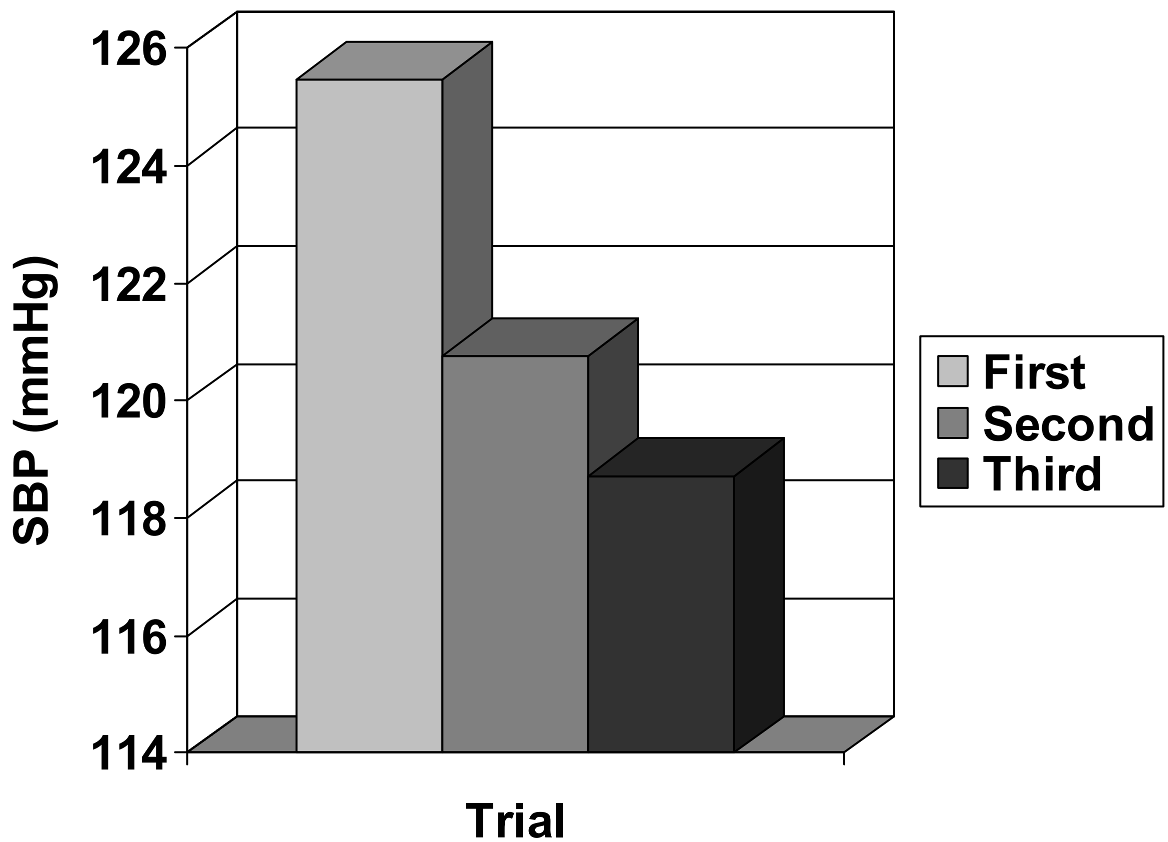


Figure 13. Mean SBP for the cold pressor (CP) and no cold pressor (No CP) groups by condition. The CP group showed a significant increase in SBP from baseline to treatment.

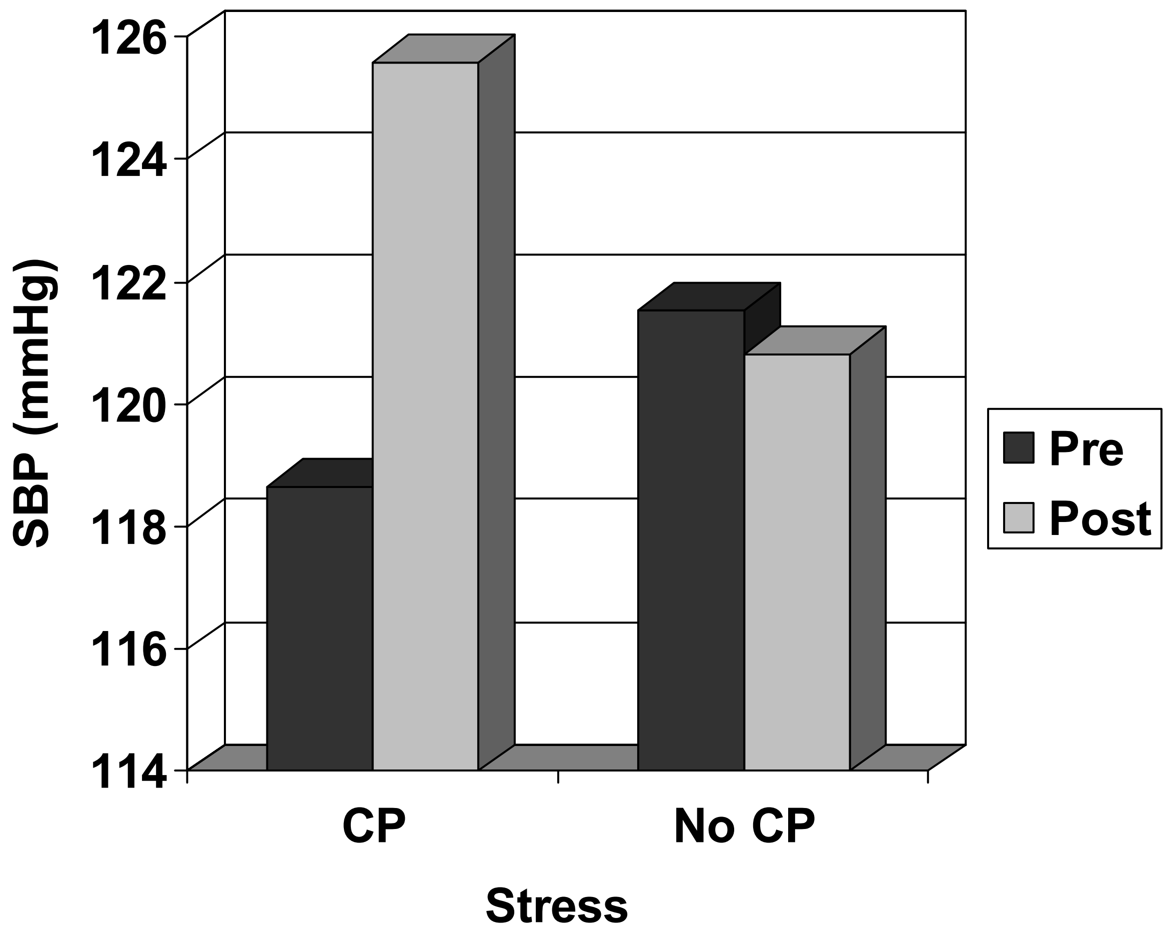


Figure 14. Mean HR by condition.

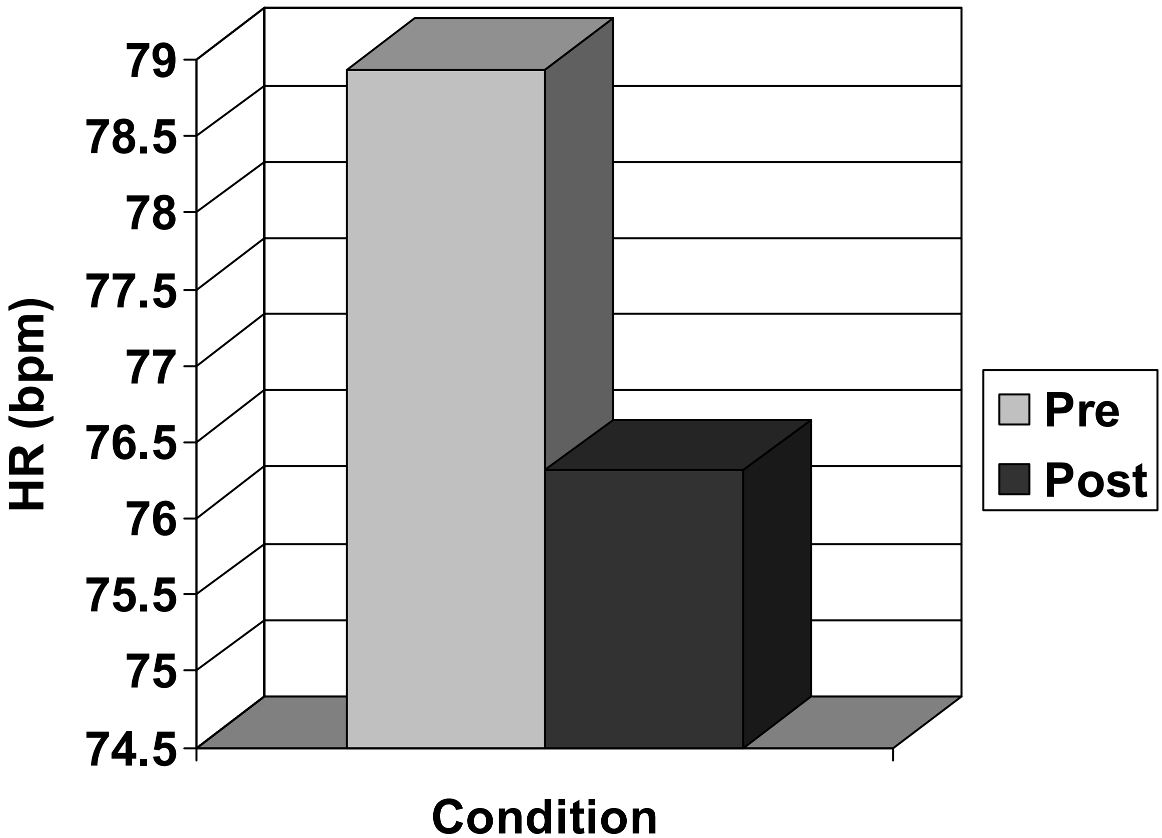


Figure 15. Mean HR for each trial.

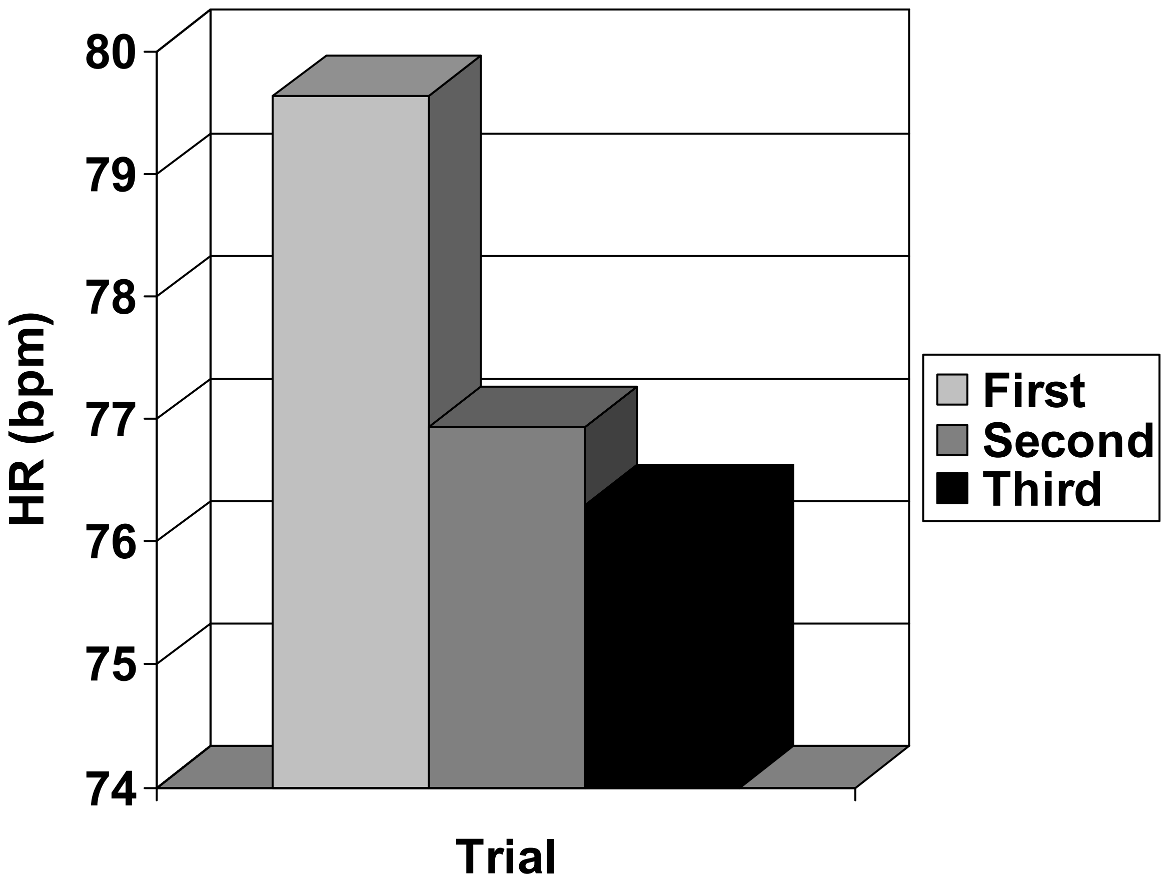
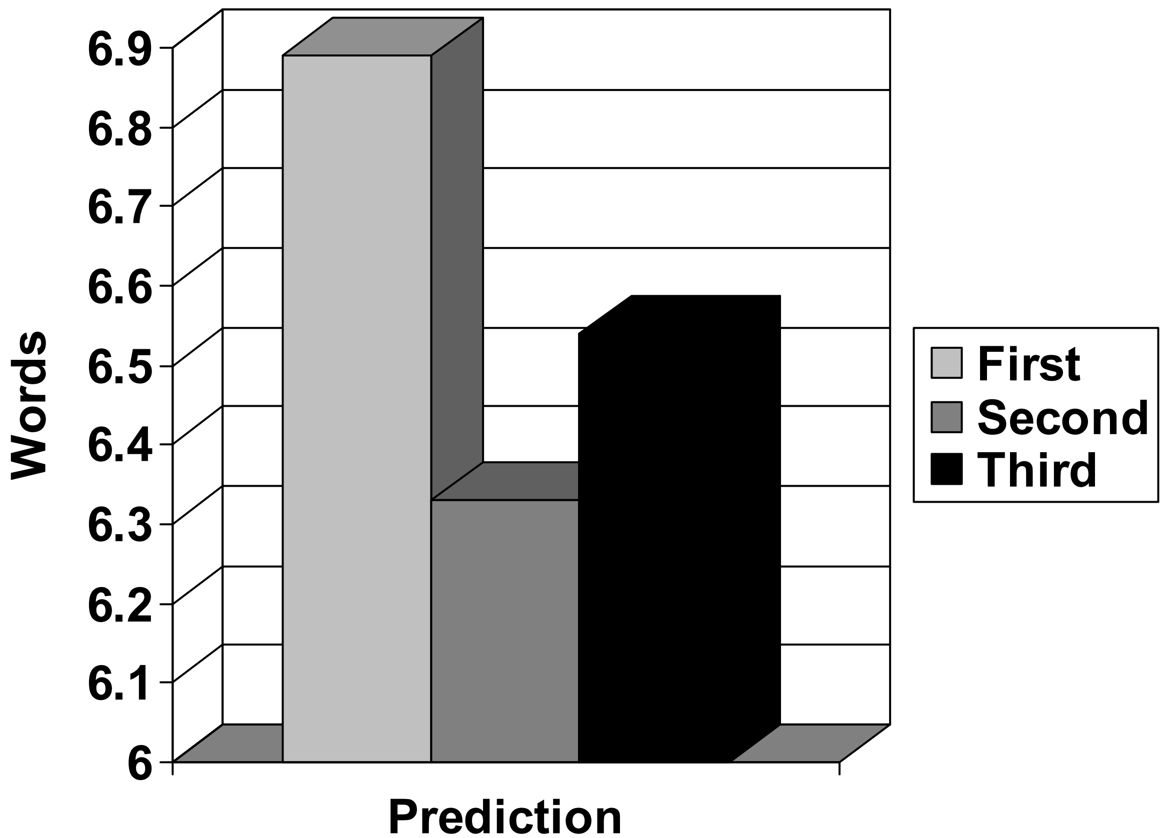


Figure 16. Prediction of recall by trial. Participant predictions were significantly higher on trial 1.



Appendix A

Medical History Questionnaire

Name: ____ Age: _________________

Race/Ethnic Origin: ___________________________ Average Grades: __________________

Please list all of your past and present surgeries, medical procedures, major diseases/illnesses, and medical conditions (include dates when possible):

____

____

____

Please circle the appropriate response and explain any "Yes" responses below.

1. Have you ever been knocked unconscious for more than 5 minutes? Yes No
2. Have you ever had a head injury? Yes No
3. Have you ever had a stroke or aneurysm? Yes No
4. Have you ever or are you currently experiencing any fainting spells or black outs? Yes No
5. Are you able to read, write, and spell without difficulty? Yes No
6. Have you ever been diagnosed with any learning disabilities? Yes No
7. Have you ever been diagnosed with memory loss, cognitive impairment, or thinking problems, or are you experiencing such problems at present? Yes No
8. Do you have a past or present history of epilepsy or seizures? Yes No
9. Do you have any paralysis? Yes No
10. Have you ever had neurological surgery? Yes No
11. Do you have a history of cardiac or respiratory arrest or lack of oxygen (e.g., hypoxia)? Yes No
12. Do you have a past or present history of neurological disorders (e.g., Parkinson's Disease, Multiple Sclerosis, or Huntington's Disease)? Yes No
13. Do you have a past or present history of alcohol or drug problems? Yes No

14. Are you currently consuming three or more alcoholic beverages per day? Yes No

15. Past or present diagnosed psychological/psychiatric problems? Yes No

16. Have you ever received psychological/psychiatric counseling? Yes No

17. Have you ever been hospitalized in a psychiatric facility/hospital? Yes No

18. Are you currently taking any prescription medications? Yes No

19. Do you currently have any diagnosed medical conditions or illnesses? Yes No

20. Do you have any uncorrected vision problems? Yes No

21. Do you have an uncorrected hearing impairment? Yes No

22. Do you have any problems or pain with movement (e.g., severe hand, arm, or shoulder pain with movement)? Yes No

23. At present, do you have any uncontrolled metabolic disorders such thyroid conditions or diabetes? Yes No

25. Have you ever been diagnosed with arthritis? Yes No

26. Do you have Raynaud's disease? Yes No

27. Are you currently experiencing any cardiovascular disorders or have you previously been diagnosed with any cardiovascular disorders? Yes No

28. Do you now or have you ever had a heart murmur? Yes No

29. Do you now or have you ever had pressure, pain or tightness in the chest brought on by exertion? Yes No

30. Have you ever been diagnosed with asthma? Yes No

31. Do you smoke? Yes No

32. Do you use caffeine? Yes No

33. Do you consume alcohol? Yes No

Please explain any "Yes" responses above:

____

____

____

Appendix B

Smoking History and Habits Questionnaire

1. What do you smoke (cigarettes, pipe, cigars, etc.)? ________________________________
2. When did you start smoking? ____
3. On average, how much do you smoke per day? ___________________________________
4. For how long have you been smoking at this rate? _________________________________
5. If you have ever quit, please report when and for how long? _________________________
6. When did you last smoke? ____

Appendix C

Coren, Porac, and Duncan Laterality Test

Circle the appropriate number after each item:	Right	Left	Both
With which hand would you throw a ball to hit a target?	1	-1	0
With which hand do you draw?	1	-1	0
With which hand do you use an eraser on paper?	1	-1	0
With which hand do you remove the top card when dealing?	1	-1	0
With which foot do you kick a ball?	1	-1	0
If you wanted to pick up a pebble with your toes, which foot would you use?	1	-1	0
If you had to step up onto a chair, which foot would you place on the chair first?	1	-1	0
Which eye would you use to peep through a keyhole?	1	-1	0
If you had to look into a dark bottle to see how full it was, which eye would you use?	1	-1	0
Which eye would you use to sight down a rifle?	1	-1	0
If you wanted to listen to a conversation going on behind a closed door, which ear would you place against the door?	1	-1	0
If you wanted to listen to someone's heartbeat, which ear would you place against their chest?	1	-1	0
Into which ear would you place the earphone of a transistor radio?	1	-1	0

# of Right + # of Left = Total Score
_______ + _______ = _______

Is mother left or right hand dominant? ________

Is father left or right hand dominant? _________

Appendix D

Affective Auditory Verbal Learning Test

Neutral List	Negative List	Positive List
Drum	Morgue	Smile
Curtain	Murder	Freedom
Bell	Kill	Cheerful
Coffee	Pimple	Friend
School	Gun	Music
Parent	Greedy	Joy
Moon	Lice	Happy
Garden	Measles	Wisdom
Hat	Slay	Blossom
Farmer	Deface	Laugh
Nose	Cruel	Beauty
Turkey	Failing	Peace
Color	Hate	Sunset
House	Acne	Garden
River	Grave	Beach

Appendix E

Informed Consent (Pre-Screening)

Title: Effects of Negative Emotion on Verbal Learning and Cardiovascular Regulation

1. **PURPOSE OF THE EXPERIMENT:** To learn more about emotion and cardiac regulation.

2. **PROCEDURE TO BE FOLLOWED IN THE STUDY:** Participants for the study will be identified after completion of three questionnaires that will be administered via a secured website. Qualified participants will be contacted and requested to continue based on their questionnaire results.

3. **ANONYMITY OF SUBJECTS AND CONFIDENTIALITY OF THE RESULTS:** Identifying information will be kept confidential and will not be released to anyone other than the individuals directly working on the project without your written consent. The information you provide will have your name removed and is given a number. Information will only be associated with a subject number that will be used during analysis and written reports of the research.

4. **DISCOMFORT AND RISKS FROM PARTICIPATING IN THE STUDY:** Some of the questionnaires may contain material that you find embarrassing or uncomfortable to answer. You may omit any questions that you find embarrassing or uncomfortable. If you have any questions after completing the questionnaires or have any problems associated with the study, you may contact the researcher or Dr. David W. Harrison (231-4422) and he will assist you directly or direct you to appropriate services.

5. **EXPECTED BENEFITS:** Your participation in this project will aid in the understanding of emotion and brain activation. No guarantee of benefits has been made to encourage your participation.

6. **FREEDOM TO WITHDRAW:** You are free to withdraw from the study at any time without penalty and your decision to withdraw will not affect your psychology course grade or application of points.

7. **EXTRA CREDIT COMPENSATION:** You will receive 1 extra credit point for your psychology course by participation in this portion of the study.

8. **USE OF RESEARCH DATA:** The information gathered from this study will be used for scientific and/or educational purposes. The findings may be presented at scientific meetings and/or published and reproduced in professional journals or books. The findings may also be used for other purposes that Virginia Tech's Department of Psychology deems proper in the interest of education, knowledge, and research.

9. **APPROVAL OF RESEARCH:** This project has been approved by the Human Subjects Committee of the Department of Psychology and the Institutional Review Board of Virginia Tech.

10. **PARTICIPANTS PERMISSION:** I have read and understand the above description of the study. I have had the opportunity to ask questions and all have been answered in an appropriate manner. I hereby acknowledge the above and voluntarily give my consent to participate in this study. I realize that I may withdraw at any time without penalty and that I may contact one of the people listed below at any time if I have questions regarding the study.

Gina A. Mollet Primary Researcher	231-7001
David W. Harrison, Ph.D. Faculty Advisor	231-4422
Jack Finney, Ph.D. Department Chair, Department of Psychology	231-6670
David Moore, Ph.D. Institutional Review Board Chair, Research Division	231-4991

Subject's Signature: ________________________________ Date: ________________

Subject's ID: __________________________ Subject's Telephone #:_______________

Appendix F

Informed Consent (Testing Day)

1. **PURPOSE OF THE EXPERIMENT:** To learn more about emotion and cardiac regulation.

2. **PROCEDURE TO BE FOLLOWED IN THE STUDY:** Participants for the study will be asked to complete questionnaires. The experiment will then be started. Some minor discomfort may be involved in the completion of this experiment as you place your hand in ice water for a short time. You will be asked to learn a list of words. Your blood pressure and heart rate will be evaluated and recorded several times during the course of the experiment.

3. **ANONYMITY OF SUBJECTS AND CONFIDENTIALITY OF THE RESULTS:** Identifying information will be kept confidential and will not be released to anyone other than the individuals directly working on the project without your written consent. The information you provide will have your name removed and is given a number. Information will only be associated with a subject number that will be used during analysis and written reports of the research.

4. **DISCOMFORT AND RISKS FROM PARTICIPATING IN THE STUDY:** Some of the questionnaires may contain material that you find embarrassing or uncomfortable to answer. You may omit any questions that you find embarrassing or uncomfortable. Additionally, you may experience some mild to moderate discomfort during the course of this experiment. This should be relatively minor discomfort lasting no longer than a few minutes. If you have any questions after leaving the experiment or have any problems associated with the study, you may contact the researcher or Dr. David W. Harrison (231-4422) and he will assist you directly or direct you to appropriate services.

5. **EXPECTED BENEFITS:** Your participation in this project will aid in the understanding of emotion and brain activation. No guarantee of benefits has been made to encourage your participation.

6. **FREEDOM TO WITHDRAW:** You are free to withdraw from the study at any time without penalty and your decision to withdraw will not affect your psychology course grade or application of points.

7. **EXTRA CREDIT COMPENSATION:** You will receive 2 extra credit points for your psychology course by participation in this portion of the study.

8. **USE OF RESEARCH DATA:** The information gathered from this study will be used for scientific and/or educational purposes. The findings may be presented at scientific meetings and/or published and reproduced in professional journals or books. The findings may also be used for other purposes that Virginia Tech's Department of Psychology deems proper in the interest of education, knowledge, and research.

9. **APPROVAL OF RESEARCH:** This project has been approved by the Human Subjects Committee of the Department of Psychology and the Institutional Review Board of Virginia Tech.

10. **PARTICIPANTS PERMISSION:** I have read and understand the above description of the study. I have had the opportunity to ask questions and all have been answered in an appropriate manner. I hereby acknowledge the above and voluntarily give my consent to participate in this study. I realize that I may withdraw at any time without penalty and that I may contact one of the people listed below at any time if I have questions regarding the study.

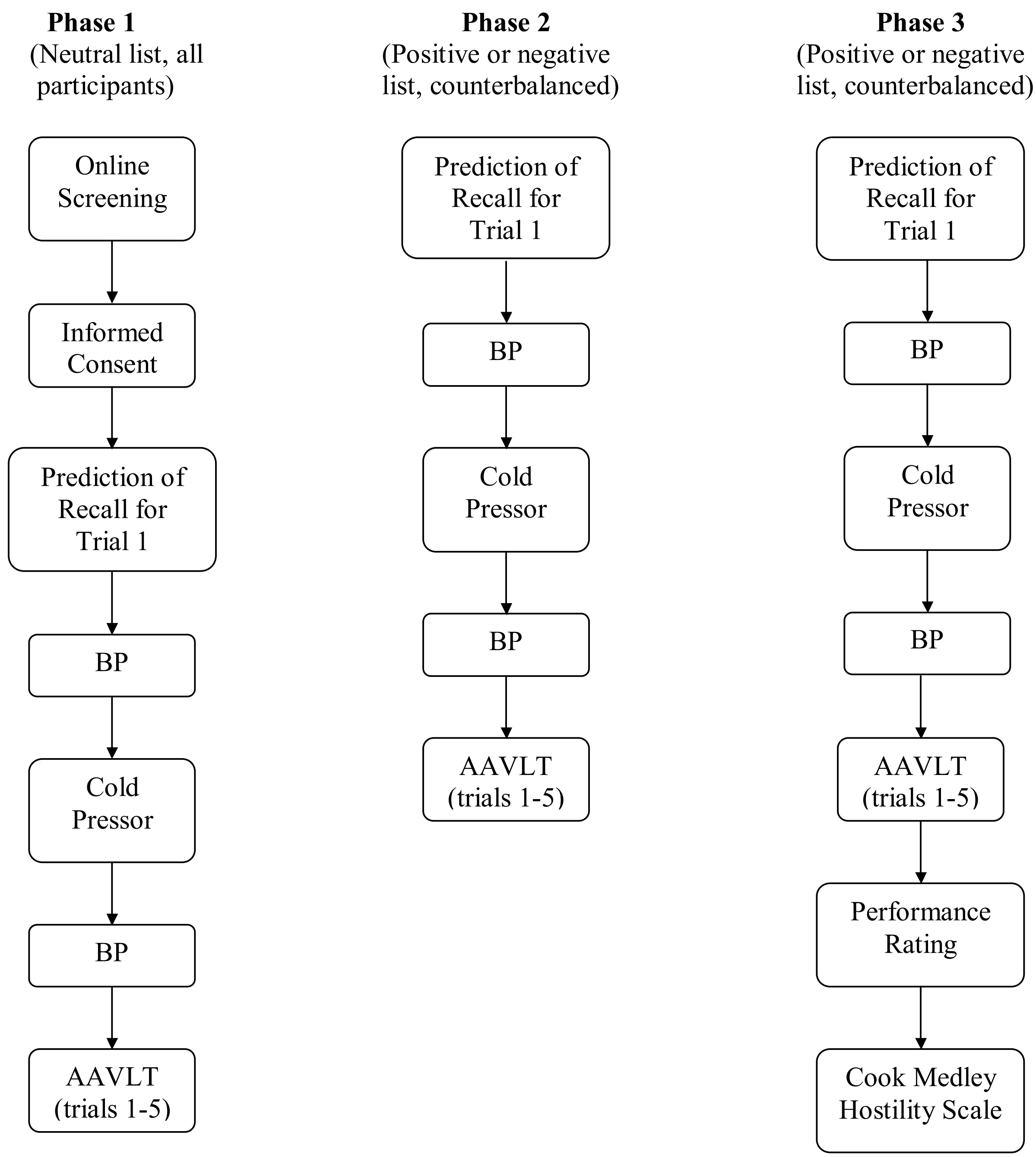
Gina A. Mollet Primary Researcher	231-7001
David W. Harrison, Ph.D. Faculty Advisor	231-4422
Jack Finney, Ph.D. Department Chair, Department of Psychology	231-6670
David Moore, Ph.D. Institutional Review Board Chair, Research Division	231-4991

Subject's Signature: ______________________________ Date: _______________

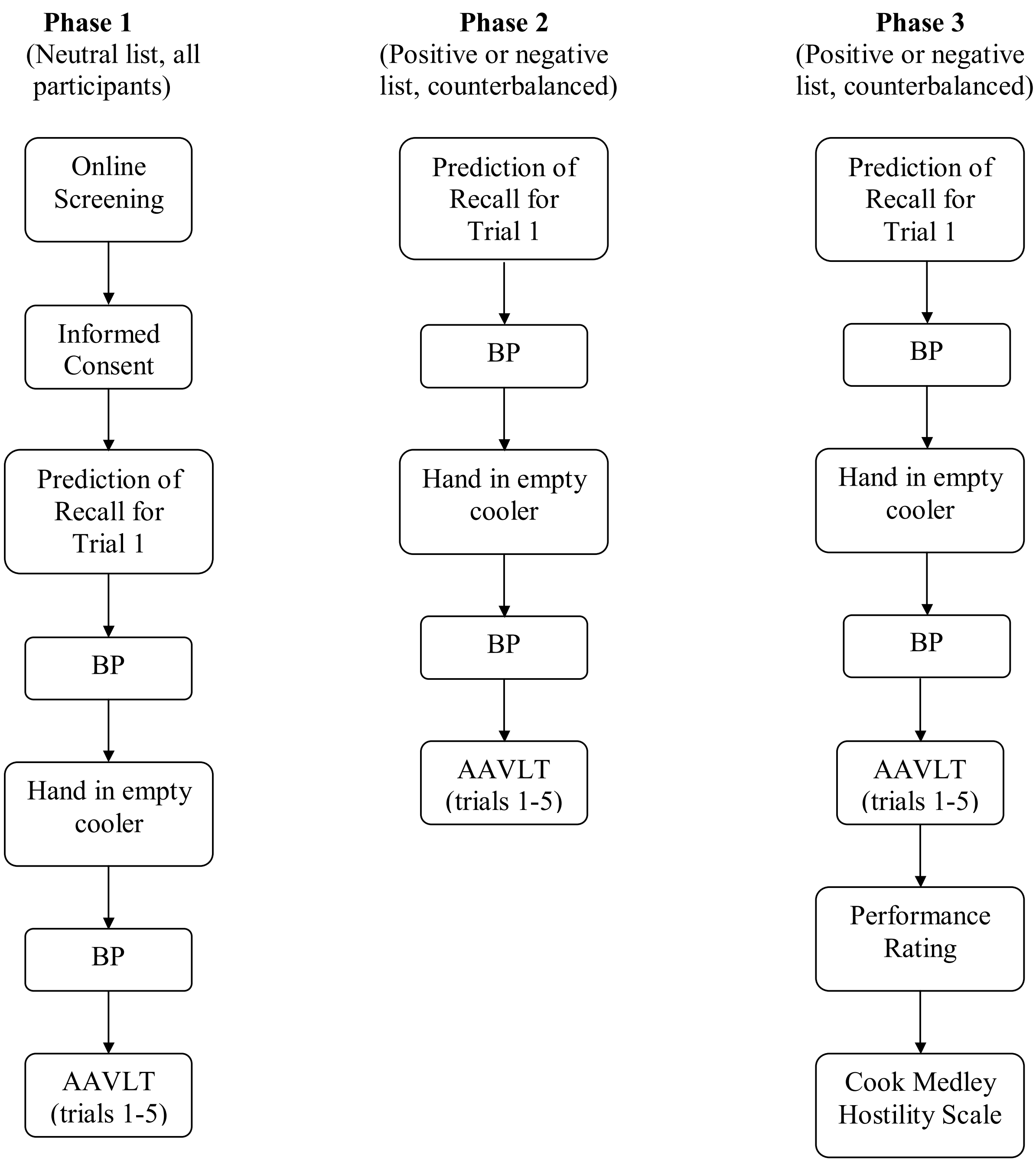
Subject's ID: ________________________ Subject's Telephone #:_______________

Appendix G

Flow Chart of Procedures
Cold Pressor Condition



Flow Chart of Procedures
No Cold Pressor Condition



Gina Alice Mollet

From: Elizabeth Knoll [mailto:knoll@umn.edu]
Sent: Thursday, March 4, 2004 11:48 AM
To: gmollet@vt.edu
Subject: MMPI-2 Permission

Dear Gina Mollet,

This constitutes formal one time permission for you to use the orignical MMPI Cook Medley Hostility Scale on a secure Web page for a study investigating hostility in relation to verbal learning and cardiovascular regulation, per your requests of 12/2/03 and 2/11/04. Permission is granted with the provision that the following credit line is placed on the web page where the items appear and that the items are removed by 11/30/04. Permission does not allow for the reproduction of test items in other forms, such as dissertation, papers, journal articles.

MMPI-2TM (Minnesota Multiphasic Personality Inventory-2)TM Manual for Administration, Scoring, and Interpretation, Revised Edition. Copyright © 2001 by the regents of the University of Minnesota. Used by permission of the University of Minnesota Press. All rights reserved. "MMPI-2" and "Minnesota Mulitphasic Personality-2" are trademarks owned by the Regents of the University of Minnesota.

Sincerely,
--
Elizabeth Knoll
Test Division
University of Minnesota Press
111 Third Avenue South, Suite 290
Minneapolis, MN 55401-2520
612-627-1964 (phone)
612-627-1980 (fax)
www.upress.umn.edu/tests

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Institutional Review Board
Dr. David M. Moore
IRB (Human Subjects) Chair
Assistant Vice Provost for Research Compliance
CVM Phase II - Duckpond Dr., Blacksburg, VA 24061-0442
Office: 540/231-4991; FAX: 540/231-6033
e-mail: moored@vt.edu

November 25, 2003

MEMORANDUM

TO: David W. Harrison Psychology 0436
Gina Mollet

FROM: David M. Moore

SUBJECT: **Expedited Approval –** "Hostility and Negative Emotion Induction"– IRB # 03-584

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective November 24, 2003.

Approval of your research by the IRB provides the appropriate review as required by federal and state laws regarding human subject research. It is your responsibility to report to the IRB any adverse reactions that can be attributed to this study.

To continue the project past the 12 month approval period, a continuing review application must be submitted (30) days prior to the anniversary of the original approval date and a summary of the project to date must be provided. My office will send you a reminder of this (60) days prior to the anniversary date.

Cc: File
Department Reviewer: Jack Finney Psy 0436

VITA

GINA MOLLET

PERSONAL INFORMATION

Academic Address: Department of Psychology
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0436
Email Address: gmollet@vt.edu

EDUCATION

1998-2000 University of Minnesota, Morris
Major Field of Study: Psychology and Spanish

2000-2002 B.A. University of South Dakota
Major Field of Study: Psychology and Spanish
GPA: 3.7

2002-2003 Virginia Polytechnic Institute and State University
Major Field of Study: Neuropsychology
Major Advisor: David W. Harrison, PhD
GPA: 3.9

EMPLOYMENT

2002-2004 *Graduate Teaching Assistant*
Virginia Polytechnic Institute and State University, Blacksburg, Virginia

2003 *Neuroscience Lab Assistant*
University of South Dakota, Vermillion, South Dakota

2003 *Upward Bound Program Tutor*
Virginia Polytechnic Institute and State University, Blacksburg, Virginia

2002 *Disaster Services Specialist*
Siouxland American Red Cross, Sioux City, Iowa

2000-2002 *Financial Aid Office Assistant*
University of South Dakota, Vermillion, South Dakota

2000-2001 *Assistant Case Manager, Crossroads Womens' Shelter*
Woodbury County Community Action Agency, Sioux City, Iowa

1999 *Teaching Assistant*
Orouba Language School, Cairo Egypt

CLINCIAL TRAINING

2002-2004	Clinical Neuropsychology Laboratory Psychological Services Center Virginia Polytechnic Institute and State University Blacksburg, Virginia Trained in Quantitative Electroencephalogram, standardized test administration, and syndrome analysis

HONORS AND AWARD

1998	Lisa Bernard Memorial Scholarship
1998	William T. Stout Scholarship
1998	Academic Scholarship
1998-2002	Dean's List
2002	Study Abroad Scholarship

PROFESSIONAL ORGANIZATIONS AND ACTIVITIES

Psi Chi Honor Society for Psychology
Phi Betta Kappa Honor Society
Sigma Delta Pi Honor Society for Spanish
Golden Key International Honor Society
American Psychological Association – Student Affiliate
American Psychological Association of Graduate Students
Graduate Student Association of Virginia Tech – Psychology Department Delegate

VOLUNTEER WORK

Women's Center, Blacksburg, Virginia

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Neuropsychology of emotion, cardiovascular psychophysiology, emotional correlates of head trauma, sex differences

MANUSCRIPTS ACCEPTED FOR PUBLICATOION

Herridge, M., Harrison, D.W., Mollet, G.A., & Shenal, B. (2004). Hostility and Emotional Facial Recognition: Effects of Arousal on Perceptual Accuracy and Cardiovascular Reactivity. Manuscript accepted for publication, April, 2004.

MANUSCRIPTS SUBMITTED FOR PUBLICATION

Emerson, C.S., Mollet, G.A., & Harrison, D.W. (2004). Anxious-Depression in Boys: An Evaluation of Frontal Executive Functions. Manuscript submitted for publication.

PUBLISHED ABSTRACTS

Foster, P. S., Beck, A. L., Mollet, G. A., & Harrison, D. W. (2003). Homologous hemispheric comparisons using quantitative electroencephalography: Is symmetry to be expected? *Archives of Clinical Neuropsychology, 18,* 75.

Mollet, G.A, Emerson, C.S., & Harrison, D.W. (2004). Anxious-Depression in Childhood: An Evaluation of Executive Functions. *Journal of the International Neuropsychological Society, 10 (3),* 142.

MANUSCRIPTS IN PREPARATION

Park, A.Y., Harrison, D.W., & Mollet, G.A. (in preparation). Direction of Vection Vestibulopathy as a Function of Lateralized Temporal Lobe Activation: An Investigation with Quantitative Encephalography. Manuscript in preparation for publication.

Mollet, G.A., Foster, P.S., Walters, R.P., & Harrison, D.W. (in preparation).Thalamic Syndrome: Lateralized Multimodal Hallucinations. Manuscript in preparation for publication.

Mollet, G.A., Walters, R.P., & Harrison, D.W. (in preparation). Alexia without Agraphia: A typical vs. an atypical lesion. Manuscript in preparation for publication.

POSTERS PRESENTED

Beck, A.L., Mollet, G.A., Foster, P.S., Walters, R.P., & Harrison, D.W. (2003). Thalamic Syndrome: Lateralized Multimodal Hallucinations. Poster presented at the 19th Annual Virginia Tech Graduate Research Conference.

Foster, P. S., Beck, A. L., Mollet, G. A., & Harrison, D. W. (2003). Homologous hemispheric comparisons using quantitative electroencephalography: Is symmetry to be expected? Poster session presented at the annual meeting of the National Academy of Neuropsychology, Dallas, TX.

Mollet, G.A., Emerson, C.S., Beck, A.L., & Harrison, D.W. (2003). Frontal Lobe Dysfunction in Anxious-Depressed Boys. Poster presented at the 19th Annual Virginia Tech Graduate Research Conference.

Mollet, G.A, Emerson, C.S., & Harrison, D.W. (2004). Anxious-Depression in Childhood: An Evaluation of Executive Functions. Poster presented at the 32nd annual meeting of the International Neuropsychological Society, Baltimore, MD, February 2004.

Mollet, G.A., Walters, R.P., & Harrison, D.W. (2004). Alexia without Agraphia: Connecting the Disconnection. Poster presented at the 20th Annual Virginia Tech Graduate Research Conference.

Walters, R.P., Beck, A.L., Harrison, D.W., & Mollet, G.A. (2003). A Lack of Relationship Between Auditory and Visual Hallucinations in a Rehabilitative Population. Poster presented at the 19th Annual Virginia Tech Graduate Research Conference.

GRANTS RECEIVED

2004	Graduate Student Association Travel Fund. $196
2004	Graduate Research Development Program. $225