The influence of lateralized stressors on cardiovascular regulation and perception in high and low hostile men

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(Abstract)

The influence of hostility on the lateralized tasks of cardiovascular regulation, verbal fluency, nonverbal fluency, and dichotic listening was assessed. Twenty-four subjects divided into two groups, high- and low-hostile men underwent physiological measurements of SBP, DBP, and HR before and after verbal and figural fluency tasks, which were used as stressors. In addition, subsequent to the administration of each fluency task, dichotic listening performance was evaluated across unfocused, focus left, and focus right trials.

It was expected that high-hostile men would produce results indicative of differential right hemisphere activation when compared with low-hostile men. In addition, it was predicted that high-hostile men would display a weakness in both the performance of the right-frontal nonverbal fluency task and in their ability to maintain relative cardiovascular stability subsequent to the presentation of that stressor. As predicted, high-hostile men produced more perseverative errors than did low hostile men on this task. Further, subsequent to administration of the nonverbal fluency task, high-hostile men produced a reliable increase in blood pressure when compared to baseline and to low-hostile males.

Differences in dichotic listening performance were also expected as a function of the fluency tasks. It was predicted that high-hostile men would evidence a priming effect in that a left-ear bias would be detected after the nonverbal fluency task but not the verbal fluency task. This was indeed the case. However, interestingly, the low-hostile men also displayed a priming effect at the left ear during the nonverbal fluency condition. Results are discussed within the context of the functional cerebral systems of emotion and arousal. Implications for further research are explored.

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Introduction

The current state of literature on emotion and arousal indicates that they are best considered as separate constructs. However, recent research points to an integration of these constructs within the framework of functional cerebral systems theory. On a behavioral level of examination, research from this vantage point has produced data demonstrating a close association between the relative intra and inter-hemispheric activation states of emotion and arousal. On a neurobiological level, researchers consistently include the same, and closely related, cortical and subcortical structures in descriptions of autonomic and emotional systems.

Functional cerebral systems theory, a product of the Russian neurologist, Alexander Romanovich Luria (1966), provides a dynamic framework with excellent explanatory value and testability. It promotes the systematic exploration of functional interactions within the nervous systems. To some extent, this approach has been carried out within both the emotion and arousal literatures. The association of different parts of the limbic system with emotional processing, and the mapping of the parasympathetic and sympathetic ganglia and innervations in the periphery are exemplars of integrated systems.

However, the application of this theoretical approach is incomplete. How the brain processes and acts on emotion, arousal, and various other processes, is an active, cutting edge area of research at the present time. Current issues that remain unresolved include the lateralization of autonomic nervous system control within the CNS, the lateralization of emotion, anterior-posterior inhibitory and excitatory relationships relative to sensorimotor functions within these constructs, relative activation states both inter- and intra-hemispherically, and how cerebral systems interfere and prime other systems.

Localization and lateralization of arousal

Issues of localization and lateralization within the functional cerebral systems of arousal have received a degree of attention within recent history. There are several factors of concern when exploring these systems. One of these factors is that of laterality, and another factor is that of anterior-posterior relationships. Recently, cerebral laterality of autonomic nervous systems has been explored by a number of researchers. However, the anterior-posterior relationships that were of interest in earlier research on arousal have been neglected.

In consideration of these systems it is useful to examine the classical arousal literature, which focused on diffuse efferents projecting from the reticular activating formation in the myencephalon. Stimulation of the reticular formation in the brainstem is the basis of classic arousal theory. Such stimulation has been associated with arousal in many forms including: cortical arousal as indicated by desynchronized EEG (Morruzzi & Magoun, 1949), behavioral arousal (e.g. wakefulness), and peripheral arousal (e.g. sympathetic arousal) (Lindsley, 1960). Similarly, deactivation of this system is associated with sleep, or coma, and large amplitude, irregular slow waves.

However, the reticulo-cortical activation/deactivation relationship has come under scrutiny (as illustrated by Lacey & Lacey, 1970). For example, as Vanderwolf & Robinson (1981) point out, a sleeping animal may have high frequency, low amplitude

EEG as in paradoxical, or REM, sleep and a waking animal may have low frequency, high amplitude EEG, as would be expected in deep sleep. Similar to Lacey (1967) fractionation is observed as Vanderwolf & Robinson (1981) conclude that neocortical slow wave activity is not well correlated with arousal level or consciousness and that the states of sleep and waking are not dependent on the integrity of the cerebral cortex or of the ascending reticulo-cortical projections. However, localization of cortical activity is not discussed, and a dated view of sleep is espoused.

The electroencephalogram research, used by many fractionation researchers, is a good source for contradictory information. The magnitudes of different bandwidths of EEG vary significantly across electrode sites, across individuals, and across tasks. In sleep during the REM cycle, selective alpha suppression is evident across the occipital regions (Cantero et al., 2000). In the waking brain, alpha suppression occurs upon eyes open conditions more sharply at occipital electrode sites (Hugdahl, 1998).

Further, it is an error to assume that sleep is an inactive state. Reticular activity has been proposed as a mediator of paradoxical sleep. This relationship has been demonstrated in cats with reticular formation activity implicated in the generation and maintenance of paradoxical sleep via control of neurotransmitter release (Rodrigo-Angulo et al., 2000).

Subsequent to brain damage and in cases of behavioral slowing high magnitude localized delta activation is observable in the waking brain. Fernandez-Bouzas et al. (1995) consistently found that brain maps analyzing the delta band were better at detecting lesions than maps analyzing other bandwidths. In other words, localized delta activity by electrode site is associated with underlying pathology in the represented brain regions. The level of delta activity also has important implications. In comparative research on rats it has been demonstrated that severity of neural damage is correlated with the relative power of the EEG delta band evident (McDonough, et al. 1998). These results lend credence to the view that delta bandwidth activity is indicative of inactivity. It is important to note that delta activity varies across electrode sites in the brain as a function of many factors including reticular formation activity, brain damage, the intake of chemicals (barbiturates), and localized seizure activity.

The reticulo-cortical relationship involves extensive interconnections with the anterior cerebral regions. Isaac (1960) introduced the idea of the frontal lobes as an "arousal inhibitor." This is consistent with other inhibitory functions associated with frontal lobe functions (e.g. effortful control from the developmental literatures, inhibition of saccadic eye movements, etc. . .). An interesting supposition, put forth by Isaac (1960), was the idea that any activity that reduces reticular formation activity would improve a deficit elicited by prefrontal lobectomy.

One way of reducing reticular activity is by reducing sensory input. Malmo (1942) found that when testing prefrontal lobectomized monkeys in normal and less than normal illumination levels; performance was superior in the low-light condition. In a dark illumination condition, Isaac & Devito (1958) found that the activity level of pre-frontal lobectomized monkeys and normal monkeys was equalized.

However, in current autonomic asymmetry research, the anterior cerebral regions' inhibitory function has largely been ignored. The literature on the localization of autonomic control on the level of the cerebral hemispheres seems to be limited to laterality. Hugdahl (1998) reviews literature delineating sympathetic control of the autonomic nervous system to the right hemisphere. Heller, et al. (1990) demonstrated sympathetic arousal in humans with stimulation of the right hemisphere with a visual half-field methodology. Hachinsky et al. (1992), with experimentally elicited strokes in rats, demonstrated right-hemisphere lateralized sympathetic arousal through an impressive array of physiological indicators including heart rate, blood pressure, plasma epinephrine and norepinephrine. Norepinephrine is the post-ganglionic neurotransmitter of the sympathetic nervous system (except for the sweat glands, where acetylcholine is the post-ganglionic neurotransmitter).

In a series of experiments Werner Wittling has attempted to demonstrate lateralized preferential control of the autonomic nervous system. Wittling et al. (1998) demonstrated cerebral laterality in sympathetic nervous system control using lateralized film presentations for selective hemispheric stimulation and impedance cardiography in the evaluation of cardiac output, systolic time intervals, and myocardial contractility.

Tachistoscopic presentations of visual stimuli are a common way to assess laterality. However, Wittling et al. (1998) modified the standard administration of this task to make it even more focused. Specifically, they implored a technique that fades out the portion of the visual presentation that is represented in the fovea, eliminating bilateral visual processing. This is done through the use of an oculometer combined with a computer, which controls the location of the masking stimulus (a gray area on the visual stimulus). For a review of this technique see Wittling, 1990.

Wittling et al. (1998) argue that right-hemisphere stimulation has a stronger influence on the heart's pump capacity, which leads to higher output performance. Contractility was found to be clearly higher during sensory stimulation/presentation to the right hemisphere when compared with the left hemisphere stimulation/presentation. This is consistent with other research that has localized cerebral sympathetic control to the right hemisphere. Yoon et al. (1997), using a sodium amobarbital injection procedure (Wada Test) found an increased low frequency/high frequency ratio (heart rate variability) subsequent to inactivation of the left hemisphere. They argued that this was representative of greater right hemispheric dominance in the sympathetic modulation of cardiovascular activity.

Further, electrical stimulation studies support the notion of cerebral lateralization of autonomic control based on the two major divisions, sympathetic and parasympathetic. For instance, electrical stimulation of the right insular cortex in humans results in tachycardia while stimulation of the left insular cortex results in bradycardia (Oppenheimer et al. 1992). In a study examining neurotransmitter correlates, it was demonstrated that cortisol secretion, an indicator of global sympathetic activity, corresponds with right hemisphere stimulation (Wittling & Genzel, 1995). Functional Magnetic Resonance Imaging has been used to explore individual factors relating to ANS arousal. For example, Critchley et al (2000) found increased right inferior parietal activity in conjunction with increased skin conductance. This result provides consistency with the cardiovascular research and notion of right hemisphere dominance in sympathetic control.

Control of the branches of the autonomic nervous system appears to be divided in responsibility with sympathetic regulation, a task of the right hemisphere, and parasympathetic regulation, a task of the left hemisphere. This relationship is somewhat counterintuitive given that, at the level of the brain stem, both sides have parasympathetic and sympathetic fibers that are specialized for different aspects of parasympathetic and sympathetic functioning. It was commonly thought that the brain probably held to these same lateralizations (Lane & Jennings, 1995). However, the aforementioned research and the preceding research are counter to that notion.

Wittling et al. (1997) demonstrated cerebral asymmetry in parasympathetic control of the heart. Again, using a lateralized film presentation with an electronically controlled foveal vision block as the independent variable manipulation, cerebral asymmetry of autonomic control was examined. In this experiment, power spectral analysis of heart rate variability was used as the dependent variable. They found higher parasympathetic activity subsequent to stimulation of the right visual field. Further, it was demonstrated that cortisol secretion, an indicator of global sympathetic activity, corresponds with right hemisphere activation, providing consistency with the notion of right hemisphere dominance in sympathetic control. Wittling et al. (1997) conclude from their series of studies that the right hemisphere modulates the entire range of sympathetic activity, and that it is also likely that the left hemisphere modulates the entire range of parasympathetic activity.

While researchers continue to refine the cerebral lateralization of autonomic nervous system control, it seems necessary to re-introduce the concept of frontal lobe inhibition of autonomic nervous system functions. These relationships have heretofore been lost in the conceptualizations of prominent researchers in the arousal literature. It is also an area of study that is not well specified. While older research clearly illustrates the inhibitory function of the frontal lobes as a moderating influence on the production of arousal, these relationships have not been demonstrated at the level of the telencephalon.

Everhart (2001) and Williamson & Harrison (2003) have attempted to explore anterior inhibitory relationships in the modulation of autonomic arousal. Consistent with other researchers in the emotion literature (Heller et al. 1997), they support the notion of post-central hemispheric asymmetry in the modulation of lower systems involved in arousal. However, they have attempted to re-introduce anterior inhibition of posterior systems involved in autonomic nervous system regulation. Methodologically, this is more complex than the examination of laterality. It is not currently feasible to anesthetize the anterior left or right cerebral regions as it is with the hemispheres (Wada Test). However, another approach is to examine dual task performance as a function of cerebral distance.

Dual task research can potentially provide a powerful framework for the evaluation of the functional cerebral systems in arousal. Distributed attention among concurrent activities has been a topic of concern and debate within cognitive psychology for decades. This is also true of the neuropsychological approaches to brain-behavior relationships. Filimonov (as cited in Luria, 1966) presented the concept of graded potentials, which he related to functional pluriopotentialism. To summarize, he postulated that no cerebral formation is responsible for one unique task, and that the same tissue carries out multiple tasks.

Relatedly, Kinsbourne and Hicks (1978) proposed the concept of functional cerebral space. Essentially, the extent of inhibitory interference of one task on others varies inversely with the functional distance between the cerebral regions involved with the performance of each task. A pattern of activation in any one region may spread throughout much of the cerebral cortex via the cellular network that unifies the entire cortex (Purpura, 1967).

The interconnection that allows for efficient communication between similar neural patterns makes it difficult to perform two activities within proximal functional space, concurrently. It is thought that interference occurs when concurrent tasks are attempted that compete for similar or adjacent cerebral areas within the same hemisphere (Everhart, 2001). Although controversial, Kinsbourne's model has been successfully applied to the study of concurrent activities.

A relatively new approach (e.g. Everhart 2001; Williamson & Harrison, 2003) is to view the ANS as an active functional cerebral system, rather than a system to be activated. ANS control is an ongoing process, always on, and in so being, may be interfered with and, in turn, may interfere with proximal and integrated systems. Williamson & Harrison (2003) and Everhart (2001) used lateralized frontal stressors to interfere with ongoing mediation of cardiovascular activity. Both Williamson and Harrison (2003) and Everhart (2001) explore anterior-posterior arousal relationships within the functional context of emotional traits.

The re-introduction of anterior-posterior inhibitory relationships to the arousal literature provides for unique hypotheses as far as the current state of the literature would reflect. For example, this vantage point may be useful both as an explanatory tool as well as guiding future research ideas within the domain of research that uses traditional stressors like the cold-pressor task or the hand dynamometer paired with arousal indices.

While some researchers do argue that arousal systems are functionally independent of emotion (Wittling, 1998), there are many indisputable parallels between the functional output of autonomic nervous system control and emotional behaviors such as expression, experience, and perception.

Emotion

Emotional experience is not unique to the human condition. Animals display behaviors consistent with a fear-response when confronted with a threatening situation just as humans do. This comparative experience implies, on some level, comparative structure, and, on another level, begets the question of definition. It is important to note that emotions like fear, anger, sadness, and happiness, are constructs describing rather large subsets of behavior. Ohman (1985) defines emotion, for example, as a "flexibly organized ensemble of responses, which uses whatever environmental support is available to fulfill its biological function."

This is a noticeably loose definition. It has to be with constructs like emotional memory (Fornari et al., 2000), expressive aprosodia and receptive aprosodia (Ross, 1981) emotional intelligence (Goleman, 1995), approach and withdrawal (Davidson 1998), and terms like melancholy, wistfulness, euphoria, mirth, and doldrums floating around in the collective consciousness of researchers and the lay-public. However, there are enough constants within the literature from which to make general and very specific predictions of function.

From an evolutionary perspective emotions reflect, to some extent, the function of older mechanisms. Telencephalic structures like the amygdala (Davidson et al. 1999), cortex (Heilman & Gilmore, 1998), septal region (Thomas & Evans, 1983), and basal ganglia (Gray et al., 1997) have been the recent focus of explanations of human emotion. However, older structures (thalamus, hypothalamus, and reticular formation), often associated with cognition, attention, and arousal (Tucker et al., 2000), have also been associated with the processing of emotional experience and production of emotional behaviors.

Relatedly, Jackson (1879) introduced the principle of hierarchic integration through inhibitory control. Specifically this precept refers to the modulation, inhibition, and elaboration of older brain mechanisms, rather than the replacement of said mechanisms. This type of relationship is clearly demonstrated in the arousal literature by Isaac (1960) with frontal lobe inhibition of the reticular formation. The point being that emotional processes are predicated on integrated functional systems. Cortical relationships with brain stem and subcortical processes, as well as peripheral innervations are all necessary for the normal production of emotional behaviors. It seems to be the consensus of many theorists that the cortex plays a predominant role in the regulation of emotional systems (Tucker, 2000; Heilman & Gilmore, 1998). This relationship makes it possible to make behavioral and functional (ANS etc. . .) predictions based on relative activation states of the higher order structures.

Accordingly, Tucker et al. (2000), who conducted an extensive review of emotional brain systems, states that emotion is comprised of specialized neurophysiological subsystems in the control of motor, autonomic, and sensory processing. Further, they propose that in order to supply a coherent theory of emotion, that it is necessary to understand how these subsystems are coordinated by higher-level structures (telencephalic) to produce emotional states.

Of the higher order theories, there are several pertaining to cerebral lateralization and localization of emotion. Tucker and Williamson's seminal work (1984) postulates right hemisphere dominance in the processing and expression of negative emotions and left hemisphere dominance in the processing and expression of positive motions. What was proposed was an interhemispheric balance model. Simply stated, greater right hemisphere activation relative to the left yields a negative emotional state and greater left hemisphere activation relative to the right yields a positive emotional state. More recently Tucker advocates a vertical integration of emotional behavior from the brain stem up through limbic systems from which, through the amygdala, extensive temporal lobe interconnections are evident. Also, Tucker (1993) emphasizes the role of cortical operations within integrated functional systems. His supposition is that the subcortical systems function in support of cortical operations (Tucker, 1993).

Tucker has extended his theoretical position to many areas of emotional processing; however, one particularly interesting study involved the examination of depression through the lateralized presentation of auditory sounds (dichotic listening task). It was demonstrated that depressed individuals show impairment on left ear presentations. The author, given the supposition of negative emotional processing being in some part a function of right hemisphere systems, expected this. However, it is somewhat counter to Tucker & Williamson's (1984) idea of interhemispheric balance. With increased activity of the right hemisphere, it seems more likely that a left ear advantage would be evidenced as it is in hostility research (Demaree, 1997). Consistent with the results in the depressed subjects, it was demonstrated that normal subjects, through induction of a depressed mood, also displayed the degraded left ear performance (Tucker, 1981; Liotti & Tucker, 1992).

Tangentially, but of particular import to the conduction of research within these theoretical domains, Tucker et al. (1999) brings up an important issue in testing relative activation patterns in individual differences research. He asserts that "metric sensitivity" of different testing instruments may create an illusion of specific impairment, or differential activation. In other words, using testing instruments that are not psychometrically equivalent may yield results that are indicative of test material characteristics rather than the constructs assessed by the testing tools.

Tucker cites a study, testing this argument by comparing verbal and visuospatial skills in patients with affective disorders (Miller et al., 1995). Using comparative norms depressed patients performed poorly on both tasks, but when compared to each other, depressed subjects demonstrated a significantly greater impairment on the spatial localization task than the verbal naming task. Again Tucker (1999) asserts that this is evidence of a right hemisphere deficit in depressed persons. Methodologically, it is admirable to use psychometrically equivalent tasks, however, it is also important, especially given the topic of study, that functional equivalency is considered. In this particular example, the spatial localization task is a right post-central task, and the verbal naming task a left hemisphere task. The verbal naming task, arguably, involves a greater portion of cerebral space in the left hemisphere (frontal and post-central tissue) than the visual spatial task. This makes interpretation of right hemisphere versus left hemisphere deficits in depression difficult to conclude as patterns of relative activation as a function of mood might produce different results with differentially lateralized tasks (verbal and nonverbal fluency for example).

Tucker's construct of balance has been adopted by other researchers in the description of functional cerebral systems of emotional processing. Heller (1993) proposed another influential neuropsychological theory of emotion. Heller breaks down emotion into experiential and perceptual processes. This theory specifies both inter- and intra- hemispheric relationships as important in the differentiation of both affective valence and emotional behavior. Consistent with other theories (Fox & Davidson, 1984; Davidson, 1992) relative activation of the right frontal region in comparison to the left frontal region is associated with a negative emotional state. Relative activation of the left frontal region relative to the right is a positive emotional state.

By Heller's account, emotional valence is determined by relative activation of the frontal lobes. Arousal is determined by activation of the right parieto-temporal cortex. The level of arousal activation, according to Heller, influences the type of emotion expressed or experienced within a valence. For example, increased relative activation of the right frontal area to the left frontal area, combined with right parietal temporal activation is anxiety. The same frontal relationship with a decrease in right parieto-temporal activation is depression. Heller attempts to integrate arousal theory into what amounts to a quadrant model of emotional functioning. However, her theory neglects the left parieto-temporal areas contribution to the arousal dimension. According to Heilman and Valenstein (1993), Heller's model cannot account for emotions such as anger. This seems to be a factor of over simplicity with relative activation patterns only described across three brain areas.

Neuropsychological models of emotion vary in specificity and in focus. Some suggest general interhemispheric relationships (Tucker & Williamson, 1984) while others propose intra- and inter-hemispheric interactions (Heller, 1993). Code (1986) reviewed research on the evolution of neurological theories of emotion at the time. One model, the right hemisphere model, is purported to be inclusive of both positive and negative emotions. It specifies the right hemisphere as dominant in the processing of all emotion. Heilman and Valenstein (1993) offer some useful precepts along with this perspective.

Heilman and Valenstein (1993) state that there are four determinants of emotional experience. The first is emotional cognition. Iwata et al. (1986, as cited in Heilman & Valenstein, 1993) suggest that cognitive interpretation of stimuli helps determine the qualitative nature of the emotional experience, including its valence. This may seem paradoxical given the overall theoretical idea that negative and positive emotions are both preferentially processed in the right cerebrum. However, it is important to note that emotional cognition, as contextually defined by Heilman and Valenstein (1993), is not the same thing as self-talk cognitions that are generally discussed within the cognitive-behavioral theoretical perspectives (Bandura, 1997).

The second determinate, or functional system, is arousal level. Most theories of emotion include physiological arousal as a driving component, even as far back as James (1884) original treatise on the origins of emotional experience. While it is easy to find research that just focuses on arousal, such is not necessarily the case with emotion. In general, positive and negative emotions can be linked to level of arousal, low or high.

The third determinate is motor intension-activation. Heilman & Valenstein cite the right cerebrum's role in excitation in regards to motor activation as important to the expression of emotion. Many theories in the cognitive literature only address the experience of emotion as a passive system, however, neuropsychological models tend to include expression. This is natural given the prevalent use of case-study methodologies in neuropsychology. Expressive disorders of emotion are readily observable with certain types of brain injury (Williamson et al. 2003).

The fourth component cited is approach-avoidance. Relatedly, Fox and Davidson (1984) present a view of emotional expression with emphasis on right and left frontal modulation. Much of Fox's work has consisted of developmental EEG research. Specifically Fox infers right and left frontal activation from localized alpha suppression. Two constructs are proffered as indicative of left versus right frontal activation respectively, approach and withdrawal.

Approach and withdrawal behaviors, as recently conceptualized (Fox et al. 1996), refer to social interactions. Approach behaviors are associated with positive affect and withdrawal behaviors are associated with negative affect. These behaviors are evident, at least in some form, as early as infancy. Most of the EEG research quoted from Fox's lab involves the comparison of baseline EEG patterns. Groups are selected based on a variety of indicators to fall within positive and negative emotionality categorizations. In one study, with a group selection criteria of motor reactivity and a disposition component (assessed through parent report and observation) infants with high motor reactivity and a disposition towards negative affect were found to be more likely to evidence greater right frontal EEG asymmetry supporting the notion of right frontal mediation of negative emotion (Calkins et al., 1996).

In another study, with implications for the extent of behavioral generalization of Fox's constructs from EEG records, it is demonstrated that resting frontal EEG asymmetry and social behavior during peer play was related to the occurrence of maladaptive behavior in preschool aged children. Specifically high sociable children that exhibited greater right frontal EEG asymmetry were more prone to externalizing behaviors, and shy children with this same right frontal EEG asymmetry were more likely to show internalizing problems (Fox et al., 1996). Apparently, frontal EEG asymmetry does not differentiate between highly sociable and shy children. Fox et al. (1996b) claim that resting frontal asymmetry within the Alpha band may be a marker for certain temperamental dispositions.

One criticism of this line of research is the use of Alpha suppression to indicate brain activity. There is more support in the literature for using alpha measures over post-central tissues than over pre-central tissues. Some researchers question the validity of Davidson's work on frontal alpha. However, the lateralization of EEG patterns still is consistent with the notion of right hemisphere dominance in the processing of negative emotions. For example, Crawford et al. (1996) found that self-generated happy emotions did not produce as much activation as measured by low alpha activity in the right parietal region as did negative emotions.

Thus far emotional theories have been discussed from the vantage point of a deceptively simple dichotomy, positive and negative. However, this dichotomy trivializes the complexity and range of emotional intensity, expression, and perception, and skirts across issues of nuance. Factor analytic studies have demonstrated that, given a large enough range of emotional descriptors that two dimensions do, in fact, arise, valence (positive and negative) and arousal (calm and excited) (Mayer & Gaschke, 1988; Watson & Tellegen, 1985), which may be part of researchers' focus on these two issues. However, very specific disruptions in emotional processing can occur. For example, gene carriers of Huntington's disease, prior to onset of overt symptoms, evidence a deficit in the perception of affective faces compared to those that do not carry the dominant gene. However, this deficit was only elicited within a very narrow band of negatively valenced affective faces, namely disgust (Gray et al., 1997).

This makes it plausible to make specific functional predictions based on differentiated emotional systems. In general, the functional cerebral systems of negative emotions are clearer than those of positive emotions. Recent research has shown that negative emotions do tend to co-vary with one another. For example, Shenal and Harrison (1998) demonstrated that high-hostile males reported more depressive and anxious symptomatology than low-hostile males. The co-morbidity of anxiety and depression has been well documented within clinical populations (Wittchen et al., 2001; Alloy, 1991; Mineka et al., 1998; Swendsen, 1997). It is thought that relative activation of the right frontal lobe produces negative affect (Fox & Davidson, 1984). This co-variation is functionally implied by research on functional cerebral systems of depression, hostility, and anxiety.

Neuropsychologically, it is important to note that terms such as depression and anxiety are theoretically cumbersome. For example, Shenal (1999) proposed that different relative activation and deactivation patterns within the brain might produce symptoms consistent with a diagnosis of depression. A left frontal depression would be characterized by low arousal, and reduced verbal fluency, whereas patients with right frontal damage often present emotional regulation problems and lability for crying (Wilson, 1924). Though the symptomatology might lend to a categorization of depression, the actual behaviors appear quite different. For example a change in appetite is considered a possible symptom of depression (DSM-IV, 1994). An increase in appetite might indicate one possible activation pattern whereas a decrease would indicate another. This has important implications for classification systems and future research directions. Currently diagnostic categories in use in psychology have produced neuropsychologically inconsistent categories.

This co-variation and acute specificity evident in emotional processing brings questions of functionality to the forefront. One possible way the brain might process emotion is the presence of specialized systems. A system might exist for fear, anger, anxiety, and so on (Adolphs et al., 1996). This supposition begets the assertion of functional independence, meaning that each emotion is uniquely mediated. However, another possibility is that emotional systems are interconnected. Mediation of one emotion may also reflect mediation of other emotions, and may also involve nondevoted systems. This involvement of nondevoted systems is consistent with a dimensional view of emotion (Heilman, 1997). Specifically, emotional experience can be divided into a number of dimensions (arousal, valence, approach and avoidance, and so on).

Heilman (1997) offers the excellent analogy of a violinist within an orchestra. Heilman dubs his emotional perspective, modular theory. By modular, it is meant that a system works independently. However, this does not mean that they are not, or cannot be, influenced by other systems. In fact, the assertion is that anatomically distributed modular networks mediate conscious experience of emotion. A network (orchestra) is a set of modules (violinists) necessary for predicting behavior or experience. Already referenced within earlier works, Heilman (1997) proposes three major modules; valence, arousal, and motor activation. Functionally, then an emotion is the aggregation of the output of integrated functional systems.

Through the exploration of functional cerebral systems of specific emotions or states, it is possible to make predictions on other similarly valenced systems. For instance, research on hostility and anger has shown that several brain areas are integral. Specifically, the orbital frontal cortex has been implicated in the expression of anger.

Supporting this notion of the involvement of this region in anger, increasing intensity of angry facial expressions is associated with increased activation of the orbital frontal cortex (Blair, et al. 1999). Specifically, using Eckman and Freisen's (1978) standardized set of pictures of facial affect, it was found that in healthy males, perception of angry facial expressions is associated with an increased glucose metabolic rate in the right orbital frontal cortex. Interestingly, the differentiation and similarity between processing sad and angry affective pictures in glucose metabolic rate was demonstrated across regions. While angry faces elicited right orbital frontal activation, sad faces did not. Sad faces and angry faces did both elicit activation in the anterior cingulate cortex and the right temporal pole, demonstrating a right hemisphere dominance in processing both sets of negative affective information.

Further supporting the notion of orbital frontal cortex activation in anger, Dougherty et al. (1999) demonstrated activation in this area subsequent to anger induction. However, it is important to note that, in this particular study, the activation was in the left orbitalfrontal cortex. This may be a function of the methodology used in the anger induction (auditorally presented scripts). Though, it is not entirely clear what relationship induction method has with activation of functional cerebral systems associated with emotion. In this particular study, in terms of laterality, it is difficult to discern the impact of the use of language as an induction technique for anger.

Further elaborating this system of hostility, the orbital frontal cortex exhibits intimate connections with the post-central fissure subcortical structure, the amygdala (Kandel, 1991), a component of the basal ganglia and the limbic system. Amygdalar projections to the temporal cortex are also evident as part of this system. The dorsolateral prefrontal cortex and the anterior cingulate cortex appear to have a role in the expression of hostility. Davidson et al. (2000) state that abnormalities in any of these regions, or within their interconnections, are associated with failures in emotional regulation and also increased propensity for impulsive aggression and violence.

Activation in right-post central structures has been associated with anger. Specifically, regional brain activity, as measured by PET scan, has implicated the right temporal lobe as active subsequent to anger induction (Kimbrell et al., 1999). Using a scripted anger induction technique, Dougherty et al (1999) demonstrated increased regional brain activity at the right temporal lobe during anger. Electrical stimulation studies in animals also support the notion of right post-central activity in anger. In rats, electrical stimulation of the amygdala elicits aggressive vocalizations (Blanchard & Blanchard, 1972).

An anterior posterior inhibitory model of hostility has been explored systematically that specifies intrahemispheric deactivation of the right frontal lobe relative to the right post-central tissue in the elicitation of hostility and possibly fear (Demaree & Harrison, 1997, Everhart, 1997, Williamson & Harrison, 2003). The current model of negative emotion that our lab (Demaree & Harrison, 1997; Everhart, 1997; Herridge et al., 1997) is working from is a right hemisphere anterior-posterior inhibitory model. Frontal regions are thought to be inhibitory over the posterior regions (e.g. the subcortical amygdaloid bodies). In negative emotional states a relative interhemispheric dominance is thought to exist with the right hemisphere relatively more aroused than the left hemisphere. This is important, in that relative deactivation of the right-frontal lobe, as argued, is only relative to the post-central structures, and does not indicate lateralized relationships.

In hostility, a relative intrahemispheric activation state is hypothesized with right frontal deactivation compared to right temporal activation. Similarly, a relative intrahemispheric activation state of left frontal deactivation compared to left temporal activation is, arguably, the relationship in the absence of hostility. Davidson et al. (2000b) supports this notion arguing that the mechanism underlying the suppression of negative emotion is via an inhibitory connection from regions of the prefrontal cortex, possibly the oribitofrontal cortex, to the amygdala.

From this model, a functional cerebral systems program of research examining sensory and motor function in high and low hostile males has been useful. It was expected that the results of this approach would support the supposition of greater right versus left cerebral activation, and the relative intrahemispheric activation pattern of right frontal deactivation relative to right post central activation.

The primary projection area for vision is the occipital cortex, specifically, Broadman's area 17, with secondary (area 18) and tertiary (area 19) association areas surrounding it. Lateralized differences between males designated high-hostile and males designated low-hostile have been found for visual identification tasks. Harrison, Gorelczenko & Cook (1990) found at rest (no stressor) differences between these groups in the identification of the emotional valence of faces. Specifically, high-hostile males were less accurate identifying neutral faces and in the perceptual processing of emotional faces within the contralaterally-controlled left-visual field. Neutral faces projected to the right cerebrum were reliably identified as "angry" by high-hostile males in comparison with low-hostile males. In subsequent research a stressor was applied, a cold-pressor task, and it was shown to have a negative effect on high-hostile males identification of emotional faces in comparison to low-hostile males (Herridge & Harrison, 1996).

Moving through the sensory systems, the primary projection area for audition is the superior temporal gyrus. Assessing contralateral variables in audition is possible with a dichotic listening task. This method employs headphones and recorded words or sounds presented to both ears. Following administration of a cold-pressor task, high-hostile males displayed an enhanced left ear advantage in the identification of speech sounds presented through a dichotic listening task. Further, high-hostile males displayed increased cardiovascular reactivity following the cold-pressor task, whereas low-hostile males demonstrated cardiovascular stability. Low-hostile males displayed an enhanced right ear advantage in the identification of the dichotic speech stimuli as a function of cold-pressor stress. These results suggest greater right-cerebrum reactivity to stress among high-hostile males and dramatically opposite effects with left cerebral activation to the cold-pressor stress among low-hostile males (Demaree & Harrison, 1997).

The somatosensory strip is located immediately posterior to the cruciate fissure and superior to the primary projection area for audition. Extending the functional cerebral systems approach to the somatosensory system yields similar conclusions for hemispheric lateralization and hostility. Intentional facial affect configuration differentially alters skin conductance and tone among high and low-hostile males. High-hostile males display increased skin conductance at the left, reduced rate of habituation at the left hemibody, and enhanced sympathetic tone. Low-hostile males display increased skin conductance at the right hemibody, diminished sympathetic tone, and rapid habituation at the left hemibody (Herridge, Harrison, & Demaree, 1997). These results are consistent with increased right brain activation in high-hostile males.

Motor research has also produced results consistent with the model of relative activation presented in hostility. The motor strip is immediately anterior to the cruciate fissure. Contralateral control by the motor strip approaches 90 percent for the distal extremities with ipsilateral projection approaching 10 percent for the proximal body regions, making it ideal for the evaluation of group differences in cerebral laterality. Grip strength was assessed by Harrison et al. (2000) among high- and low-hostile males. High-hostile males were significantly stronger at the left hand and significantly weaker at the right hand with diminished functional symmetry absent an experimental stressor. These results also support the more refined inhibitory model of anterior cerebral regions providing regulatory control over the posterior cerebral regions, rather than a "balance model" (e.g. Tucker & Williamson, 1984) positing general right hemispheric activation with hostility. These results provide direct evidence through grip strength of both increased right anterior activation and decreased left anterior activation among high-hostile males using low-hostile males as a comparison group.

Integration

A common thread present throughout theoretical conceptualizations of emotion has been the construct, arousal. At the turn of the 20^{th} century, William James (1884) and

Carl Lange (Rand, 1912 –translation-) postulated that physiological feedback from the body produces emotional experiences. Later Schacter and Singer (1962) agreed with James and Lange that people emotionalize physical sensations. However, they introduced a cognitive element into the process of emotional experience. They argued that individuals interpret situations and reactions relative to contextual cues. They then arrive at an interpretation for their own and others' emotional experience. They also reinforced the notion of arousal as a key variable in emotional experience. Contrarily, Valins (1966) argued that thought alone was sufficient to produce emotional behavior, that the role of arousal had been overestimated. The function of arousal in the emotional process is not a source of theoretical continuity.

The functional cerebral systems of emotion and arousal appear to be shared to a high degree, at least on the cortical level. Relative activation states of brain areas tend to produce changes in both emotional experience and expression, while also influencing shifts in autonomic arousal in a predictable lateralized fashion. While relative activation states are only, perhaps, representative of part of what is going on; the working model may be useful for predicting behavioral output of these integrated systems.

It is possible to make predictions of functional output based on relative activation patterns demonstrated, or implied, in arousal and emotion. For instance, in hostility, a negatively valenced high arousal emotion, a relative activation pattern based on inter- and intra-hemispheric relationships, has produced a successful line of research (as reviewed). Specifically, the hostility model assumes a relative deactivation of right anterior cerebral regions to right post-central regions, while also specifying a relative hemispheric activation favoring the right hemisphere. This pattern is expected both in the experience of hostility, and in the elicitation of a sympathetic autonomic arousal pattern. Functionally, it is argued that the anterior cerebral regions serve an inhibitory role over the post central regions, hence the described intrahemispheric arousal pattern.

Williamson & Harrison (2003) explored the argued relative activation states evident in hostility and in the maintenance of autonomic arousal. In an experimental approach, using verbal and nonverbal fluency as left and right frontal stressors, respectively, high and low hostile males were compared both on the performance of the fluency tasks and on the autonomic nervous system indicators of systolic and diastolic blood pressure, and heart rate. It was argued that due to the resting state dominance of right hemisphere activity observed in high hostile males, that they would have more difficulty maintaining regulation of autonomic nervous system functions during the right frontal task, nonverbal fluency.

This difficulty was expected to manifest as a function of interference, as would be predicted by the functional cerebral distance principle (Kinsbourne & Hicks, 1978). It was also expected that the high hostile males would perform poorer on the nonverbal fluency task than the low hostile males. The results were consistent with this line of reasoning, high hostile males showed both the cognitive and physiological differences that were predicted. Namely, high hostile males displayed higher systolic blood pressure subsequent to the nonverbal fluency task administration and they also evidenced significantly more perseverative errors on the nonverbal fluency task than did low hostile males. This is, arguably, reflective of differential capacities (for interference) in the right frontal region as a function of hostility. Adding additional variables to this methodology representing perhaps post-central cerebral tissue would be interesting.

In another study, with a similar methodology, predictable relationships between emotion and arousal were also made. Specifically, Everhart (2001) compared high and low anxious men on autonomic nervous system regulation and on verbal and nonverbal fluency. Further, Everhart used an additional stressor, the cold pressor task with both groups. Everhart based his predictions on Heller's quadrant model of emotion, which emphasizes anxiety, another negatively valenced, high arousal emotion. Heller's model (1993) specifies increased right frontal activation with respect to left frontal activation and increased right parietotemporal activation (as represented by the arousal component). Everhart expected that the anxious individuals would display greater reactivity to both stimuli, fluency and the cold pressor. Further, it was expected that performance on nonverbal fluency would differ as a function of anxiety, whereas performance on the verbal fluency task was not expected to be affected.

Everhart found that high anxious males displayed increased autonomic reactivity subsequent to administration of the nonverbal fluency task and the cold pressor task than did low anxious men. Further, no differences were found in nonverbal fluency output as a function of group. However, perseverative errors were not compared, only output, which may account for the lack of results. The relationship between frontal regulation and postcentral activation as a function of emotional state is supported. Nonverbal fluency, a right frontal task, did differentially affect autonomic nervous system activity as a function of the presence of anxiety.

One interesting result, perhaps suggesting a difference between anxiety and hostility, was evident subsequent to the verbal fluency task and submersion in the cold pressor apparatus. High anxious males were less able to regulate ANS activity and less able to generate words than low anxious males after multiple trials of verbal fluency. This finding is somewhat difficult to interpret given the addition of the cold-pressor task; however, it does imply left hemisphere involvement in ANS regulation, which is counter to Heller's (1993) supposition of right post-central control of ANS reactivity.

Both of these experiments, Williamson and Harrison (2003) and Everhart (2001), are relatively unique in the conceptualization of autonomic nervous system activity. Autonomic nervous system regulation is conceptualized as an ongoing functional task. It seems to be a logical formulation of arousal processes given the idea of cortical mediation of arousal systems (Wittling, 1997) and the idea of vertical integration (Tucker, 1993). This conceptualization has significant implications for interpretation of data. Specifically, as these researchers did, ANS regulation can be considered as a dual task. Relative activation states of ANS regulation have an impact on other processes, like emotion and the performance of cognitive tasks, and vice versa.

Individual differences research is currently a great source for information on concomitant effects of emotion and arousal. Schmidt and Fox (1994) compared groups on factors of sociability (high and low) and shyness (high and low) on measures of EEG, heart rate and heart rate variability. The high shy/high sociable group evidenced greater Alpha Power at the compared posterior electrode sites (P3 and P4) indicating greater activation of the right parietal area. Additionally this group had higher heart rate and lower vagal tone (decreased variability) than the other compared groups. This is consistent with the reviewed literature on relative activation states in emotion and arousal. The high shy, high sociable group is consistent with other researcher's conceptualizations of anxiety, a high arousal, and negatively valenced emotion (Heller, 1993; Everhart, 2001).

Further, associations between EEG asymmetries and electrodermal lability in low versus high depressive and anxious individuals have been demonstrated. Papousek and Schulter (2000) argue that associations between frontal activation asymmetries and electrodermal lability, a sympathetically mediated response system, are modified by emotional factors. In their high anxious group, more spontaneous EDA (skin conductance) was observed in individuals with relatively greater right frontal activity (as indicated by differences in the alpha bandwidth at FP1 and FP2, the frontal poles).

Further, similar relationships were found in the comparison of the high and low depression group. At F7 and F8, asymmetry in beta activity was evidenced as a function of depression. The higher depressed group showed greater right frontal activity than the lower depressed group, as would be expected. Further, this corresponded with increased electrodermal lability in these more depressed subjects.

<u>The Present Experiment</u>

Earlier experiments show promise for making increasingly accurate predictions based on functional cerebral systems associated with emotion and arousal. In this experiment, current knowledge on the functional cerebral systems of hostility and ANS laterality were applied to make predictions of ANS regulation, fluency performance (verbal and nonverbal), and dichotic listening performance. This is potentially useful in supporting or negating theoretical distinctions in brain activity associated with hostility, while furthering both veins of functional cerebral systems research with frontal and post-central behavioral measurements carried out within the same experimental procedure. Further, the use of lateralized stressors is also a relatively new idea (Williamson & Harrison, 2003) and demonstrating replication of lateralized effects would be useful.

Verbal and nonverbal fluency, successfully used in previous research as left and right anterior cerebral region stressors respectively (Everhart, 2001; Williamson & Harrison, 2003), are again used this way for this experiment. Dichotic listening was used as the sensory variable. It was expected that previous research would be replicated in that high hostile men would demonstrate inferior performance on the right-frontal mediated tasks of nonverbal fluency tasks and sympathetic nervous system function. Further it was expected that the type of fluency task would differentially mediate the performance of high hostile and low hostile men on the dichotic listening task.

Methodology

Participant Selection

Twenty-four male subjects between the ages of 18 and 21 years were used to compare high and low hostile men on cardiovascular reactivity, verbal fluency and nonverbal fluency measures (these analyses include the raw fluency scores and the perseverative error scores), and dichotic listening performance in unfocused, focus left, and focus right conditions. These subjects were recruited from the Introductory Psychology course and other psychology courses at Virginia Polytechnic Institute and

State University. Subjects received extra credit points in compensation for their participation that was applied to their overall grade in the course from which they were recruited. Only right-handed participants were used in the experiment. This was done to ensure maximum homogeneity within the experiment and to add further validity to the argument that any observed differences are more likely due to differences in group membership rather than handedness. Additionally, this procedure maintains consistency with previous research from this lab, which allows for a more direct comparison of the results of this experiment with others of similar design.

Classification

During group testing, participants with a history of a past self-reported traumatic head injury, other neurological damage, or any serious illnesses (according to the HIMHI – Appendix A) were excluded from the experiment. Group testing was scheduled through the sign-up system through the department of Psychology. This sign-up system was available through the Virginia Polytechnic Institute and State University's Department of Psychology webpage. This page employs the newly developed Momentum™ Experiment Scheduling System. Students were able to see a list of available experiments and select one to which they met the requisite criteria. Further, announcements as to the presence of the signup system were made during department of psychology courses.

Once they signed-up, students were directed to attend a group screening at one of three times; Monday from 5:00pm to 6:00pm, or Tuesday/Thursday at 4:00-5:00pm. Screening sizes ranged from 1-12 subjects per time slot. A total of 102 subjects were screened. The purpose of the group screening was to establish qualification for the experiment and group affiliation. The group testing took place in a classroom. Participants were administered the Coran, Porac, and Duncan laterality test (Coran, Porac, & Duncan, 1979) (Appendix B) to determine hemibody preference. This is a self-report measure that assesses right (+1) and left (-1) hemibody preference based on preferred use of either the left or right eye, ear, arm, and leg. The test ranges from scores of -13 to +13, denoting left and right hemibody preference, respectively. A score of +7 or above was required for continued participation in the experiment.

Further, participants were administered two self-report scales, the Cook-Medley Hostility Scale (CMHS) (Cook & Medley, 1954) (Appendix C), and the Beck Depression Inventory II (BDI-II). The CMHS is the most frequently utilized measure of hostility and has been shown to be a valid predictor of medical, psychological, and interpersonal outcomes (Contrada & Jussim, 1992). Consistent with previous research using this scale (Demaree et al. 2002; Demaree & Harrison, 1997; Shenal & Harrison, 2000; Herridge & Harrison, 1996; Everhart, 1997; Williamson & Harrison, 2003), participants who scored at 29 or above on the scale were asked to continue with the experimental phase and were classified as high-hostile. Participants who scored at 19 or below on the scale were asked to continue with the experimental phase and were classified as low-hostile. Physiological and cognitive differences have been demonstrated using this demarcation (Williamson & Harrison, 2003; Demaree, 1997). The participants chosen for the experimental phase were contacted and scheduled for further testing.

The BDI-II was used to assess the subjects' level of depression. This measure consists of 21 questions that tap into specific symptoms, attitudes, and behaviors related to depression. Scores on this inventory range from 0 to 63, with 0 - 13 considered "minimal" 14 - 19 indicating "mild depression," 20 - 28 indicating "moderate depression," and 29 - 63 indicating "severe depression." Participants with scores above the cutoff for minimal depression (14) were excluded from the experiment to maintain homogeneity of groups.

Apparatus

The laboratory chamber was comprised of a chair facing a one-way mirror within a flat white curtain enclosure. Located in this chamber were the verbal fluency, nonverbal fluency, cook medley hostility scale, beck depression inventory-II, blood pressure instruments and dichotic listening apparatus.

Physiological SBP, DBP, and HR were assessed using the Norelco Healthcare Electronic Digital Blood Pressure / Pulse Meter with Microphoneless Cuff and oscillometric technique (1985; Model HC3030). Accuracy of this device has been obtained in previous work (Harrison & Kelly, 1987). Calibration assessed and accuracy tested against other blood pressure devices for this experiment.

Verbal Fluency The Controlled Oral Word Association Test (COWAT) (Appendix F) assesses the oral or written production of words beginning with a designated letter (Benton & Hamsher, 1976). It consists of three trials in which, in this instance, participants are instructed to write as many words as possible in one minute beginning with a specified letter (e.g. F, A, or S). Proper names, numbers, and the same word with different suffixes are not permitted. The final score is the sum of all acceptable words produced across three trials. The letters F, A, and S are the most frequently utilized. However, the present experiment uses a variation of this protocol. Specifically, the letters F, S, and T were used. These letters were chosen based on the tendency of normals to produce an equal number of responses for each letter (approximately 11-12 words per minute) (Everhart, 1997; Williamson & Harrison, 2003). Perseverative responses were also scored. A perseveration was defined as a repeat of previously produced word.

Nonverbal Fluency For nonverbal fluency the Ruff Figural Fluency Test (RFTT) (Ruff, 1988) was used. It consists of five parts, each containing different stimulus presentations. Each part has 35 dot matrices arranged in a 5 X 7 array. Participants were instructed to connect the dots in as many unique ways that they could conceive within a one-minute period (See Appendix G). It is scored by counting the number of unique designs and number of perseverative errors for each trial. A perseveration is any repetition of a previous design within the participant's responses. Also, overdraws were scored as perseverative errors as well. Nonverbal fluency is then considered the total number of unique designs minus the number perseverative errors (not counting overdraws) within each part. The first three sheets or the test protocol, instead of the standard five, were used in this experiment in order to maintain consistency with the COWAT (Everhart 1997; Williamson & Harrison, 2003).

Dichotic Listening

Hearing

Auditory acuity was assessed using the Qualitone Acoustic Appraiser (Model WR-C) and lightweight portable Qualitone TD-39 headphones. Frequencies at 500, 750, 1000, 1500, 2000, 2500, and 3000 Hz were assessed at an intensity of 35 dB. Accurate detection (as defined by raising the corresponding arm to the side of sound presentation) of all presented stimuli was required.

Perceptual

A computer-synthesized audiotape, made by the Kresge Hearing Research Laboratory, of thirty pairs of concurrently voiced consonant vowels (CV) (ba, da, ga, ka, pa, ta) was played for each subject. This has been used as a dichotic listening device in numerous studies (e.g. Obrzut, et al. 1988). Stimuli were presented at about 75 dB using a Marantz tape deck. The interstimulus interval was set at 6 seconds. The six CVs were printed in 2 cm black upper-case letters on a 96 X 144 cm index card displayed about 0.5 m in front of the subject.

Procedure

Upon arrival at the testing center, participants were administered the CMHS and the BDI-II to check for test-retest reliability of the grouping. Participants were only tested if the score was consistent with their assigned grouping. No inconsistent scores were noted. They were then fitted with the blood pressure monitor on their left arm. Participants were informed that they would be asked to complete the verbal and the nonverbal fluency tests and the dichotic listening test. The researcher left the testing room and gave the following instructions over the intercom: “Please take about one minute to become accustomed to your surroundings.”

A rest period of 120 seconds was observed. Then, subsequent to the instruction set, SBP, DBP, and HR were recorded. These measures were administered at least twice to test for reliability. The criteria for a reliable measurement were as follows: a difference of greater than 20 mmHg for either SBP or DBP and a difference of 10 or more beats per minute for HR.

Immediately following the recording of the physiological data, the participant was asked to complete the RFFT (Appendix E) or the COWAT (Appendix D) using the appropriate instruction set for the test. Order of the fluency tests was administered in a counterbalanced fashion. Upon completion of the fluency test SBP, DBP, and HR were recorded again along with the reliability check measurements.

At this point the training phase for the dichotic listening test was administered. The experimenter read each of the six phonemes on the index card and had the participant point to them. Headphones were used for the auditory presentation of five phonemes. The researcher provided corrective feedback when necessary. The participant was required to identify correctly four of the five phonemes to continue participation.

Participants were then administered the unfocused condition of the dichotic listening test as indicated in Appendix F. Following this, the participant received the focus left and then the focus right condition of the dichotic listening test. The focus conditions were not counterbalanced due to the hypothesized direction of effect and the involved functional systems. Instructions for the focus conditions are specified in Appendix G and

Appendix H respectively. Procedures were then repeated for the second fluency condition in exactly the same manner, minus the training phase for the dichotic task.

Results

Data Analysis

Physiological Measures

Separate analyses of variance (ANOVA) were performed on each of the physiological variables (HR, SBP, and DBP) to measure cardiovascular reactivity to the fluency stressors. The design is as follows: Group (2 levels) x (Condition [2 levels] x Trial [2 levels] x Participant). Thus, data from each measurement category were analyzed with a three-factor mixed design analysis of variance (ANOVA), with fixed factors of Group (high-hostile and low-hostile), and repeated measures of Condition (verbal and nonverbal fluency) and Trial (baseline, post-fluency).

Fluency Measures

Separate analyses of variance (ANOVA) were performed on Fluency scores (verbal and nonverbal fluency) to analyze the number of words or designs for each task (to assess performance across time), and the number of preservations. The design was: Group (2 levels) x (Condition [2 levels] x Trial [3 levels] x Participant). Thus, data were analyzed with a three-factor mixed design analysis of variance (ANOVA), with the fixed factor of Group (high-hostile and low-hostile), and with the repeated measures of Condition (verbal and nonverbal fluency) and Trial (trials 1, 2, and 3). This statistical analysis was repeated using perseveration scores, instead of number of designs or number of words generated, in order to assess verbal and nonverbal perseveration during each fluency task.

Dichotic Listening

Independent ANOVAs were conducted on dichotic listening variables. Specifically, the raw data were analyzed comparing participant's responses to the left ear and top the right ear. Also, errors defined as a response not indicative of either ear presentation were evaluated. This data was compared as a function of Group (high-hostile and low-hostile) Condition (verbal and nonverbal fluency) X Focus (unfocused, focus left, and focus right) X Participant. Additionally percentage correct scores were calculated and analyzed with the same ANOVA design.

Results

It was hypothesized that high-hostile men would evidence increased cardiovascular reactivity following administration of a nonverbal fluency test (condition 2). An ANOVA consisting of group (high and low) X condition (1 and 2) with the repeated measure of Trial (1 and 2) was performed (See Table 1). A significant group X condition X trial interaction was found for systolic blood pressure (SBP), $F(1, 22) = 6.2$, $p = .02$ (See Figure 1). Systolic blood pressure increased following the nonverbal fluency confrontation test in high-hostile men. Systolic blood pressure decreased following the verbal fluency confrontation test in high-hostile men. No change was evident in systolic blood pressure following the nonverbal fluency confrontation test in low-hostile men. Finally, verbal fluency produced an increase in systolic blood pressure in low-hostile men. Post-hoc analyses indicate that none of the individual components of the interaction are significant outside of the interaction effect.

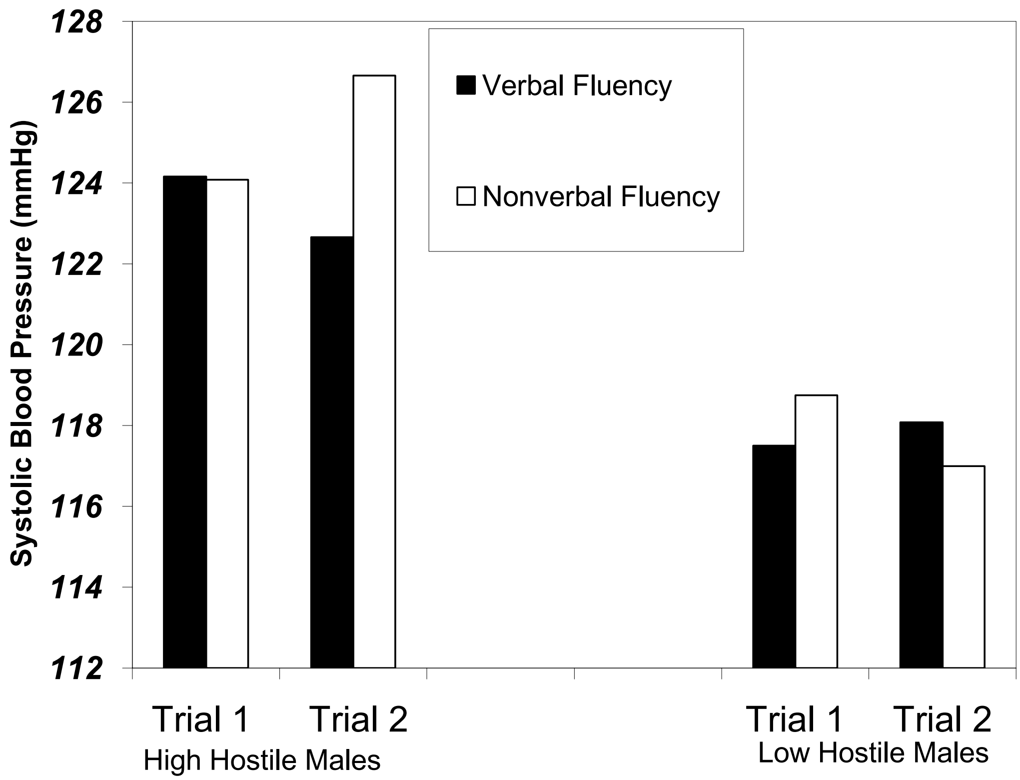
Table 1

Analysis of Variance for physiological variables

Source	df	F
Systolic blood pressure		
Group x Condition x Trial	(1, 22)	6.21*
Group x Condition	(1, 22)	0.44
Condition x Trial	(1, 22)	0.46
Group x Trial	(1, 22)	0.63
Condition	(1, 22)	0.52
Trial	(1, 22)	0.00
Group	(1, 22)	2.99
Diastolic blood pressure		
Group x Condition x Trial	(1, 22)	0.19
Group x Condition	(1, 22)	0.71
Condition x Trial	(1, 22)	2.78
Group x Trial	(1, 22)	0.48
Condition	(1, 22)	2.19
Trial	(1, 22)	0.30
Group	(1, 22)	2.19
Heart Rate		
Group x Condition x Trial	(1, 22)	0.02
Group x Condition	(1, 22)	0.02
Condition x Trial	(1, 22)	1.77
Group x Trial	(1, 22)	5.11*
Condition	(1, 22)	0.00
Trial	(1, 22)	1.63
Group	(1, 22)	0.11

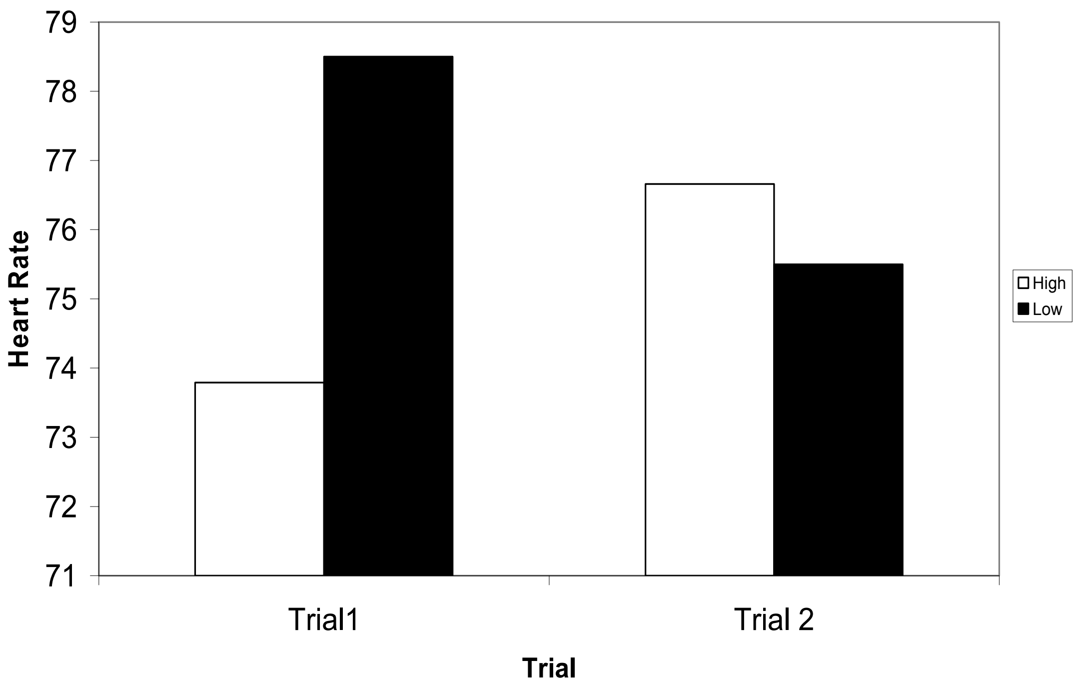
*$p \leq .05$

Figure 1. Systolic Blood Pressure in mmHg as a function of group (high- and low- hostile men), condition (Verbal and Nonverbal Fluency tests), and trial (baseline and post-stress).



No significant main effects were found across the SBP, DBP, and HR measures (see Table 1). A significant interaction effect was found for HR with a group X trial effect detected $F(1, 22) = 5.11$, $p = .03$ (See Figure 2). Collapsed across conditions HR increased in high hostile men on average from 73 beats per minute to 76 beats per minute from trial 1 to trial 2. In low hostile men HR decreased, on average, from 78 beats per minute in trial 1 to 75 beats per minute in trial 2. Post hoc-analyses demonstrated no significant difference in overall group heart rate means as a function of condition.

Figure 2. Mean heart rate per group collapsed across conditions comparing baseline to post-stress performance.



In order to test performance differences on fluency output during ongoing mediation of cardiovascular activities an ANOVA consisting of the fixed effects of group and condition with the repeated measure of trial was performed on the fluency data (See Table 2). For this analysis, group (high and low hostile participants), trial (3 levels), and fluency (verbal fluency and nonverbal fluency tests) were the factors.

Table 2

Analysis of Variance for Fluency Output

Source	df	F
Fluency		
Group x Condition x Trial	(1, 22)	0.39
Group x Condition	(1, 22)	0.01
Condition x Trial	(1, 22)	0.73
Group x Trial	(1, 22)	0.01
Condition	(1, 22)	17.74*
Trial	(1, 22)	7.88
Group	(1, 22)	0.02

*$p \leq .05$

No significant interactions were found. A significant main effect was found for condition, F(1, 22) = 17.74, p = .0004 (See Figure 3). Post hoc analyses revealed that nonverbal fluency scores were significantly higher than verbal fluency scores collapsed across groups. Further, a significant main effect for trial was found across both conditions, F(2,44) = 7.88, p = .0012 (See Figure 4). Post hoc analyses revealed that trial 1 scores were significantly lower than trials 2 and 3 collapsed across groups.

Figure 3. Comparison of generativity on verbal and nonverbal fluency collapsed across groups.

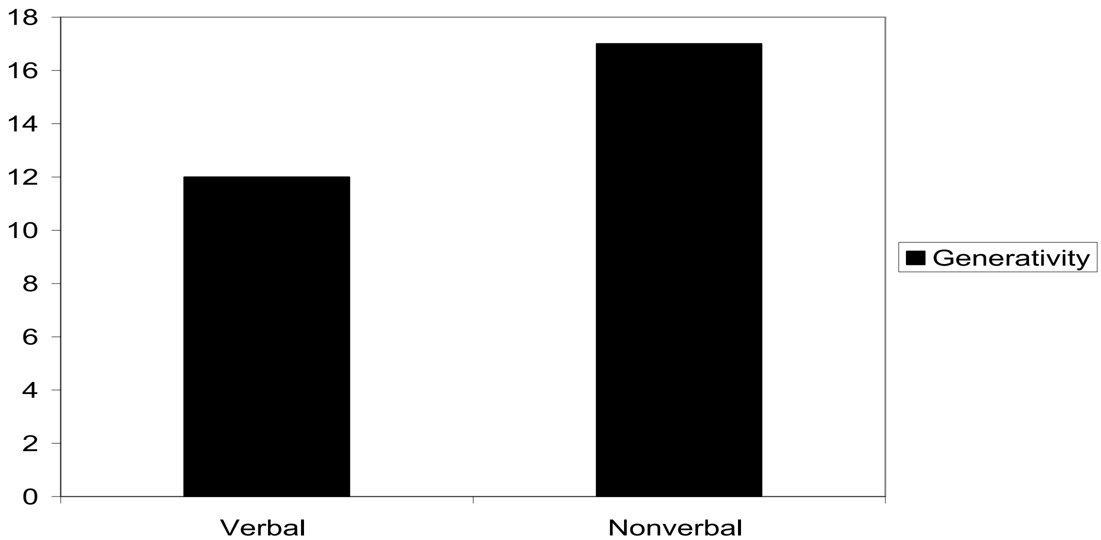
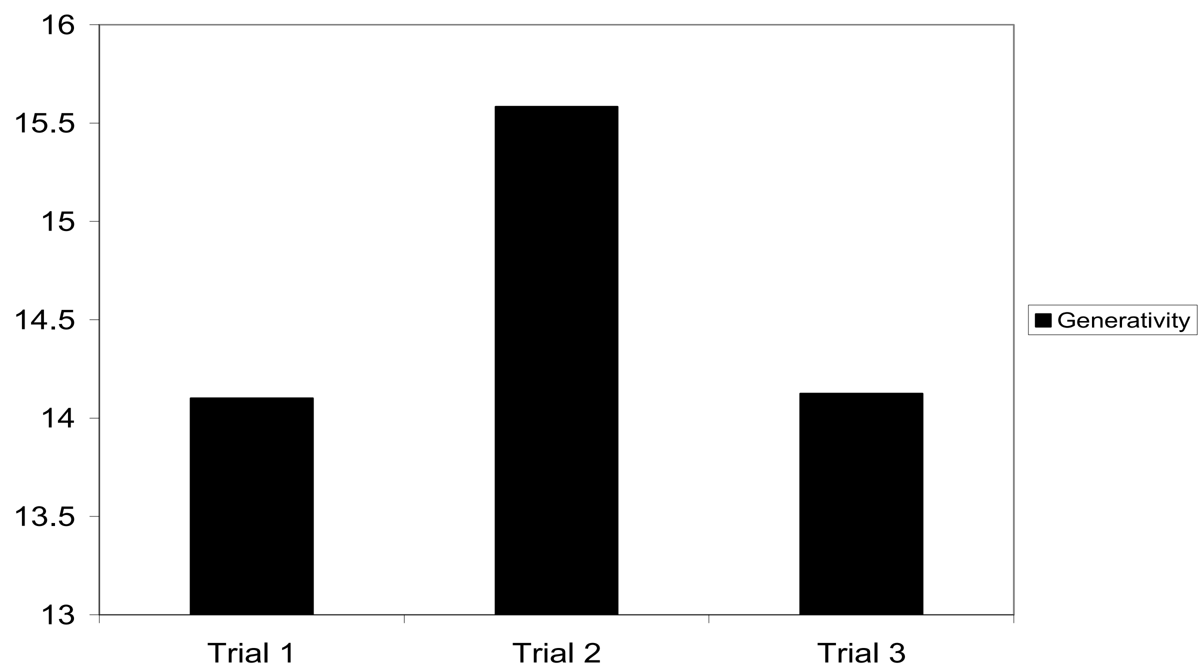


Figure 4. Comparison of generativity on verbal and nonverbal fluency across trials (3 levels) collapsed across group and condition.



In order to further test the hypothesis that high hostile men evidence decreased performance on nonverbal fluency during ongoing mediation of cardiovascular activities, an ANOVA consisting of the fixed effects of group and condition with the repeated measure of trial was performed using perseverative errors on the fluency tests as data (See Table 3). A significant group X condition interaction was found. High-hostile men, as predicted, produced more perseverative errors on nonverbal fluency than did the low-hostile men, $F(1, 22) = 6.40$, $p = .0191$ (See Figure 5). Overall, there was a main effect for Group with high-hostile men displaying more perseverative errors than low- hostile men, $F(1, 22) = 5.25$, $p = .0318$ (See Figure 6).

Table 3

Analysis of Variance for Perseverative Errors

Source	df	F
Perseverative Errors		
Group x Condition x Trial	(1, 44)	0.23
Group x Condition	(1, 22)	6.40*
Condition x Trial	(1, 44)	0.23
Group x Trial	(1, 44)	0.16
Condition	(1, 22)	25.60*
Trial	(1, 44)	0.16
Group	(1, 22)	5.25

*$p \leq .05$

Figure 5. Mean perseverative errors on verbal and nonverbal fluency comparing high and low hostile men.

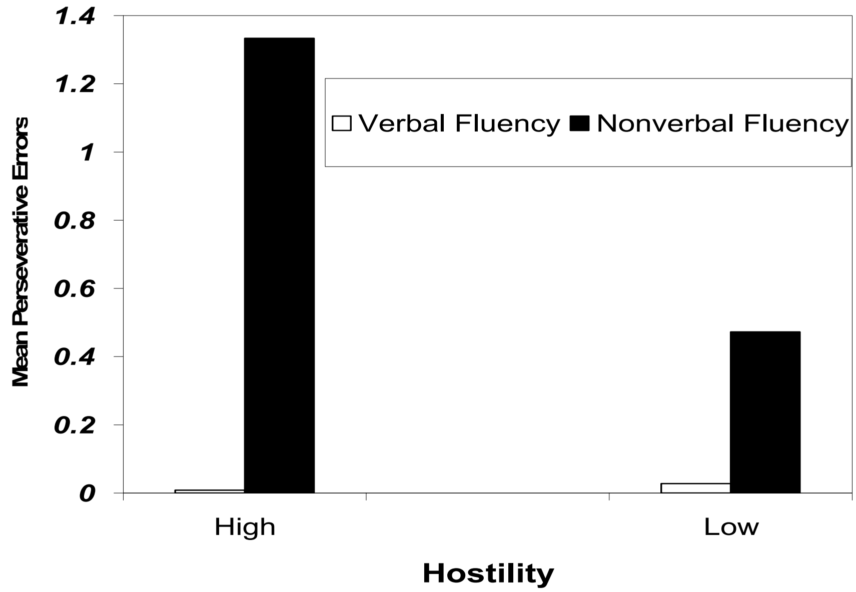
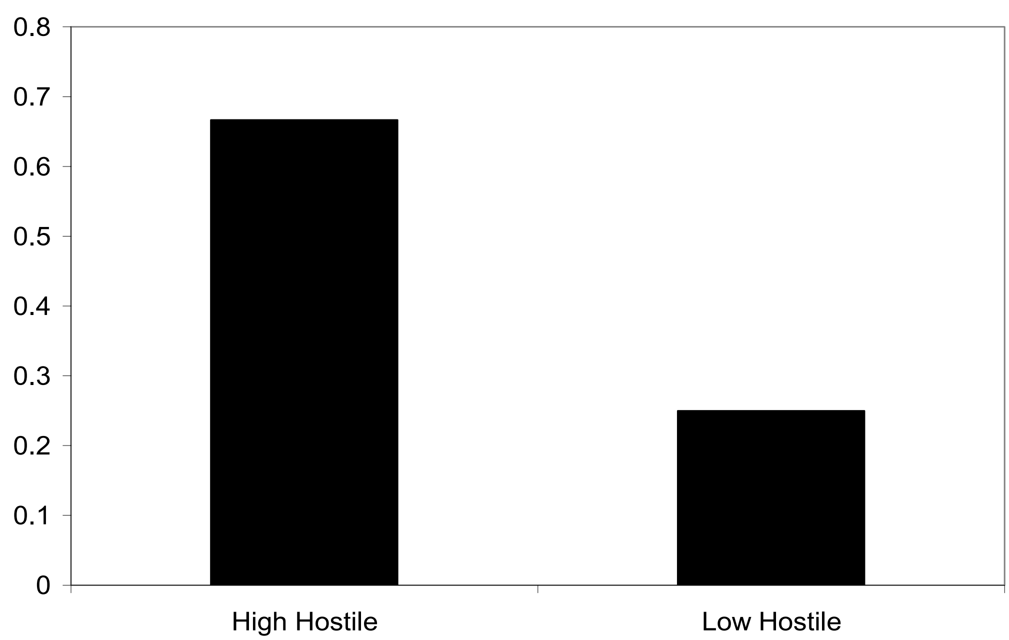
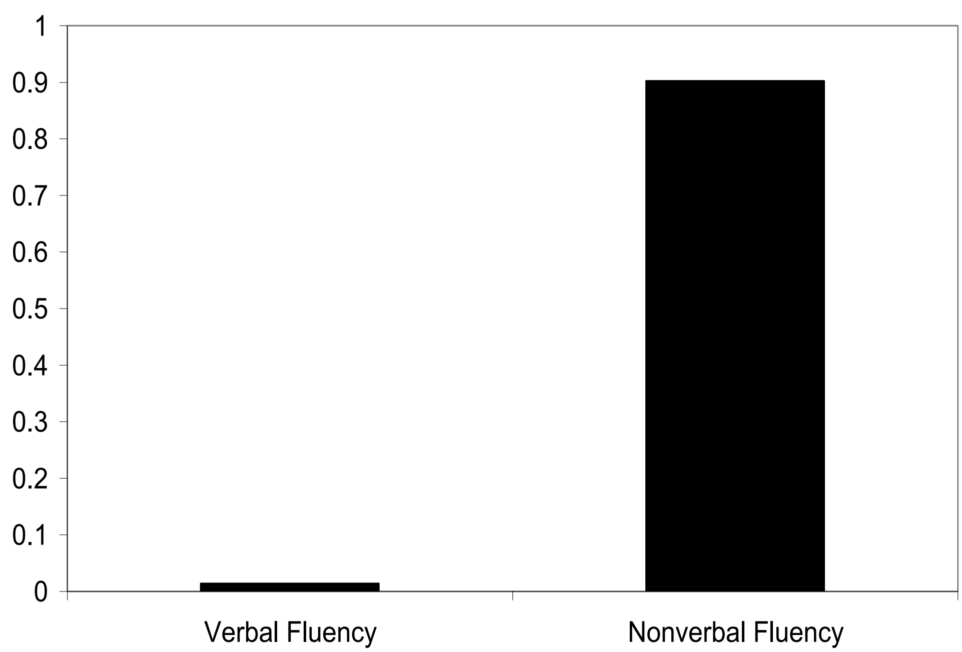


Figure 6 Mean perseverative errors collapsed across conditions comparing high and low hostile men.



Post hoc analyses revealed that errors were significantly more frequent among high-hostile men. This variance is mostly attributable to the large number of nonverbal fluency perseverative errors produced by high-hostile men. There was a main effect for condition with more perseverative errors made on the nonverbal fluency tests than on the verbal fluency tests for both groups, $F(1, 22) = 25.60$. $p = .0001$ (See Figure 7). Post hoc analyses revealed that condition 1 scores were significantly lower than condition 2 scores. Specifically, an average of .9028 perseverative errors was found on the nonverbal fluency test in comparison to .0139 perseverative errors on the verbal fluency test.

Figure 7. Mean perseverative errors collapsed across group comparing verbal and nonverbal fluency performance.



Testing of the dichotic listening variables was performed to assess the effect of group, condition, and focus, on performance. These data were compared as a function of

Group (high-hostile and low-hostile) X Condition (verbal and nonverbal fluency) X Focus (unfocused, focus left, and focus right) X Participant. At the left ear, the following effects were detected; Group X Focus $F(2, 44) = 4.63$, $p = .05$, Condition X Focus $F(2, 44) = 3.80$, $p = .0301$, and focus $F(2, 44) = 18.36$, $p = .0001$. The predicted 3-way interaction of Group X Condition X Focus showed a trend towards significance with a p-value of .27 (See Table 4).

Table 4

Analysis of Variance for Dichotic Listening at the left ear

Source	df	F
Dichotic Listening – Left Ear		
Group x Condition x Focus	(2, 44)	1.31
Group x Condition	(1, 22)	0.00
Condition x Focus	(2, 44)	3.80*
Group x Focus	(2, 44)	4.63*
Focus	(1, 44)	18.36*
Group	(1, 22)	0.01
Condition	(1, 22)	2.74

*$p \leq .05$

Table 5

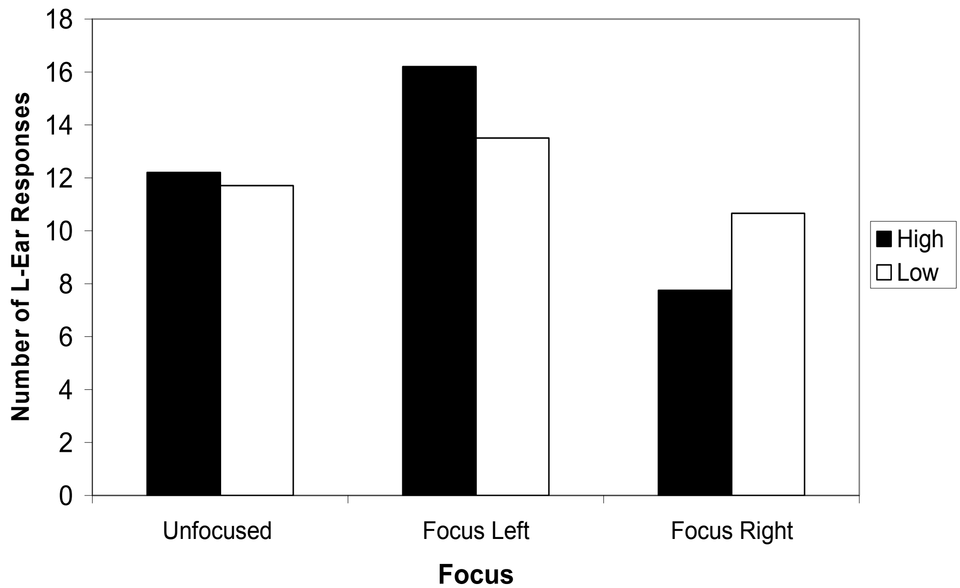
Analysis of Variance for Dichotic Listening at the right ear

Source	df	F
	Dichotic Listening – Right Ear	
Group x Condition x Focus	(2, 44)	0.39
Group x Condition	(1, 22)	0.94
Condition x Focus	(2, 44)	0.93
Group x Focus	(2, 44)	4.21*
Focus	(1, 44)	25.71*
Group	(1, 22)	0.34
Condition	(1, 22)	0.37

*$p \leq .05$

Within the Group X Focus effect, post-hoc analyses revealed that across the 3 levels of focus, high-hostile men displayed more left-ear responses during the focus left trial than low hostile men. Additionally, high-hostile men showed more left-ear responses in the unfocused trial than did low-hostile men (See Figure 8). Within the Condition X Focus effect, post-hoc analyses revealed that, collapsed across group, participants displayed more left ear responses in the focus left trial as a function of the nonverbal fluency condition.

Figure 8. Mean ear response collapsed across conditions comparing focus performance of high and low hostile men on dichotic listening.



Independent ANOVA examination of dichotic listening performance at the right ear revealed a Group X Focus effect, $F(2, 44) = 4.21$. $p = .0212$, and a Focus effect, $F(2, 44) = 25.71$, $p = .0001$. No other statistically significant effects were noted at the right ear. No other trends were notable (See Table 5).

Table 5

Analysis of Variance for Dichotic Listening at the right ear

Source	df	F
Dichotic Listening – Right Ear		
Group x Condition x Focus	(2, 44)	0.39
Group x Condition	(1, 22)	0.94
Condition x Focus	(2, 44)	0.93
Group x Focus	(2, 44)	4.21*
Focus	(1, 44)	25.71*
Group	(1, 22)	0.34
Condition	(1, 22)	0.37

*$p \leq .05$

Post-hoc analyses revealed that high-hostile males had less right ear responses on the unfocused condition than did low-hostile men. Interestingly, high-hostile men had more right ear responses on the focus right trial than did low-hostile men. Overall, high-hostile men performed better than low hostile men on the focus left and focus right trials at both the right and left ear.

Independent ANOVA examination of dichotic listening errors was performed. That is, responses that did not indicate an occurring right or left ear response were scored as errors. There were no group differences in error rates. However, a condition difference was detected with more errors made after completion of the verbal fluency task in comparison with the nonverbal fluency task $F(1, 22) = 6.38$, $p = .0193$. Further, a condition by focus effect $F(2, 44) = 4.24$, $p = .0208$ was detected whereby more errors were committed on the focus left trial collapsed across group as a function of the verbal fluency task when compared with the same trial subsequent to the nonverbal fluency task. No other significant relationships were detected (See Table 6).

Table 6

Analysis of Variance for Dichotic Listening Errors

Source	df	F
	Dichotic Listening – Error	
Group x Condition x Focus	(2, 44)	1.00
Group x Condition	(1, 22)	1.90
Condition x Focus	(2, 44)	4.24*
Group x Focus	(2, 44)	0.29
Focus	(1, 44)	0.39
Group	(1, 22)	0.64
Condition	(1, 22)	6.38*

*$p \leq .05$.

Discussion

The primary findings of this experiment replicate previous research by Williamson & Harrison (2003). An interaction between hostility level, fluency task, dichotic listening, and physiological response was detected. Subsequent to the administration of the nonverbal fluency task, systolic blood pressure increased in high-hostile men, while remaining stable in low-hostile men. Further, after the verbal fluency task, systolic blood pressure decreased slightly in high-hostile men and increased slightly in low-hostile men (neither a significant change by it self). These physiological results are consistent with increased activity of the right hemisphere in high-hostile men as a function of the nonverbal fluency task.

Further supporting the notion of differential right hemispheric functioning, high-hostile men committed an increased number of perseverative errors on the nonverbal fluency task when compared to low-hostile men. This group difference is crucial as, although high-hostile men displayed decreased perseverative errors on the verbal fluency task compared to the nonverbal fluency task, this particular measure is not directly comparable in that the two measures are not psychometrically equivalent. However, it is interesting to note that verbal fluency performance was nearly identical for high and low hostile men, adding discriminatory support of a relative right-frontal performance lag as a function of hostility level.

Taken together, the cardiovascular reactivity of high-hostile men after the nonverbal fluency task and the relatively poor performance on the nonverbal fluency task (perseverative errors), there appears to be a distinct difference between the right frontal performance of high and low hostile men. Williamson and Harrison (2003) argued that this difference was attributable to an interference effect. Adding the right-frontal stressor, nonverbal fluency, to the arguably weak functional cerebral system contributing to the presentation of hostility, interfered with ongoing frontal mediation of cardiovascular processes.

The present experiment detected the same interactions with less than half the n-size of the Williamson & Harrison (2003) experiment. This increased power may be attributable to the parsing of depressed subjects from the data pool. Depression may introduce a confounding variable in the examination of hostility. Research has demonstrated associated left-prefrontal deactivation in depression (Henriques & Davidson, 1990, 1991; Jacobs & Snyder, 1996). It is unclear what effect a combination of hostility and depression might have. It appears that it may have diluted the power of the 1999 experiment.

What the mechanism underlying these relationships is has sparked debate within the literature. Some researchers have demonstrated baseline asymmetries in electrical activity measured at the scalp in hostility (Harmon-Jones & Allen, 1998). They found greater left-frontal activation in trait hostility when compared to right-frontal activity. However, other results have been more equivocal. Demaree and Harrison (1997) demonstrated increased beta bandwidth activity in high-hostile men at both the right and left frontal electrode sites. Harmon-Jones (2001) argues that the underlying mechanism of prefrontal asymmetry relates only to the approach and withdrawal component of emotional presentation. However, how this argument relates to trait emotion without an emotional induction procedure is unclear. What is clear is that systematic research has demonstrated reliable differences in motor and sensory performance in high-hostile men compared to low-hostile men. These differences are consistent with decreased performance of the right-anterior cerebral regions in high-hostile men.

Along these lines, namely following the assumption of degraded relative performance of the right anterior cerebral regions in high-hostile men, it was expected that they would display an increase in cardiovascular reactivity and increased errors on the nonverbal fluency task compared to low-hostile men. Further, as a function of disrupted right-frontal function following the nonverbal fluency task, a left-ear bias was expected on the dichotic listening test (e.g. a priming effect). These results occurred in the predicted directions. Notably, while high hostile men demonstrated differentiated performance on the nonverbal fluency task and on physiological reactivity with low hostile men, there was no evident distinction on the dichotic listening task.

The results of the dichotic listening task were equivocal in that the predicted interaction between hostility level and fluency task was not significant, though several group effects were detected. An overall left-ear bias was evidenced as a function of hostility. Specifically, high-hostile men gave more left-ear responses than low-hostile men in the unfocused trial of the dichotic listening task across both conditions. While this is the predicted direction of the expected bias as a function of hostility, given the design of the experiment it is difficult to assess whether the interaction between hostility and ear bias is a function of the introduction of a stressor (verbal or nonverbal fluency). The relationship may have been present without the stressor, but no baseline dichotic listening measure was taken.

Interestingly high and low hostile men actually performed very similarly on the focus left portion of the dichotic listening task during the nonverbal fluency condition. They both gave more left ear responses (e.g. increased accuracy on the task), a priming effect. Though not recorded, the dichotic listening task was cited as "challenging" and "frustrating" by many subjects.

It is within the realm of possibility that the dichotic listening task may have elicited a hostile response in the low hostile subjects (not reflected in the arousal measures). It would be interesting to record frustration level on the dichotic listening task as a function of the administered fluency tasks. Given that the nonverbal fluency condition influenced dichotic listening performance across groups, perhaps it also influenced subjective account of frustration level. The link between frustration and hostility is supported by common sense and by research. For example Norman, Rousseau, and Schlottmann (1974) demonstrated that male college students with elicited increases in frustration will give longer shocks to confederates in a Milgram-esque "learning" experiment.

A precedent in the literatures on emotion has been set in that several researchers have demonstrated that eliciting emotional states in otherwise normal individuals can produce similar response to those already categorized. As noted previously, Liotti and Tucker (1992) demonstrated degraded left ear performance on a dichotic listening task after inducing depression in normal subjects. These results are consistent with previous research performed by Tucker (1981).

Another interesting result detected on the dichotic listening task was on error rates. Both high and low hostile men had more errors after performing the verbal fluency task when compared with the nonverbal fluency task. Further, on the focus left condition, both groups had more errors after administration of the verbal fluency task than after the administration of the nonverbal fluency task. This may reflect priming of the left-hemisphere, thus making the task of leftward focus more challenging.

Given the observed effects of the frontal lobe stressors on dichotic listening performance, it seems valid to conclude that lateralized stressor do have a measurable impact on accuracy, errors, and ear preference. However, the group interaction effect was not detected. In addition to the possible frustration effect, there may also be procedural and task issues that contributed to the lack of group differences as a function of fluency task. The dichotic listening task is relatively long (about 5 minutes). Previous research in our lab has incorporated a stressor task to amplify differences in high and low hostile men. It is not clear how long these differences persist as a function of group and the type of stressor. There are a number of ways this issue might be explored in future research. Continuous cardiovascular measures could be one method. These measures included heart rate variability, inter-beat intervals, impedance cardiography, and others. The advantage of this is that the cardiovascular change can be measured over time after the administration of a stressor task. A time window of physiological reactivity may then be established. Selection of cognitive tasks (e.g. dichotic listening, visual pursuit tasks, comprehension tasks, etc. . .) could then be selected to fit within that window.

The use of alternative cardiovascular measures may be advantageous for other reasons as well. Methodologies have been developed that allow for independent measures of the divisions of the ANS. Heart rate is a commonly used indicator of autonomic arousal. It is simple to present a task, perhaps a stressor-task, and elicit an increase or decrease in heart rate. However, the interpretation of such a result is a little bit more complex than the interpretation of skin conductance, for example. The reason for this is that the heart is innervated by both parasympathetic and sympathetic nerve fibers. An increase in heart rate may be the result of sympathetic activation or parasympathetic withdrawal. However, it is possible to infer lateralized activation based on corroborative data.

There are several measures of cardiac function that provide indicators of sympathetic and parasympathetic arousal. One measure that allows for selective assessment of sympathetic and parasympathetic laterality is spectral analysis of heart rate variability (HRV). Heart rate variability analyses focus on the inter-beat intervals rather than heart rate. There can be significant changes in the inter-beat intervals across time that are not detectable with a gross heart rate measure. Short-term spectral analysis of the heart rate variability measure is broken up into three components, high frequency, low frequency, and very low frequency. However, the very low frequency is generally not interpreted, as the processes behind its existence are not well understood (European Heart Journal, 1996). The high frequency component is considered to be a good measure of parasympathetic influences, and the low frequency component is more strongly related to sympathetic influences. There is disagreement on the validity of the low frequency component as a measure of sympathetic response. Another technique that allows for differential analyses of parasympathetic and sympathetic influences on cardiac function is impedance cardiography. Through impedance cardiography, a measure of sympathetic cardiac response can be obtained.

A closer look at the physiological responses to the fluency stressors reveals that the characteristics of the subject population strongly influence the direction of response. It is now confirmed that high and low hostile men give predictably different physiological responses to nonverbal and verbal fluency tasks as assessed by blood pressure measures. The increase in blood pressure in high-hostile men is consistent with emerging theories of the functional cerebral systems of arousal and emotion.

While research has been continually mounting on the role of the right hemisphere in anger/hostility, increasing behavioral specificity is needed. The novelty of this experiment is using lateralized stressors and dependent variables to test both inter- and intra-hemisphere patterns of response.

This experiment is an extension of a project in which nonverbal and verbal fluency were used as stressors to test cardiovascular reactivity in high- and low-hostile men. The addition of the dichotic listening task was intended to provide a post-central fissure (sensory) measure of asymmetrical processing as a function of hostility and administration of lateralized frontal stressors.

Future research on emotion should take into account affected regional cerebral asymmetries as a function of selected task, group selection, and chosen dependent variables. A stressor task is a popular independent variable manipulation in a multitude of research domains including research on traumatic brain injuries, personality, development, alcohol abuse, DSM diagnoses like Generalized Anxiety Disorder, chronic pain, physical fitness, learning, and many more (Andersson & Finset, 1998; Breslin et al. 1995; Anshel, 1996; Hazlett et al. 1994; Sharpley et al. 1994). Further, stressor tasks, like the hand dynamometer, are often used as part of neuropsychological evaluations from both a standardized test battery approach (Halstead-Reitan) and process oriented approaches. While stressor tasks are in wide use, the functional cerebral systems of the stressor task, subject traits, and the dependent variables are seldom considered. This experiment is a demonstration of how accounting for these variables may lead to better predictability of response.

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Appendix A

Head Injury / Medical History Inventory (HIMHI)

Name:____

Age:____________________

Have you ever experienced or been diagnosed with any of the following, or are you experiencing any of the following at present? Please circle the appropriate response and explain any “Yes” responses below.

1.	Severe head trauma or injury	Yes	No
2.	Stroke or Aneurysm	Yes	No
3.	Learning disabilities (problems with reading, writing, or comprehension)	Yes	No
4.	Epilepsy or seizures	Yes	No
5.	Paralysis	Yes	No
6.	Neurological surgery	Yes	No
7.	Other neurological or nervous system problems	Yes	No
8.	Alcohol or drug problems	Yes	No
9.	Are you using alcohol or drugs (other than for prescribed purposes) at present?	Yes	No
10.	Past psychological / psychiatric problems	Yes	No
11.	Are you currently taking any prescription medications?	Yes	No
12.	Are you currently suffering from any medical conditions or illnesses?	Yes	No
13.	Do you have any uncorrected vision problems?	Yes	No
14.	Do you have an uncorrected hearing impairment?	Yes	No
15.	Do you have any problems or pain with movement (e.g., severe hand, arm, or shoulder pain with movement)?	Yes	No

Please explain “Yes” responses:

____

Appendix B

Handedness Questionnaire

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

# of Right + # of Left = Total Score

__________ + __________ = __________

Is mother left or right hand dominant?__________

Is father left or right hand dominant?__________

Appendix C

Cook Medley Hostility Scale

Directions: 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.

1. When I take a new job, I like to be tipped off on who should be gotten next to. T F

2. When someone does me wrong I feel I should pay him back if I can, just for the principle of the thing. T F

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. T F

4. I have often had to take orders from someone who did not know as much as I did. T F

5. I think a great many people exaggerate their misfortunes in order to gain sympathy and help of others. T F

6. It takes a lot of argument to convince most people of the truth. T F

7. I think most people would lie to get ahead. T F

8. Someone has it in for me. T F

9. Most people are honest chiefly through the fear of getting caught. T F

10. Most people will use somewhat unfair means to

gain profit or an advantage rather than to lose it. T F

11. I commonly wonder what hidden reason another person may have for doing something nice for me. T F

12. It makes me impatient to have people ask my advice or otherwise interrupt me when I am working on something important. T F

13. I feel that I have often been punished without cause. T F

14. I am against giving money to beggars. T F

15. Some of my family have habits that bother and annoy me very much. T F

16. My relatives are nearly all in sympathy with me. T F

17. My way of doing things is apt to be misunderstood by others. T F

18. I don't blame anyone for trying to grab everything he can get in this world. T F

19. No one cares much what happens to you. T F

20. I can be friendly with people who do things which I consider wrong. T F

21. It is safer to trust nobody. T F

22. I do not blame a person for taking advantage

of someone who lays himself open to it. T F

23. I have often felt that strangers were looking at me critically. T F

24. Most people make friends because friends are likely to be useful to them. T F

25. I am sure I am being talked about. T F

26. I am likely not to speak to people until they speak to me. T F

27. Most people inwardly dislike putting themselves out to help other people. T F

28. I tend to be on guard with people who are somewhat more friendly than I had expected. T F

29. I have sometimes stayed away from another person because I feared saying or doing something that I might regret afterwards. T F

30. People often disappoint me. T F

31. I like to keep people guessing what I'm going to do next. T F

32. I frequently ask people for advice. T F

33. I am not easily angered. T F

34. I have often met people who were supposed to be experts who were no better than I. T F

35. I would certainly enjoy beating a crook at

his own game. T F

36. It makes me think of failure when I hear of the success of someone I know well. T F

37. I have at times had to be rough with people who were rude or annoying. T F

38. People generally demand more respect more respect for their own rights than they are willing to allow for others. T F

39. There are certain people whom I dislike so much that I am inwardly pleased when they are catching it for something they have done. T F

40. I am often inclined to go out of my way to win a point with someone who has opposed me. T F

41. I am quite often not in on the gossip and talk of the group I belong to. T F

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. T F

43. I have often found people jealous of my good ideas just because they had not thought of them first. T F

44. When a man is with a woman he is usually

thinking about things related to sex. T F

45. I do not try to cover up my poor opinion or

pity so that he won't know how I feel. T F

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 onto those under them. T F

47. I strongly defend my own opinions as a rule. T F

48. People can pretty easily change me even though

I thought that my mind was already made up on a

subject. T F

49. Sometimes I am sure that other people can tell

what I am thinking. T F

50. A large number of people are guilty of bad

sexual conduct. T F

Appendix D

Controlled Oral Word Association Test

Administration

I AM GOING TO SAY A LETTER OF THE ALPHABET AND I WANT YOU TO WRITE AS QUICKLY AS YOU CAN ALL THE WORDS YOU CAN THINK OF THAT BEGIN WITH THAT LETTER. FOR INSTANCE, IF I SAY "B" YOU MIGHT WRITE BARK, BATTALION, BEAST, OR WORDS LIKE THAT. DO NOT USE WORDS WHICH ARE PROPER NAMES SUCH AS BOSTON, BETTY, BUICK OR NUMBERS. ALSO, DO NOT USE THE SAME WORD WITH A DIFFERENT PREFIX OR SUFFIX, SUCH AS BEAT OR BEATING, OR THE SAME WORD IN A DIFFERENT TENSE, SUCH AS FIGHT, OR FOUGHT. YOU WILL HAVE ONE MINUTE FOR EACH LETTER AND I WILL NOTIFY YOU WHEN ONE MINUTE HAS PASSED. FOLLOWING COMPLETION OF THE FIRST LETTER I INSTRUCT YOU TO MOVE ON TO THE SECOND COLUMN FOR THE 2ND LETTER AND THE 3RD COLUMN FOR THE 3RD LETTER. DO YOU HAVE ANY QUESTIONS? BEGIN WHEN I SAY THE FIRST LETTER. THE FIRST LETTER IS F. . . . GO AHEAD.

Timing begins immediately and one minute is allowed for each letter. When one minute is up, say STOP. Wait about 5 seconds before beginning the next trial. Next, say; **BEGIN WHEN I SAY THE NEXT LETTER. THE NEXT LETTER IS S... GO AHEAD.** The scores is the total number of acceptable words produced over the three minutes.

Appendix E

Ruff Figural Fluency Test

Administration

Begin with sample items of Part 1

IN FRONT OF YOU ARE THREE SQUARES, EACH CONTAINING FIVE DOTS. NOTE THAT THE ARRANGEMENT OF THE FIVE DOTS IS ALWAYS THE SAME. I WANT YOU TO CONNECT TWO OR MORE DOTS BY ALWAYS USING STRAIGHT LINES. YOU DO NOT NEED TO CONNECT ALL FIVE DOTS. THE PURPOSE OF THE TEST IS FOR YOU TO MAKE AS MANY DESIGNS OR FIGURES AS POSSIBLE, BUT EACH DESIGN HAS TO BE DIFFERENT IN SOME WAY FROM ALL THE OTHERS. DO YOU HAVE ANY QUESTIONS?

Following completion of the sample, give feedback as to errors, i.e. if there are two identical designs, point out the duplicated designs and repeat the instructional set. If the sample designs are elaborate (e.g. all five dots are consistently connected) re-emphasize the instructions that a design can be drawn by connecting two or more dots. Following completion of the sample, turn the page and state

TURN THE PAGE. DO NOT BEGIN UNTIL INSTRUCTED. ON THIS PAGE, DRAW AS MANY DIFFERENT DESIGNS OR FIGURES AS POSSIBLE. CONNECT AT LEAST TWO DOTS WITH A STRAIGHT LINE. YOU DO NOT NEED TO USE ALL FIVE DOTS. WORK AS QUICKLY AS POSSIBLE AND MAKE EVERY DESIGN DIFFERENT. GET READY GO.

Allow one minute for each part of the test. When this time is up, say **STOP**. Allow about 5 seconds and then instruct the subject. **TURN THE PAGE AND**

COMPLETE THE PRACTICE TRIALS. Allow about 20 seconds for this. Then, **TURN THE PAGE, START IN THE UPPER LEFT SQUARE, AND WORK FROM LEFT TO RIGHT. WORK AS QUICKLY AS POSSIBLE AND MAKE EVERY DESIGN DIFFERENT. GET READY. GO.**

Appendix F

Dichotic Listening

Complete the training phase. The experiment will read and point to each of the six phonemes on an index card. The subject is asked to repeat each phoneme. Headphones are used for auditory presentation of the phonemes. The subject is instructed to state the phoneme that they hear. The subject must identify five of six phonemes correctly in order to continue with the experiment. Subjects are then instructed:

YOU WILL HEAR THIRTY TRIALS OF SYLLABLES. YOU WILL HEAR A SYLLABLE IN ONE EAR AND ANOTHER SYLLABLE IN THE OTHER EAR. IT WILL SOUND LIKE TWO PEOPLE TALKING TO YOU AT THE SAME TIME. YOUR JOB IS TO LISTEN VERY CAREFULLYAND POINT TO THE SYLLABLE ON THE CHART THAT YOU HEAR MOST CLEARLY.

Appendix G

Dichotic Listening Focus Condition Left

The experimenter will read the following to the subject:

YOU ARE ABOUT TO HEAR THIRTY TRIALS OF WORDS. YOU WILL HEAR A SYLLABLE IN ONE EAR AND ANOTHER SYLLABLE IN THE OPPOSITE EAR, AND IT WILL SOUND LIKE TWO PEOPLE TALKING TO YOU AT THE SAME TIME. YOUR JOB IS TO LISTEN VERY CAREFULLY AND POINT TO THE SYLLABLE ON THE CHART THAT YOU HEAR IN YOUR LEFT EAR.

Appendix H

The experimenter will read the following to the subject:

YOU ARE ABOUT TO HEAR THIRTY TRIALS OF WORDS. YOU WILL HEAR A SYLLABLE IN ONE EAR AND ANOTHER SYLLABLE IN THE OPPOSITE EAR, AND IT WILL SOUND LIKE TWO PEOPLE TALKING TO YOU AT THE SAME TIME. YOUR JOB IS TO LISTEN VERY CAREFULLY AND POINT TO THE SYLLABLE IN YOUR RIGHT EAR.

Appendix I

Informed Consent for Participants of Investigative Projects

Title of Project: Emotion and Arousal: A dynamic evaluation of relative activation states

Experiment number:

1. PURPOSE OF EXPERIMENT

You are invited to participate in a study to obtain data regarding your medical history, handedness, blood pressure, hearing, and to fill out a few forms.

2. PROCEDURE TO BE FOLLOWED IN THIS STUDY

To accomplish the goals of this study, you will be asked to complete several questionnaires related to your medical history, handedness, and emotional state. Later, you may be called by telephone and asked to participate further in this research.

3. ANONYMITY OF SUBJECTS AND CONFIDENTIALITY OF RESULTS

Identifying information will be kept strictly confidential. At no time will the researchers release you personal information from the study to anyone other than individuals working on the project without your written consent. The information you provide will have your name removed and only a subject number will identify you during analyses and written reports of the research. The exception to this confidentiality is if you indicate verbally or via questionnaire that you are planning to hurt or kill yourself. If this occurs, we are bound by law to refer/obtain help for you to prevent such acts.

4. DISCOMFORT AND RISKS FROM PARTICIPATING IN THE STUDY

You may feel some embarrassment from answering the questionnaires. You may omit any questions that you feel embarrassing. If, after you have left the experiment, you have any problems associated with this study please call Dr. David W. Harrison (231-4422) so that he may assist you directly or direct you to appropriate services.

5. EXPECTED BENEFITS

Your participation in the project will help determine scores that may identify normal individuals as having relatively high or low levels of depression and/or anger for future research.

No guarantee of benefits has been made to encourage you to participate.

6. FREEDOM TO WITHDRAW

You are free to withdraw from this study at any time without penalty. If you choose to withdraw, you will not be penalized by reduction in points or grade for your psychology course.

7. EXTRA CREDIT COMPENSATION

For participation in this study you will receive one point extra credit for your psychology course, with the possibility of two extra credit points.

8. USE OF RESEARCH DATA

The information from this research may be used for scientific or educational purposes. It may be presented at scientific meetings and/or published and reproduced in professional journals or books, or used for any other purpose that Virginia Tech's Department of Psychology considers proper in the interest of education, knowledge, or research.

9. APPROVAL OF RESEARCH

This project has been approved by the Human Subjects Committee of the Department of Psychology and by the Institutional Review Board of Virginia Tech.

10. SUBJECT'S PERMISSION

I have read and understand the above description of this study. I have had and opportunity to ask questions and have had them all answered. I hereby acknowledge the above and give my voluntary consent for participation in this study.

I further understand that if I participate I may withdraw at any time without penalty.

I understand that if I have any questions regarding this research and its conduct, I should contact any of the persons named below.

John B. Williamson, MS 231-6914

Primary Researcher

David W. Harrison, Ph.D. 231-4422

Faculty Advisor

David Moore, Ph.D.   231-5281

Chair, IRB

Research Division Subject's Signature:______________________________ Date:___________

Subject's ID: _____________________ Subjects Telephone # __________________

Curriculum Vitae

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EDUCATION

Ph.D.	Virginia Polytechnic Institute and State University Clinical Psychology Specialty: Neuropsychology
M.S.	Virginia Polytechnic Institute and State University Clinical Psychology Specialty: Neuropsychology
B.A.	The Florida State University Major: Psychology

AWARDS AND HONORS

2002	NCS Graduate Research Award
2001	Group Treatment for Adult Offenders with Dual Diagnosis – Funded by Virginia Department of Corrections – Coauthor Year 1: $37,344 Year 2: $49,792
2001	Memory Screening Outreach Program. Virginia Neuropsychology Associates; Coauthor Funded by U. S. Pharmaceuticals Group, Pfizer, Inc., and Eisai, Inc. $149,995.
2001	Virginia Tech Graduate Travel Award

2000 16th Annual Symposium of Virginia Tech Research Award – 1st place, Social Sciences

1992-1996 Florida Undergraduate Scholars

1996 Honors within major awarded upon graduation after completion of Honors Thesis (Undergraduate)

Honor Societies:

Phi Beta Kappa
Golden Key National Honor Society

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Dissertation Research
2002 Title: Emotion and arousal: A dynamic evaluation of relative activation states

The influence of hostility on the lateralized tasks of cardiovascular regulation, verbal fluency, nonverbal fluency, and dichotic listening was assessed. Twenty-four subjects divided into two groups, high- and low-hostile men, underwent physiological measurements of SBP, DBP, and HR before and after verbal and figural fluency tasks, used as stressors. In addition, subsequent to the administration of each fluency task, dichotic listening performance was evaluated across unfocused, focus left, and focus right trials.

It was expected high-hostile men would produce results indicative of differential right hemisphere function when compared with low-hostile men. In addition, it was predicted high-hostile men would display a weakness in both the performance on the right-frontal nonverbal fluency task, and in their ability to maintain relative cardiovascular stability subsequent to the presentation of that stressor. As predicted, high-hostile men produced more perseverative errors than did low hostile men on this task. Further, subsequent to administration of the nonverbal fluency task, a reliable increase in blood pressure when compared to baseline and low hostile men was observed in high-hostile men.

Differences in dichotic listening performance were also expected as a function to pre-administered fluency tasks. It was predicted high-hostile men would evidence a priming effect in that a left-ear bias would be detected after the nonverbal fluency task but not the verbal fluency task. This was indeed the case. However, interestingly, the low-hostile men also displayed a priming effect at the left ear during the nonverbal fluency condition. Results are discussed within the context of the functional cerebral systems of emotion and arousal. Implications for further research are explored.

Master's Thesis Research
1999 Title: Functional cerebral asymmetry in hostility: A dual task approach with fluency and cardiovascular regulation

The influence of hostility levels on verbal and nonverbal fluency, and the concurrent cerebral regulation of autonomic nervous system functioning was examined in 48 right-handed males, half classified as low-hostile and half as high-hostile. Recent research has supported inhibitory roles for the anterior right cerebrum in sympathetic regulation, and the anterior left cerebrum in parasympathetic regulation. Two neuropsychological tests purportedly mediated by left and right anterior cerebral systems, respectively, are the Controlled Oral Word Association Test and the Ruff Figural Fluency Test. Fluency and perseverative errors were assessed using these measures. Systolic and diastolic blood pressure, and heart rate were assessed with a digital blood pressure meter.

It was predicted high-hostile men would evidence interference on cardiovascular regulation concurrent with the nonverbal fluency task in comparison to low-hostile men. Further, interference was expected to manifest in the cognitive variables with more perseverative errors on the nonverbal fluency task in high-hostile men than in low-hostile men.

he results support a capacity-limited prediction. High-hostile men evidenced significantly heightened systolic blood pressure subsequent to the nonverbal fluency task in comparison with low hostile men. Further, high-hostile men displayed more perseverative errors in nonverbal fluency than did the low-hostile men. These results support the expectation that differences exist between high and low hostile men for right frontal functioning. These findings were discussed within the proposed anterior-posterior inhibition model of hostility.

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Williamson, J. B., Shenal, B. V., Rhodes, R. D, Demaree, H.A., & Harrison, D.W. (2003) Case study: Topographical brain mapping in an adolescent diagnosed expressive aprosodic. *Applied Neuropsychology*, *10,* 176-181.

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Williamson, J. B., & Harrison, D. W. (2004). The influence of lateralized stressors on cardiovascular regulation and perception in high and low hostile men. Poster to be presented at the annual meeting of the International Neuropsychological Society, Baltimore, MD. *The Journal of the International Neuropsychological Society, In press*.

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Foster, P. S., Williamson, J. B., & Harrison, D. W. (2000). Quantitative electroencephalogram of an individual diagnosed with non-fluent aphasia. *Archives of Clinical Neuropsychology, 15*, 8, 653-850.

Higgins, D. A., Demaree, H. A., Williamson, J. B., & Harrison, D. W. (2000). Hand grip strength and functional cerebral asymmetry differences in low- and high-hostile men. *Journal of the International Neuropsychological Society*, *6*(2), 118.

Williamson, J. B., Everhart, E., & Emerson, C. (1999). Receptive prosodic ability in depressed and non-depressed school aged boys. *The Clinical Neuropsychologist*, *13*, 2, 211-244.

Williamson, J. B., Everhart, E., & Emerson, C. (1999). Hand fatigue asymmetry in the motor performances of depressed boys. *The Clinical Neuropsychologist*, *13*, 2, 211-244.

Crews, W. D. Jr., Jefferson, A. L., Broshek, D. K., Rhodes, R. D., Williamson, J., B., Brazil, A., Barth, J. T., & Robbins, M. K. (1999). Neuropsychological dysfunction in patients with end-Stage pulmonary disease: Lung transplant evaluation. *Archives of Clinical Neuropsychology*, *14*, 646.

PRESENTATIONS

Williamson, J. B., & Harrison, D. W. (2004). *The influence of lateralized stressors on cardiovascular regulation and perception in high and low hostile men.* Poster to be presented at the annual meeting of the International Neuropsychological Society, Baltimore, MD.

Williamson, J. B., Foster, P., & Harrison, D. W. (2003). *Cerebral asymmetry as a function of hostility.* Annual meeting for the Society for Psychophysiological Research, Chicago, IL.

Foster, P., Williamson, J. B., & Harrison, D. W. (2003). *That was so funny you can see it on my brain.* Annual meeting for the Society for Psychophysiological Research, Chicago, IL.

Foster, P., Williamson, J. B., & Harrison, D. W. (2003). *The effect of varying intensities of white noise on cerebral activation.* Annual meeting for the Society for Psychophysiological Research, Chicago, IL.

Foster, P.S., Williamson, J. B., Beck, A., & Harrison, D. W. (2003). *The Ruff Figural Fluency Test: Heightened right frontal lobe delta activity as a function of performance.* Annual meeting for the National Academy of Neuropsychology, Fort Worth, TX.

Williamson, J. B. & Harrison, D. W. (2002). *Arousal: A neuropsychological review.* Annual meeting for the National Academy of Neuropsychology, Miami Beach, FL.

Harrison, D. W., Walters, R. P., Williamson, J.B., & Foster, P. (2002). *Lateralized visual hallucinations: Analysis of affective valence.* Annual meeting for the National Academy of Neuropsychology, Miami Beach, FL.

Williamson, J. B., Harrison, D. W, & Foster, P. (2002). *Emotion and arousal: A functional cerebral systems analysis.* Annual meeting for the Society for Psychophysiological Research, Washington D. C.

Williamson, J. B., & Harrison, D. W. (2002). *Localized arousal states: A functional cerebral systems analysis of stressor methodologies.* Annual meeting for the Southeastern Psychological Association, Orlando, FL.

Foster, P., Williamson, J. B., & Harrison, D. W. (2002). *The Design Learning Test: Assessment of Learning Using the Right Hemisphere.* Annual meeting for the National Academy of Neuropsychology, Miami Beach, FL.

Christie, I., Williamson, J. B., Foster, P., & Park, A. (2001). *Electroencephalographic and autonomic examination of complex melodies and rhythms.* Annual meeting for the Society for Psychophysiological Research, Montreal, Quebec, Canada.

Williamson, J. B., & Harrison, D. W. (2001). *Localized arousal states: A functional cerebral systems analysis of stressor methodologies.* Annual meeting for the Virginia Psychological Association, Roanoke, VA.

Williamson, J.B., Higgins, D., & Beck, A. (2001). *A cross-sectional comparison of frontal lobe development and aging.* Annual meeting for the Southeastern Psychological Association, Atlanta, GA.

Beck, A. L., Higgins, D. A., Williamson, J. B., Foster, P. S., & Harrison, D. W. (2001). *Frontal lobe deterioration: Evidence from sex differences in aging effects.* Annual meeting for the Southeastern Psychological Association, Atlanta, Georgia.

Williamson, J. B., & Harrison, D. W. (2000). *Cerebral asymmetry in the dual-task performances of high-hostile males.* Annual meeting for the National Academy of Neuropsychology, Orlando, FL.

Williamson, J.B., Shenal, B. V., Rhodes, R., Foster, P. S., & Harrison, D. W. (2000). *Quantitative EEG assessment of an adolescent with expressive aprosodia.* Annual meeting for the National Academy of Neuropsychology, Orlando, FL.

Foster, P. S., Williamson, J. B., & Harrison, D. W. (2000). *Quantitative electroencephalogram of an individual diagnosed with non-fluent aphasia.* Annual meeting for the National Academy of Neuropsychology, Orlando, FL.

Higgins, D. A., Demaree, H. A., Williamson, J. B., & Harrison, D. W. (2000). *Hand grip strength and functional cerebral asymmetry differences in low- and high-hostile men.* Annual meeting for the International Neuropsychological Society, Denver, Colorado.

Williamson, J. B., Foster, P. S., & Harrison, D. W. (2000). *Differential effects of hostility level on nonverbal and verbal fluency.* Annual meeting for the Southeastern Psychological Association, New Orleans.

Williamson, J. B. & Harrison, D. W. (2000). *Cerebral asymmetry in the dual-task performances of high-hostile males.* Poster presented at 16th annual research symposium of Virginia Tech.

Crews, Jr., W. D., Jefferson, A. L., Broshek, D. K., Rhodes, R. D., Williamson, J. B., Brazil, A., Barth, J. T., & Robbins, M. K. (1999). *Neuropsychological dysfunction in patients with end-stage pulmonary disease: Lung transplant evaluation.* Annual meeting for the National Academy of Neuropsychology, San Antonio, TX.

Williamson, J. B., Everhart, E., & Emerson, C. (1999). *Receptive prosodic ability in depressed and non-depressed school aged boys.* Annual meeting for the American Psychological Association, Boston, MA.

Williamson, J. B., Everhart, E., & Emerson, C. (1999). *Hand fatigue asymmetry in the motor performances of depressed boys.* Annual meeting for the American Psychological Association, Boston, MA.

Williamson, J. B., Higgins, D., & Demaree, H. A. (1999). *Differential effects of hostility level on hand fatigue asymmetry.* Annual meeting for the Southeastern Psychological Association, Savannah, GA.

Foster, P. S., Webster, D., & Williamson, J. B. (1999). The *psychophysiological differentiation of actual, imagined, and recollected mirth.* Annual meeting for the Southeastern Psychological Association, Savannah, GA.

Williamson, J. B., Emerson, C. & Everhart, E. (1998). *An investigation of receptive prosodic ability in depressed and non-depressed school aged boys***.** Annual meeting for the Virginia Psychological Association (VPA), Wintergreen, VA.

Steele, S., Williamson, J. B., Emerson, C., & Everhart, E. (1998). *An investigation of receptive prosodic ability in depressed and non-depressed school aged boys.* Poster presented at the 14th Annual research symposium of Virginia Tech.

CLINICAL EXPERIENCE

2003-2004 Clinical Neuropsychology Intern
University of Chicago, Chicago, IL
Neuropsychological assessment: Adult/Medical, Forensic, Traumatic brain injury, Pediatric Individual/Family therapy: Schizophrenia, biopolar disorders, ADHD, adjustment disorders, etc. . .
Research: Autonomic nervous system correlates of hostility (heart rate variability, impedance cardiography, continuous blood pressure, neuroendocrine variables).

2002(Summer) Memory Disorder Clinic/Neuropsychological Services
Osler Neurologic, Melbourne, Florida
Served on multidisciplinary team conducting memory screenings and neuropsychological assessments. Acted as a consultant for fine tuning the memory screening battery.

2002-2003 Clinician/Behavior Analyst (Independent Contractor)
Intervention Services, Melbourne, Florida
Individual therapy and applied behavioral services provided to children, adults, and families.

2001 – 2002 Neuropsychology Graduate Supervisor
Psychological Services Center, Virginia Tech
Graduate level practicum team specializing in the assessment and treatment of neuropsychological disorders related to TBI, stroke, dementia, learning disability, and headaches. Supervision of other Graduate students.

2001 - 2002 Neuropsychology Technician
Neuropsychological and Counseling Services (NCS)
Assessment of neuropsychological syndromes including agnosias, aphasias, disorders of neglect, pseudobulbar palsy, etc. . .

2001 - 2002 EEG Technician
Neuropsychological and Counseling Services (NCS)
Administration of quantitative electroencephalograms for the purpose of neuropsychological testing.

2000-2001 Therapist
Hollins Head Injury Program and Research Institute
Assessment and treatment of issues related to traumatic brain injury and other neuropsychological disorders.

2000 Graduate Clinician – Clinical Practicum Team
Psychological Services Center
Virginia Tech
Assessment and treatment of a variety of psychological disorders, including depression, anxiety, learning disabilities, Attention Deficit Hyperactivity Disorder (ADHD), and relationship problems through individual, couples, and family therapies.

1997-2001 Graduate Clinician - Neuropsychological Practicum Team
Psychological Services Center, Virginia Tech
Graduate level practicum team specializing in the assessment and treatment of neuropsychological disorders related to TBI, stroke, dementia, learning disability, and headaches.

1998-1999 Graduate Clinician - Clinical Practicum Team
Psychological Services Center
Virginia Tech
Assessment and treatment of a variety of psychological disorders, including depression, anxiety, learning disabilities, attention deficit disorder (ADHD), and relationship problems through individual, couples, and family therapies.

1999- 2000 Externship - Therapist
Hollins Head Injury Program and Research Institute
Assessment and treatment of issues related to traumatic brain injury and other neuropsychological disorders.

1999 Therapist
Virginia Neuropsychology Associates, INC
Dementia Assessment and Neuropsychological research
Supervisor: Dave Crews, Ph.D.

1998 Therapist
Post Traumatic Stress Clinic
Intellectual and achievement assessment.

1996-1997 Behavior Specialist
Appalachee Center for Human Services
Pace Secondary School
Population: Severely Emotionally Disturbed Middle/High School Students
Assessment and treatment of behavior problems within the school setting utilizing functional assessment techniques.

TEACHING EXPERIENCE

Spring, 2002 Introductory Psychology – Session Instructor (Virginia Tech)

Fall, 2001 Directed Individual Study – Supervisor Undergraduate Research (Virginia Tech) Topics: Methodologies in neuroscience research. Formulation of literature based hypotheses.

Fall, 2001	Theories of Personality – Course Instructor (Virginia Tech) Course topics: History of personality theory; including psychodynamic, trait, behavioral, and others. Emphasis on neuropsychological processes in the development of personality.
Summer, 2001	Introductory Psychology – Course Instructor (Virginia Tech)
Spring, 2001	Nervous Systems and Behavior – Course Instructor (Virginia Tech) Course topics: functional neuroanatomy, basic relationships between brain and behavior, and theoretical applications.
Fall, 2000	Sensation and Perception – Course Instructor (Virginia Tech) Course topics: Overview of sensory and perceptual systems and their integration in influencing behavior. Emphasis was on sensory receptor characteristics, neural structure, psychophysical data, perceptual phenomena and issues, and theories about the human perceptual process.
Fall, 2000	Lab in Sensation and Perception – Course Instructor (Virginia Tech) Course Topics: Overview of the major experimental techniques and phenomena of sensation and perception. Emphasis was on psychophysical methods, signal detection, dark adaptation, and perceptual illusions.
Fall & Spring 1999	Physiological Psychology Teaching Assistant (Virginia Tech) Duties: Instruction to undergraduate students in the study of physiological processes as they pertain to psychology; lectured on special topics in biopsychology.
Fall & Spring 1998	Introductory Psychology Section Instructor (Virginia Tech) Duties: Responsible for leading group discussions, as well as lecturing on major topics in psychology.

PROFESSIONAL ACTIVITIES

Membership

American Psychological Association (APA) student affiliate
Division 40 (Neuropsychology) student affiliate
The Society for Psychophysiological Research (SPR) student affiliate
National Academy of Neuropsychology (NAN) student affiliate
The International Neuropsychological Society (INS) student affiliate
Southeastern Psychological Association (SEPA) student affiliate
Virginia Psychological Association (VPA) student affiliate