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The influence of hostility on electroencephalographic activity and memory functioning during an affective memory task

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Abstract

Objective: The purpose of this study was to examine the neural correlates of emotional learning and hostility via the use of EEG and the Auditory Affective Verbal Learning Test (AAVL).
Methods: The Cook–Medley Hostility Scale (CMHO) was used to identify right-handed men ($N = 16$) and women ($N = 44$) as low or high hostile. Participants were administered the positive and negative word lists of the AAVL lists, and were asked to recall the words during a 5-trial paradigm. EEG data were recorded from 19 scalp sites before and following learning trials; separate bandwidths of the EEG spectrum were analyzed.
Results: As predicted, completion of the negative AAVL resulted in self-reported negative mood induction. Moreover, primacy and recency effects were demonstrated with the negative and positive versions of the AAVL, respectively. Unexpectedly, high hostiles demonstrated greater right versus left hemisphere high alpha power than low hostile counterparts. Low hostiles evidenced greater alpha power and low beta power than did high hostiles.
Conclusions: These results suggest differing patterns of hemispheric asymmetry and overall brain activity for low and high hostiles during emotional learning.
Significance: The findings are important with regard to understanding the relationship between hostility, emotional learning, and associated neural systems.

Keywords: Hostility; EEG; Verbal learning; Emotional memory

1. Introduction

Given the well-known relationship between hostility and coronary artery disease (Dembroski et al., 1989; Hecker et al., 1988; Littman, 1993; Miller et al., 1996; Siegman et al., 2000), as well as the effects of hostility on physiological reactivity to mental/emotional stressors (Demaree and Harrison, 1997b; Demaree et al., 2000; Everson et al., 1995; Fredrickson et al., 2000; Smith and Gallo, 1999; Vogele, 1998), it is important to develop an understanding of the underlying neurophysiological mechanisms and neuroanatomical systems associated with emotional processing in hostility. Several prominent general models of emotion and cerebral function suggest that individuals with characterologic negative affect experience relative right hemisphere activity in comparison to the left hemisphere. A variety of other negative affective responses such as sadness and anxiety have also been implicated (Borod, 1993; Borod

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et al., 1998; Demaree et al., 2005; Heller, 1993). A similar model makes predictions regarding asymmetrical cortical activity within the left and right frontal lobes. For instance, Davidson (1998b), as well as other laboratories (Harmon-Jones, 2003) have frequently reported that increased left frontal activity is associated with positive affect, while increased right frontal activity is associated with negative affect (Heller, 1993). A derivative of this model suggests that these differences may be contingent upon approach versus withdrawal-related behavior (Harmon-Jones and Allen, 1998).

The present study was not designed to test the specific models of emotion that are described above. That is, in this study the relationship between individual differences (i.e., hostility level), performance on positive and negative word learning tasks, and electrophysiology is examined. To date some researchers (i.e., JC Borod as well as the primary author in the present study) consider emotional words (e.g., lexical emotion) as a "third channel" of emotion processing (in comparison to emotional speech or emotional faces). In comparison to the other channels of emotion processing, there is very little literature on the effect(s) of emotional words (as compared to emotional speech or emotional faces) on brain function; there is even less on how hostility may interact with these important variables. To this extent current well-known models of emotion (Davidson, 1998b; Heller, 1993) may be less suited to explain such effects without significantly altering the model. Specifically, our study combines a heavy cognitive load (i.e., learning and memory) with subvocal rehearsal of newly acquired information with positive and negative stimuli. Given the infusion into the language system (and presumably left hemisphere) as well as emotion regulation systems, the capability of testing the well-known hemisphere models for emotion is difficult.

While the prominent models of emotion hold conceptual differences, one common theme includes relative right hemisphere activity during certain transient negative emotional states such as fear, sadness, and anger. Less is known about hemispheric differences with regard to the characterologic trait of hostility. Some have postulated that the components of physiological arousal, subjective experience of hostility, and alterations in emotional processing are attributable to relative right hemisphere activity (Demaree and Harrison, 1997a,b). It should be noted that the neuropsychological theories referenced above have not been systematically examined in conjunction with emotional/verbal learning (as is the case with the present investigation). However, given the associations between hostility and altered autonomic nervous system function, the link between emotion and verbal learning is somewhat intuitive. A primary goal of the present study is to explore the relationship between hostility, affective learning, and hemispheric differences in brain activity.

Previous studies within our laboratory have initiated the exploration of this relationship. For instance, one series of studies utilized the Affective Auditory Verbal Learning Test (Snyder and Harrison, 1997; Snyder et al., 1998) to examine learning patterns, physiological reactivity, and changes within the electroencephalograph (EEG) spectrum among healthy individuals who report high levels of hostility (Everhart et al., 2005). The AAVL was derived from Toglia and Battigs Handbook of Word Norms (Toglia and Battig, 1978), and has been used in other laboratories (Papps et al., 2003). It consists of two 15-item word lists, one of which is comprised of positive affective words whereas the other is comprised of negative affective words. The primary findings demonstrate that primacy effects are observed with the negative word list whereas recency effects are observed with the positive word list (Demaree and Everhart, 2004; Demaree et al., 2004; Everhart and Demaree, 2003; Everhart et al., 2003; Snyder and Harrison, 1997; Snyder et al., 1998). Regarding regional brain changes during the AAVL, one previous experiment found diminished low alpha power (7.5–9.5 Hz) over parietal scalp sites among participants who were asked to learn the negative word list. It was our interpretation (as is conventional) that reductions in alpha power are associated with increased brain activity (Davidson and Henriques, 2000; Glass, 1966; Lindsley and Wicke, 1974; Shagass, 1972). It is possible that learning the negative words of the AAVL resulted in increased neuronal activity within these regions.

To date, only one study has been completed that examined the relationship between the performance of high hostiles on the AAVL and regional brain changes in EEG. Interestingly, Everhart et al. (2003) found that high hostiles evidenced increased alpha power (i.e., decreased brain activity) relative to low hostiles during the presentation of the negative AAVL. One interpretation of this finding is that high hostiles are more familiar with the negative words found on the list (e.g., murder, kill, gun), although the precise reasons for this finding have yet to be determined. This research suffered from several shortcomings in that the design did not allow for examination of within group differences (e.g., low and high hostiles) of EEG changes that occur to the positive versus negative word list. Relatedly, the study design did not permit comprehensive examination of narrow bandwidths.

In order to remedy the problems of the previous research, which presented only the positive or negative word lists of the AAVL, participants were presented with both word lists in a counterbalanced fashion. In effect, this increased the overall task demands, but also allowed for examination of within group differences across the EEG spectrum.

The present research was designed to better understand the neural correlates of emotional learning among individuals with differing hostility levels by determining the impact of the AAVL on cortical arousal, as measured by EEG. The present research is different from prior work in two primary ways. First, all participants received both word lists which allowed for examination of within group differences. Second, the present research examined the effect of hostility on narrow EEG bandwidths. Given previous findings and theories discussed, the following hypotheses were made: