Acoustic Startle Response in High and Low Hostiles Before And After A Cold Pressor Task

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ABSTRACT

High-hostiles exhibit exaggerated physiological responses to stressors as seen by increased cardiovascular reactivity (BP & HR) (Rhodes, Harrison, & Demaree, 2002; Demaree & Harrison, 1997). This exaggerated physiological response style is associated with cardiovascular disease and premature death (Everson et al., 1997). This experiment hypothesized that diminished regulatory control would also be evident in the Acoustic Startle Response (ASR). In this experiment, high- and low-hostile undergraduate men (N = 40) were exposed to a series of startle probes before and after a cold pressor (CP). Startle responses were measured using electromyography (EMG) recorded over the orbicularis occuli. Cardiovascular measures of blood pressure and heart rate were also taken. A 2 X 2 mixed factorial ANOVA was performed with Group (high and low hostile) as the fixed factor, Condition (pre and post CP) as the repeated measure, and peak magnitude EMG (mV) of startle responses as the dependent variable. For startle responses, significant main effects for Group and Condition indicated that high hostiles had larger startle responses than low hostiles and startle responses decreased after the cold pressor (CP). A significant Group X Condition interaction effect was found. Post-hoc analyses revealed no significant group differences before the CP. After the CP, high-hostiles had significantly higher startle responses than low hostiles. High-hostiles’ startle responses did not change significantly after the CP, whereas low-hostiles’ startle response magnitude decreased significantly after the CP. Low-hostiles HR increased significantly after the cold pressor and both groups SBP decreased significantly after the cold pressor.
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Introduction

Acoustic Startle Response in High and Low Hostiles Before And After A Cold Pressor Task

The use of the Acoustic Startle Response (ASR) as an index of emotion has gained considerable popularity for examining individual differences in emotional state and trait (Lang, 1995; Hoffman, 1997). It has been shown to be sensitive to affective, cognitive, and arousal-related deficits resulting from neurological impairment (Morris, Bradley, Bowers, Lang, & Heilman; 1991). Startle expression is affected by contextual and emotional factors that are grounded in the evolutionary value of the startle response for immediate protection. Startle potentiation during aversive compared with pleasant and/or neutral conditions has been repeatedly demonstrated with pictures (Bradley, Cuthbert, & Lang, 1990, 1991, 1996), film clips (Jansen & Frijda, 1994), mental imagery (Vrana & Lang, 1990; Cook, Hawk, Davis, & Stevenson, 1991; Hawk, Stevenson, & Cook, 1992), shock threat (Grill, Ameli, Foot, & Davis, 1993), odors (Miltner, Matjak, Braun & Diekmann, 1994), and pheromones collected from subjects in a highly anxious state (Pause, Ohrt, Sojka, Ferstl & Prehn, 2006). These experiments provide evidence that aversive or unpleasant stimuli and emotional states augment startle via priming of subcortical systems, whereas appetitive stimuli or pleasant emotions attenuate the startle response.

Brissette and Cohen (2002) suggested that people with elevated levels of cynical hostility show more pronounced negative affective reactions to naturally occurring conflicts. Although hostility refers to negative attitudes, beliefs, and appraisals concerning others (Buss, 1961; Smith, 1994), this negative bias may also extend to environmental stressors without interpersonal elements, such as an acoustic startle probe. Similar to hostility, Temple and Cook (2007) found that individuals scoring high on both defensiveness and anxiety showed the greatest potentiation
of startle during unpleasant compared to pleasant picture viewing but that defensive individuals, regardless of their levels of self-reported trait anxiety, showed greater baseline levels of pre-startle EMG and greater levels of startle magnitude (LaRowe, Kline & Patrick, 2004). The authors also replicated a prior experiment (LaRowe, et al. 2003) indicating that high-defensiveness individuals exhibit enhanced startles compared to low-defensive individuals. Individuals high in negative affectivity show significant valence modification of startle compared to low-scoring subjects. These experiments demonstrate that trait characteristics associated with hostility and negative affectivity moderate startle magnitude such that higher levels of defensiveness primes individuals for defensive behavior, which in turn augments the ASR. These experiments also demonstrate that individuals experiencing high levels of negative affect are more likely to react with an exaggerated startle response when presented with negatively valenced stimuli.

Since hostility is a multifaceted construct that is similar to defensiveness and can be broadly defined as an increased experience of negative emotion (Mollet & Harrison, 2006), high hostiles are hypothesized to exhibit a larger startle response compared to low hostiles. Since high-hostiles have a negative affect bias (Harrison, Goreлизenko, & Cook, 1990), and experience more negative affect (Mollet & Harrison, 2006), they are hypothesized to show significant valence modification, such that following an aversive event (cold pressor task), they will exhibit a significantly increased startle response whereas low-hostiles will not.

This laboratory has posited a model of frontal lobe modulation over the posterior regions for aggression and hostility during stressful challenge (Demaree, Everhart, Youngstrom, & Harrison, 2005; Demaree & Harrison, 1997; Everhart & Harrison, 1995; Williamson & Harrison, 2003). Demaree and Harrison (1997) proposed that the orbitofrontal areas maintain an inverse
relationship with the temporal areas in regulating autonomic responsitivity via inhibitory connections including the uncinate and other longitudinal intra-hemispheric fibers connecting the frontal lobe with posterior brain regions.

Research has often shown high levels of hostility to be predictive of heightened cardiovascular reactivity to stressful situations (Rhodes, Harrison, & Demaree, 2002; Smith, Glazer, Ruiz, & Gallo, 2004); higher reactivity levels on blood pressure and heart rate measures (Demaree & Harrison, 1997; Keefe, Castell, & Blumenthal, 1986), and premature death (Everson et al., 1997). Specifically, our laboratory has argued that increased levels of hostility may be derived from diminished right frontal regulatory capacity such that high hostiles are unable to optimally regulate sympathetic tone with heightened HR and BP while processing concurrent right frontal stressors and demands requiring right frontal resources. The capacity of functional cerebral systems that regulates sympathetic cardiovascular tone and negative affective tone may vary as a function of high levels of hostility and the requirement for dual concurrent processing demands (i.e.: regulatory control of anger and regulatory control for sympathetic tone). Specifically, high-hostiles have been shown to have altered right hemispheric functioning (Williamson & Harrison, 2003), with right cerebrum activation in response to pain stress (Demaree & Harrison, 1997).

Several authors provide evidence that the right hemisphere, and particularly the central nucleus of the amygdala, modulates the startle circuit’s activity via an ipsilateral projection of the caudal amygdalofugal pathway to the nucleus reticularis pontis caudalis (NRPC) which projects to the facial motor nucleus that innervates the orbicularis oculi muscle (Grillon & Davis, 1995). This later circuit is proposed to be responsible for the execution of affective modulation of the acoustic startle response in humans. Although there is a cross-species similarity of general
reflex circuitry, the specific neural circuit responsible for the execution and affective modulation of the acoustic startle response in humans remains unclear (Bradley et al., 1996) and further research is needed to test the current theories of affective startle modulation. Kettle, Andrews, and Allen’s (2006) coactivation startle reflex model proposes that the facial motor nucleus has stronger ipsilateral than contralateral innervation of the orbicularis oculi. Relative activation in the amygdaloid bodies of the right anterior temporal lobe has been found with increased hostility (see Williamson & Harrison, 2003). Thus, according to the coactivation startle reflex model and the anterior-posterior cerebral model of frontal regulation over sympathetic tone in hostiles, it is predicted that high hostile men will display significantly elevated startle magnitude levels at the right eye compared to left eye because the startle reflex occurs ipsilaterally and low right frontal lobe capacity in high-hostiles should allow disinhibition of amygdalar activity which would augment the startle response ipsilaterally at the right eye.

Affective startle modification, clearly a robust phenomenon (Cook, 1999), allows us to examine activity in the brain-stem circuit and possibly the cerebral asymmetries in its descending modulatory pathways that include frontal corticofugal pathways. Short term-habituation of startle, as studied by Hirano et al. (1996), is mediated primarily by mechanisms intrinsic to the direct startle pathway. But, studies of the effects of human frontal lobe lesions on the habituation to peripheral vision suggest that the frontal cortex increases habituation of attention to redundant stimuli (Menemeier, Chatterjee, Watson, Wertman, Carter, & Heilman, 1994). A similar course of habituation for startle suggests that habituation processes may be modified by frontal cortex activity and that the evaluation of the repetitive startling stimulus could be modified by frontocortical activity. This hypothesis then infers that poor frontal capacity would be associated with diminished habituation.
The Ruff Figural Fluency Test (RFFT) has been shown to be sensitive to right frontal lobe dysfunction (Ruff et al., 1994). High-hostile males have been shown to produce more perseverative errors on measures of nonverbal fluency (RFFT) than low-hostile males (Williamson & Harrison, 2003). This was interpreted as high-hostiles, compared to low-hostiles, having increased interference and reduced capacity within right frontal systems. Foster, Williamson and Harrison (2004) provided additional evidence for this hypothesis by measuring QEEG in individuals scoring low and high on the RFFT. They reported heightened delta activity in the right frontal lobe (F2, F8), supporting the hypothesis that poor figural fluency is correlated with decreased right frontal activation. Thus, examining habituation of startle magnitude as a function of design fluency and perseveration scores on the RFFT may provide additional evidence that high-hostiles have poor right frontal capacity and provide further evidence that frontal systems mediate acoustic startle response and habituation. Specifically, habituation deficits are expected to occur in the high-hostile group compared to the low-hostile group. Habituation deficits are also likely to increase as the right frontal lobe processes a dual task demand as a function of stress. Further, high-hostiles are expected to have habituation deficits at the right eye, following the rationale that high-hostile males have reduced right frontal capacity and affective startle modulation is believed to occur ipsilaterally.

The involvement of the right hemisphere in hostility also has implications for the cerebral regulation of HR and systolic blood pressure (SBP). A differential rate of right hemisphere activation occurring with increases in HR and SBP has been indicated in several experiments and involves the cerebral regulation of autonomic functioning (Hachinsky, Oppenheimer, Wilson, Guiraudon, & Cechetto, 1992; Heller, Lindsay, Metz, & Farnum, 1990; Oppenheimer, Gelb, Girvin, & Hachinski, 1992; Wittling et al., 1998). Using emotionally positive or negative films,
Wittling et al. (1998) demonstrated an increase in SBP during right cerebrum (left hemispace) presentation. Increases in the Galvanic skin response (GSR) and slow habituation rate at the left hemibody have also been found in hostile participants contracting facial muscles depicting emotional faces (Herridge et al., 1997). Regulation of sympathetic features of HR and SBP may be compromised in high-hostile individuals with altered right hemispheric functioning. This relationship has been noted in several experiments (e.g., Demaree & Harrison, 1997; Williamson & Harrison, 2003). High hostiles generally display heightened HR and SBP in response to right cerebral stressors (Demaree & Harrison, 1997; Shapiro et al., 1993; Sloan et al., 1994; Williamson & Harrison, 2003). Lane and Schwartz (1987) describe a relationship whereby emotional arousal may induce more sympathetic activity in individuals who demonstrate more cerebral lateralization. Additional support of altered right hemispheric functioning in high hostiles was found by Demaree and Harrison (1997), who showed an increase in heart rate (HR) and right cerebrum activation in response to pain stress among high-hostile individuals. Thus, it is hypothesized that high-hostiles, compared to low-hostiles, will exhibit increased systolic blood pressure and heart rate in response to the startle probes because the loudness, unpredictability, and unpleasantness of the startle probes may serve as a right cerebral stressor. High-hostiles are also expected to show increased systole in response to the cold pressor task.

In the present experiment, I will use a mixed factorial design with the fixed effect of group (high-hostiles and low-hostiles), and repeated measures of location (left and right hemiface), condition (pre and post cold pressor), and trial (10 startle probes per condition) to examine overall and lateralized acoustic startle response magnitudes, habituation, and cardiovascular responding.

**The Acoustic Startle Response as an index of Emotion**
The use of the Acoustic Startle Response (ASR) as an index of emotion and attention has gained considerable popularity (Lang, 1995; Hoffman, 1997) for examining the theoretical offerings posed by our lab regarding hostility and psychophysiological reactivity. The ASR is a defensive, withdrawal reflex in response to a loud and unexpected auditory stimulus. Although the ASR includes whole body movement, the eye blink component of the ASR is reliably the first indicator of the reflex and its magnitude, quantified as peak EMG activity over the orbicularis oculi muscle, serves as a measure of startle reactivity (LaRowe, 2004).

The acoustic startle reflex is a defensive withdrawal behavior caused by an unexpected loud stimulus that induces a brainstem reflex that includes autonomic and involuntary muscle responses. Early interest in the human startle response was stimulated by the work of Landis and Hunt (1939). They described the features of the reflex as a forward thrusting of the head and a descending flexor wave reaction, extending through the trunk to the knees. The first, fastest, and most stable element in the sequence is the sudden closure of the eyes. The magnitude of the eye blink is measured in microvolts from EMG recordings obtained over the orbicularis oculi. The primacy of the eye blink has been confirmed by subsequent research, which further showed that closure of the eyes alone may occur to stimuli not sufficiently strong to engage the whole reflex. Although research varies widely in subject population and theoretical orientation, results consistently show that variations in the intensity of the eyeblink response indexes the brain’s receptivity to information input.

The amplitude of the startle reflex is influenced by contextual variables in both non-human and human animals (Anthony, 1985; Graham, 1975; Hoffman & Ison, 1980). Although these effects reflect automatic, subcortical mechanisms (Leitner, Powers, Stitt, & Hoffman, 1981), experiments have shown that the startle reflex varies systematically with the attentional
demands of a coincident information-processing task. For example, the startle eye blink is increased while viewing negative information but decreased while viewing positive stimuli. It can be extended that individuals who are biased to negative information such as high-hostiles should have an exaggerated startle blink.

Startle magnitude has been shown to vary with certain emotional dispositions such as non-clinical depression (Mneimne et al., 2008), generalized anxiety disorder (Ray, Molnar, Aikins, Newman, Borkovec, & Castonguay, 2009), inhibited adolescents with anxiety disorders (Reeb-Sutherland, 2009), defensiveness (LaRowe, 2003), and anxiety (Temple & Cook, 2007). The link between startle and anxiety states has been demonstrated for posttraumatic stress disorder (PTSD) and panic disorder (Jovanovic, Norrholm, Sakoman, Esterajher, & Kozarić-Kovačić, 2009). Enhanced startle has been found among individuals with PTSD (Grillon, Morgan & Orr, 1994) and exaggerated startle is listed as a symptom of PTSD in the DSM-IV. Elevated startle has also been reported in patients with panic disorders, but only under stressful conditions (Grillon et al., 1994). One of the more robust findings in this line of research is that high-fear individuals show greater potentiation of startle blinks than low-fear individuals during exposure to unpleasant compared to pleasant stimuli (Cook et al., 1991).

Psychopathy has also been shown to modulate the magnitude and laterality of the eyeblink component of the ASR. Acoustic startle response and habituation impairment are considered to be endophenotypes for schizophrenia (Braff et al., 1992; Kunugi et al., 2007; Takahashi et al., 2008). Schizophrenics and relatives of schizophrenics demonstrate impaired prepulse inhibition at the right eye (Cadenhead, 2002), consistent with longstanding findings of left hemisphere dysfunction across a variety of measures in schizophrenia spectrum disorders (Gur & Chin, 1999; Salisbury, Shenton, Sherwood & Fischer, 1998).
Temple and Cook (2007) found that defensiveness was associated with enhanced attentional modulation of the startle response. Defensiveness is the tendency to endorse negative characteristics of others and the tendency to deny minor faults of oneself. “Repressors” are characterized by self-reports of high defensiveness and low trait-anxiety. They often paradoxically display higher levels of sympathetic reactivity as evidenced by increased heart rate in response to several types of stressors (Derakshan & Eysenck, 1997; 2001; Weinberger et al., 1979). Although LaRowe, Kline and Patrick’s (2004) main hypothesis regarded startle probe onset, they found that individuals scoring high on both defensiveness and anxiety showed the greatest potentiation of startle during unpleasant compared to pleasant picture viewing. Defensive individuals, regardless of their levels of self-reported trait anxiety, showed greater baseline levels of pre-startle EMG and greater levels of startle magnitude (LaRowe, Kline & Patrick, 2004). Following a cold-pressor task, high-hostile males displayed increased cardiovascular reactivity (BP and HR), whereas low-hostiles demonstrated cardiovascular stability (Demaree & Harrison, 1997). The psychophysiological reactivity model (Smith, 1994) links hostility to cardiovascular disease. According to this model, hostile persons are more likely to be vigilant for possible conflicts in their environment and are more likely to respond in a physiologically exaggerated style to these stressors. Given the similarities between defensiveness and hostility, and based on the psychophysiological reactivity model, it can be hypothesized that hi-hostiles, like those scoring high on defensiveness, will show potentiated startle responses due to their high sympathetic physiological reactivity and experiencing of increased negative affect.
Lateralization of the Startle Response in High-Hostiles

The startle response has been extensively researched in rats and non-human primates but comparatively less is known about the human anatomy of the startle reflex (Davis, Walker, & Lee, 1997). Early components of the human startle reflex occur less than 20 ms after the stimulus onset, which indicates that a relatively simple neuronal circuit is involved (Cook, Haw, Davis, 1991). Researchers in sensory physiology have suggested that the startle reflex circuitry involves at least two parallel neural pathways. Response latency is thought to index facilitation along the more direct of these pathways, whereas magnitude is influenced by activity in the longer pathway (Graham & Murray, 1977; Hoffman & Ison, 1980). Substantial research supports the independence of these parameters (latency and magnitude) of the startle response. Whereas latency is inversely related to attention directed toward any sensory modality (Antony, 1985), startle magnitude appears to be sensitive to processes mediated at higher levels of the nervous system, such as selective attention and habituation (Bohlin, Graham, Silverstein, & Hackley, 1981).

The neural circuit that executes and modulates the acoustic startle response in rats has been clearly defined (Davis, Walker, & Lee, 1999). An acoustic startle probe is received by auditory nerve fibers, which project ipsilaterally onto cochlear root neurons. Thick axon collaterals then project from the cochlear root neurons contralaterally at the level of the brain stem and terminate in the NRPC. The NRPC projects contralaterally to the facial motor nucleus, back to the side ipsilateral to the startle probe input. The facial motor nucleus then innervates muscles through ipsilateral projections. The amygdala modulates the circuit’s activity via an ipsilateral projection of the caudal amygdalofugal pathway to the NRPC (Grillon & Davis, 1995).
In humans, acoustic startle response testing may reveal increased reflex responses in clinical conditions such as hyperekplexia (Wilkins et al., 1986; Brown et al., 1991; Chorovery et al., 1992), multiple system atrophy (Kofler et al., 1998), blepharospasm (Muller et al., 2007), or restless legs syndrome (Frauscher et al, 2007), and reduced startle reactions in Steel Richardson Olszewski syndrome (Vidailhet et al, 1992; Valldeoriola et al., 1998), dementia with Lewy bodies (Kofler et al., 2001), or cervical dystonia (Muller et al., 2003). Some of these diseases may display an asymmetrical distribution of symptoms. In spite of that, EMG recordings of the acoustic startle response have routinely been obtained unilaterally.

Investigations into the laterality of the acoustic startle response have employed various techniques such as mixed blocks of monoaural and binaural startle probes, both in healthy controls and temporal lobectomy patients and during affective manipulation. Using monoaural probes, significantly larger eyeblink magnitudes at the eye ipsilateral to the acoustic probe have been observed (Bradley, Cuthbert, & Lang, 1991; Bradley et al., 1996; Hackley & Graham, 1987) but bilateral responses at the orbicularis oculi imply bilateral projections (Kettle, et al., 2006). Investigation into the hemispheric dominance of the acoustic startle response has yielded inconsistent findings such that some experiments suggest that laterality of the probe (the ear that the monoaural probe was presented to) does not significantly affect eyeblink magnitude (Bradley et al., 1991; Hackley & Graham, 1987), though Bradley et al. (1996) have found greater startle in response to right ear probes. Using binaural probes, some studies have found that eyeblink magnitude is not significantly different when recorded over the left or the right eye (Bradley et al., 1991, 1996; Buchanan et al., 2004). Additionally, research regarding the modulating role of the amygdala is mixed, with evidence that the amygdala influences overall eyeblink magnitude (Angrilli et al., 1996) and evidence that it may not (Buchanan et al., 2004).
Cerebral dominance of affective acoustic startle response modulation has also been investigated. Bradley et al. (1991) presented blocked, monoaural probes during affective picture viewing and found significant affective modulation for left ear probes when recorded from either eye but not for right ear probes. Bradley (1996) found similar results with significant, but weaker, affective startle response modulation for right ear probes when recorded over the right but not the left eye. Thus, Bradley et al., (1991, 1996) concluded that the right hemisphere might be dominant in affective modulation on the basis of the assumption that affective modulation was occurring in the hemisphere contralateral to probe input. Based on research with temporal lobectomy patients, Angrilli et al. (1996) and Funayama et al. (2001) also suggest that the right amygdala may be dominant in affective acoustic startle response potentiation.

Based on Kettle et al. (2006) findings, they developed the coactivation startle reflex model, which proposes that monoaural probes elicit bilateral eyeblinks, though eyeblinks will be significantly larger on the hemiface ipsilateral to probe input. Overall, eyeblinks are significantly larger for right ear probes when recorded from the right eye. They also believe that the anterior temporal lobes (ATL) have a greater ipsilateral influence on affective SR modulation but act interdependently, with the left ATL decoding the arousal value of stimuli and the right ATL having a more specific role in the production of defensive and autonomic responses. Lang hypothesizes that the emotion-modulated startle effects are the result of emotional priming of largely subcortical aversive and appetitive circuits (Ruiz-Padial, Sollers, Vila, & Thayer, 2003). In their model developed using rats, they posit that habituation occurs via a primary spinal circuit while a secondary circuit does not habituate as readily. This secondary circuit involves the central nucleus of the amygdala and resistance to habituation of the affective modulation of the startle reflex in humans supports this model (see Bradley et al., 1999). This evidence suggests
that the central nucleus of the amygdala plays an important role in the affective modulation of
the acoustic startle reflex. Furthermore, it is likely that trait and emotional states invoking
prefrontal regions plays a reciprocal role. For instance, Skinner (1985) has suggested that an
intact frontal cortex may tonically inhibit subcortical (amygdala) activity that, in turn, is
associated with autonomically mediated defensive behavior. Indeed, Davidson (2002) and
Drevets (1999) have both proposed models and provided data that show that activity of the
prefrontal cortex is inversely related to amygdala activity. Additionally, Davidson (2000) has
reported that medial prefrontal cortex activity is inversely associated with activity of the
amygdala and is involved in the modulation of the startle response. Thus, diminished right
frontal capacity observed in hi-hostiles (Williamson & Harrison, 2003) should lead to an
increased eye blink magnitude in the right compared to the left eye.

Evidence from our laboratory and others investigating laterality differences in emotional
processing and the differential effects of stress on high and low hostile individuals has generated
several neuropsychological perspectives explaining these differences. Methods employed in
investigations with hostiles have been carried out in various sensory and motor modalities using
tachiscopic presentation of emotional stimuli (Shenal & Harrison, 2004), dichaptic vibrational
tactile stimulation (Foster et. al, 2010, in press) dichotic listening tests (Demaree & Harrison,
1997; Snyder & Harrison, 1997), grip strength (Demaree, Higgings, Williamson, & Harrison,
2002), affective verbal learning tests (Mollet & Harrison, 2006), affective recognition (Harrison
& Gorelczenko, 1990), and vestibular stressors (Carmona, Holland, Stratton, & Harrison, 2008;
Carmona, Holland, & Harrison, 2009). The results from these investigations have lead to a right
cerebral model of hostility that suggests altered right cerebral activation in high-hostiles results
in a negative emotional bias and heightened sympathetic cardiovascular reactivity. Comparing
lateralized differences in the startle response in high and low hostiles will contribute to our understanding of how high hostile individuals respond to stressors on a reflexive level and as a function of frontal lobe regulatory control.

From functional cerebral systems theory (Luria, 1971) and our capacity theory perspective (Shenal & Harrison, 2004; Foster et al., 2009; see Carmona et. al, 2009), this profile of emotional bias and cardiovascular lability seen in high hostiles is believed to result from diminished right frontal lobe capacity and it’s susceptibility to decompensation and the subsequent dysregulation of negative emotional and cardiovascular functioning that may result from dual-task demands. From our quadrant theory perspective, this is believed to result in autonomic dysregulation and disinhibition of right posterior and subcortical areas leading to increased levels of arousal and negative emotionality.

**Behavioral, Physiological and Cognitive Aspects of Hostility**

Hostility has been defined as a multidimensional construct with cognitive, behavioral, and physiological correlates. Cognitively, hostility is described as an attitude that connotes a devaluation of the worth and motives of others, an expectation that others are likely sources of wrong doing, a relational view of being in opposition towards others, and a desire to inflict harm or see others harmed. Behaviorally, hostility motivates aggressive behavior towards objects and people (Spielberger et al., 1985). Physiologically, hostility has been associated with the chronic over activation of the sympathetic nervous system (Keefe, Castell, & Blumenthal, 1986) leading to heightened arousal levels that are strongly correlated with the development of cardiovascular disease (CVD). The heightened arousal level and high degree of physiological reactivity present in the hostile disposition makes hostility one of the most problematic affective constructs associated with CVD. In addition, high-hostile individuals are at heightened risk for CVD
because they demonstrate heightened cardiovascular lability (Davis, Matthews, & McGrath, 2000) and are more likely to engage in behaviors that put them at risk for CVD (Calhoun, Bosworth, Siegler, & Bastian, 2001). Hostility has been associated with myocardial infarction and has been found to be a significant predictor of the development of CVD outside of other known risk factors (Dembroski & Williams, 1989).

The Quadrant Theory may be applied to the ASR research. The Quadrant Theory follows from Liotti and Tucker’s (1995) and Denny-Brown’s (1956) description of the brain as having intrahemispheric reciprocal relationships along the longitudinal axis (via the longitudinal tract). Moreover, the left and right cerebrum are mutually inhibitory via the corpus callosum such that the two hemispheres oppose and complement each other. The frontal lobes are known to be inhibitory, especially over posterior regions, which are shown to be excitatory in response to sensory input. Accordingly, the brain is organized so that frontal activation inhibits the ipsilateral posterior cerebrum. This has the effect of releasing inhibition over the contralateral posterior cerebrum as well as inhibitory action over the left contralateral frontal lobe. Due to the relatively large amounts of energy required by the brain, a system that lowers metabolic rate in areas contralateral to, and furthest from, areas of highest energy consumption would be beneficial, as this selective neural activation would likely result in the efficient use and preservation of limited resources.

With particular concern to hostility, dysfunction in the ability to inhibit posterior systems (i.e., the temporal-parietal region) by anterior systems (i.e., the prefrontal and orbital-frontal regions) within the right hemisphere gives rise to hostile behavior, heightened sensitivity to negative affective stimuli and increased sympathetic tone. Specifically, the orbital-frontal cortex and its connections to the amygdala and limbic system play a regulatory role over anger in
hostility (Herridge, Harrison, Mollet & Shenal, 2004) and orbital-frontal disinhibition of the amygdala via the uncinate fasciculus produces physiological changes associated with anger and aggression (Damasio & Anderson, 1993). Disinhibition along the longitudinal, uncinate and occipito-frontal fasciculi would likely occur when frontal capacities are taxed or limited compromising metabolic rate.

In dual-processing tasks, the processing of one task may lead to interference or facilitation of a second consecutive or concurrent task (see Pashler, 1994, for a review of various dual-task models) and proficient completion of dual tasks is dependent on the extent to which neural networks overlap or share neural resources. The frontal lobe space is “shared” by a number of abstract cognitive processes all competing to utilize cerebral resources, cortically and subcortically, to regulate behavior. Thus, the heterogeneity of frontal lobe functions increases the likelihood of cognitive conflicts.

The functional cerebral systems notion of dual-processing demands to include autonomic regulation has been explored in our laboratory. We have examined the impact of cognitive tasks on cerebral activation and cardiovascular functioning in both hostile populations and anxiety-prone populations. For example, Williamson and Harrison (2003) used concurrent fluency tasks that are sensitive to activation in either the left or right frontal lobe (also see Foster & Harrison, 2004; Mitchell & Harrison, 2009) to examine directional and disordinate influences on parasympathetic and sympathetic activation in high-hostile men. High-hostile men demonstrated increased systolic blood pressure in response to a design fluency task that challenged the capacity of the right frontal system (Foster & Harrison, 2004), whereas a verbal fluency task that challenged left frontal capacity resulted in decreased systolic pressure. Moreover, high-hostile men showed heightened perseverative errors in the design fluency task—a common clinical
finding with diminished right frontal capability. Shapiro et al. (1994) advocates that impaired function in the prefrontal cortex, be it from a lesion or metabolism as measured by regional cerebral blood flow (rCBF) is associated with hostile behaviors. Several case studies using quantitative electroencephalography (QEEG) (e.g., Demaree & Harrison, 1996; Everhart & Harrison, 1995) suggest that among high-hostile individuals there is dysfunctional anterior to posterior regulation of cerebral systems that increases the likelihood of the expression of the characteristics of hostility.

Extending the Quadrant Theory to existing ASR research may provide some additional explanation. Kettle (2006) provide evidence for their coactivation startle reflex model that states that the right anterior temporal lobe (ATL) is responsible for autonomic activation and defensive psychobiological responses to startle probes and startle magnitude is under greater influence ipsilaterally. Increased frontal activation in hi-hostiles inhibiting posterior regions, including the ATL, should result in increased eye-blink at the left eye before and after stress according to the quadrant theory. However, taxed frontal capacity following the pain-stress of the CP may yield disinhibition over right posterior regions resulting in increased startle magnitude ipsilaterally at the right eye, relative to that present before stress. However, as hi-hostiles activate their right cerebrum to stress, it is hypothesized that they will exhibit increased startle magnitude specifically at the right eye.

**Methods**

**Participants**

The Virginia Polytechnic and State University IRB approved this experiment. Participants were acquired via Sona systems (1997) from the undergraduate Psychology Department Subject pool. IRB approved flyers advertising the experiment were placed
throughout several buildings on campus. Participants consisted of a total of 40 college-age males evenly divided between two groups, twenty low-hostiles and twenty high-hostiles. Due to relatively heightened cerebral lateralization among men, only males were used to ensure as much homogeneity as possible within the experiment. All participants received course credit for their participation. All identifying information obtained from participants was coded to insure that all sensitive information was kept confidential. All research was conducted according to IRB standards and ethics.

Materials

Self-report measures

Cook-Medley Hostility Scale (CMHS)

Participants completed the Cook-Medley Hostility Scale (CMHS) (Cook & Medley, 1954) as part of the on-line screener survey. The Cook-Medley Hostility Scale is the most often used measure of hostility and shows construct validity as a predictor of interpersonal, medical, and psychological outcomes (Contrada & Jussim, 1992). The CMHS is a 50-item true/false questionnaire that measures aspects of hostility and has been shown to be a valid indicator of hostility in previous research (Herridge, Harrison, Mollet & Shenal, 2004) (See Appendix A). The CMHS shows a high degree of reliability ($r = .84$) (Smith & Frohm, 1985), convergent, and discriminant validity (Raikkonen, Matthews, Flory, & Owens, 1999) with respect to physiological measures such as blood pressure regulation. Participants who obtained a score of 19 or lower on the CMHS were classified as low-hostiles. Participants who obtained a score of 29 or higher were classified as high-hostiles. These classifications are consistent with previous research examining physiological and neuropsychological correlates of trait hostility.
(Williamson & Harrison, 2003; Shenal & Harrison, 2003; Herridge, et al., 2004; Rhodes et al., 2002).

**Coren, Porac, and Duncan Laterality Questionnaire (CPD).**

Participants completed the Coren, Porac, and Duncan Laterality Questionnaire as part of the on-line screener survey to determine sufficient right hemibody preference (CPD; Coren, Porac, & Duncan, 1979) (See Appendix B). The questionnaire is a 13 item self-report inventory. Scores range from +13, for complete right lateral preference, to -13, for complete left lateral preference. Participants scoring +7 or above were included in this experiment, as used in previous experiments in our lab (Herridge, et al., 2004; Williamson & Harrison, 2004).

**Medical History Questionnaire.**

Participants completed the Medical History Questionnaire used previously in experiments in our lab (Williamson & Harrison, 2003) as part of the on-line screener survey (See Appendix C). The Medical History Questionnaire assesses neurological trauma and major medical disorders. It asks questions regarding head injuries, strokes, seizures, paralysis, medical illness, psychiatric problems, sensory impairments, prescription medication use, and problems or pain related to movement (Foster et al, 2004). In order to continue in the experiment, participants must report an unremarkable medical history as pertaining to head injury, learning disability, neurological dysfunction or cardiovascular abnormalities.

**Ruff Figural Fluency Test (RFFT).**

Participants completed the RFFT in the laboratory. The RFFT (Ruff, 1996; Ruff et al., 1987) is a measure of nonverbal fluency consisting of five individual parts, with each part consisting of a different stimulus pattern (See Appendix D). The participants are instructed to draw as many unique designs as possible by connecting at least two of the dots comprising a 5-
dot matrix. Nonverbal fluency is then considered as the total number of unique designs produced within a 1-minute time frame.

_Beck Depression Inventory 2nd edition (BDI-II)._ 

Participants completed the Beck Depression Inventory 2nd edition (Beck, 1996) in the laboratory. The BDI is the most commonly used self-report measure to assess levels of clinical depression (See Appendix E). The BDI is scored by summing the ratings of the 21 items. Scores of 0-9 are considered asymptomatic; 10-18 indicates mild-to-moderate depression; 19-29 indicates moderate-to-severe depression; and 30-63 indicates extremely severe depression. This self-report measure will not be used as inclusionary criteria, but to serve as a covariate in further analyses because depression has been reported to be associated with hostility and with altered startle response.

_State-Trait Anxiety Inventory (STAI)._ 

Participants completed the STAI (STAI, Speilberger, Gorusch, Lushene, Vagg, & Jacobs, 1983) in the laboratory (See Appendix F). The STAI is the most commonly used self-report measure of anxiety. The STAI responses will not be used as inclusionary criteria, but to serve as a covariate in further analyses because individuals scoring high on scales of anxiety have been shown to have an exaggerated startle response.

_Stimuli_

The acoustic startle stimulus was a 100 dB (SPL; A scale) broadband white noise with instantaneous onset presented binaurally through headphones from a portable compact disc player (Venturer Portable CD Player, Model: CD1832). Broadband white noise contains frequencies in the 20 Hz to 20 kHz range and is the most commonly used acoustic startle stimulus in ASR experiments (Blumenthal et al., 2005) because it is a more effective startle
stimulus than pure tones (Blumenthal & Berg, 1986a; Blumenthal & Goode, 1991). Broadband white noise were created in an audio recording software program (Logic Pro 8) and recorded onto a compact disc that was played in a portable CD player. The audio signal was split so that the startle probes were routed to the participant’s headphones and to a channel on the Biopac bioamplifier. This was done in order to synchronize the startle probes audio signal and startle response reaction (EMG) for data reduction. Sound intensity was maintained at 100 db by using the Radioshack Digital Sound Level Meter (model 33-2055). The duration of the startle stimulus was 50 milliseconds, based on Blumenthal et al. (2005) recommendations. The acoustic startle probes were spaced pseudorandomly apart from each other in time (no longer than 15 seconds, standard deviation of 7.5 seconds) to reduce the possible effects of temporal learning.

**Apparatus and Physiological Recording**

The laboratory chamber consisted of a chair facing into a desk. The cold pressor equipment was located out of view to the left of the participant. The experimenter and physiological recording equipment were located next to but out of view of the participant.

**Cold Pressor Task (CPT)**

The ice water for the CPT was maintained in a small ice cooler at (+1 degrees Celsius). Water temperature was measured using a standard mercury thermometer. Participants were instructed to place their left hand in the ice water to the level of their wrist. The experimenter instructed them to remove their hand after 45 seconds elapsed.

**Physiological Recordings**

Electromyographical (EMG) measures of the acoustic startle response were recorded using the BioPac MP36 Bioamplifier. Eyeblink startle responses were measured from both the left and the right orbicularis oculi. Blumenthal et al. (2005) recommends using Ag/AgCl.
miniature electrodes, in which the contact surface (diameter of less than 5 mm) is recessed within a plastic casing having an external diameter of less than 15 millimeters. Accordingly, two pairs of 5 millimeter Ag/AgCl electrodes were placed directly under the pupil in forward gaze. Another electrode was placed 1-2 centimeters lateral to the first electrode as recommended in the Committee report: Guidelines for human startle eyeblink electrzymyographic studies (Blumenthal, Cuthbert, Filion, Hackley, Lipp & Boxtel, 2005). Conductive gel (Ten20 conductive gel) was placed in the electrodes.

Systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were assessed using the Industrial and Biomedical Sensors Corporation pulse/pressure machine (model SD 700A). SBP and DBP were measured by obtaining Korotkoff sounds at the left arm. A 125 millimeter adult blood pressure cuff was used for all participants. Blood pressure was taken according to the American Medical Association standards for blood pressure (Pickering, 2005).

Data Reduction

Raw EMG signals was sampled at 1000 Hz, amplified, and recorded using the BioPac bioamplifier system and BioPac Pro Acqknowledge software. The raw EMG signal was filtered to minimize noise that is above and below the EMG signal frequency band. A 1000 Hz low-pass filter was used and a 5 Hz high pass filter were used. Raw EMG data was then integrated and rectified for later analysis.

Procedure

Participants completed the CMHS, CPD, and Medical History Questionnaire for the online screener survey. Participants meeting the requirements previously stated were invited via e-mail to participate in the laboratory session of the experiment. Upon arrival, participants read
and signed the informed consent form. Next, they completed the BDI-II, STAI, and RFFT.

Before continuing, responses on the BDI-II were checked to ensure participants were not suicidal. The experimenter then placed the blood pressure cuff on the participants’ left arm.

Participants were then prepped for EMG measurements. In order to obtain acceptable impedance levels, the impedance between the skin surface and the conductive surface of the electrodes was reduced by gently removing any make-up, skin oil and dead skin cells with without causing undue discomfort. In order to do this, a small amount of Neuroprep abrasive gel was placed on sterile gauze and rubbed below each eye and forehead (for ground electrode) by the experimenter and wiped clean with a new, clean, sterile gauze and rubbing alcohol. One electrode was placed below the lower eyelid in line with the pupil in forward gaze, and a second electrode was placed approximately 1-2 centimeters lateral to the first. A signal ground electrode was attached to the central forehead (Blumenthal et al., 2005). All impedances were brought below 30 Kohms.

During the first baseline recording, participants were instructed to look straightforward and try to not blink for about 5 seconds. During this time, facial EMG was recorded and checked for noise artifacts such as from the power lines or electrical sources (60 Hz interference), or from other biosignals such as electrocardiogram, or EMG activity from other facial muscles.

Cardiovascular measures of blood pressure and rate were also recorded at this time to serve as a baseline measure. EMG measurement of eye-blink magnitude corresponding to the startle responses were recorded (in microvolts) immediately after each of the 10 startle probes.

Following the 10th and final probe, participants’ headphones were removed; and cardiovascular measures of BP and HR, as well as facial EMG were recorded. The rationale behind this is that the acoustic startles should serve as a stressor. After the post startle probe stressor measurements were recorded, participants answered 2 likert scale questionnaires about the startle probes. Then,
a recovery period lasted 1 minute, after which cardiovascular measures of HR and BP, and facial motor tone (EMG) were recorded again to serve as a baseline measure for the cold pressor condition that followed. During the 1 minute recovery period, participants were instructed to remain in their seat and to relax.

Next, in the cold pressor condition, participants completed a cold pressor task for 45 seconds. Participants placed their left hand in the ice water and were instructed to keep their hand submerged until the experimenter instructed them to remove their hand from the ice water. Participants were allowed to make a fist while submerging their hand in the ice water. Participants were also informed that if the ice water became too uncomfortable, they could remove their hand without any penalty or detriment to the experiment. After 45 seconds of submersion, participants were instructed to remove their hand from the ice water and were given paper towels to dry their hand off. The headphones were then placed on the participants and ten acoustic startle stimuli were then presented through the headphones. Measurement of eye-blink magnitude corresponding to the startle response were made using EMG (in microvolts).

Immediately following the 10th and final probe, cardiovascular measures of BP and HR, as well facial motor tone (EMG) were recorded again. Participants then removed their headphones and completed a second survey. Then, a recovery period ensued lasting 1 minute, after which cardiovascular measures of HR and BP, and facial motor tone was recorded. Participants were instructed to remain in their seat and to relax during the recovery period. Following the final measurement, the blood pressure cuff and electrodes were removed. Participants were debriefed and thanked for their participation.
Results

Statistical Analyses

Separate analyses were performed on the self-report, Acoustic Startle Response (EMG), and Cardiovascular (blood pressure and heart rate) measurements. T-tests were performed to evaluate group differences (high-hostile and low-hostiles) on the self-report measures. All pairwise comparisons were made using Tukey’s Honestly Significant Difference test (Winer, 1971).

Self-Report Measures

All participants ($N = 40$) were undergraduate male students age ($M = 19.3, SD = 0.90$). There was a significant difference between high and low hostiles on the CMHS, $t(1,38) = 16.52, p < .0001$, with high hostiles having higher scores ($M = 32.7, SD = 3.03$) than low hostiles ($M = 16.3, SD = 3.2$). There was no significant difference between high hostiles ($M = 9.75, SD = 2.69$) and low hostiles ($M = 10.10, SD = 2.4$) on the CPD Laterality Questionnaire. Participants included in the experiment did not report significant psychiatric conditions, neurological trauma or major medical disorders on the Medical Health Questionnaire. There was a significant difference between high and low hostiles on the BDI-II, $t(1,38) = 2.92, p <.01$, with high hostiles having elevated depression scores ($M = 10.6, SD = 8.82$) over those recorded from the low hostiles ($M = 4.26, SD = 0.95$). There was no significant difference between high hostiles ($M = 5.35, SD = 5.35$) and low hostiles ($M = 4.65, SD = 2.01$) on the STAI.

Acoustic Startle Response

To analyze the startle response magnitudes, a five factor mixed design analysis of variance (ANOVA) was performed with EMG (mV) as the dependent variable, with Group as the independent factor, Condition (pre and post cold pressor), Location (left and right eye), and
Trial (10 startle probes) as the repeated measures. There was no significant Group X Condition X Location X Trial interaction, $F(9, 342) = 0.68, p = 0.73$.

There was a significant main effect for Group $F(1,38) = 5.86, p < .05$, indicating that high hostiles had larger startle response magnitudes ($M = 0.593$) than low hostiles ($M = 0.405$). A significant main effect for Condition $F(1,38) = 36.02, p < .0001$, indicated that startle responses were higher in the pre cold pressor condition ($M = 0.551$) than after the cold pressor ($M = 0.446$). The analysis revealed a significant Group X Condition interaction $F(1,38) = 7.27, p < .05$. (See Figure 1).

More refined ANOVAs were performed; one comparing groups before the cold pressor and another comparing groups after the cold pressor. These analyses indicated that the high hostile ($M = 0.622$) and low hostile ($M = 0.481$) groups did not differ in their startle response magnitudes before the cold pressor task $F(1,38) = 3.19, p = .08$. However, after the cold pressor, high hostiles had a significantly elevated startle response ($M = 0.564$) over that of the low hostiles ($M = 0.329$), $F(1,38) = 8.58, p < .01$.

To further probe the interactions in the EMG results, separate ANOVAs were performed within each group to determine if startle response magnitudes changed significantly as a function of the cold pressor task. These analyses indicated that the high hostile’s startle response did not change significantly from before ($M = 0.622$) to after the cold pressor task ($M = 0.564$), $F(1,19) = 1.20, p = 0.25$, while the low hostile’s startle response decreased significantly from before ($M = 0.481$) to after the cold pressor task ($M = 0.329$), $F(1,19) = 3.71, p < .0001$.

**Cardiovascular Measures (BP & HR)**

All Cardiovascular data were transformed to a Log based 10 scale to deal with skewedness. Separate four factor mixed design analysis or variance (ANOVAs) were performed
with Heart Rate (HR; Beats Per Minute), Systolic (SBP) and Diastolic (DBP) Blood Pressure (mm Hg) as the dependent variables, with Group as the independent factor, and with Condition and Trial as the within subjects factor.

For HR data, a significant Group X Condition X Trial interaction was not found $F(1,38) = 0.10, p = 0.76$. There was no Condition X Trial interaction, $F(1,38) = 1.2, p = 0.28$ and there was no Group X Trial interaction, $F(1,38) = 0.04, p = 0.84$. There were no main effects for Trial, $F(1,38) = 1.63, p = 0.21$, for Condition $F(1,38) = 2.6, p = 0.11$, or for Group, $F(1,38) = 0.91, p = 0.34$. However, a significant Group X Condition interaction was found, $F(1,38) = 4.67, p < .05$ (See Figure 2).

More refined analyses were performed on the HR data to probe the Group X Condition interaction. A One –Way ANOVA was performed comparing high and low hostiles’ HR before the cold pressor. There was a significant main effect for group $F(1,38) = 37.25, p < .001$, indicating that high hostiles had a significantly higher HR ($M = 1.86$) than low hostiles ($M = 1.82$) before the cold pressor. A One-Way ANOVA was performed comparing high and low hostiles’ HR after the cold pressor. There was no significant main effect for group $F(1,38) = 0.73, p = 0.39$. A One-Way ANOVA was performed to compare high hostiles’ HR before and after the cold pressor. There was no significant main effect for condition $F(1,38) = 0.24, p < .62$, indicating that high hostiles HR did not change significantly after the cold pressor task. A One-Way ANOVA was performed to compare low hostiles’ HR before and after the cold pressor. There was a significant main effect for Condition, $F(1,38) = 7.23, p < .05$, indicating that low hostiles’ HR increased significantly from before the cold pressor ($M = 1.82$) to ($M = 1.85$) after the cold pressor.
For SBP data, a significant Group X Condition X Trial interaction was not found $F(1,38) = 1.11, p = 0.29$. There was no Condition X Trial interaction, $F(1,38) = 0.02, p = 0.88$, no Group X Trial interaction, $F(1,38) = 0.07, p = 0.79$, or Group X Condition interaction $F(1,38) = 1.56, p = 0.22$. There were no main effects for Trial, $F(1,38) = 0.09, p = 0.76$ or for Group, $F(1,38) = 1.15, p = 0.29$. There was a main effect for Condition $F(1,38) = 6.58, p < .05$, indicating that SBP decreased from before the cold pressor ($M = 2.07$) to ($M = 2.068$) after the cold pressor.

For DBP data, a significant Group X Condition X Trial interaction was not found $F(1,38) = 2.24, p = 0.14$. There was no Condition X Trial interaction, $F(1,38) = 0.04, p = 0.84$, no Group X Trial interaction, $F(1,38) = 0.05, p = 0.81$, and no Group X Condition interaction $F(1,38) = 0.06, p = 0.81$. There was no main effects for Group $F(1,38) = 0.08, p = 0.78$, for Trial $F(1,38) = 1.04, p = 0.31$, or for Condition $F(1,38) = 0.01, p = 0.92$.

**Discussion**

The prediction that high hostiles would exhibit a larger startle response was supported with a significant main effect for group. This is consistent with the psychophysiological reactivity model (Smith, 1994) that links hostility to cardiovascular disease. According to this model, hostile persons are more vigilant for conflicts in their environment and have exaggerated physiological responses to a variety of stressors. Previous experiments have generally shown high hostiles, compared to low hostiles, to have increased cardiovascular reactivity to a stressor (cold pressor) (Demaree & Harrison, 1997), but this experiment provided evidence that the exaggerated physiological response occurs on a simple reflex level. This is significant because it demonstrates that although hostility is considered a trait with a strong cognitive component, physiologically, high hostiles’ reactivity to stressors is seen in the startle response, which occurs before cognition and appraisal of the stimulus. On the contrary, changes in heart rate and blood
pressure can typically be felt, cognitively appraised, and even modified with conscious effort for example by breathing deeply. Exaggerated startle responses may also suggest hypereflexia in high hostiles. Perhaps, in high hostiles, other reflexes are also exaggerated which may bear some significance to cardiovascular reactivity.

The hypothesis that the cold pressor would increase startle responses was not supported. Rather, a significant main effect for condition indicated that startle responses decreased significantly after the cold pressor. There are several likely reasons for this finding; all participants completed the cold pressor task after the first series of startle probes. Thus, with the law of initial values in mind, it would be expected that startle response magnitudes would decrease over time with repeated exposure to the stimulus. It may be possible that participants were uncomfortable while they held their hands in the cold pressor and immediately following the completion of the CP they began to recover. Thus, if the startle probes were administered while participants were performing the cold pressor task, startle responses may not have decreased significantly. Significant decreases in startle responses may also be related to expectancies; after the cold pressor, participants were familiar with the stimulus and knew what to expect.

The Group X Condition interaction however, suggests that the interaction was driven by the fact that low-hostiles’ startle response magnitudes decreased significantly as a result of the cold pressor, while high-hostiles startle response didn’t change significantly. Therefore, although there were main effects for Group and Condition, the real finding is that whether or not the cold pressor had it’s intended effect, high hostiles maintained a relatively larger startle response magnitude that failed to habituate significantly like the low-hostiles’ did.
The hypothesis that high hostiles would have a larger startle response at baseline compared to low hostiles was not fully supported. However, the group difference at baseline approached significance ($p = .08$), with high hostiles having a larger startle response. Post hoc analyses supported the hypothesis that habituation deficits would occur in the high hostile group but not the low hostile group; high hostiles’ startle response did not change significantly after the cold pressor while the low hostiles’ startle response decreased significantly. There may be several reasons for this. Previous research from our lab has shown that low hostiles demonstrated cardiovascular stability (Demaree & Harrison, 1997), whereas high hostile men displayed increased cardiovascular reactivity (BP & HR). Although the results from this experiment are not entirely consistent with previous lab findings, it appears that a similar trend occurred here with the startle response instead of cardiovascular measures; namely that high hostiles’ failure to habituate can be seen as physiological reactivity in this case. It could also be argued that the stimulus, in this case the cold pressor, was not effective for the high hostiles, thus provoking no effect. On the other hand, although no significant change was seen after the cold pressor in high hostiles, high hostiles had significantly higher startle responses than low hostiles after the cold pressor. Thus, it could be argued that the cold pressor served to maintain higher reactivity to the startle probes for high hostiles, while actually causing significantly less reactivity to the startle probes for low hostiles. These response patterns have several implications. One, high hostiles’ startle responses remained stable across conditions, indicating a rigid and inflexible physiological response style that could be associated with their high risk for developing cardiovascular disease. Two, low-hostiles’ startle responses decreased significantly after the cold pressor suggesting that they may actually react to stressors with decreased reactivity. This notion is significant for future investigations into hostility, namely because low
levels of hostility may serve as a protective factor. However, less is known about what would lead to this type of physiological reaction. Future investigations should examine if low-hostiles cognitively appraise stressful scenarios differently than high-hostiles, and more importantly, if teaching high-hostiles how to differently appraise stressful scenarios can reduce their physiological reactivity to stress.

It is possible that the cold pressor recruited frontal systems in the low hostiles, leading to habituation, whereas frontal recruitment did not occur in the high hostiles. This would be consistent with our capacity theory (Shenal & Harrison, 2004; Foster et al., 2009; see Carmona et. Al, 2009) which relates the profile of emotional bias and cardiovascular lability seen in high hostiles to diminished right frontal lobe capacity and it’s susceptibility to decompensation. Frontal systems, in particular the cingulate gyrus, mediate the startle response. Thus the cold pressor may have taxed the limited resources of the frontal lobes in high hostiles, leading to elevated reactivity and inefficient habituation. The right hemisphere, and particularly the central nucleus of the amygdala, modulate the startle circuit’s activity (Grillon & Davis, 1995). High hostiles have been shown to have altered right hemispheric functioning (Williamson & Harrison, 2003), with right cerebrum activation in response to pain stress (Demaree & Harrison, 1997). In the current experiment, low hostiles’ startle responses decreased significantly over time despite the cold pressor stressor, while the high-hostiles’ ASR did not. This supports previous research from our lab indicating high-hostiles respond to stressors with right cerebrum activation.

The hypothesis that high hostiles would have larger startle response magnitudes after the cold pressor was not supported. This may be partially explained by the significant difference in levels of depression between the high and low-hostile groups. Previous research shows that individuals with high levels of depression do not show valence modification of the startle
response. In other words, their startle response magnitudes are not potentiated by negatively valenced stimuli. In this case, the high-hostiles were significantly more depressed than the low-hostiles and did not show any significant change in startle response magnitude in response to the cold pressor task, which is arguably a negatively valenced experience.

Hypotheses regarding laterality differences were not supported. Overall, and for group differences, the left and right eye startle magnitudes were not significantly different. This may be the case especially with distal body regions, where laterality differences are minimal (Harrison, 1991). Laterality differences might not be detected in proximal locations. The acoustic startle response engages the entire body and while the eyeblink component is the most reliable and most often measured indicator of the startle response, startle responses could be measured at distal body regions including at the arms and legs. It is possible that laterality differences in the startle response could be detected at these distal locations due to the increasing amount of contralateral organization for distal limbs compared to proximal midline body regions. Future experiments using the acoustic startle paradigm should consider measuring the startle response at distal limbs also because the motor units involved in controlling larger limbs require larger motor units than the orbicularis occuli which may cause laterality differences. Another reason laterality differences were not found is that the startle response is a consensual reflex, thus laterality differences may be difficult to detect in healthy populations such as the sample used in this experiment. It could be too, that although there were no laterality differences, the right brain may be have a more general contralateral and ipsilateral response to startling stimuli. Counter to original hypotheses, the cold pressor did not have an effect on laterality differences either. Harrison (1991) demonstrated that laterality differences are stronger in distal regions of the body.
Hypotheses regarding cardiovascular measures were not fully supported. As predicted, a Group X Condition interaction for HR was found. However, contrary to hypotheses, high hostiles’ HR did not increase significantly after the cold pressor task; instead, the low hostiles’ HR increased significantly after the cold pressor task. These results are not consistent with previous findings from our lab. This finding is also not what would have been expected since the low-hostiles’ startle response magnitudes decreased significantly. Additionally, both groups SBP decreased significantly. With regards to SBP at-least, it may be that, as previously mentioned, the cold pressor recruited frontal resources in the low-hostiles, which may have resulted in lowered SBP, but this would not be consistent with their increase in HR.

Further research on this topic should address the effects of arousal on the startle response. One way this could be done is by including measures of electrodermal activity and heart rate variability measures alongside of heart rate and blood pressure. This would allow a more definitive understanding of the arousal processes and how they relate to the modification of the startle response when other stressors are introduced, such as a cold pressor task. Future experiments could also be performed to investigate the effects of pheromones collected from high and low hostiles. For instance, high hostile pheromones may have the effect of communicating a “threat” in the environment and increase startle response magnitudes while low hostile pheromones may have the opposite effect.
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Appendix A: Cook Medley Hostility Scale (CMHS)

Participant #_________________

C M H S

Direction: If a statement is true or mostly true, as pertaining to you, circle the letter T. If a statement is false, or usually not true about you, circle the letter F. Try to give a response to every statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>T</th>
<th>F</th>
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</thead>
<tbody>
<tr>
<td>1. When I take a new job, I like to be tipped off on who should be gotten next to.</td>
<td></td>
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<tr>
<td>2. When someone does me wrong, I feel I should pay him back if I can, just for the principle of the thing.</td>
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<tr>
<td>3. I prefer to pass by school friends, or people I know but have not seen for a long time, unless they speak to me first.</td>
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<tr>
<td>4. I often had to take orders from someone who did not know as much as I did.</td>
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<tr>
<td>5. I think a great many people exaggerate their misfortunes in order to gain the sympathy and help of others.</td>
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<tr>
<td>6. It takes a lot of argument to convince most people of the truth.</td>
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<tr>
<td>7. I think most people lie to get ahead.</td>
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<tr>
<td>8. Someone has it in for me.</td>
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<tr>
<td>9. Most people are honest chiefly through the fear of getting caught.</td>
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<tr>
<td>10. Most people will use somewhat unfair means to gain profit or an advantage, rather than lose it.</td>
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<tr>
<td>11. I commonly wonder what hidden reason another person may have for doing something nice for me.</td>
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<tr>
<td>12. It makes me impatient to have people ask my advice or otherwise interrupt me when I am working on something important.</td>
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<td>13. I feel that I have often been punished without cause.</td>
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<tr>
<td>14. I am against giving money to beggars.</td>
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<tr>
<td>15. Some of my family have habits that bother me very much.</td>
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<td>16. My relatives are nearly all in sympathy with me.</td>
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<td>17. My way of doing things is apt to be misunderstood by others.</td>
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<tr>
<td>18. I don’t blame anyone for trying to grab everything they can get in this world.</td>
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<tr>
<td>19. No one cares what happens to you.</td>
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<tr>
<td>20. I can be friendly with people who do things I consider wrong.</td>
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<td></td>
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<tr>
<td>21. It is safer to trust nobody.</td>
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<td></td>
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<tr>
<td>22. I do not blame a person for taking advantage of someone who lays himself open to it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. I have often felt that strangers were looking at me critically.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Most people make friends because friends are likely to be useful to them.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. I am sure that I am being talked about.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. I am likely not to speak to people until they speak to me.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Most people inwardly dislike putting themselves out to help other people.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. I tend to be on guard with people who are somewhat more friendly than I had expected.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. I have sometimes stayed away from another person because I feared doing or saying something that I might regret afterwards.</td>
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<td>---</td>
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<td></td>
</tr>
<tr>
<td>30. People often disappoint me.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>31. I like to keep people guessing what I’m going to do next.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>32. I frequently ask people for advice.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>33. I am not easily angered.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>34. I have often met people who are supposed to be experts who were no better than I.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>35. It makes me think of failure when I hear of the success of someone I know well.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>36. I would certainly enjoy beating a crook at his own game.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>37. I have at times had to be rough with people who were rude or annoying.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>38. People generally demand more respect for their own rights than they are willing to allow for others.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>39. There are certain people whom I dislike so much I am inwardly pleased when they are catching it for something they have done.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>40. I am often inclined to go out of my way to win a point with someone who has opposed me.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>41. I am quite often not in on the gossip and talk of the group I belong to.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>42. The man who had the most to do with me when I was a child (such as my father, step-father, etc.) was very strict with me.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>43. I have often found people jealous of my good ideas just because they had not thought of them first.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>44. When a man is with a woman, he is usually thinking of things related to her sex.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>45. I do not try to cover up my poor opinion or pity of a person so that he won’t know how I feel.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>46. I have frequently worked under people who seem to have things arranged so that they get credit for good work, but are able to pass off mistakes to those under them.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>47. I strongly defend my own opinions as a rule.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>48. People can pretty easily change me even though I thought that my mind was made up on a subject.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>49. Sometimes I am sure that other people can tell what I’m thinking.</td>
<td>T  F</td>
<td></td>
</tr>
<tr>
<td>50. A large number of people are guilty of bad sexual conduct.</td>
<td>T  F</td>
<td></td>
</tr>
</tbody>
</table>
Appendix B: Coren, Porac, & Duncan Laterality Questionnaire (CPD)

Participant #: ___________________________

Circle the appropriate number after each item.

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>L</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>With which hand would you throw a ball to hit a target?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>With which hand do you draw?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>With which hand do you use an eraser on paper?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>With which hand do you remove the top card when dealing?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>With which foot do you kick a ball?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>If you had to pick up a pebble with your toes, which foot would you use?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>If you had to step up on a chair, which foot would you place on the chair first?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>Which eye would you use to peep through a keyhole?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>If you had to look into a dark bottle to see how full it was which eye would you use?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>Which eye would you use to sight down a rifle?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>If you wanted to listen to a conversation going on behind a closed door, which ear would you place against the door?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>If you wanted to listen to someone's heartbeat, which ear would you place against his or her chest?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>Into which ear would you place you earphone of a transistor radio?</td>
<td>1</td>
<td>-1</td>
<td>0</td>
</tr>
</tbody>
</table>

# of Right + # of Left = Total Score

_______ + _______ = _________

Is mother right or left hand dominant? __________

Is father right or left hand dominant? __________
Appendix C: Medical Health Questionnaire

Participant #_________________

Medical History Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do you have any history of congenital or developmental problems?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Do you have any history of learning disabilities or special education?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Have you ever suffered a head injury resulting in a hospital stay longer than 24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Have you ever been knocked out or rendered unconscious (more than 5 minutes)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Have you ever suffered &quot;black-out&quot; or fainting spells?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Do you have a history of other neurological disorders (e.g. stroke or brain tumor)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Have you ever received psychiatric/psychological care or counseling?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Have you ever been hospitalized in a psychiatric facility/hospital?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Have you ever been diagnosed with a psychiatric/psychological disorder?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Have you ever been administered any (neuro)psychological tests or measures?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Do you have a history of substance abuse or alcohol abuse?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Do you have a history of high blood pressure?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Do you have any uncorrected visual or hearing impairments?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Are you able to read, write, and speak English effectively?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Do you consume three or more alcoholic more than two nights a week?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Have you ever experienced a medical or psychiatric condition that could potentially affect cognitive functioning, such as stroke,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>electroconvulsive treatment, epilepsy, brain surgery, encephalitis, meningitis, multiple sclerosis, Parkinson's Disease,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Huntington's Chorea, Alzheimer's dementia, Schizophrenia, Bipolar Disorder?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Have you ever used smoked or used tobacco products?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Do you use any unprescribed or &quot;illegal/street&quot; drugs?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are you taking any of the following medications: antidepressant, antianxiety, antipsychotic?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Are you taking any allergy or cold medication?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MORE ON NEXT PAGE-------------------------------------------------→

If you answered “yes” to any of the above please explain fully:

________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
Appendix D: Ruff Figural Fluency Test (RFFT)

Participant#________

Part 1
Part 2
Part 3
Appendix E: Beck Depression Inventory (2nd ed.) (BDI-II)

Participant#________________

Instructions: This questionnaire consists of 21 groups of statements. Please read each group of statements carefully. Pick out the one statement, in each group, that best describes the way you have been feeling during the past two weeks, including today. Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest numbered statement of that group. Be sure that you do not choose more than one statement for any group, including statement 16 (Changes in Sleeping pattern) and statement 18 (Changes in Appetite).
Appendix F: State Trait Anxiety Inventory (STAI)

Participant# __________

<table>
<thead>
<tr>
<th>SELF-EVALUATION QUESTIONNAIRE</th>
<th>STAI Form Y-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please provide the following information:</td>
<td></td>
</tr>
<tr>
<td>Name __________________________</td>
<td>Date __________ S</td>
</tr>
<tr>
<td>Age __________ Gender (Circle) M F T</td>
<td></td>
</tr>
<tr>
<td>DIRECTIONS: Anumber of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate circle to the right of the statement to indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.</td>
<td></td>
</tr>
<tr>
<td>1. I feel calm __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>2. I feel secure __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>3. I am tense __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>4. I feel strained __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>5. I feel at ease __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>6. I feel upset __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>7. I am presently worrying over possible misfortunes __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>8. I feel satisfied __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>9. I feel frightened __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>10. I feel comfortable __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>11. I feel self-confident __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>12. I feel nervous __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>13. I am jittery __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>14. I feel indecisive __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>15. I am relaxed __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>16. I feel content __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>17. I am worried __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>18. I feel confused __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>19. I feel steady __________________________</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>20. I feel pleasant __________________________</td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>
# SELF-EVALUATION QUESTIONNAIRE

**STAI Form Y-2**

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
</table>

**DIRECTIONS**

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate you *generally* feel.

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. I feel pleasant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I feel nervous and restless</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I feel satisfied with myself</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. I wish I could be as happy as others seem to be</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>15. I feel like a failure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. I feel rested</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. I am “calm, cool, and collected”</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>18. I feel that difficulties are piling up so that I cannot overcome them</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. I worry too much over something that really doesn’t matter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. I am happy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. I have disturbing thoughts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. I lack self-confidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. I feel secure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. I make decisions easily</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. I feel inadequate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. I am content</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Some unimportant thought runs through my mind and bothers me</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. I take disappointments so keenly that I can’t put them out of my mind</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. I am a steady person</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. I get in a state of tension or turmoil as I think over my recent concerns and interests</td>
<td></td>
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</tr>
</tbody>
</table>
Figure 1. Startle response magnitude (mV) in High and Low Hostiles before and after a cold pressor task.
Figure 2: Heart Rate (BPM) log 10 in High and Low Hostiles before and after the cold pressor task and startle probes.