

Electroencephalographic (EEG) and Personality Correlates of
Anger, Hostility, and Aggression

by

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Background: Anger, Hostility, and Aggression have been thought of as major influencing factors of numerous negative health behaviors. To date, research has focused on identifying various personality types in effort to further understand the role of these negatively portrayed emotional, cognitive, and behavioral phenomena. However, due to conceptual inconsistencies, anger, hostility, and aggression are typically used synonymously and erroneously, thus requiring further understanding utilizing existing theoretical frameworks including the reinforcement sensitivity model and trait-congruence attentional bias theories.

Purpose: The current study investigated the encephalographic and behavioral responses to a modified Stroop task with the sole purpose of further understanding possible personality, neurophysiological, and behavioral correlates underlying the constructs of anger, hostility, and aggression.

Methods: Participants were asked to complete a series of self-report inventories assessing personality traits and measures of anger, hostility, and aggression. This was followed by the completion of a modified Stroop task during which electroencephalogram (EEG) and behavioral recordings (reaction times) of 51 women

and 40 men recruited from psychology and neuroscience classes at East Carolina University were obtained. The modified Stroop task consisted of two phases: 1. A practice phase, during which the participants were oriented to the task via the presentation of a block of 10 neutral visual word stimuli to which they would respond using a four-button keypad, quickly and accurately pressing the button corresponding to the color each word was written; 2. A test phase consisting of two blocks of target stimuli (positively or negatively valenced word stimuli) interspersed in oppositely valenced word stimuli.

Results: Higher BAS scores were associated with the presence of anger, whereas, higher BIS scores were associated with reduced likelihood to self-report aggression.

Regarding EEG frontal scalp sites, greater right frontal activity was observed for higher self-reported BIS scores, whereas higher BAS and Anger scores were associated with left frontal activity. Moreover, there were no significant findings in relation to event-related potential amplitudes or latencies in response to valenced word stimuli, nor were there significant findings associated with word stimuli presentation and reaction times.

Discussion: Findings were reviewed in the context of such theoretical models as the reinforcement sensitivity model and trait-congruence attentional bias theories.

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CHAPTER I: INTRODUCTION

Hostility has been extensively studied in its relationship to physical health, most notably cardiovascular disease (CVD). Several studies have proposed that individuals with increased states of hostility are at greater risk for CVD. For instance, individuals with hostility often display associated risk factors such as elevated blood pressure and heart rate (Brondolo, Grantham, Karlin, Taravella, Mencía-Ripley, Schwartz, et al., 2009). However, harboring hostility may have even greater effects on our health. It appears there is also evidence supporting that hostility contributes to lowered pulmonary functioning (Jackson, Kubzansky, Cohen, Jacobs, & Wright, 2007) and metabolic syndrome (Elovainio, Merjonen, Pulkki-Råback, Kivimäki, Jokela, Mattson, et al., 2011). Due to the strong relationship between hostility and physical health, researchers continue to look for underlying mechanisms of this connection.

Researchers have targeted personality profiles in order to aid in the identification of individuals most at risk for CVD. Individuals more prone to CVD were described to be highly ambitious, rigidly organized, extremely time conscious, aggressive, and impatient (Rosenman, 1990). As the field of health psychology developed and evolved, additional research was conducted evaluating how one's mental states and behavior influence health. Emphasis has since shifted from broader personality constructs to focus on the deleterious effects of anger, hostility, and aggression. As such, the Type D personality variables of negative affect, namely hostility and anger, and social inhibition are suspected to be key players in the development of CVD and consequently have flooded cardiovascular health research (Denollet, 2005). Further in the consideration of personality and behavior patterns for identifying those at risk for CVD and other health

conditions is the influence of biopsychological motivational systems. In particular, the approach-withdrawal model as posited by Gray (1990), hypothesized the existence of three main systems, the fight/flight system (FFS), behavioral inhibition system (BIS) and the behavioral activation system (BAS) that influence one's behavior. Emphasis is placed on BIS and BAS, as they relate to the presentation of positive affect and approach behavior or negative affect and withdrawal behavior respectively. According to Gray (1990), personality traits are associated with individual differences in the strengths of BAS and BIS systems. Thus the strength of each of these systems has typically been measured via Carver and White's (1994) self-report measure, the BIS/BAS Scales. Psychophysiological research examining baseline cortical asymmetry has corroborated the neurophysiological underpinnings of these systems with approach behavior (BAS) relating to greater left than right frontal activation, whereas withdrawal behavior (BIS) is associated with greater right than left frontal activation (Sutton & Davidson, 1997). However, inconsistent with this theory is the association of anger with BAS, suggesting that anger may in fact operate as approach related behavior (Harmon-Jones, 2003). Furthermore, these two systems have been found to be associated with negative health behavior including non-active sedentary lifestyle, failure to wear a seat belt, and medication non-adherence (Voigt et al., 2009). Nevertheless, whether conceptualizing anger, hostility, and aggression as part of a particular personality typology or in relation to a theorized motivational model, it is evident that underlying behavior patterns laden with negative affect, attitudes, and conduct (i.e., anger, hostility, and aggression) can be insidious to an individual's health.

Electrophysiological measures have also been investigated in relation to physical and mental health conditions. Most research in this area has focused on using the electrophysiological measure of baseline EEG alpha band (8-12Hz) asymmetry, that is measuring electrical cortical activation across the hemispheres while at rest, as a potential biomarker for such mental health conditions as depression and schizophrenia (Gordon, Palmer, & Cooper, 2010). Similar techniques have also been implemented in an attempt to understand hostility, aggression, and especially anger (Harmon-Jones, 2003). While little research is available as it pertains to using EEG as a potential biomarker for high levels of disruptive anger, hostility, aggressive behavior; investigation of this relationship may aid in the development of yet another tool to identify those individuals at risk for adverse health consequences related to the harboring of anger, hostility, and aggression.

Lastly, it is important to consider cognitive mediators as they influence the presentation of anger, hostility, and aggression in human behavior. Information processing is suspected to play a large role in the manifestation of anger, hostility, and aggression. Particularly, it is suspected that there exists an attentional bias that predisposes individuals to interpret ambiguous events with more hostile intent and consequently result in anger and aggression (Dodge, 2006). Consequently, processing daily interactions through such a filter may increase the risk for heightened psychophysiological arousal (e.g., increased galvanic skin conductance, increased heart rate and blood pressure, increased reactivity, etc.) over long periods of time, contributing to the development of chronic illness (Scarpa & Raine, 1997).

The aim of the present study is to review research in the areas of personality, neurophysiology, and cognitive information processing to develop the rationale for experimental study of relevant individual differences in the presentation of anger, hostility, and aggression, using an emotional Stroop task. Investigation of these individual differences may lead to further understanding of the complexity of these constructs and provide insight into which measures may be most useful in identifying individuals most at risk for the development of chronic health problems resulting from their harboring. As such, those individuals most at risk may be identified early and referred for additional support (e.g., behavioral medicine) that may aid in decreasing negative health consequences.

CHAPTER II: LITERATURE REVIEW

Defining Hostility

What are anger, hostility, and aggression? Anger, hostility, and aggression are terms that are often used interchangeably to refer to the global label of hostility. However, most current research examining hostility tends to utilize the three-factor model of conceptualizing hostility or trait anger (Martin, Watson, & Wan, 2000). This model asserts that the construct of hostility or trait anger includes three major components: affective, cognitive/attitudinal, and behavioral. As such, the terms anger, hostility, and aggression, represent each of the areas respectively.

“Anger” typically represents an affective or negative emotional state based upon subjective feelings varying in intensity, whereas “hostility” constitutes a cognitive and attitudinal tendency, with held beliefs of cynicism and mistrust of others. Meanwhile, “aggression” is associated with the overt behavioral response, perhaps precipitated by anger or hostility (Martin et al, 2000). However, many surmise that the interaction or aggregate combination of all three factors influence health and thus due to the conceptual overlap of these constructs that altogether are referred to as the AHA! Syndrome (Speilberger & Reheiser, 2010).

It is important to note the influence of the state-trait anger theory when conceptualizing AHA! constructs. State-trait anger delineates the differences between state-anger, anger that tends to be a transitory reaction to a specific stimulus or situation, and trait-anger, which can be described as disposition to being anger prone or eliciting state anger across multiple situations more frequently and more intensely than low trait-anger individuals. Compared to individuals low in trait anger, high trait anger

individuals elicit more anger across situations and experience anger more frequently and more intensely. Also, since anger tends to be a motivator of aggression, individuals high in trait anger are more likely to behave aggressively resulting in a higher likelihood for aggression related consequences (Deffenbacher et al., 1996). Despite the conceptual confusion among the constructs of anger, aggression, and hostility, most researchers now acknowledge that each term represents its own domain within the framework of the human experience with those areas being affect, behavior, and cognition.

Is it All About Personality?

Type A Behavior Pattern (TABP). In an effort to identify individuals most at risk for developing CVD, researchers have attempted to study individual differences as they relate to personality profiles. Type A behavior pattern (TABP; also known as coronary prone behavior pattern) presents a combination of several psychological and behavioral constructs and behaviors including anger, hostility, and aggression. Identified by two cardiologists, Friedman and Rosenman, TABP highlighted the emotional connection to our health. Rosenman (1990) described TABP as an:

Action-emotion complex involving behavioral dispositions such as ambitiousness, aggressiveness, competitiveness, and impatience; specific behaviors such as muscle tenseness, alertness, rapid and emphatic vocal stylistics, and accelerated pace of activities; and emotional responses such as irritation, hostility, and increased potential for anger (pg.2).

Original support for the relationship between TABP and negative health outcomes was led by Friedman and Rosenman throughout the 50's and 60's. Prolific amounts of research described predictive relationships suggesting TABP to increase the likelihood of CHD and relevant symptomology. Specifically, early research reported

TABP to be related to increased muscle vasodilatation and more enhanced secretion of norepinephrine, epinephrine, and cortisol (Williams et al., 1982), increased blood cholesterol levels, elevated triglycerides, and increased blood clotting time (Friedman & Rosenman, 1959).

Despite the original hype surrounding the potential in identifying individuals with TABP, studies began reporting inconsistent findings from the mid-80's to the present, with many researchers championing anger and hostility as the “real culprits” within TABP responsible for cardiac related illness (Razzini et al., 2008). For instance, a major study analyzing the relationship between TABP and one's health was demonstrated in the Western Collaborative Group Study (WCGS), in which the researchers observed similar behavioral and emotional tendencies among a CVD population (Hecker, Chesney, Black, & Frautschi, 1988). Two-hundred-fifty Coronary Heart Disease (CHD) cases and 500 matched controls from the WCGS were studied using a Type A structured interview assessing 12 operationally defined components previously established to be representative of TABP. Aside from being the first study to establish a prospective relationship between TABP and coronary heart disease, these researchers noted that not all facets of TABP were indicative of CVD; rather an emphasis should be placed on hostility (Hecker, Chesney, Black, & Frautschi, 1988).

Type D personality. Many researchers have moved away from studying the TABP and are beginning to examine yet another behavior pattern identified to be highly related to the development of CHD. The type D or “distressed” behavior pattern is characterized by two global traits: negative affect and social inhibition. Negative affect refers to the tendency to experience negative affect or negative cognitive states (e.g.,

dysphoria, hostility, anxiety, and irritation) across many different situations, while social inhibition refers to the tendency to inhibit expression of emotions in social situations. Persons characterized by both high negative affectivity and high social inhibitions have been shown to be vulnerable to many physical ailments, disease courses, and especially cardiovascular disease biomarkers (Denollet, 2005; O'Dell, Masters, Spielmans, & Maisto, 2011).

Designed specifically to assess outcomes for cardiac patients, many studies have demonstrated a strong relationship between negative affect and social isolation with cardiac events. A series of studies conducted by Denollet and his associates has shown the Type D personality to be predictive of adverse outcome for cardiac patients, including mortality, myocardial infarction, and revascularization procedures (Denollet, 2000). For example, Denollet, Vaes, and Brutsaert (2000) examined the 5-year prognosis of 319 patients with CHD. Utilizing cardiac death, non-fatal cardiac events, and perceived impairment in quality of life (QoL), the researchers revealed that decreased left ventricular ejection fraction (the volumetric fraction of blood pumped from the ventricle), type D personality, and younger age of onset increased the risk of cardiac events significantly, with the convergence of the two or three of the risk factors predicting the poorest prognosis and a non-response to treatment 4-fold.

Despite being constructed to study predictive outcomes within a cardiac population, the Type D personality has also been linked to general ill health and poor health behaviors. Mols and Denollet (2010) performed a meta-analysis of studies utilizing the Type D personality construct with non-cardiac populations between the years of 2007 and 2009. The majority of the studies included non-cardiac patients with

chronic pain, asthma, tinnitus, sleep apnea, vulvovaginal candidiasis, mild traumatic brain injury, vertigo, melanoma, diabetic foot syndrome, and older patients in primary care. In general, the findings revealed that non-cardiac patients with Type D attributes reported a poorer health status and were more likely to present with anxiety and depressive symptoms. Furthermore, compared to their non-Type D counterparts, patients with Type D personality were more vulnerable to non-adherence to their medical regime.

Additional corroboration demonstrating the impact of Type D personality on general health of non-cardiac patients was found in a study examining maladaptive behaviors among a sample of 200 university students and faculty members, with 34.5% of their participants qualifying as Type D personality. Results indicated a significant difference in health behaviors (as assessed by Preventive Health Behavior Checklist and Timeline Follow Back Measurement) within the Type D versus the non-Type D personality participants. Results suggested that those individuals indicating a Type D personality profile were found to engage in more maladaptive health behaviors. These individuals were likely to smoke more, exercise less, and eat a poorer diet than their non-Type D counterparts. Despite inherent limitations in attempting to link Type D personality as an underlying mechanism to ill health, the findings show promise for use of Type D measurement as part of the health care system (Gilmour & Williams, 2012). Nevertheless, these results further support earlier findings demonstrating a relationship between Type D personality and metabolic disorder (e.g., a cluster of risk factors, including increased central fat deposition, glucose intolerance or insulin resistance, dyslipidemia, and hypertension; Mommersteeg, Kupper, & Denollet, 2010) and adverse

lifestyle behaviors (e.g., smoking, excessive alcohol consumption, poor diet, and lack of exercise; Williams, O'Connor, Howard, Hughes, Johnston, Hay, et al., 2008; Mommerstein et al., 2010). Taken together, the constructs of negative affect and social isolation underlying Type D personality are maladaptive in healthy and non-healthy populations providing a continued need to assess individuals for Type D in medical and non-medical settings. Perhaps further exploration may be warranted for specific factors (i.e., hostility) that may mediate many of the negative outcomes.

Behavioral inhibition and behavioral activation systems (BIS/BAS). In discussing the influence of personality and behavior patterns on health outcomes, another factor that should be considered in the larger health picture are BIS and BAS. More heavily focused in the physiological and neuropsychological aspects of personality, Gray's (1990) reinforcement sensitivity model sought to reveal that individual differences in these two competing systems would result in a unique temperament or personality style in which to interact with one's environment (Heponiemi, et al., 2004). The BIS, is proposed to be activated by aversive stimuli (punishment and non-reward) resulting in increased attentiveness, inhibition, withdrawal and negative affect. In contrast, the BAS operates in response to appetitive stimuli (reward, motivation, and non-punishment) and results in the experience of positive affect and approach behavior. Further, Kennis, Rademaker, and Geuze (2013) demonstrated distinct neurophysiological brain correlates to the BIS and BAS systems, see Figure 1 and Figure 2. In relation to overall health and well-being, there is evidence to support the relationship between different system sensitivities (e.g., high BAS or low BAS) to negative health outcomes, such that cardiac reactivity (i.e., heart rate,

respiratory sinus arrhythmia, and pre-ejection period) and high BAS sensitivity are greatly associated (Heponiemi et al., 2004).

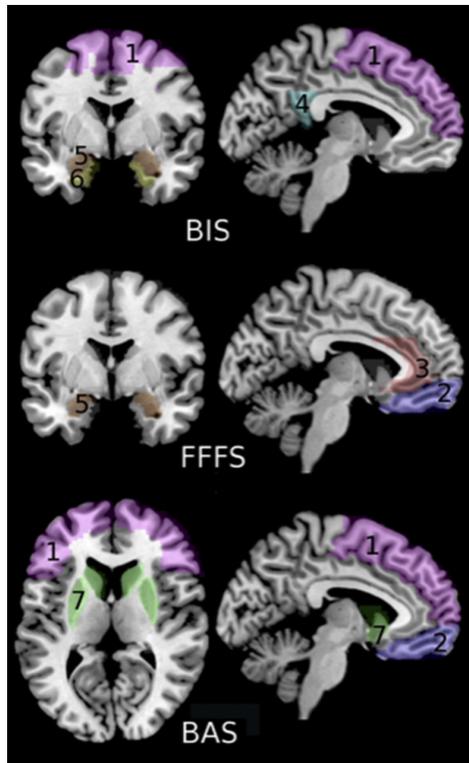


Figure 1. Overview of the brain areas proposed to be involved in BIS, FFFS and BAS. fMRI Image. Courtesy: Kennis, Rademakera and Geuze, 2013; 1. Dorsal prefrontal cortex. 2. Ventral prefrontal cortex. 3. Anterior cingulate cortex. 4. Posterior cingulate cortex. 5. Amygdala. 6. Hippocampus. 7. Dorsal and ventral striatum.

<u>Behavioral Inhibition System</u>	<u>Behavioral Activation System</u>
Dorsal Prefrontal Cortex	Prefrontal Cortex
Posterior Cingulate Cortex	Ventral Striatum
Septohippocampal System	Ventral Pallidum
Amygdala	Ventral Tegmental Area
Medial Hypothalamus	
Periaqueductal Grey	

Figure 2. Proposed neurobiological systems underlying behavioral inhibition and behavioral activation systems.

A general relationship between BIS/BAS and high-risk health behaviors is also observed. Voigt et al. (2009) examined the health behaviors of 1014 undergraduate students (58.4% female) attending four universities in various regions of the United States. Via online survey administration, all participants completed Carver and White's BIS/BAS Questionnaire and portions of the 2007 State and Local Youth Risk Behavior Survey, an instrument developed by the Centers for Disease Control and Prevention. In particular the researchers were interested in health behaviors such as safety, tobacco use, drug use, alcohol consumption, sexual practices, eating habits, and physical activity. Findings revealed a positive correlation between BIS and poor diet, lack of exercise, unsafe acts (e.g., not wearing seatbelt while driving), and drug use. In contrast, BAS was most related to unhealthy behaviors related to safety, tobacco and other drug use, alcohol consumption, and sexual practices. These results were interpreted to suggest that BAS was related to acts of impulsivity and sensation seeking whereas BIS to those of inhibition or avoidance (Voigt et al., 2009).

Supportive findings demonstrating the influence of BIS scores on health behavior were shown by Moran et al. (2011). The researchers examined underlying personality correlates associated with nonadherence to treatment for obstructive sleep apnea (OSA). Results suggested individuals with elevated BIS scores and neuroticism predicted nonadherence with use of continuous positive airway pressure treatment (CPAP). While more confirmatory evidence is needed to draw greater conclusions, these results support the influence of personality factors on an individual's health behaviors.

Furthermore, it may be wise to consider the influence of anger, hostility, and aggression among health behaviors and development of CVD. Although BAS is generally related to the experience of positive affect, several studies have identified the experience of anger to be highly correlated to BAS (Harmon-Jones, 2003), thus perhaps muddying the relationship found between cardiac reactivity and BAS sensitivity. This provides evidence that in some instances perceived negative emotions may serve as motivators, especially as it pertains in the case with anger. These findings were evidenced in a study by Harmon-Jones (2007), in which participants were exposed to affective pictures to elicit neutral, fear/anxiety, and anger reactions while recording EEG activity. They were then administered traditional measures (i.e., BIS/BAS Scales) to capture individual differences in BIS and BAS strength. Results indicated that persons high in trait anger had greater left frontal activity to anger-inducing pictures, demonstrating the role of trait anger in the neural circuitry of approach motivation, which tends to be much more easily activated in these individuals (Harmon-Jones, 2007).

Considering all research regarding behavioral dispositions, personality types, and reinforcement models of human behavior, there is an apparent interplay of biological, psychological, and social factors that may overlap to influence one's health. Seeing how these models of personality and relational behavior include components associated with negative affect, including the constructs of AHA!, it may be important to tease apart these models and examine how they overlap or may be combined in effort to identify at risk individuals.

The Brain and Hostility

The neuroanatomical underpinnings of anger, hostility, and aggression.

Trying to identify the neural substrates related to anger, hostility, and aggression has been difficult. The elusive nature of each of these constructs is relatively difficult to measure physically. For example, both anger and hostility are considered to be rather endogenous in nature, referring to one's inner worlds and thus rely heavily on self-report measures. As such, most research attempting to study the anatomical aspect of AHA! has focused on outwardly projected behavior of aggression.

Aggression may be classified in several ways. These include, but are not limited to, the target of the aggression (self or other), mode of aggression (verbal or physical), or cause of aggression (Siever, 2008). However, Siever (2008) suggests the most widely utilized and valuable classification is that of premeditated versus impulsive aggression. Premeditated aggression, also known as predatory, instrumental, or provocative aggression, is typically a planned behavior that is not associated with frustration or in response to a threat. This type of aggression is generally goal directed and purposeful. In contrast, impulsive aggression tends to be associated with heightened autonomic arousal and negative emotions and affect. Impulsive aggression, also referred to as affective, hostile, or reactive aggression, tends to occur in defensive situations when threats are apparent. This form of aggression is also most associated with pathology and violence. Nonetheless, both premeditated and impulsive aggression styles are seen as an essential evolutionary aspect to human survival (Siever, 2008).

Much research has identified key roles of certain anatomical substrates, including the prefrontal cortex (PFC) and the limbic system structures including the amygdala,

insula, hippocampus, and anterior cingulate (Davidson, 2004; Siever, 2008). Blair (2004) and Gregg and Siegel (2001) note the existence of relevant aggressive brain circuitry with both the PFC, anterior cingulate cortex (ACC), and amygdala modulating sublimbic structures, especially along the pathway between the anterior-medial hypothalamus and the periaqueductal gray matter (PAG). The apparent role of the Prefrontal Cortex (PFC) is to provide a top-down processing approach involved with monitoring incoming stimuli (e.g., social and behavioral cues from others) predicting reward or punishment. Nevertheless, the amygdala is postulated to play a unique role in modulating or triggering aggressive behavior with negative consequences utilizing a bottom-up processing approach (Blair, 2004; Siever, 2008). Despite sensory processing within these brain areas, appraisal of the stimuli occurs with much influence by culture, social factors, and learning history, which may ultimately modulate the perception of the stimuli. Hence cognitive processes biased by negative schema (e.g., hostile attributional bias, previous trauma, or enduring negative experiences) or past emotional conditioning with the amygdala, may trigger a negative emotional or aggressive action while the PFC and ACC attempt to modify or suppress the onset of such experiences by applying an individual's personal attitudes, beliefs, and expectations to the interpretation of the current situation (Siever, 2008).

Additional support for the significant role of PFC and amygdala are noted in a review article examining a neuropsychological model relating self-awareness with hostility. Researchers Demaree and Harrison (1997) described several brain regions and their roles in self-awareness and the manifestation of hostility. The authors defined self-awareness as a form of awareness of oneself and of one's environment. Of most

importance, the authors noted the 'checks-and-balances' relationship of the amygdala and orbitofrontal cortex. The amygdala, when stimulated, results in an aroused state linked to aggression and hostility. Conversely, the orbito-frontal cortex is responsible for awareness and inhibition of negative emotional expression. It is hypothesized that these two areas of the brain work in tandem to mitigate hostile responses. As such, their model suggests that the probability to aggress may be increased in relation to deficits of self-awareness (Demaree & Harrison, 1997).

The neurochemistry and psychopharmacology of AHA! The search for the biological underpinnings of aggression focuses not only on anatomical correlates, but also neurochemical influences. The literature is replete with studies designating several neural and hormonal mechanisms underlying the manifestation of AHA!, including acetylcholine, dopamine, and norepinephrine (Eichelman, 1990). However, extensive research highlight serotonin (5-HT) and testosterone as key players for mediating aggression and anger. Nevertheless, the function of each neurochemical modulator has a unique role for behavioral and emotional expression.

Serotonin is a neurotransmitter in which a strong relationship between the regulation of anger and aggression has been established. Serotonin has been found to have an inverse relationship with aggression, in that higher amounts of serotonin lead to decreased aggression; whereas lower amounts of serotonin lead to increased aggression (Pihl & Peterson, 1993; see Siever, 2008, for a review). Specifically, in a review by Olivier and van Oorschot (2005) suggest 5-HT_{1B} receptors directly modulate aggressive behavior as demonstrated in studies examining offensive aggressive behavior of 5-HT_{1B} receptor knockout mice (Saudou et al., 1994) and studies examining

the effect of selective serotonin reuptake inhibitors and a reduction in offensive aggressive behavior (Olivier et al., 1990). Further, this relationship has been shown using several methods of serotonin manipulation in animals. One such method is that of decreasing the amount of precursor (i.e., tryptophan) available to synthesize 5-HT. In these studies, animals enduring either a diet depleted of tryptophan or a diet with excess tryptophan demonstrated aggressive and non-aggressive behaviors respectively (Gibbons, Barr, Bridger, & Liebowitz, 1979; Chamberlain, Ervin, Pihl, & Young, 1987).

Similar findings have been found in humans. A study by Moeller, Dougherty, Swann, Collins, Davis, and Cherek (1996), did just that by recruiting ten healthy male subjects and restricting them to a low tryptophan diet for two days followed by consumption of a tryptophan depleting drink prior to engaging in a Point Subtraction Aggression Paradigm, a task requiring either a non-aggressive response resulting in the addition of points which can be traded in for money, or an aggressive response leading to the subtraction of points from a fictitious individual. Findings supported the tryptophan depletion hypothesis as suggested by increased aggressive responding in men.

Additionally, psychopharmacological manipulation has also substantiated the serotonin-aggression relationship. Berman, McCloskey, Fanning, Schumacher, and Coccaro (2009) examined the effects of 40mg of paroxetine hydrochloride or an inert placebo on performance of a reaction time task (Taylor Aggression Paradigm) in 40 aggressive individuals and 40 non-aggressive individuals (as defined by a determined cutoff score in response to an semi-structured aggression interview). Results suggest that those individuals with a pronounced aggressive history receiving the paroxetine hydrochloride treatment demonstrated a reduction in aggressive responding during the

task. This suggests that increasing levels of serotonin via a selective serotonin reuptake inhibitor may reduce aggression in general.

When considering the influence of hormones on behavior, testosterone has traditionally been seen to have a strong relationship with anger and aggression. Animal research using rodents has demonstrated an increase of aggressive behavior that is related to higher levels of testosterone (Lumia, Thorner, & McGinnis, 1994; Melloni, Connor, Hang, & Ferris, 1997). In fact, hormone removal and replacement studies provide strong evidence for the role of testosterone in aggressive behavior as castration generally leads to decreased aggression, while reintroduction of testosterone restores aggressive behavior (Albert, Jonik, & Walsh, 1992). However, in humans the role of testosterone is a bit more controversial, showing mixed results in regards to the relationship.

Several studies have shown that high concentrations of testosterone are associated with populations characterized by high aggression. In one such investigation, Dabbs, Carr, Frady, and Riad (1995) examined salivary testosterone levels and prison records (e.g., reason for incarceration and disciplinary actions taken while in prison) for 692 male inmates in a maximum-security state prison. Results suggested that higher testosterone levels were related to crimes of sex (e.g., rape and child molestation) and violence as compared to those individuals with lower testosterone who were found to be associated with non-violent crimes such as burglary and drugs. Additional corroboration in the literature has shown that testosterone is associated with delinquency in adolescents (Dabbs, Jurkovic, & Frady, 1991) and

general arousal and “rambunctious” behavior in a non-prison population (Dabbs, Hargrove, & Heusel, 1996).

In contrast, there is some evidence that suggests a lesser role of testosterone as it relates to aggression. For instance, Coccaro, Beresford, Minar, Kaskow, and Geraciotti (2007) assessed lumbar cerebral spinal fluid (CSF) concentrations of free-floating testosterone in 31 men with varying diagnoses of personality disorders. Aggression was assessed via categorical (intermittent explosive disorder criteria) and dimensionally (semi-structured interview). Unlike findings in previous studies, testosterone was not shown to be associated with increased aggression; rather higher CSF testosterone concentrations were related to sensation seeking behavior.

Electrophysiological Correlates of Anger, Aggression, and Hostility

Frontal cortical activity and brain asymmetry. Traditionally, research on resting frontal cortical asymmetry has demonstrated asymmetric activity differences related to emotional valence (positive versus negative), motivational direction (approach versus withdrawal), or a combination of the two. When examining the role of emotional valence on frontal cortical activity, researchers have focused on state and trait emotions (i.e., state-trait anxiety), emotion eliciting stimuli, and emotionally evocative situations. For instance, Tomarken, Davidson, Wheeler, and Doss (1992) assessed the individual differences in resting anterior brain asymmetry of 90 undergraduate women. Findings revealed that those individuals demonstrating relative left cortical activity reported increased positive affect and decreased negative affect as compared to their extreme relative right activity counterparts.

Further evidence for the affective valence model of frontal asymmetry was demonstrated through observation of frontal cortical asymmetry in depressed and never depressed individuals. Stewart, Coan, Towers, and Allen (2011) examined these differences during a Directed Facial Action task in which they asked 306 adult participants aged 18-34 years (31% male) to hold four facial expressions (representing either happy, afraid, angry, or sad) for one-minute intervals between EEG resting segments. Results revealed that individuals with clinically significant depressive symptoms (as rated on the Beck Depression Inventory and Structured Clinical Interview for the DSM-IV) showed less relative left frontal cortical activity across all emotional expressions as compared to the individuals whom had never had depression.

Nevertheless, corroborating evidence of the valence model of asymmetry appears across the developing lifespan, suggesting a possible relatively stable trait-like property. A study examining frontal cortical activity in infants aged 10 months or younger while watching film clips of an actress presenting with happy or sad facial expressions provided evidence of such a difference between positive and negative affect biases. When presented happy segments, the infant EEG recordings showed increased left cortical activation as compared to the presentation of the sad clips. This result supports the relationship between higher left frontal cortical activity and positive affect (Davidson & Fox, 1982). As previously noted, motivational direction is also suggested to relate to frontal asymmetric activity differences. EEG examination has suggested that the left anterior region of the brain is associated with the expression and experience of approach-related motivation and positive affect (BAS), while the right anterior region relates to avoidance and negative affect (BIS).

However, in relation to anger, studies examining electroencephalogram (EEG) and frontal cortical activity have shown an unexpected result. Harmon-Jones and Allen (1998) examined the relationship between anger and frontal cortical asymmetry by examining the EEG recordings of 26 adolescents aged 11- 17 years (15 boys). Trait Anger was assessed using the Buss-Perry Aggression Questionnaire (1992), while state affect was measured using the Positive and Negative Affect Schedule- Children's Version (PANAS-C). Anger elicitation appeared consistent with cortical activity in the left anterior region of the brain, providing support toward the idea of anger being an approach response. This concept complicates our understanding of anger and hostility, initially only thought of as negative affect, by suggesting that anger may facilitate toward reaching goals (Harmon-Jones & Allen, 1998).

Additionally, these findings also provide evidence for a combined valence and motivational direction approach to understanding the meaning of frontal asymmetrical cortical activation. Due to new information regarding negative affect such as anger, aggression, and hostility, further evaluation and examination of their role is necessary toward a better understanding of their influence on health.

Electrophysiology, attention bias, and the relation to anger, hostility, and aggression. The use of electrophysiological recording techniques for the studying of emotional and cognitive phenomena is seen throughout the literature (to be discussed later). While most research utilizing the Stroop paradigm utilized behavioral measures such as response time (RT), examination of event-related potentials (ERPs) has become increasingly popular due to the advantage of being able to provide a direct measure of neural activity over the time course of tasks requiring attention and cognitive

processing. ERPs are assumed to measure post-synaptic voltage changes during neurotransmission. These electrical changes are recorded through the placement of electrodes on the scalp of the participant. They are transformed into visual wave- forms (using ERP averaging techniques) depicting positive and negative deflections of voltage. Typically amplitudes are then designated with a P or N to signify either positive or negative deflection respectively. A number to indicate their timing or latency in milliseconds then follows this. For example, a P300 or P3 would suggest the presence of a positive amplitude at about 300 milliseconds during a given task (Luck, Woodman, & Vogel, 2000). Study of particular ERP components suggests that different deflection points and latencies are related to particular cognitive processes. For instance, earlier recorded amplitudes and latencies tend to represent exogenous or sensory processing of presented stimuli while latter peaks are suspected to represent endogenous cognitive processing (Hillyard & Kutas, 1983).

Several studies have demonstrated a relationship between emotion and ERP amplitudes. Larger ERP amplitudes to both negative and positive stimulus presentation suggesting an informational processing bias have been demonstrated across several processing paradigms and tasks. For example, a study conducted by Bernat, Bunce, and Shevrin (2001) investigated subliminal and supraliminal processing of affective stimuli in a sample of 17 undergraduate students. The students participated in a two-phase task in which the first part required only watching affectively valenced words quickly flashed on the computer screen during recording of EEG. The second task required students to participate in a forced-choice detection task. Findings revealed that negative word stimuli showed greater ERP positivity across all components (P1, N1, P2,

P3, and LP). Similar findings suggesting the use of ERP investigation of emotional processing found that attentional processes associated with emotional processing were related to augmented ERP components, particularly augmented P3 amplitudes (Schupp, Junghöfer, Weike, & Hamm, 2003).

Research examining the influence of trait anger, hostility, and aggression during tasks evoking ERPs is currently limited, particularly as it pertains to information processing of emotionally valenced stimuli. As noted earlier in this document, anger is associated with approach related behavior, which itself is generally connected with positive affect. Results of multiple studies suggested a link between impulsive aggression and reduction in parietal P300 amplitudes (Barratt et al., 1997; Harmon-Jones et al., 1997). In contrast, several other studies demonstrated P300 enhancement for negative than neutral stimuli, indicating enhanced salience of threat, (Franken et al., 2009; Stewart et al., 2010). Similar to the conceptual confusion in research suggesting that anger, an inherently described negative emotion, as approach related behavior, ERP research appears to follow suit, thus requiring further study.

Cognitive Mediators Of Anger, Hostility, And Aggression

The modified Stroop paradigm and attentional biases. The Stroop task was developed to assess selective attention processes requiring a respondent to name the color of the ink a particular item that was written, ignoring the item itself. During this process, it is common for persons to take longer to name the color of the ink for an item if the item was an “antagonistic” meaningful word because of interference due to the automatic nature of processing written material. It is proposed that processing written material (e.g., reading familiar words) is an automatic response, thus when prompted to

inhibit one's response to an automatic process in order to process a less automatic aspect (e.g., read aloud the color of the ink), this phenomena causes delays or latencies in responding. For instance, the item would be the word "brown," but it would be written in green ink. However, adaptations of the Stroop task began to reveal other uses (Williams, Mathews, & MacLeod, 1996).

The emotional analog form of the Stroop task was an offshoot of the original task developed to assess the prevalent attentional biases underlying many forms of psychopathology, most predominantly for emotional disorders. It was found that when participants attempted the task containing emotionally laden words, delays occurred when approaching words pertaining to the individual's personal concerns. These delays were found to be most prominent if the words were negative verses positive (Williams, et al, 1996). For example, Mathews and MacLeod (1985) examined performance of 24 generally anxious outpatients and 24 non-anxious controls on an emotional color-naming task for physical, social and non-threatening words. Sample words for physical and social threatening content included disease, hazard, indecisive, and failure. Non-threatening word examples included playful, holiday, and entertainment. Findings revealed that anxious individuals demonstrated slower processing for all words, but especially for words related to threat. The researchers attributed their finding to a possible selective attention or information processing bias for essentially meaningful words related to the participants' personal concerns (Mathews & MacLeod, 1985.) Similar evidence of a selective attention bias within information processing has been identified across emotional disorders such as generalized anxiety disorder and worry (Mogg, Mathews, & Weinman, 1989), post traumatic stress disorder (McNally, Kaspi,

Riemann, & Zeitlin, 1990), and panic disorder (McNally, Riemann, & Kim, 1990); as well as, health concerns including pain (Roelofs, Peters, Zeegers, & Vlaeyen, 2002) and alcohol dependence (Ryan, 2002).

Evidence supports the use of the Stroop in assessing attentional bias and elicitation of aggression, anger, and hostility. Smith and Waterman (2003) used the emotional Stroop task with both forensic (prisoners) and non-forensic (undergraduates) populations. The forensic population 20 women and 30 men, were indexed and matched based on their crime (violent or non-violent) while the undergraduates, 20 women and 10 men, were matched on index offense (violent or non-violent) and based on self-reported anger questionnaires. Results revealed a bias toward aggression-related words for both violent prisoners and aggressive undergraduates suggesting an attentional bias for aggressive or violent content resulting in a slowed response for the negative or aggressively themed words. Based on findings like these, utilization of the emotional Stroop task or other similar valenced tasks to assist in measurement of hostility appears to be quite valid.

Hostile attributional bias. Although not considered a clinical diagnosis, the constructs of anger, hostility, and aggression are thought to host another cognitive bias. Known as the hostile attributional bias (Dodge, 2006), this model views hostility as a cognitive bias in which hostility may reflect a skewed appraisal system allowing for biased interpretation of perceived negative experiences. Persons with this attributional bias tend to interpret the intent of others as hostile, especially if social cues are ambiguous or unclear, thus potentially resulting in outbursts of aggression (Dodge, 2006). As such, persons likely seeing through this particular lens are more predisposed

to experience the negative aspects of anger, hostility, and aggression. Perhaps this may be linked to evidence suggesting individuals may be evolutionarily predisposed to have a negativity bias as it relates to allocating attention toward threat-related stimuli (Ito, Larsen, Smith, & Cacioppo, 1998), but those individuals with higher trait anger, hostility, and aggression activate this reactive response much quicker.

Trait-Congruency Hypothesis. Related to the hostile attribution bias is the trait-congruency hypothesis. This hypothesis suggests that affective traits are linked to the heightened activation of congruent emotion networks (Parrott, Zeichner & Evces 2005). In the case of anger, this would suggest that individuals high on trait anger are more susceptible to direct their attention toward anger related stimuli. Additionally, these individuals are also thought to process anger related information much quicker creating a facilitative bias toward the trait-congruent information.

Cohen, Eckhardt, and Schagat (1998) empirically investigated this phenomenon in their study examining the effect of state- and trait-anger. State-anger was manipulated by exposing participants to an insult (being blamed for a computer malfunction) designed to elicit anger or to a neutral interpersonal interaction. The 130 participants were divided into either a high trait-anger or low-trait anger group as determined by relative scores on a measure of anger and aggression. Next, the individuals participated in a visual search task requiring them to identify a target word among three other distractor words, by selecting the corresponding button to the target words quadrant location on the computer screen. The results from this study demonstrated that, high trait anger individuals who were insulted (i.e., angered)

selectively attended to and more rapidly processed anger-relevant stimuli compared to their low trait-anger counterparts (Cohen et al., 1998).

When conceptualizing the underlying mechanisms contributing to the experience of AHA!, it is important to consider cognitive aspects. Appraisal, social factors, and learning history, may ultimately modulate the perception of the stimuli. Hence attentional biases in cognitive processing may contribute to making those individuals more susceptible to experience anger to be most vulnerable to several public health concerns including those health concerns previously noted, especially CVD.

Why Study EEG and Personality Correlates of Hostility?

Since hostility has traditionally been studied solely through survey and behavioral measures, EEG studies would provide another venue to conceptualize the effect of hostility on an individual, thus providing more insight to possible ways to more fully understand the complex construct of hostility. Similarly, due to the negative relationship of negative affect (anger) and physical health (e.g., cardiovascular disease), correctly identifying individuals susceptible to negative affect is vital to developing and utilizing alternative interventions for health care prevention and promotion.

Aims and Hypotheses

There has been much research in regards to the individual differences within personality, electrophysiology, and cognitive information processing as it relates to the presence of anger, hostility, and aggression. To date, however, the relationships among these variables have yet to be reviewed systematically. The present study utilizes an emotional Stroop task using emotionally valenced words to test the effect of information processing on the presence of varying levels of anger, hostility and

aggression. Self-reported personality characteristics using the BIS/BAS scales and inhibitory neural correlates derived from ERPs will also be examined with the aim of identifying potential risk factors that contribute to negative health behavior, especially as it relates to the development of CVD. The aims of this study are to:

(1) Examine relationships amongst self-report measures of personality, affect, and behavior. It is hypothesized that negative personality traits will reflect higher levels of anger, hostility, and aggression. For instance, because Type D personality taps into the negative behaviors/traits contributing to CVD (e.g., negative affect and social inhibition), there should be a strong positive correlation between this measure and those of anger, hostility, and aggression. Similarly, measures of anger, hostility, and aggression are anticipated to positively correlate with the personality construct of neuroticism.

(2) Investigate the P300 ERP component as it relates to information processing of positive and negative word presentation in the present emotional Stroop task. One of the most studied ERP components, and perhaps the most relevant to the current study is the P3. The P3 component is a positive deflection at approximately 300 milliseconds during the time course of a given task. In particular the P3 has shown to be augmented when individuals are confronted with self-relevant stimuli (Gray, Ambady, Lowenthal, & Deldin, 2004). As such, it is hypothesized that persons with higher self-reported trait anger, hostility, and aggression will have augmented P3 ERP components when presented with negatively valenced word stimuli as it relates to a general negativity or hostile attributional cognitive bias.

(3) Replicate findings from past research regarding resting asymmetry (RA) and measures of BIS/BAS and to further investigate the relationship between resting asymmetry and measures of self-reported anger, hostility, and aggression. It is hypothesized that higher self-reported BIS will be related to greater right frontal activity while higher BAS will be associated with greater left frontal activity. In relation to RA, BIS/BAS, and AHA!, it is hypothesized that scores on anger, hostility, and aggression measures would be associated with greater left frontal cortical activity and BAS.

(4) Investigate facilitation effects associated with attentional bias to affectively valenced stimuli in an emotional Stroop task through examination of reaction times. It is hypothesized that individuals endorsing higher levels of anger, aggression, and hostility, will show greater facilitation (i.e., quicker response times) to negatively valenced stimuli, especially those stimuli reflecting those constructs. This would be congruent with previous studies suggesting a facilitation bias related to the trait-congruent hypothesis (Parrott, Zeichner & Evces 2005).

CHAPTER III: METHODS

Participants

Eighty-two participants were required for the present study based on a priori power analysis to detect large effects with 80% power using GPower 3.1. However, in order to offset possible errors with technology and unknown participant variables, the current study recruited 91 right-handed male and female undergraduate student participants of at least 18 years of age. There were 51 women and 40 men in the sample (56% women). The average age of the sample was 20.18 years ($SD = 3.36$), ranging from 18 to 34 years of old. Participants were recruited from the East Carolina University's undergraduate psychology and neuroscience classes. Participants were screened for anxiety, depression, and attention deficit and hyperactivity disorder. In order to prevent unwanted confounds, individuals who meet criteria for these conditions were not eligible for participation. As noted previously, anxiety, depression, and attention deficit and hyperactivity disorder have been shown to influence performance on Stroop and modified emotional Stroop task. All eligible participants received course credit for participation.

Measures and Questionnaires

Anger, Hostility, and Aggression Questionnaires.

Buss-Perry Aggression Questionnaire (AQ). The AQ is a 29-item questionnaire measuring the four main constructs of Anger (seven items), Hostility (eight items), Verbal Aggression (five items), and Physical Aggression (nine items). The participant rates each statement on a 5-point rating scale with values of 1 indicating the statement is "extremely uncharacteristic of me" to a value of 5 "extremely characteristic

of me,” (Buss & Perry, 1992). A sample of 1200 participants in a study analyzing the generalizability of the AQ in the general population found that each factor of the AQ demonstrated moderate to high internal consistency reliability, Verbal Aggression (.68), Anger (.70), Hostility (.75) and Physical Aggression (.82). Additionally, their analyses suggest the AQ is suitable and valid measure for use in the general population (Gerevich, Bácskai, & Czobor, 2007).

State-Trait Anger Expression Inventory-2 (STAXI-2). Consisting of 57 items administered in three parts (“How I Feel Right Now,” How I Generally Feel,” and “How I Generally react when Angry or Furious”, the STAXI-2 is a self-report measure aimed at studying the experience of anger, aggression, and hostility as it pertains to affective state, general disposition, expression of anger, and control of anger. The respondents answer each part using a 4-point (*1 = Not at all or Almost Never through 4 = Very much so or Almost always*). Item values are then used to calculate scores for six scales, State Anger, Trait Anger, Anger Expression-Out, Anger Expression-In, Anger Control-Out, and Anger Control-In. Internal consistency reliability is provided by alpha coefficients reported for the STAXI-2 scales ranging from .73 to .95, while other reports suggest a median alpha coefficient of .84 or higher .

Clinical Anger Scale (CAS). Designed initially to study levels of “clinical anger” within in- and outpatient populations, the CAS utilizes 21 questions to assess the affective, cognitive, physiologic, and behavioral manifestations of expressed anger as it relates to a person’s present life, themselves, others, and general things. Each of the 21 presented statements is followed by four responses in which the participant is asked to select the response most fitting to how they generally feel. The responses are graded

on a 4-point rating scale with A = 0, B = 1, C = 2, and D = 3, with lower valued responses indicating less symptomology of clinical anger than higher valued. The CAS has shown high convergent validity with other measures of anger (e.g., State Trait Anxiety Questionnaire) and has yielded high internal consistency reliabilities of .94 (both men and women), .95 (men only), and .92 (women only). Similarly, test-retest reliability has consistently shown reliability coefficients of .77 to .85 (Snell, Gum, Shuck, Mosley, & Hite, 1995).

Cook-Medley Hostility Scale (Ho). Originally designed to measure teacher-student interactions, the Ho is now part of the greater Minnesota Multiphasic Personality Inventory (MMPI). The Ho is a 50-item true/false questionnaire measuring constructs related to hostility including cynicism, hypersensitivity, distrust of others, and aggressive responding. Higher scores on the Ho are correlated with higher levels of hostility (Cook & Medley, 1954). The Ho has been shown to correlate to cognitive, behavioral and affective measures of hostility and aggression (Pope, Smith, & Rhodewalt, 1990).

Personality and State-Trait/Mood Questionnaires.

Mini IPIP. The Mini-IPIP is a 20-item short form of the 50-item International Personality Item Pool (IPIP), which was developed based on the Big Five trait factor model. For each of the 20 items, the respondent selects the most appropriate response on a 7-point Likert scale with varying degrees of agreement ranging from 1-*Disagree Strongly*, to 7- *Agree Strongly*. Consisting of four questions per factor, the scale has been shown to be a valid and reliable measure of the Big Five factors of personality (neuroticism, extraversion, intellect/imagination, agreeableness, and conscientiousness)

with notable internal consistency alphas at or $> .60$ (Donnellan, Oswald, Baird, & Lucas, 2006).

Type D scale (DS¹⁴). Consisting of 14 items, this scale is a brief, psychometrically sound measure of negative affect (NA) and social inhibition (SI), which comprise the type D or “distressed” personality construct. Participants respond to each of the items using a 5-point Likert scale (0 to 4) with anchors of *false, rather false, neutral, rather true* and *true*. Internal consistency alphas for the NA and SI subscales of the DS14 are .88 and .86 respectively. Additionally, test-retest coefficients for the subscales are .72 and .82 (Denollet, 2005). The scale has been successfully used to identify individuals with type D personality, which has been shown to be related to negative physical and mental health outcomes (Denollet, 2005; Grande, Romppel, Glaesmer, Petrowski, & Herrmann-Lingen, 2010).

BIS/BAS scales. The behavioral inhibition scale (BIS) and behavioral activation scales (BAS), developed by Carver and White (1994), are comprised of 20 questions spanning four domains: BIS, BAS reward responsiveness, BAS drive, and BAS fun seeking. The BIS scale has seven items that measure sensitivity to withdrawal behavior and expectations of punishment; while the BAS scales, with a total of 13 items measure anticipation of reward, motivation toward desired goals, and desire to approach novel situations with expectation of reward. Participants respond to each item using a 4-point Likert scale, with a score of 1 indicating “Strongly Agree” to a score of 4 indicating “Strongly Disagree” (Carver & White, 1994; Peterson, Gable, & Harmon-Jones, 2008). Carver and White’s (1994) research has shown reliabilities for the varying scales ranging from 0.66 to 0.76. Furthermore, psychometric evaluation of the scales has

shown efficacy within clinical populations (e.g., anxiety and depression), suggesting strong relationships of BIS to both anxiety and depression; however more support suggested a strong association of BIS/BAS to relevant personality constructs, such as neuroticism (BIS) and positive affect (BAS; Campbell-Sills, Liverant, & Brown, 2004). For the purposes of this study, the BAS scales were considered individually as well as a single scale. BIS was used as its original single scale.

State-Trait Anxiety Inventory (STAI). The STAI will be used to measure levels of anxiety in the pool of participants. Due to the documented effects of high levels of anxiety on emotionally laden Stroop tasks (Mogg, Mathews, & Weinman, 1989), it is crucial for assessment and data analysis in order to rule out and control for possible confounding effects. The STAI Form-Y is a 40-item questionnaire that assesses both trait and state anxiety. Utilizing a 4-point rating Scale (e.g., Almost Never to Almost Always), the STAI has documented internal consistency alphas between .86 to .95 and test-retest coefficients between .65 and .75, for a two-month period (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

Experimental Word Stimuli

Experimental word stimuli (see appendix C) were those previously evaluated and used in a valenced lexical decision making task by Kousta, Vinson, and Vigliocco (2009). The 120 experimental stimulus words represented three affective categories (40 positive, 40 negative, and 40 neutral) and were matched in terms of arousal, with both positive and negative words being significantly more arousing than neutral words. Each word selected for the word lists was based on valence and arousal norms following the procedure in the Affective Norms for English Words (ANEW) database (Bradley & Lang,

2009). Additional factors accounted for included concreteness, image ability, age of acquisition, orthographic neighborhood, and familiarity of the word in accordance to available data in the English Lexicon Project (Balota et al., 2007).

Emotional Stroop Task

The emotional Stroop task was composed of a total of three blocks, which were comprised of a practice phase (one block) and a test phase (two blocks). Each block began with a fixation cross presented at the middle of the screen for 700 ms, followed by the presentation of a single word for 2000 ms. Participants were instructed to respond quickly and accurately to the presented word stimuli (see appendix K) using a four-button keypad. The objective was to press the designated button (one of four color options from left to right; red, yellow, green, and blue) corresponding to the color each target word was written.

The practice phase was used to orient the participant to the task. Each participant was provided a visual guide showing the four buttons (from left to right on the keypad) and the corresponding colors; red (1), yellow (2), green (3), and blue (4). During the practice phase the participants were presented with ten practice items consisting of only neutral words. Each participant received the practice block until 90% accuracy was achieved (9 of 10 correct responses). Following the practice phase, participants were informed that they were about to begin the testing phase and were reminded of task's objective and instructions for using the keypad via a standardized script (see appendix D).

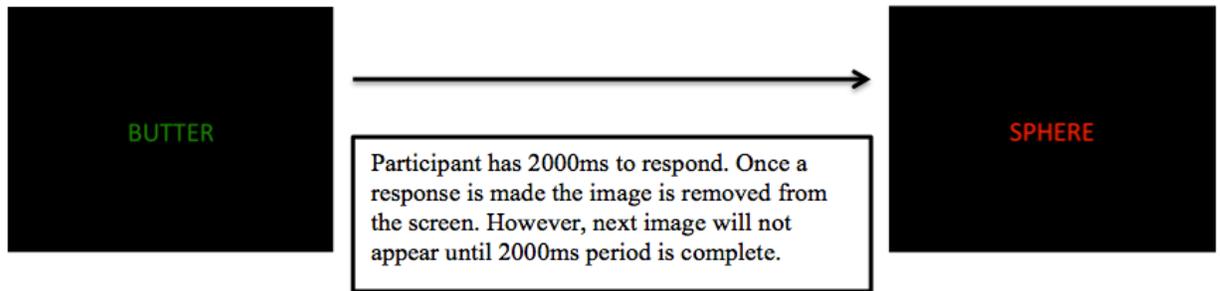


Figure 2. Practice Phase

During the testing phase, participants encountered two blocks of the previously described emotional Stroop task. Testing blocks were created by pseudorandomly ordering positively valenced words (e.g., Peach, Joy, Cash, and Joke) or negatively emotionally valenced target words (e.g., Murder, Hell, Gun, and Pain) among a majority of oppositely valenced words (also known as the “frequent” stimuli). Blocks utilized each of the word stimuli for the frequent trials a total of four times to represent each color (Red, Yellow, Green, and Blue), resulting in the use of 160 words (40 words in each of the four colors). Words were assigned a position via a random number generator using the designated range of 1-160 without replacement. Next, 24 target words or rare stimuli (15 percent of the stimuli) were selected via and interspersed within the frequent stimuli. For this, an odd number from the number set of 1-11 was randomly generated (using a random number generator) and used as the number of frequent words seen before the presentation of a target word. For instance, if the odd number were the number three, then there would be three frequent words presented before the presentation of the target word. Consequently, due to the size of the program and limitations with the

software, 24 frequent words had to randomly be selected and removed prior to the insertion of the target words.

Participants were instructed to quickly and accurately press a button corresponding to the color of each word regardless of valence. Further, the order of the blocks was counterbalanced to control for potential order effects that may occur as a result of valence. For the first block, group one received the positively valenced target word condition, immediately followed by the negatively valenced target word sequence in the second block. Group 2 received the conditions in the opposite order (negative target word stimuli in the first block; positive target word stimuli in the second block). During any one block, 240 words were presented in a random order and color. Over the duration of the two blocks, each word would have been presented in each of the four colors at least once.

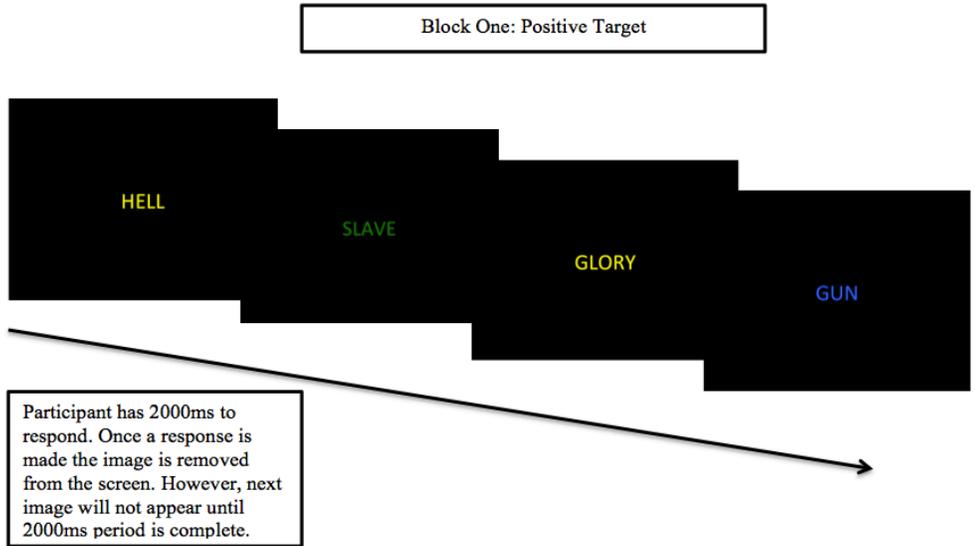


Figure 4. Test Phase: Block One

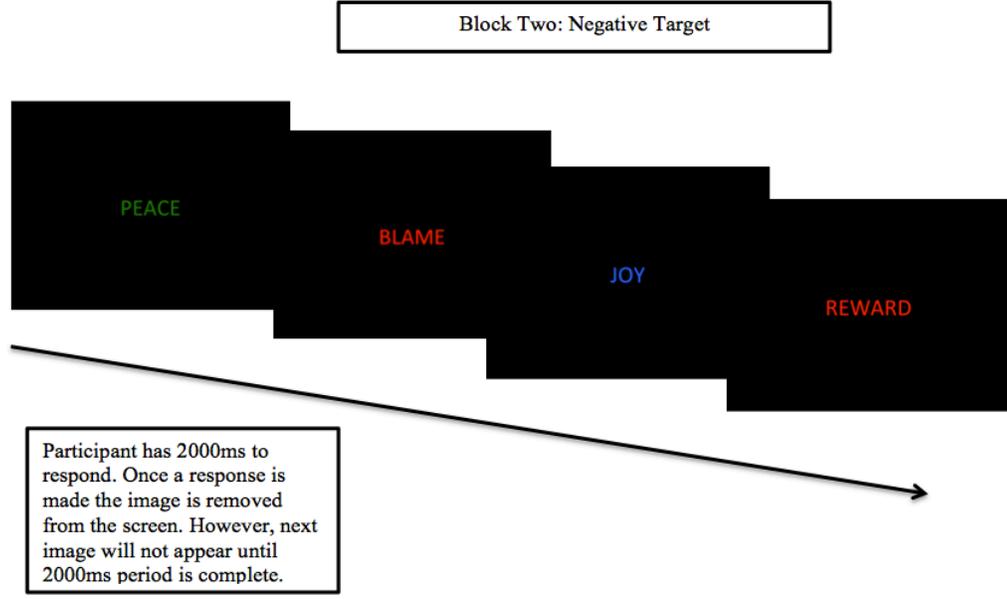


Figure 5. Test Phase: Block Two

Electroencephalogram (EEG) Recording

EEG recording of cortical electrical activity was captured using Ag/AgCl - sintered electrodes mounted in an elastic Quik-Cap (Compumedics Neuroscan; Herndon, VA) at 32 scalp sites using the international 10/20 placement system (Fp1, Fp2, F7, F8, F3, F4, FT7, FT8, FT9, FT10, T3, T4, FC3, FC4, C3, C4, CP3, CP4, TP7, TP8, T5, T6, P3, P4, O1, O2, Fz, FCz, Cz, CPz, Pz, Oz) including ground references linked to the ears (A1- A2/2). To achieve a baseline cortical measure, participants were instructed to sustain eight alternating one-minute intervals in which they were asked to maintain their eyes open (O) or eyes closed (C) in alternating intervals (O, C, O, C, O, C, O, C) as adapted from Harmon-Jones and Allen (1998). For the current study, frontal asymmetry data were collected from comfortably-seated participants during eight one-minute eyes open and eyes closed phases. During these phases, participants were asked to relax and sit still facing forward. As the phase name suggests, eyes were either open or closed during these one minute durations. These phases alternated as follows: eyes open (EO1), eyes closed (EC1), eyes open (EO2), eyes closed (EC2), eyes open (EO3), eyes closed (EC 3), eyes open (EO4), and eyes closed (EC4) as adapted from Harmon-Jones and Allen (1998).

Procedures

Each participant was recruited via East Carolina University's psychology undergraduate research pool. All study procedures took place in the Cognitive Neuroscience Laboratory located within the Department of Psychology. Prior to engaging in the study, each participant independently read and reviewed an informed consent document approved by the University and Medical Center Institutional Review

Board (see appendix A). Once consent was established and the documents signed, each participant was administered a battery of self-report measures including a brief demographic record form (see appendix B) and a series of personality and behavioral measures. The demographic record form addressed such areas as age, handedness, brief physical and mental health history, and lifestyle behaviors (smoking and exercise frequencies), meanwhile personality and behavioral surveys noted in the aforementioned section addressed their respective domains

Preparation for the EEG recording involved connecting each participant to the neuroscan EEG system with the elastic Quick-Cap and a conductive gel. Once connected, initial task instructions were provided in order to allow for a brief period to acclimate to the wearing of the EEG cap. The EEG baseline recording and participation in the practice test phase blocks of the modified Stroop task then followed. Finally, after the completion of the surveys and tasks accompanying the EEG recording, participants were debriefed and any questions posed by the participant were clarified.

Analyses

Hypothesis one. Correlational analyses were performed to investigate relationships among negative personality measures (i.e., BIS and neuroticism) and measures of hostility, anger, and aggression (AHA!). These correlational analyses were used to investigate the hypothesis that higher self-reported BIS and neuroticism would be associated with AHA!. Additionally, a regression model exploring the predictive utility of the aforementioned negative personality traits and AHA! in classifying individuals with Type D behavior pattern was employed.

Hypothesis two. To investigate the P300 ERP components as it relates to information processing of positive and negative word presentation this study employed

a within subject repeated measure ANCOVA with factors of affective valence of the stimulus word (positive and negative) and Fz scalp site amplitude measured in μV , using self-reported anger, hostility, and aggression as covariates.

Hypothesis three. Correlational analyses were utilized in an attempt to replicate findings from past research examining the relationship between resting asymmetry and the BIS/BAS Scale. Additional correlational analyses investigated inter-correlations within the measures of AHA! and BIS/BAS, and the relationships among each of these measures with each other and resting asymmetry. Resting asymmetry scores were calculated (R-L) for alpha power (8-12 Hz) across four electrode pairings (i.e., FP21, F87, F43, and FT87). The relationships between the resting asymmetry scores and the scores obtained on BIS/BAS and AHA! self-report measures were subsequently examined.

Hypothesis four. Interference or attentional bias, as measured via reaction time on the emotional Stroop task, was analyzed using a within subject repeated measures ANCOVA design with factors of affect (positive and negative) and recorded reaction time, using self-reported anger, hostility, and aggression as covariates.

CHAPTER IV: RESULTS

Statistical analyses were conducted using SAS JMP 10.0 statistical software package (SAS Institute Inc.; Cary, NC). Raw data were inspected for missing data and normality. As a result, each hypothesis will indicate sample size relevant to the variables being analyzed accounting for missing data. Of the 91 participants in the study, 51 were women and 40 were men (44%). The mean age was 20.2 years.

Hypothesis One: Relationships Between Negative Personality Traits, Anger, Hostility, Aggression And Type D Behavior Pattern

In order to determine relationships among negative personality traits and measures of anger (A), hostility (H), verbal aggression (VA), and physical aggression (PA), correlational analyses were performed. The personality traits of neuroticism (N) (subscale from the Mini IPIP) and behavioral inhibition (BIS subscale from the BIS/BAS scales) were selected as negative traits due to their noted associations with high levels of negative trait affect. Data from seven participants were removed from analyses due to handedness, leaving an *N* of 84. All participants fully completed the surveys resulting in no missing data for these analyses. Basic descriptive statistics and zero-order correlation coefficients between neuroticism, anger, hostility, verbal aggression, physical aggression, and BIS are presented in Table 1.

Table 1
Zero-Order Correlations and Simple Descriptive Statistics (N = 84)

	Zero-Order <i>r</i>					
	N	H	A	VA	PA	BIS
H	.351**					
A	.522****	.558****				
VA	.240*	.418****	.635****			
PA	.252*	.248*	.609****	.558****		
BIS	.314**	.251*	.051	-.117	-.235*	
<i>M</i>	13.18	20.54	16.63	15.05	22.77	18.29
<i>SD</i>	4.86	6.41	6.39	4.40	8.63	2.57

Note: * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Note. N = Neuroticism, A = Anger, H = Hostility, VA = Verbal Aggression, PA = Physical Aggression, and BIS = Behavioral Inhibition System Total.

Self-reported Neuroticism scores ($M = 13.18$, $SD = 4.86$) were significantly positively correlated with BIS ($M = 18.29$, $SD = 2.57$), $r = .314$, $n = 84$, $p = .004$, 95% CI [0.106, 0.495], anger ($M = 16.63$, $SD = 6.39$), $r = .522$, $n = 84$, $p < .0001$, 95% CI [0.346, 0.662], hostility ($M = 20.54$, $SD = 6.41$), $r = .351$, $n = 84$, $p = .001$, 95% CI [0.147, 0.526], verbal aggression, ($M = 15.05$, $SD = 4.40$), $r = .240$, $n = 84$, $p = .03$, 95% CI [0.027, 0.432], and physical aggression ($M = 22.77$, $SD = 8.63$), $r = .252$, $n = 84$, $p = .03$, 95% CI [0.040, 0.443]. These findings suggest that persons with high levels of neuroticism are likely to experience increased anger and hostility, which may increase their likelihood to engage in verbal or physical aggression. In contrast, BIS scores were significantly negatively correlated with physical aggression, $r = -.235$, $n = 84$, $p = .03$, 95% CI [-0.428, -0.021], suggesting that individuals experiencing increased levels of behavioral inhibition may be less likely to engage any form of physical aggression.

Significant positive correlations were also found between anger and all other Buss-Perry Anger Questionnaire subscales including, hostility ($r = .558$, $n = 84$, $p < .0001$), verbal aggression ($r = .635$, $n = 84$, $p < .0001$), and physical aggression ($r = .609$, $n = 84$, $p < .0001$). Similarly, hostility was also significantly positively correlated with verbal aggression ($r = .418$, $p < .0001$) and physical aggression ($r = .248$, $n = 84$, $p = .03$). Meanwhile, as expected verbal and physical forms of aggression were significantly and positively correlated ($r = .558$, $n = 84$, $p < .0001$). These findings suggest that despite increased negative or hostile thoughts around a situation (cognitive component) being associated with increased verbal and physical aggression, the emotional experience of anger appears to have a much stronger relationship and perhaps a driving force in the occurrence of aggressive behaviors.

Predicting Type D Behavior Pattern. Logistic regression was conducted to determine whether the aforementioned negative personality traits and measures of anger, hostility, verbal aggression, and physical aggression significantly predicted whether an individual was likely to be classified as having Type D behavior pattern, which is a risk factor for cardiovascular disease. Scores on each predictor were standardized to allow for comparison across metrics. When all six predictor variables are considered together, they significantly predict whether or not an individual is classified as having Type D behavior pattern, $\chi^2(6, N = 84) = 20.78, p = .002$. The model was able to correctly classify 18% of individuals correctly as having Type D and 88% correctly classified as not having Type D, for an overall success rate of 86%.

Next, a mixed stepwise fit procedure utilizing a p -value threshold of .25 for entrance into the model was employed to improve the model. The new model eliminated physical aggression as a predictor and the reduced model was better statistical fit. As expected, the remaining five predictors in the model significantly predicted whether or not an individual is classified as having Type D behavior pattern, $\chi^2(5, N = 84) = 20.46, p = .001$. The reduced model was able to correctly classify 27% of individuals with Type D behavior pattern and 97% of individuals as not having type D. The overall success rate of the reduced model is 88%.

Table 2 and Table 3 show the logistic regression coefficients, Wald tests, and odds ratios for each of the predictors in the full and reduced models respectively. Employing a .05 criterion of statistical significance, Neuroticism and BIS were the only predictors that had a significant partial effect in the full model, whereas hostility was an additional significant predictor in the reduced model. Using the reduced model, inverting

the odds ratio for Neuroticism indicates that for each one standard deviation increase on the subscale there is a 4.1-increased likelihood that one would have Type D behavior pattern and thus be more vulnerable to potential health risks related to Type D.

Similarly, inverting the odds ratios for hostility revealed a 3.4-increased likelihood of Type D. In contrast, for each one standard deviation increase for self-reported BIS, there was a 2.6-increased chance of not being classified as Type D. This finding is somewhat unexpected due to the modest significant positive correlation among BIS and both Neuroticism and Hostility.

Table 2
Full Model Predicting Type D from Negative Personality Traits

Predictor	<i>B</i>	Wald X^2	<i>p</i>	Odds Ratio
Neuroticism	1.462	5.240	.022	4.31
Anger	0.907	1.627	.202	2.48
Hostility	1.132	3.375	.066	3.10
Verbal Aggression	- 1.153	2.264	.132	0.32
Physical Aggression	- 0.285	0.314	.575	0.75
BIS	- 1.025	4.520	.034	0.36

Table 3
Reduced Model for Predicting Type D from Negative Personality Traits

Predictor	<i>B</i>	Wald X^2	<i>p</i>	Odds Ratio
Neuroticism	1.418	5.131	.024	4.13
Anger	0.738	1.330	.249	2.09
Hostility	1.210	4.101	.043	3.35
Verbal Aggression	- 1.174	2.418	.122	0.31
BIS	- 0.960	4.382	.036	0.38

Univariate analyses were conducted to examine differences in scores across measures based on Type D behavior pattern classification (those with Type D and those without Type D). Independent samples t-test indicated that individuals classified as having Type D behavior pattern were significantly more neurotic ($M = 17.46$, $SD =$

4.87) than those without Type D behavior pattern ($M = 12.53$, $SD = 4.55$), $t(82) = 3.31$, $p < .0014$, $d = 1.08$. Further, individuals with Type D behavior pattern also reported significantly more anger ($M = 21.91$, $SD = 5.67$) and hostility ($M = 24.73$, $SD = 4.54$) than those without Type D behavior pattern $M = 15.84$, $SD = 6.14$, $t(82) = 3.09$, $p = .003$, $d = 1.01$; $M = 19.90$, $SD = 6.44$, $t(82) = 2.39$, $p = .019$, $d = .78$, respectively. However, BIS was not significantly different between groups.

Hypothesis Two: P300 Amplitude And AHA!

Event related potential (ERP) P300 amplitudes (μV) were captured for each participant at the Fz scalp site. ERPs were averaged for both the positive target and negative target word stimuli conditions. Participants were counterbalanced into two groups, both of whom were presented two opposing target conditions. Group One ($N = 25$) received the positive target condition first, in which they were presented a series of negatively valenced words with positively valenced words randomly interspersed. Group Two ($N = 31$) was presented the negative target condition first, consisting of a series of positively valenced words with sporadic negatively valenced words presented throughout the duration of the trial. Due to artifact and left-handedness, data for 31 participants were excluded from these analyses leaving a sample size of 56 participants.

A repeated measures multivariate-approach mixed factorial ANCOVA (2 groups x 2 target conditions) indicated that the effect of primary interest, P300 amplitude at the Fz scalp site in response to target condition, failed to show a significant interaction between groups and target condition, $F(1, 50) = 1.027$, $p = .389$ (see Figure 1), nor were the effects of target condition (positive target or negative target), $F(1, 50) = .750$, p

= .389, and group, $F(1, 50) = .629, p = .432$, significant. Although, no significant interactions were indicated for any covariate with target condition as per the omnibus within subjects analysis, $F(5, 50) = 1.305, p = .277$, it is worth noting that the interactions between target condition and self-reported anger, and the interaction of target condition and verbal aggression both fell just short of significance, $F(1, 50) = 3.971, p = .052$, and $F(1, 50) = 3.593, p = .064$.

The same statistical procedure was utilized to examine P300 latencies in response to target condition. The interaction between groups and target condition fell short of significance, $F(1, 50) = 3.188, p = .080$ (see Figure 2), as did the effects of target condition, $F(1, 50) = 3.627, p = .063$. Between subjects examination of group was also not significant, $F(1, 50) = .256, p = .616$. A single significant interaction was found between target condition P300 latencies and self-reported verbal aggression, $F(1, 50) = 4.143, p = .047$. The omnibus within subjects test of interactions fell short of significance, $F(5, 50) = .2080, p = .084$. Interestingly, a closer look at the univariate analyses of variance, when applying the conservative Bonferroni adjusted alpha of .0125 per test ($.05/4$) to control for familywise error, showed that the target, $F(1, 50) = 3.627, p = .063$ and interaction between target and verbal aggression fell short of statistical significance, $F(1, 50) = 4.143, p = .047$. When considering both P300 amplitude and latencies, these findings do not provide support to the hypothesis that P300 amplitudes are greater in response to negatively (or positively) valenced word stimuli. Figure 3 and figure 4 show the entire ERP image in response to positive and negative target word stimuli.

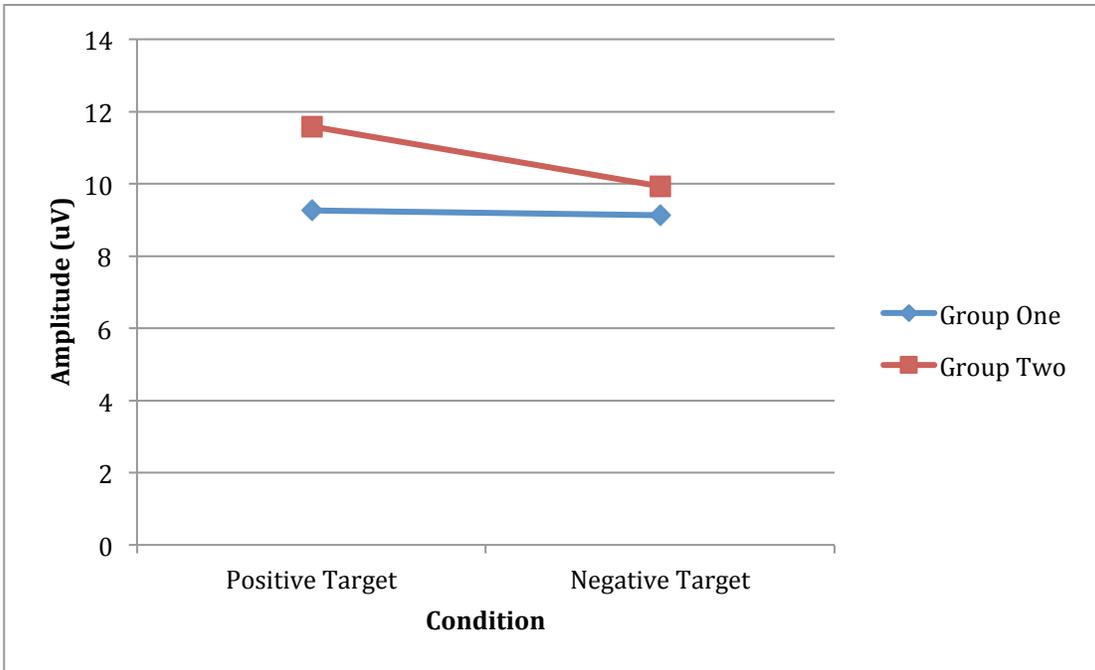


Figure 6. P300 Average Amplitude for Group One and Group Two at the Fz Scalp Site for each target condition

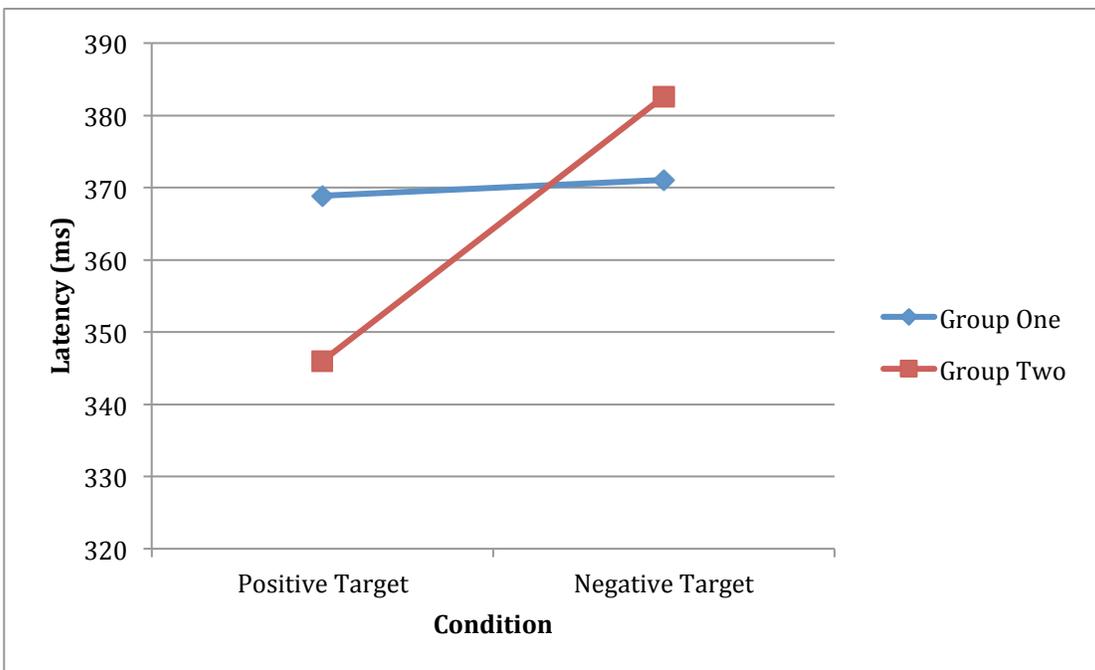


Figure 7. P300 Average Latencies for Group One and Group Two at the Fz Scalp Site for each target condition.

Figure 8. Positive Target ERP Grand Average at Electrode Fz

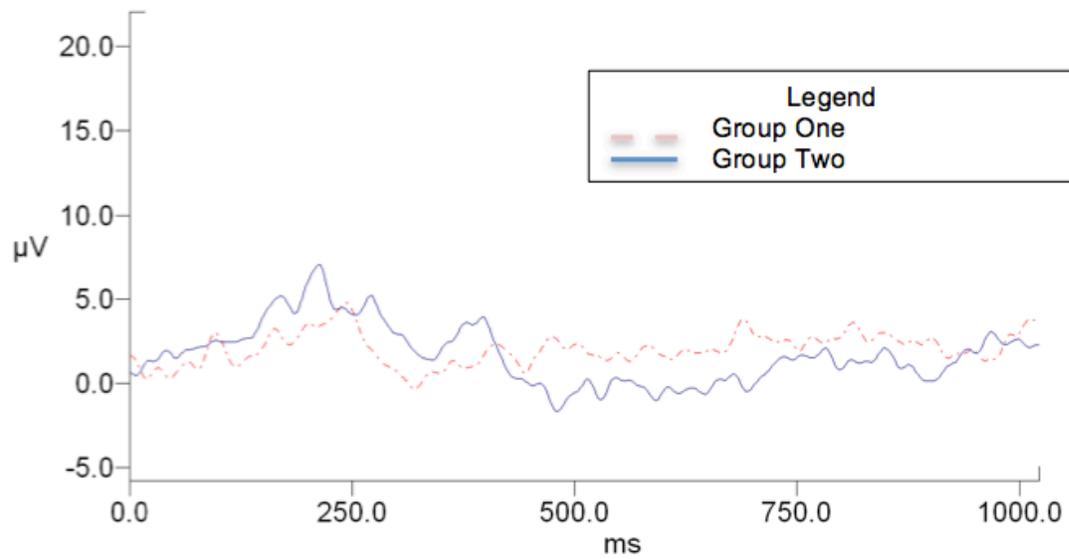
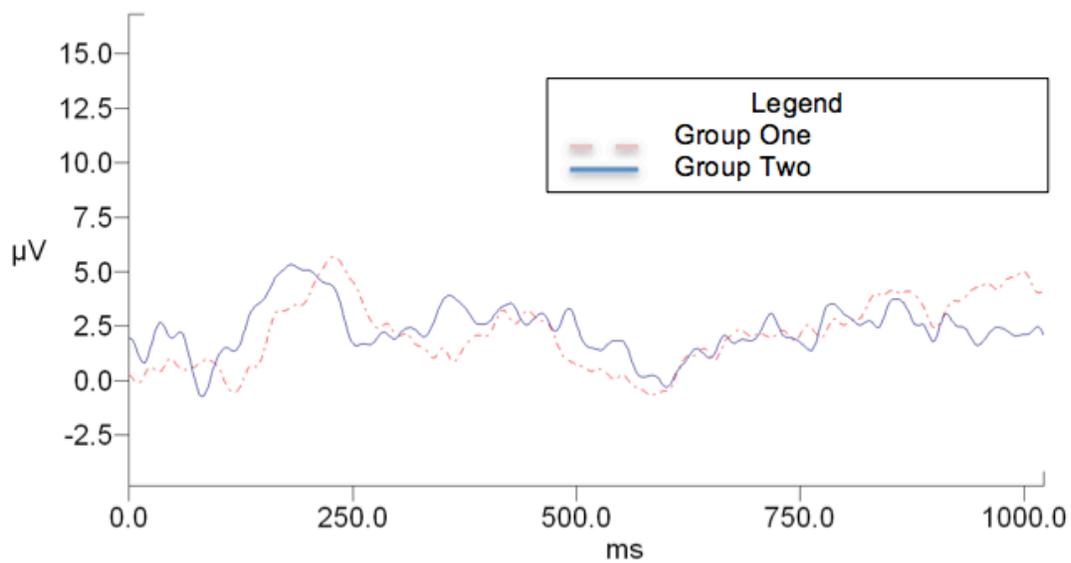


Figure 9. Negative Target ERP Grand Average at Electrode Fz



Hypothesis Three: Relationships Among AHA!, BIS/BAS, And Resting Asymmetry

Complete data were available for 36 participants. Data for 51 participants were excluded for correlational analyses due to baseline asymmetry artifact. An additional five participants were removed as a result of handedness. Results for evaluation of assumptions of normality indicated a positively skewed leptokurtic distribution of resting frontal asymmetry activity, which was corrected with natural logarithmic transformations.

Frontal asymmetry scores were calculated for overall alpha power (8-12 Hz) by subtracting left alpha power scores from right alpha power scores at frontal electrode pairs (e.g., $\ln[\text{alpha power at F4 electrode}] - \ln[\text{alpha power at F3 electrode}]$, creating the F43 asymmetry score). The asymmetry score is thought to represent increased brain activity with negative scores suggesting greater relative right hemisphere EEG activity and positive scores suggesting greater relative left activity (Davidson, 1988).

AHA! Inter-correlations. Directional correlation analyses were performed in order to determine the relationships, if any, among AHA! subscales of the Buss-Perry Aggression Questionnaire, BIS/BAS subscales, and resting asymmetry for frontal electrode pair sites (FP21, F87, F43, and FT87). Table 4 provides basic descriptive statistics and zero-order correlation coefficients between the BIS/BAS subscales and AHA! subscales. All subscales of the Buss-Perry Aggression Questionnaire were inter-correlated with one another. Self-reported Anger ($M = 14.92$, $SD = 5.51$) was significantly and positively correlated with self-reported Hostility ($M = 19.22$, $SD = 5.79$), $r = .635$, $n = 36$, $p < .0001$, 95% CI [0.387, 0.797], Verbal Aggression ($M = 13.56$, $SD = 4.31$), $r = .758$, $n = 36$, $p < .0001$, 95% CI [0.572, 0.870], and Physical Aggression ($M = 20.83$, $SD = 7.71$), $r = .507$, $n = 36$, $p = .0010$, 95% CI [0.215, 0.717]. Self-reported

Hostility was significantly and positively correlated with Verbal Aggression, $r = .520$, $n = 36$, $p = .0004$, 95% CI [0.231, 0.725]. Further, Verbal and Physical Aggression subscale scores were also correlated with one another, $r = .573$, $n = 36$, $p = .0003$, 95% CI [0.301, 0.759]. The relationships noted among these variables highlight the related underpinnings for these typically associated constructs, but also show the interdependent nature of the often negatively perceived underlying cognitive pattern (hostility), emotional state (anger), and behavior (verbal and physical aggression).

BIS/BAS Inter-correlations. Examination of the correlations among the BIS/BAS subscales found that several individual subscales were correlated. Self-reported scores of the BAS-Drive (BAS-D) subscale ($M = 11.92$, $SD = 2.39$) were significantly and positively correlated with BAS-Fun Seeking ($M = 12.86$, $SD = 1.97$), $r = .409$, $n = 36$, $p = .013$, 95% CI [0.092, 0.650], BAS-Reward Responsiveness (BAS-RR) subscale ($M = 18.42$, $SD = 1.90$), $r = .390$, $n = 36$, $p = .019$, 95% CI [0.071, 0.637] and BAS-Total (BAS-TOT) scale ($M = 43.19$, $SD = 4.79$), $r = .824$, $n = 4$, $p < .0001$, 95% CI [0.680, 0.907]. Self-reported BAS-FS was also significantly and positively correlated with the BAS-TOT scale, $r = .735$, $n = 36$, $p < .0001$, 95% CI [0.536, 0.857]. Meanwhile, BAS-RR was significantly and positively correlated with BAS-TOT, $r = .716$, $n = 36$, $p < .0001$, 95% CI [0.506, 0.845]. These findings lend support to the hypothesized unitary motivational or approach-related construct underlying the behavioral activation system. Individuals reporting increased behavioral activation were likely to report so for items related to all BAS subscales.

AHA! and BIS/BAS Relationships. Significant correlations were also noted among the various AHA! and the BIS/BAS subscales. Specifically, self-reported Anger

was significantly and positively correlated with BAS-D subscale, $r = .405$, $n = 36$, $p = .014$, 95% CI [0.088, 0.647]. In contrast, self-reported Behavioral Inhibition (BIS) was significantly and negatively correlated with Verbal Aggression, $r = -.347$, $n = 36$, $p = .038$, 95% CI [-0.606, -0.202], and Physical Aggression, $r = -.531$, $n = 36$, $p = .0009$, 95% CI [-0.732, -0.246]. These relationships provide evidence to suggest the emotional state of Anger, although frequently perceived as negative, may be a driving or motivational experience that aids in obtaining goals. These findings lend support to the hypothesis that persons reporting higher amounts of inhibition, as captured by the BIS subscale, are less likely to report engaging in either verbal or physical aggression, thus highlighting those characteristics of BIS associated with inhibition and behavioral withdraw.

Table 4
Zero-Order Correlations and Simple Descriptive Statistics for Overall Sample
(N = 36)

	Zero-Order Correlations							
	A	H	VA	PA	BIS	BAS-D	BAS-FS	BAS-RR
H	.635****							
VA	.758****	.520***						
PA	.507**	.319	.573****					
BIS	-.307	.060	-.347*	-.531***				
BAS-D	.405*	.111	.290	.143	.097			
BAS-FS	.317	.070	.114	-.022	.001	.409***		
BAS-RR	-.021	-.063	-.078	.100	.239	.390*	.297	
BAS-TOT	.325	.059	.161	.102	.144	.824****	.735****	.716****
<i>M</i>	14.92	19.22	13.56	20.83	18.22	11.92	12.86	18.42
<i>SD</i>	5.51	5.79	4.31	7.71	2.31	2.39	1.97	1.90

* $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Note. A = Anger, H = Hostility, VA = Verbal Aggression, PA = Physical Aggression, BIS = Behavioral Inhibition System Total, BAS-TOT = Behavioral Activation System Total, BAS-RR = Behavioral Activation System Reward Responsiveness, BAS-D = Behavioral Activation System Drive, BAS-FS = Behavioral Activation System Fun Seeking.

AHA!, BIS/BAS, and resting asymmetry. Table 5 and Table 6 provide basic descriptive statistics and zero-order correlation coefficients for alpha asymmetry scores, BIS/BAS subscales, and AHA! subscales for averaged eyes open and eyes closed conditions respectively. Correlational analyses examining the relationships among self-reported AHA!, BIS/BAS, and resting asymmetry for the eyes open condition found significant and positive correlations between EO_F87 ($M = .3344$, $SD = .3706$) and Anger, $r = .414$, $n = 36$, $p = .012$, 95% CI [0.099, 0.654], and between EO_F87 and BAS-FS, $r = .409$, $n = 36$, $p = .013$, 95% CI [0.093, 0.650]. A relationship was also noted for EO_F43 ($M = .0839$, $SD = .1479$) and BAS-FS, $r = .487$, $n = 36$, $p = .003$, 95% CI [0.188, 0.703]. There were also identified significant positive correlations among several of the electrode pair sites, including EO_FP21 ($M = .0949$, $SD = .1355$) and EO_F87, $r = .421$, $n = 36$, $p = .011$, 95% CI [0.108, 0.659], and EO_F43, $r = .355$, $n = 36$, $p = .034$, 95% CI [0.030, 0.612]. Additionally, EO_F87 was significantly and positively correlated with EO_F43, $r = .756$, $n = 36$, $p < .0001$, 95% CI [0.569, 0.869], and EO_FT87 ($M = .3414$, $SD = .3890$), $r = .680$, $n = 36$, $p < .0001$, 95% CI [0.452, 0.824].

Additional correlational analyses examining the relationships among self-reported AHA!, BIS/BAS, and resting asymmetry for the eyes closed condition identified significant and positive correlations between EC_F87 ($M = .4409$, $SD = .4200$) and Anger, $r = .438$, $n = 36$, $p = .008$, 95% CI [0.128, 0.670], and between EC_F87 and BAS-FS, $r = .403$, $n = 36$, $p = .015$, 95% CI [0.085, 0.646]. EC_F87 was also found to have a significant and negative relationship with self-reported BIS, $r = -.334$, $n = 36$, $p = .047$, 95% CI [-0.597, -0.006]. There were only two electrode pair sites found to be

correlated with each other. EC_F87 was significantly and positively correlated with EC_FT87 ($M = .4464$, $SD = .4204$), $r = .829$, $n = 36$, $p < .0001$, 95% CI [0.688, 0.910].

Table 5
*Zero-Order Correlations and Simple Descriptive Statistics
for Eyes Open Condition, Sample (N = 36)*

Zero-Order Correlations				
	EO_FP21	EO_F87	EO_F43	EO_FT87
EO_F87	.421*			
EO_F43	.355	.756****		
EO_FT87	.233	.680****	.453**	
A	.248	.414*	.270	.203
H	-.056	.190	.061	.196
VA	.125	.154	-.036	-.087
PA	.131	.116	.074	-.089
BIS	-.177	-.290	-.129	.096
BAS-D	.102	.076	.016	.064
BAS-FS	-.011	.409*	.487**	.221
BAS-RR	-.009	.023	.039	.183
BAS-TOT	.043	.216	.224	.196
<i>M</i>	0.0949	0.3344	0.0839	0.3414
<i>SD</i>	0.1355	0.3706	0.1479	0.3890

* $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Note. A = Anger, H = Hostility, VA = Verbal Aggression, PA = Physical Aggression, BIS = Behavioral Inhibition System Total, BAS-TOT = Behavioral Activation System Total, BAS-RR = Behavioral Activation System Reward Responsiveness, BAS-D = Behavioral Activation System Drive, BAS-FS = Behavioral Activation System Fun Seeking, EO_FP21 = alpha asymmetry score for averaged eyes open condition at electrode site FP21, EO_F87 = alpha asymmetry score for averaged eyes open condition at electrode site F87, EO_F43 = alpha asymmetry score for averaged eyes open condition at electrode site F43, EO_FT87 = alpha asymmetry score for averaged eyes open condition at electrode site FT87.

Table 6
*Zero-Order Correlations and Simple Descriptive Statistics for
 Eyes Closed Condition Sample, (N = 36)*

Zero-Order Correlations				
	EC_FP21	EC_F87	EC_F43	EC_FT87
EC_F87	.308			
EC_F43	-.089	.063		
EC_FT87	.181	.829****	.153	
A	.257	.438**	-.225	.258
H	-.128	.207	-.128	.171
VA	.337*	.272	-.074	.062
PA	.227	.138	-.074	.001
BIS	-.222	-.334*	.077	-.114
BAS-D	.278	.176	-.087	.088
BAS-FS	-.043	.403**	-.087	.230
BAS-RR	.092	.024	-.076	.022
BAS-TOT	.158	.264	-.109	.147
<i>M</i>	0.1048	0.4409	0.0812	0.4464
<i>SD</i>	0.1336	0.4200	0.1866	0.4204

* $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Note. A = Anger, H = Hostility, VA = Verbal Aggression, PA = Physical Aggression, BIS = Behavioral Inhibition System Total, BAS-TOT = Behavioral Activation System Total, BAS-RR = Behavioral Activation System Reward Responsiveness, BAS-D = Behavioral Activation System Drive, BAS-FS = Behavioral Activation System Fun Seeking, EO_FP21 = alpha asymmetry score for averaged eyes open condition at electrode site FP21, EO_F87 = alpha asymmetry score for averaged eyes open condition at electrode site F87, EO_F43 = alpha asymmetry score for averaged eyes open condition at electrode site F43, EO_FT87 = alpha asymmetry score for averaged eyes open condition at electrode site FT87.

Hypothesis Four: AHA! and Reaction Times in Response to Affectively Valenced Word Stimuli

In order to investigate the hypothesis of interference (slowing of reaction time) or facilitation (quickenning of reaction time) resulting from an attentional bias to affectively valenced stimuli, participant reaction times during an emotional Stroop task were examined. Average reaction times (ms) were recorded for 86 participants over two block periods. Data from seven participants were excluded from the analyses due to left-handedness, while an additional three were excluded for missing data resulting from software recording errors. Reaction time variables were log transformed to address positive skewness, and these included an overall average of participants' reaction time to all presented stimuli, reaction time for only target stimuli, and reaction time for only non-target stimuli. Additionally, self-reported anger, hostility, verbal aggression, and physical aggression were measured prior to the administration of the first block and were to be covariates.

A repeated measures multivariate-approach mixed factorial ANCOVA (2 Groups x 2 Blocks) indicated that the effect of primary interest (overall reaction time to emotionally valenced stimuli), the interaction between groups and blocks was not significant, $F(1, 75) = .807, p = .372$ (see Figure 1), nor were the effects of block, $F(1, 75) = .638, p = .427$, and group, $F(1, 75) = .669, p = .416$. One significant interaction was found between reaction times on blocks and scores on the scale of Verbal Aggression, $F(1, 75) = 5.507, p = .022$. However, when applying a Bonferroni adjusted alpha of .0125 per test (.05/4) to control for familywise error, this interaction fell short of

significance. This is consistent with the non-significant statistic for the omnibus test of within subjects interactions, $F(5, 75) = 1.315, p = .267$.

In order to further investigate hypothesis four, average reaction time was separated into target only reaction time and non-target only reaction time. Means and standard deviations for reaction times (RT) for each block are presented in Table 7, with Figure 2, and Figure 3 showing reaction times over the two trials for target and non-target stimuli respectively. As with the previous analysis examining overall average reaction times across blocks, a repeated measure multivariate-approach mixed factorial ANOVA was also employed to investigate average target only reaction times. The interaction between groups and blocks was not significant, $F(1, 75) = .837, p = .363$; however, with a Bonferroni adjusted alpha of .0125, there was a significant within subject effect of block, $F(1, 75) = 1649.148, p < .0001$ (see Figure 2). In contrast, the significant effect indicated for the interaction of block and self-reported verbal aggression, $F(1, 75) = 4.965, p = .029$, fell short of statistical significance at the .0125 alpha level. A paired samples t-test was conducted to further examine the significant effect of block by comparing reaction time performance on block one with that of block two for each participant in Group One and Group Two. There was a significant difference in scores between each block in each group. Reaction times for valenced stimuli were faster in the first block than the second for both Group One, $t(39) = -109.287, p < .0001, d = .14$, and Group Two, $t(40) = -133.19, p < .0001, d = .28$. The presence of increased reaction time (slower) in the second block may be an artifact related to participant fatigue. As part of the study methodology, each participant first completed a series of surveys prior to engaging in the practice phase and test phase,

consisting of two block of the emotional Stroop task. Consequently, due to the length of the study procedures it is likely participants would become fatigued, resulting in slower reaction times toward the end of the task.

Examination of the average non-target reaction times by mixed factorial ANCOVA revealed the interaction between groups and blocks was not significant, $F(1, 75) = .738, p = .393$, nor were the effects of trial, $F(1, 75) = .681, p = .412$, and group, $F(1, 75) = .879, p = .352$. As with the examination of the previous of the overall reaction time average reaction time, one significant interaction was found between reaction times on block and scores on the scale of Verbal Aggression, $F(1, 75) = 5.125, p = .027$. However, at a Bonferroni adjusted alpha power of .0125 per, this interaction fell short of significance. This was also consistent with the non-significant statistic for the omnibus test of within subjects interactions, $F(5, 75) = .082, p = .31$. Taken together, the current findings do not suggest interference or facilitation bias for reactions times to valenced word stimuli or an interaction with any of the AHA! covariates.

Table 7

Means and standard deviations for groups' reaction time (ms) for each block

	Group One		Group Two			
	<i>M</i>	<i>SD</i>		<i>M</i>	<i>SD</i>	<i>d</i>
Overall RT Block 1	749.94	146.96		711.82	142.09	.27
Overall RT Block 2	769.33	139.20		747.05	128.64	.17
Target RT Block1	744.04	144.18		720.73	148.28	.16
Target RT Block 2	765.31	158.99		763.12	154.19	.01
Non-Target RT Block 1	750.99	148.55		710.25	142.70	.28
Non-Target RT Block 2	770.04	138.93		744.21	126.28	.20

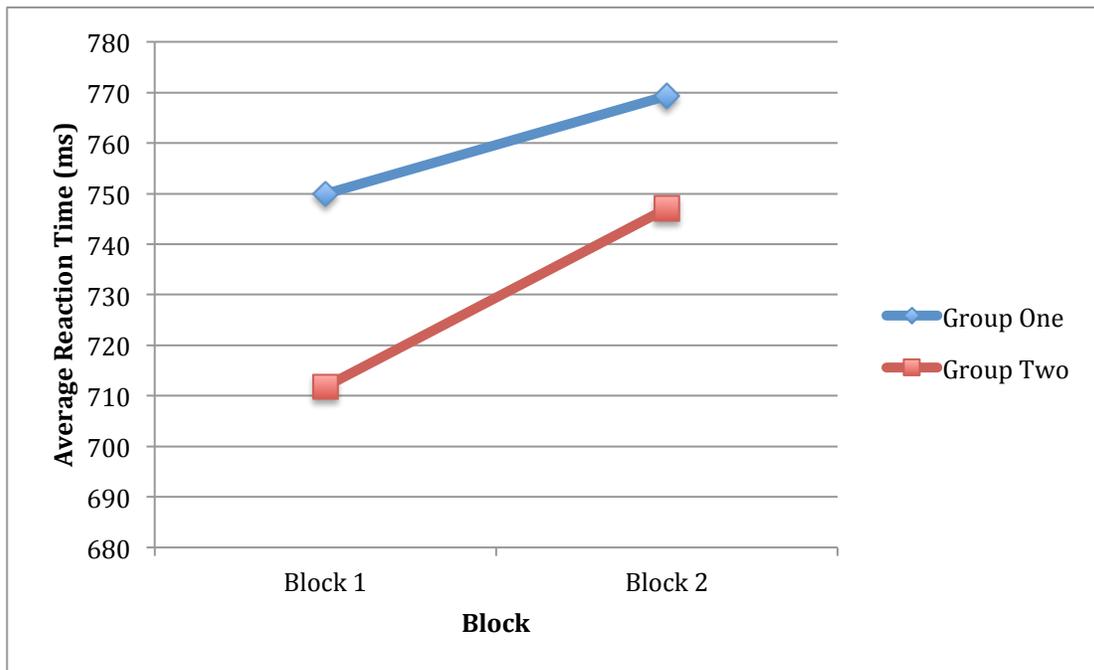


Figure 10: Average overall reaction times by block for each group.

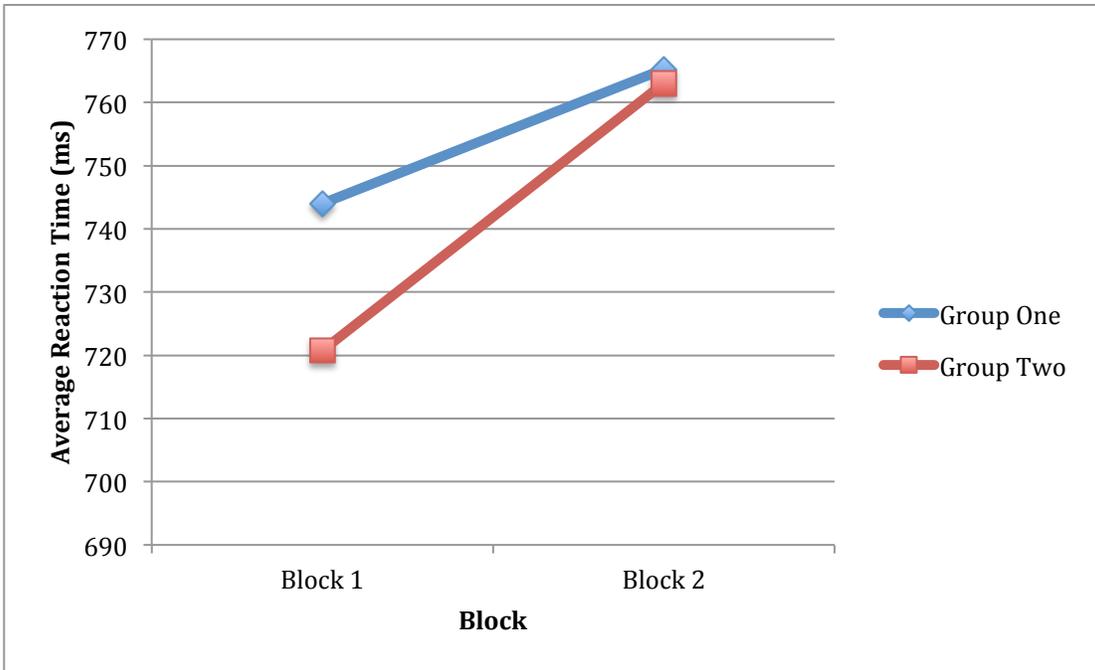


Figure 11: Average target reaction times by block for each group.

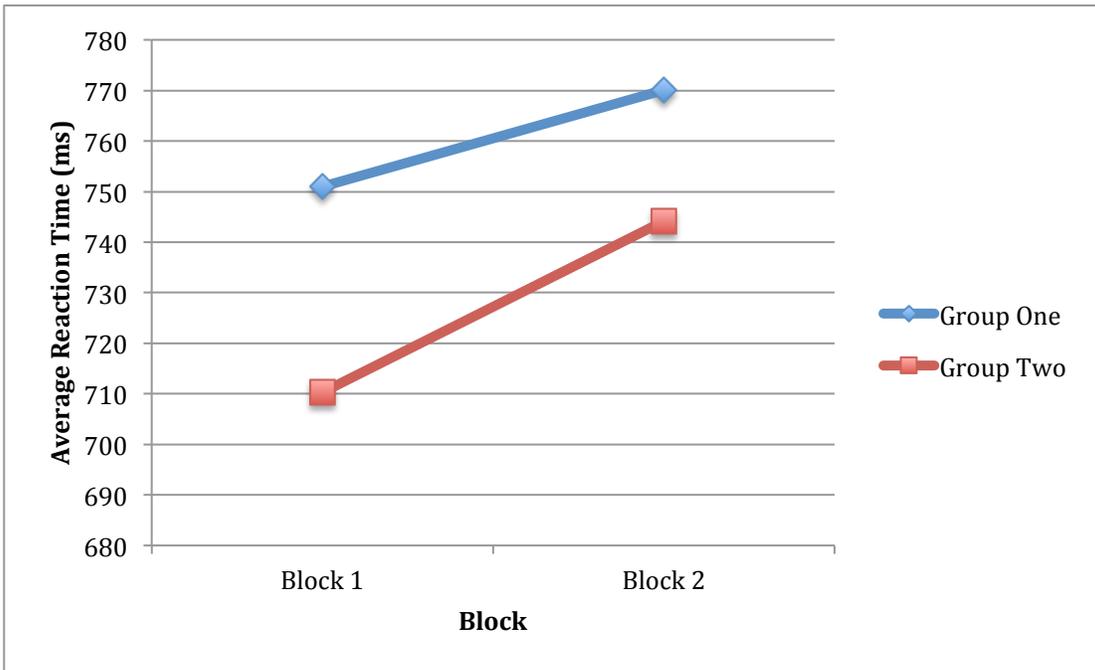


Figure 12: Average non-target reaction times by block for each group.

CHAPTER V: CONCLUSION

Discussion

The purpose of the present study was four-fold: (1) to examine relationships among self-report measures of personality, affect, and behavior; (2) to investigate the P300 ERP component as it relates to information processing of positive and negative word presentation in the present emotional Stroop task; (3) to replicate findings from past research regarding resting asymmetry and the BIS/BAS measures also examining the contributions of trait anger, hostility, and aggression; (4) to investigate interference (or facilitation) associated with attentional bias to affectively valenced stimuli in an emotional Stroop task through examination of reaction times.

Summary of Results and Relevant Implications

Personality and AHA! Despite the wide scope of the current study, each research question and hypothesis narrowed the focus and explored the relationships and roles for which anger, hostility, and aggression are involved in our understanding of health and neuropsychological processing. The main findings of hypothesis one highlighted the relationships among self-reported measures of negative personality traits with AHA!, and the predictive utility in classifying persons with Type D behavior pattern. Self-reported measures of AHA! were all associated with the five factor model's construct of neuroticism. Furthermore, high self-report for the personality traits of neuroticism and BIS were the most predictive in the classification of individuals with type D behavioral pattern.

Neuroticism is often described as a chronic tendency to remain in a negative emotional state or a behavioral tendency to respond with negative emotions to a variety

of situations, most notably to threat, frustration, or loss (Lahey, 2009). This may include such behavioral and emotional manifestations as irritability, anger, sadness, worry, or hostility. Among all the variables, the strongest relationships with neuroticism were indicated for self-reported anger, hostility, and BIS. These relationships seemingly emphasize the negatively valenced cognitive, emotional, and behavioral components underlying the construct of neuroticism.

The literature is replete with research documenting the insidious role negative personality traits and AHA! have on one's health behavior choices and physical health. Specifically, high rates of neuroticism, anger, hostility, aggression, and BIS have been shown to be associated with hypertension, cardiac reactivity, and poor adherence to medical regimens (Smith & Williams, 1992; Voigt et al., 2009; Brondolo et al., 2009; Jackson et al., 2007; Elovainio et al., 2011). Type D behavior pattern was conceptualized as a method to capture those key personality and emotional/affective features previously mentioned that correlate with negative health consequences. While emphasis of type D pattern has been placed on those individuals living with cardiovascular disease, type D behavior pattern may pose as health risk in and of itself to the general population. As such, identifying individuals with type D behavioral pattern may allow professionals to improve quality of life and well-being via preventive behavioral medicine interventions. The current findings add to the body of evidence linking AHA! to negative personality traits and their the potentially negative role in the development of chronic illness.

P300 Amplitudes and Latencies in Relations to AHA!. Contrary to expectations, the current study did not provide support that negatively valenced word

stimuli would result in P300 ERP amplitude enhancement. Previous research by Gray, Ambady, Lowenthal, and Deldin (2004) examined P300 amplitudes and latencies in response to self-relevant autobiographical information (i.e., information related to one's self-concepts). Their findings revealed that P300 amplitudes were significantly augmented when confronted with self-relevant information. In an attempt to further expound upon such findings from previous research, the current study hypothesized that individuals endorsing greater negative affect, specifically related to AHA!, would show enhanced P300 components when confronted with negatively valenced word stimuli. However, the findings of the current study did not support this hypothesis or similar findings established in previous research.

There are several possible explanations for this result. One such explanation pertains to the limited sample size available for the analyses. Approximately 38 percent of the available data were not used for the analyses of the present hypothesis due to EEG artifact. Consequently, the reduced sample ($N = 56$) had limited statistical power for multivariate analyses (especially when utilizing a Bonferroni adjusted alpha in order to control for familywise error). Perhaps if the sample size were larger, many of the results that fell short of statistical significance may have been significant, thus warranting further decomposition and statistical analyses.

Yet another possible explanation for non-significant results may lie in the current study's methodology and design. While previous research reported utilizing specific autobiographical information of each participant to examine the role of selective attention and P300 amplitudes, the current study took a more general approach in its attempts to solicit enhanced P300 amplitudes. For instance, the non-specific negatively

valenced words may not have been particularly self-relevant or specific enough for each participant in the study. Since the variables of interest were that of self-reported AHA!, perhaps the utilization of more specific words relating to anger, hostility, and aggression would have been more relevant to those individuals endorsing greater levels of AHA!, thus eliciting results comparable to those of previous P300 research. Further, the presentation of valenced word stimuli may have been susceptible to priming effects. For the current study target words (whether positively or negatively valenced) were randomly interspersed within a series of oppositely valenced word stimuli in order to elicit a novelty response for when the participant was confronted with the target word. Consequently, this presentation method may have inadvertently influenced the cognitive processing of all word stimuli, resulting in no differences. Nevertheless, these are important issues for consideration in future research.

Resting Asymmetry, BIS/BAS, and AHA! Electroencephalogram studies investigating resting asymmetry to the Reinforcement Sensitivity Theory, via Carver and White's BIS/BAS Scales (1994), have consistently demonstrated a significant positive relationship between motivation for approach related behavior, positive affect, left cortical activity to the BAS scale; whereas, withdraw related behaviors, negative affect, and right frontal cortical activity are noted to be associated with the BIS scale. Results from the current study showed that greater relative left cortical baseline activation was positively related to BAS scores, specifically the BAS-Fun Seeking subscale. BAS-Fun Seeking, which is known to encompass elements of impulsiveness not contained in other BAS subscales, scores were consistently positively correlated with greater relative left hemisphere asymmetry. This occurred during both the eyes open and eyes closed

conditions for establishing baseline asymmetry. Moreover, the current results also found BIS scores to be significantly correlated with greater relative right hemisphere asymmetry during the eyes closed baseline acquisition period, falling just short of significance for the eyes open condition. These findings lend support to prior research suggesting individuals with high BAS and BIS scores to be related to greater left and right cortical activation, respectively (Davidson & Fox, 1982). These findings also provide a bridge for further understanding the relationships among the behavioral activation and behavioral inhibition systems, and cortical asymmetry.

Moreover, the current study demonstrated the relationship between self-reported anger with BAS and left frontal cortical asymmetry. The experience of anger is often thought of as being a negatively valenced emotional state. Thus, when subsuming the emotional experience of anger in current models emphasizing the roles of behavioral activation (comprising approach related behaviors and positive affect) and behavioral inhibition (encompassing withdrawal related behaviors and negative affect) it was hypothesized that anger would likely fall within the framework of behavioral inhibition. However, research over the past several decades has demonstrated quite the opposite. Harmon-Jones and Allen (1998) revealed that individuals with higher self-reported anger demonstrated greater left frontal cortical activation as compared to their non-angry counterparts, concluding that anger may be an approach related behavior that helps individual's achieve their goals. Results from the current study corroborate previous findings by revealing consistent significant relationships among self-reported anger with BAS (BAS-Drive subscale) and left frontal cortical activation.

While these results muddy the conceptualization of anger as negative affect, it lends support to the reconceptualization of the emotions with respect to approach- and withdrawal-related behavioral outcomes as opposed to only emotional valence. Interestingly, the construct of anger is quite complex in relation to how it is categorized within the range of human emotionality. Anger is often perceived as negative affect partly because of its relationship with varied forms of aggression (i.e., verbal and physical). Because research results similar to the current findings report significant positive correlations highlighting the increased likelihood of engaging in physical and verbal aggression, along with high endorsement of anger neuroticism, it is not unlikely that anger is presumed to be a negatively valenced emotion. Taken together, these findings highlight the complexities underlying the potential multidimensionality of emotions, particularly anger, and the need for future research in providing a fuller explanation of the relevant cognitive and behavioral components of overall emotional experiences.

AHA! and Reaction Times. Behavioral manifestations of AHA! in response to affectively valenced stimuli were explored via examination of reaction times. Findings from the current study do not lend support to the presence of an interference or facilitation bias in the processing of affectively valenced stimuli. Attentional biases have received much attention in psychological research, especially within the context of attributable biases for psychological disorders. Previous research in this area emphasized the roles of facilitation (quickenings) or interference (avoidance or reduction) of the speed of processing information as a manifestation of an individual's underlying attentional and cognitive biases. For instance, Mathews and MacLeod (1985) studied

this phenomena in a sample of clinically anxious participants and found that their reaction time performance on a modified Stroop task (using anxiety related words) was much slower than anticipated. The researchers explained this as an avoidance mechanism to threatening self-relevant information. It was hypothesized in the current study that individuals with higher self-reported AHA! would respond quicker to self-relevant negatively valenced stimuli; however, this was not revealed. All statistical analyses exploring main effects and interactions for word stimuli, AHA!, and reaction time were non-significant, aside from a single significant effect of block when examining target only stimuli (which may be attributable to participant fatigue).

Similar to the non-significant nature of the findings in hypothesis two, there are several possible explanations including those of sample size and methodology. Again, a larger sample size would contribute to the overall power of the statistical analyses employed for this investigation. Nevertheless, methodology may have played a larger role. The current study attempted to modify the Stroop task to solicit response times based on the premise of the trait-congruency hypothesis. Thus persons with higher levels of self-reported AHA! would have responded or selectively attended to stimuli congruent to their emotional tendencies. Consequently, the current study utilized more general negatively valenced words as opposed to words directly related to the constructs of anger, hostility, and aggression. This change could perhaps lead to significantly different results.

Limitations of the Present Study and Suggestions for Future Research

The current study posed several potential limitations. These limitations can be easily grouped and categorized into three general categories: construct, participant, and statistical variables.

Construct Variables. Due to variability in defining the constructs of anger, hostility, and aggression, the terms may be misinterpreted and misused when analyzing results. The construct of hostility is often interchangeably used in conjunction with anger and aggression. However, hostility is typically described as an all-encompassing negative attitude or underlying cognitive trait portrayed toward others, anger as an emotional state and aggression as an overt physical or verbal manifestation (Chida, & Steptoe, 2009). For the purposes of this study, the construct of hostility was defined using a broader and integrated cognitive, behavioral, and affective characterization, which included an underlying disposition and thinking pattern (hostility) and both anger (affective) and aggressive (behavioral) components. As research in the area of anger, hostility, and aggression continues to develop, it will be important to further define each of the aforementioned domains ensuring greater construct validity.

Yet another construct related limitation pertains to the classification of participants' levels of hostility (or for this matter any of the AHA! constructs). Many studies have dichotomized the variable of hostility into two groups: Low-hostility versus High-hostility (Everhart, Demaree, & Harrison, 2008; Erik Everhart, Demaree, & Wuensch, 2003; Pope, Smith, & Rhodewalt, 1990). Because hostility is considered a continuous variable, the current study treated hostility along a continuum from low hostility to high hostility. Dichotomization of continuous variables has several

consequences including loss of information, increased risk of Type II errors, and use of less powerful non-parametric tests (Streiner, 2013). However it is important to recognize the potential benefits decomposing a variable into more manageable and sensible pieces to aid in our understanding of the construct.

Participant Variables. Several aspects related to the individual differences of the participants may have potentially mediated study variable outcomes. For instance, high familiarity with the words presented on the Emotional Stroop poses as a potential confound with task performance. Participants with high familiarity may have had less inhibition than anticipated thus ultimately affecting reaction times. Additionally, as with the use of any self-report measures, participant data may vary on the degree to which it can be reliable.

Statistical Variables. Another potentially limiting aspect regarding the current study was sample size. The sample size of a study greatly influences the amount of statistical power in the analysis process. Because of this study's purpose, time constraints, and limited population (undergraduate participant pool), a larger sample was not feasible, thus influencing the power of the current study. Meanwhile, other factors including electroencephalogram artifact and computer recording errors contributed to missing data which was ultimately deleted from the study.

Concluding Remarks

An increased understanding of anger, hostility, and aggression has major implications in our understanding of emotional, cognitive, and behavioral contributions to our health and neuropsychological underpinnings. As such, this research has attempted to elucidate much of the confusion underlying the constructs of anger,

hostility, and aggression by examining their place within varying areas of psychological research. The present research highlighted the relationships among AHA! with negative health behaviors and associated personality traits (as explored through the constructs of BIS/BAS and the Reinforcement Sensitivity Theory), yet also explored the psychophysiological and attentional processes that potentially underlie such phenomena and its application to greater understanding of the human experience. While much research exists exploring anger, hostility, and aggression, future research needs to further develop this understanding and apply it toward a better theoretical model for understanding these experiences and investigate the potential of clinical applications.

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APPENDIX A: IRB DOCUMENTATION



EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building · Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office 252-744-2914 · Fax 252-744-2284 · www.ecu.edu/irb

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: [Eric Watson](#)
CC: [Daniel Everhart](#)
Date: 2/26/2013
Re: [UMCIRB 12-001067](#)
The EEG and Personality Correlates of Anger, Hostility, and Aggression

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 2/26/2013 to 2/25/2014. The research study is eligible for review under expedited category #4, 6, 7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

The approval includes the following items:

Name	Description
BISBAS.docx History	Surveys and Questionnaires
Buss-Perry Aggression Questionnaire.docx History	Surveys and Questionnaires
Clinical Anger Scale- CAS.docx History	Surveys and Questionnaires
Demographic Information Interview Form.docx History	Surveys and Questionnaires
EEG Informed Consent 2.19.2013.docx History	Consent Forms
Mini-IPIP.doc History	Surveys and Questionnaires
PANAS.doc History	Surveys and Questionnaires
SAM- Self Assessment Manikin.docx History	Surveys and Questionnaires
STAXI-2 Item Booklet .pdf History	Surveys and Questionnaires

epirate.ecu.edu/app/Doc/0/GSJS5ULVUTOK92T96PNMPO9A37/fromString.html

Page 1 of 2

2/23/14, 10:50 PM

STAXI-2 Profile Form .pdf History	Surveys and Questionnaires
STAXI-2 Rating Sheet.pdf History	Surveys and Questionnaires
The D-Scale 14.docx History	Surveys and Questionnaires

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418 IRB00004973



Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: The EEG and Personality Correlates of Hostility
Principal Investigator: Eric Watson, MS
Faculty Supervisor: D. Erik Everhart, PhD, ABPP-CN, CBSM
Institution/Department or Division: East Carolina University
Address: 237 Rawl Building, Department of Psychology, East Carolina University
Telephone #: (252) 328-4138
Email: Watsons11@students.ecu.edu

Why is this research being done?

The purpose of this research is to understand the differences between hostility, anger, aggression, and related personality characteristics. As much of the current research suggests these characteristics negatively affect health, understanding their similarities and differences is crucial to developing potential interventions and treatment approaches. The decision to take part in this research is yours to make. By doing this research, we hope to learn if hostility, anger, aggression and other personality traits (e.g., Type D personality) are truly different from each other or are considered the same thing.

The current study proposes to examine the relationship of these different constructs in order to provide clearer boundaries and understanding of the effects of hostility, anger, aggression, and other personality/affective traits (e.g., Type D personality) on physical health. Furthermore, the current study will attempt to identify baseline asymmetry (as measured via electroencephalogram) differences in individuals with varying hostility levels when confronted with either non-emotional or emotion laden information. This will include event-related potential (ERP) differences. Lastly, the study will also examine the relationship of the many different measures (e.g., questionnaires, EEG, ERP, etc.) with the constructs of anger, hostility, and aggression.

Why am I being invited to take part in this research?

You are being invited to take part in this research because you are currently enrolled in an introductory psychology course at East Carolina. This study provides an opportunity for you to earn credit toward the research activity requirement. If you volunteer to take part in this research, you will be one of about 150 people to do so.

Are there reasons I should not take part in this research?

Participating in this study is voluntary. You may decide to withdraw from this study at any time without penalty.

What other choices do I have if I do not take part in this research?

You can choose not to participate.

Where is the research going to take place and how long will it last?

The research will be conducted in the Cognitive Neuroscience Lab, RAWL 237. By participating in this research study, you will be donating approximately 90-120 minutes of your time to complete the questionnaires, EEG recordings, and relevant task.

What will I be asked to do?

You are being asked to do the following:

- Read this informed consent document.
- Complete a series of questionnaires
- Participate in a Stroop computer task while having EEG recording

What possible harms or discomforts might I experience if I take part in the research?

There is a very slight chance that you may experience unwanted emotions from answering the questionnaires. It has been determined that the risks associated with this research are no more than what you would experience in everyday life.

Additionally, some participants may feel fearful or anxious of the EEG component of the research study. As such, each participant will be introduced to the various parts and relevant procedures of EEG recording (e.g., wearing the Quick-Cap with embedded electrodes, allowing the tech to use a blunt syringe for applying conductive gel to the electrodes, sitting in a dark sealed room while performing the computer task etc.). During this time or at any point during their participation, if the participant is able to assert their concerns about either the questionnaires or EEG equipment and withdrawal their participation.

What are the possible benefits I may experience from taking part in this research?

For your participation you will receive one participation credit toward your introductory psychology course's research requirement. Additionally, the information obtained from this study may be helpful in understanding hostility, anger, aggression and other personality traits.

Will I be paid for taking part in this research?

We will not be able to pay you for the time you volunteer while being in this study.

What will it cost me to take part in this research?

It will not cost you any money to be part of the research.

Who will know that I took part in this research and learn personal information about me?

To do this research, ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections.
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.

How will you keep the information you collect about me secure? How long will you keep it?

Your privacy and confidentiality will be maintained in the following ways. The records of this research will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a participant. Research records will be kept in a locked file, and access will be limited to the researchers, the University review board responsible for protecting human participants, and regulatory agencies. Additionally, identifying information (i.e., name, pirateID, and email) will be the only information linking you to your survey information. This information will be captured only on this consent form (name and study identification number) and demographic questionnaire (for the purpose granting research credit in SONA ExperimenTrak).

What if I decide I do not want to continue in this research?

If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will not lose any benefits that you should normally receive (e.g., ExperimenTrak credit), that is, you will still get credit even if you do not complete all the surveys or finish the EEG component. However, credit offered will be equal to the amount of time and effort reflected in your participation.

Who should I contact if I have questions?

The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator, Eric Watson by phone: (252) 328-4138 (8:30 am–5:00 pm) or Email: Watson11@students.ecu.edu. There is no wrong time to ask questions, whether it is before, during, or even after the study, feel free to contact the principal investigator regarding any questions. If you have questions about your rights as someone taking part in research, you may call the Office for Human Research Integrity (OHRI) at phone number (252) 744-2914 (8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at (252) 744-1971.

Thank you for taking the time to participate in my research. Please continue to the next page to get started with your participation.

Sincerely,

Eric Watson,
Principal Investigator

I have decided I want to take part in this research. What should I do now?

Please read each of the following statements carefully and select "YES" or "NO" for each.

1. I have read all of the above information

YES

NO

2. I understand that I have the opportunity to ask questions (via email to the principal investigator) about things in this research I do not understand before or after completion.

YES

NO

3. I understand that I can stop taking part in this study at any time.

YES

NO

4. Do you voluntarily agree to take part in this study?

YES, I voluntarily agree to take part in this study.

NO, I do not wish to participate.

Participant Name(Print)

Date

Participant Signature

Name of Person Obtaining Consent

Date

Signature of Person Obtaining Consent

APPENDIX B: DEMOGRAPHIC RECORD FORM

Demographic Information Interview Form

GENERAL INFORMATION:

Age: _____

Year of Education (from 1st Grade): _____

Gender:

Male _____ Female _____

Handedness (hand you write with, eat with, throw a ball with):

Right _____ Left _____

PHYSICAL AND MENTAL HEALTH:

History of head injury/trauma – lost consciousness or blacked out:

Yes _____ No _____

History of seizure disorder:

Yes _____ No _____

History of anxiety disorder:

Yes _____ No _____

History of attention deficit and hyperactivity disorder (ADHD):

Yes _____ No _____

Have you had any physical or chronic health conditions for which you have sought treatment? (List)

Have you had any psychological or mental health condition for which you have sought treatment? (List)

Are you currently on any medication for a psychological or mental health condition? (List)

VISION

Do you have normal vision or are you wearing corrective lenses or glasses and can read this document and a computer screen without impairment?

Yes_____ No_____

Do you have normal color vision (not color-blind)?

Yes_____ No_____

LIFESTYLE

Do you smoke?

Yes_____ No_____ If yes, how many cigarettes per day? _____

Do you exercise?

Yes_____ No_____ If yes, how many days per week? _____

APPENDIX C: EXPERIMENTAL WORD STIMULI

Positive	Neutral	Negative
Pet	Hay	Gun
Joy	Sum	Sin
Win	Act	Tax
Joke	Echo	Pain
Cash	Boot	Jail
Hero	Oath	Debt
Lust	Veal	Riot
Waltz	Aisle	Slave
Music	Note	Hell
Wage	Smell	Enemy
Scent	Ounce	Slime
Glory	Grade	Blame
Jewel*	Ether*	Ulcer*
Peace	Cause	Error
Union	Dozen	Crime
Pillow	Butter	Cancer
Salary	Deputy	Poison
Reward	Gospel	Murder
Circus	Aerial	Weapon
Meadow	Liquor	Corpse
Nature	Winter	Hunger
Victory	Apology	Destroy
Cologne	Mustard	Missile
Culture	Segment	Trouble
Revenue	Measure	Dispute
Brother	Soldier	Tobacco
Scholar	Payment	Fatigue
Success	History	Failure
Victory	Finance	Torture
Diamond	Volcano	Measles
Liberty	Sphere	Bother
Leader	Circuit	Disease
Graduate	Medicine	Accident
Champion	Business	Pressure

Affection
Education
Thrill
Rescue
Berry
Feast*

Substance
Dimension
Burner
Margin
Trend
Rabbi*

Emergency
Confusion
Misery
Terror
Gloom
Thief*

APPENDIX D: EXPERIMENTAL SCRIPTS

Baseline Instructions

“Thank you again for your participation in this experiment. Now that you are all hooked up and the EEG software is recording, the very first thing we are going to do is establish a baseline. The purpose of establishing a baseline is to allow us to compare your EEG brain activity when you are relaxed and at rest to when you are engaging in the task. To get this baseline I will be asking you to remain comfortably seated in the recliner keeping your gaze forward. Over the next several minutes, you’ll hear my voice over the intercom in order to ask you to either open your eyes or close your eyes.”

“When I ask you to open your eyes, you will continue to face forward gazing at the blank computer screen in front of you. You are allowed to blink naturally but I do ask you refrain from squinting, clenching your jaw, or making any strong or sudden movements, as this will disrupt the recording.”

“When I ask you to close your eyes, I would like you to continue facing forward keeping your eyes naturally closed. Again, please refrain from squinting, clenching your jaw, or making any strong or sudden movements.”

“I will ask you to do this several times, alternating between having your eyes open and closed. Each time you will hear me tell you to either open your eyes or close your eyes on this intercom on this table behind your chair. Do you have any questions? Let’s begin.”

Practice Instructions

[Provide participant visual aid depicting four squares of color in order, left to right, corresponding to the buttons on the keypad: Red, Yellow, Green, Blue]

“We are now going to begin the practice portion of the experiment. Take a look at the card I gave you with four blocks of color on it. Each color corresponds to a button on the keypad going in order from left to right. Red corresponds to the first button all the way to the left. Yellow corresponds to the second button... Green to the third... and Blue to the fourth button all the way to the right on the keypad. During the practice trial a words will appear on the screen one at a time. Each word will be written in one of those four colors: Red, Yellow, Green, or Blue. The goal is to press the button corresponding to the color the word is written as quickly and accurately as possible. Any Questions? Let’s give it a go!”

[Intercom to reiterate directions for the task]

“Remember, a word is going to appear on the screen and will be written in one of those four colors. Your goal is to press the button corresponding to the color the word is written as quickly and accurately as possible. The first button, all the way to the left is for Red, the second button is for Yellow, the third is for Green, and the fourth button all the way to the right is for Blue. Any questions? Let’s begin.”

Test Instructions

[Walk into the participant booth to see if there are any questions and provide directions for test]

Trial 1: “Now you are going to do the exact same thing except the trial will be a bit longer. A word will appear on the screen and be written in one of four colors. Your goal is to press the button corresponding to the color the word is written as quickly and accurately as possible. The first button, all the way to the left is for Red, the second button is for Yellow, the third is for Green, and the fourth button all the way to the right is for Blue. Any questions? Let’s begin.”

Trial 2: [over the intercom] “Ok. You are almost done. You only have one more trial left. You are going to do the exact same thing you did for the previous trial. A word will appear on the screen and be written in one of four colors. Your goal is to press the button corresponding to the color the word is written as quickly and accurately as possible. The first button, all the way to the left is for Red, the second button is for Yellow, the third is for Green, and the fourth button all the way to the right is for Blue. Any questions? Let’s begin.”