Psychology

The Relationship between Anger, Frontal Asymmetry and the BIS/BAS Subscales

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Anger is an emotional phenomenon that is often associated with hostility and aggression, which are thought to be major influencing factors for numerous negative health behaviors and outcomes. Previous research has explored the role of these negatively portrayed emotional factors through experimental models dependent on respective biological and psychological evidence. The present study aimed to expand knowledge by conceptualizing anger, hostility, and aggression within the framework of the Reinforcement Sensitivity Theory (RST), which presents neurophysiological underpinnings for motivation with particular emphasis on related baseline alpha asymmetry correlates. RST consists of Behavioral Activation (BAS) and Behavioral Inhibition (BIS) Systems. BAS is associated with left frontal activity and approach behaviors, while BIS is associated with right frontal activity and withdrawal behaviors. In this study, 36 college students were utilized to examine the relationships between BIS, BAS, self-reported emotional characteristics (anger, hostility, and aggression), and baseline alpha (8-13 Hz) frontal asymmetry scores. Results of the present study revealed a significant positive correlation between self-reported anger and baseline alpha asymmetry at the F8-F7 electrode site for eyes closed, r (36)=.438, p =.008), and eyes open conditions, r (36)=.414, p =.012). These findings demonstrate conceptual and potential neurophysiological differences between anger, hostility, and aggression.

Anger | asymmetry | approach-avoidance

Anger, hostility, and aggression are terms that are often used interchangeably to refer to the global label of hostility. However, most current research examining hostility tends to utilize the three-factor model of conceptualizing hostility or trait anger (1). This model asserts that the construct of hostility or trait anger includes three major components: affective, cognitive/attitudinal, and behavioral. As such, the terms anger, hostility, and aggression, represent each of the areas respectively.

"Anger" typically represents an affective or negative emotional state based upon subjective feelings varying in intensity, whereas "hostility" constitutes a cognitive and attitudinal tendency, with held beliefs of cynicism and mistrust of others. Meanwhile, "aggression" is associated with the overt behavioral response, perhaps precipitated by anger or hostility (1). However, many surmise that the interaction or aggregate combination of all three factors influence health and thus due to the conceptual overlap of the constructs of anger, hostility, and aggression, the three constructs together are referred to as the AHA! Syndrome (2).

In effort to identify individuals most at risk for developing chronic health conditions, researchers have attempted to study individual differences as they relate to personality profiles. One of the most famous examples from this work comes from the literature on the type A personality and cardiovascular disease. Type A behavior pattern (TABP; also known as coronary prone behavior pattern) presents as combination of several psychological and behavioral constructs and behaviors including AHA. Rosenman (3) described TABP as an:

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

Original support for the relationship between TABP and negative health outcomes was lead by Friedman and Rosenman throughout the 50's and 60's. Prolific amounts of research described predictive relationships suggesting TABP to increase the likelihood of CHD and relevant symptomology. Specifically, early research reported TABP to be related to increased muscle vasodilatation and more enhanced secretion of norepinephrine, epinephrine, and cortisol (4), increased blood cholesterol levels, elevated triglycerides, and increased blood clotting time (5).

Despite the original hype surrounding the potential in identifying individuals with TABP, studies began reporting inconsistent findings from the mid-80's to the present, with many researchers championing anger and hostility as the "real culprits" within TABP responsible for cardiac related illness (6). For instance, a major study analyzing the relationship between TABP and one's health was demonstrated in the Western Collaborative Group Study (WCGS), in which the researchers observed similar behavioral and emotional tendencies among a CVD population (7). Two-hundred-fifty Coronary Heart Disease (CHD) cases and 500 matched controls from the WCGS were studied using a Type A structured interview assessing 12 operationally defined components previously established to be representative of TABP. Aside from being the first study to establish a prospective relationship between TABP and coronary heart disease, these researchers noted that not all facets of TABP were indicative of CVD; rather an emphasis should be placed on hostility (7).

Many researchers have moved away from studying the TABP and are beginning to examine yet another behavior pattern identified to be highly related to the development of CHD. The type D or "distressed" behavior pattern is characterized by two global traits: negative affect and social inhibition. Negative affect refers to the tendency to experience negative affect or negative cognitive states (e.g., dysphoria, hostility, anxiety, and irritation) across many different situations, while social inhibition refers to the tendency to inhibit expression of emotions in social situations.

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Persons characterized by both high negative affectivity and high social inhibitions have been shown to be vulnerable to many physical ailments, disease courses, and especially cardiovascular disease biomarkers (8, 9).

Designed specifically to assess outcomes for cardiac patients, many studies have demonstrated a strong relationship between negative affect and social isolation with cardiac events. A series of studies conducted by Denollet and his associates have shown the Type D personality to be predictive of adverse outcome for cardiac patients, including mortality, myocardial infarction, and revascularization procedures (10). For example, Denollet, Vaes, and Brutsaert (10) examined the 5-year prognosis of 319 patients with CHD. Utilizing cardiac death, non-fatal cardiac events, and perceived impairment in quality of life (QoL), the researchers revealed that decreased left ventricular ejection fraction (the volumetric fraction of blood pumped from the ventricle), type D personality, and younger age of onset increased the risk of cardiac events significantly, with the convergence of the two or three of the risk factors predicting the poorest prognosis and a non-response to treatment 4-fold.

Despite being constructed to study predictive outcomes within a cardiac population, the Type D personality has also been linked to general ill health and poor health behaviors. Mols and Denollet (11) performed a meta-analysis of studies utilizing the Type D personality construct with non-cardiac populations between the years of 2007 and 2009. The majority of the studies included non-cardiac patients with chronic pain, asthma, tinnitus, sleep apnea, vulvovaginal candidiasis, mild traumatic brain injury, vertigo, melanoma, diabetic foot syndrome, and older patients in primary care. In general, the findings revealed that non-cardiac patients with Type D attributes reported a poorer health status and were more likely to present with anxiety and depressive symptoms. Furthermore, compared to their non-Type D counterparts, patients with Type D personality were more vulnerable to non-adherence to their medical regime.

Additional corroboration demonstrating the impact of Type D personality on general health of non-cardiac patients was found in a study examining maladaptive behaviors among a sample of 200 university students and faculty members, with 34.5% of their participants qualifying as Type D personality. Results indicated a significant difference in health behaviors (as assessed by Preventive Health Behavior Checklist and Timeline Follow Back Measurement) within the Type D versus the non-Type D personality participants. Results suggested that those individuals indicating a Type D personality profile were found to engage in more maladaptive health behaviors. These individuals were likely to smoke more, exercise less, and eat a poorer diet than their non-Type D counterparts. Despite inherent limitations in attempting to link Type D personality as an underlying mechanism to ill health, the findings show promise for use of Type D measurement as part of the health care system (12). Nevertheless, these results further support earlier findings demonstrating a relationship between Type D personality and metabolic disorder [e.g., a cluster of risk factors, including increased central fat deposition, glucose intolerance or insulin resistance, dyslipidemia, and hypertension (13)], and adverse lifestyle behaviors [e.g., smoking, excessive alcohol consumption, poor diet, and lack of exercise (14, 13)]. Taken together, the constructs of negative affect and social isolation underlying Type D personality are maladaptive in healthy and non-healthy populations providing a continued need to assess individuals for Type D in medical and non-medical settings. Perhaps further exploration may be warranted for specific factors (i.e., hostility) that may mediate many of the negative outcomes.

In discussing the influence of personality and behavior patterns on health outcomes, another factor that should be considered in the larger health picture are BIS and BAS. More heavily focused in the physiological and neuropsychological aspects of personality, Gray's (15) reinforcement sensitivity model sought to reveal that individual differences in these two competing systems would result in a unique temperament or personality style in which to interact with one's environment (16). The BIS, is proposed to be activated by aversive stimuli (punishment and non-reward) resulting in increased attentiveness, inhibition, withdrawal and negative affect. In contrast, the BAS operates in response to appetitive stimuli (reward, motivation, and non-punishment) and results in the experience of positive affect and approach behavior. Physiological evidence for these constructs comes from electroencephalography (EEG) studies which have demonstrated that those primarily motivated by BIS tend to have greater activity in the right frontal lobe of the neocortex, while those primarily motivated by BAS have greater activity in the left frontal lobe (17, 18, 19, 20, 21, 22).

In relation to overall health and well-being, there is evidence to support the relationship between different system sensitivities (e.g., high BAS or low BAS) to negative health outcomes; such that cardiac reactivity (i.e., heart rate, respiratory sinus arrhythmia, and pre-ejection period) and high BAS sensitivity are greatly associated (16). Additionally, a general relationship between BIS/BAS and high-risk health behaviors have been observed. Specifically, BIS has been shown to be related to poor diet, lack of exercise, unsafe acts (e.g., not wearing seatbelt while driving), drug use, and non-adherence to medical treatment (23, 24). In contrast, BAS has been related to unhealthy behaviors related to safety, tobacco and other drug use, alcohol consumption, and sexual practices (24). These results were interpreted to suggest that BAS was related to acts of impulsivity and sensation seeking whereas BIS to those of inhibition or avoidance.

It may be wise to consider the influence of AHA! among health behaviors and development of chronic health conditions. For example, although BAS is generally related to the experience of positive affect, several studies have identified the experience of anger to be highly correlated to BAS (25; 26; 20, 27), thus perhaps muddying the relationship found between cardiac reactivity and BAS sensitivity.

Interestingly, these findings provide evidence that in some instances perceived negative emotions may serve as motivators, especially as it pertains in the case with anger. This was demonstrated in by Harmon-Jones (26), in which participants were exposed to affective pictures to elicit neutral, fear/anxiety, and anger reactions while recording EEG activity. They were then administered traditional measures (i.e., BIS/BAS Scales) to capture individual differences in BIS and BAS strength. Results indicated that persons high in trait anger had greater left frontal activity to anger-inducing pictures, demonstrating the role of trait anger in the neural circuitry of approach motivation, which tends to be much more easily activated in these individuals (26). Predictably similar results have been found in relation to aggression. Particularly, individuals scoring high on the BAS scale were more likely to show a tendency towards aggression after being primed by an approach-related activity (28).

The implications of these findings are striking as they highlight that an approach related disposition may not always be conducive to good health. There are, however, hitherto unappreciated aspects of this complex phenomenon which have yet to be explored. The BAS construct can be further divided into three factors which correspond to different aspects of approach-related behavior. They include measures of reward responsiveness, drive, and fun seeking (29). There is some evidence in the literature to suggest that these factors likely have differential effects on health and wellness. For instance, fun seeking has been shown to be positively correlated to engagement in risky health behaviors related to sex, substance use, and safety negligence, while reward responsiveness has been shown to be negatively correlated with the aforementioned risky health behaviors. Likewise, drive was negatively correlated with physical inactivity (24). It could be that similar differential relationships could be observed when examining the relationships between the BAS factors, frontal asymmetry, and AHA. The present study seeks to build upon the literature by replicating the previous research findings, and extending them via exploring the relationships between AHA and the factors which contribute to BAS.

Methods

Ethics, Consent and Permissions

The study was approved by the appropriate human subjects committee and internal review board. All participants provided written informed consent for participation in this study.

Consent to Publish

Consent to publish has been obtained from all participants in the study.

Participants

Participants were recruited from the undergraduate subject pool within a department of psychology at a university. The study was approved by the appropriate human subjects committee and internal review board at the same university. An initial screening was performed to determine if the participants were right-handed and had no previous history of any psychiatric diagnoses (e.g., anxiety disorders, mood disorders, and attention deficit and hyperactivity disorder). Left-handed individuals or individuals with a history of psychiatric concerns were dismissed. A total of 36 right-handed (determined by self-report) individuals (16 men, 20 women) were recruited to participate in the study. The average age of the sample was 20.18 years (SD = 3.36), ranging from 18 to 34 years of age.

Measures and Questionnaires

Buss-Perry Aggression Questionnaire (AQ). The AQ is a 29-item questionnaire measuring the four main constructs of Anger (seven items), Hostility (eight items), Verbal Aggression (five items), and Physical Aggression (nine items). The participant rates each statement on a 5-point rating scale with values of 1 indicating the statement is “extremely uncharacteristic of me” to a value of 5 “extremely characteristic of me,” (30). A sample of 1200 participants in a study analyzing the generalizability of the AQ in the general population found that each factor of the AQ demonstrated moderate to high internal consistency reliability, Verbal Aggression (.68), Anger (.70), Hostility (.75) and Physical Aggression (.82). The AQ is suitable and valid measure for use in the general population (31).

BIS/BAS scales. The behavioral inhibition scale (BIS) and behavioral activation scales (BAS), developed by Carver and White (29), are comprised of 20 questions spanning four domains: BIS, BAS reward responsiveness, BAS drive, and BAS fun seeking. The BIS scale has seven items that measure sensitivity to withdrawal behavior and expectations of punishment; while the BAS scales, with a total of 13 items measure anticipation of reward, motivation toward desired goals, and desire to approach novel situations with expectation of reward. Participants respond to each item using a 4-point Likert scale, with a score of 1 indicating “Strongly Agree” to a score of 4 indicating “Strongly Disagree” (29, 32). Carver and White’s (29) research has shown reliabilities for the varying scales ranging from 0.66 to 0.76. Furthermore, psychometric evaluation of the scales has shown efficacy within clinical populations (e.g., anxiety and depression), suggesting strong relationships of BIS to both anxiety and depression; however, more support suggested a strong association of BIS/BAS to relevant personality constructs, such as neuroticism (BIS) and positive affect [BAS (33)]. For the purposes of this study, the BAS scales were considered individually as well as a single scale. BIS was used as its original single scale.

Electroencephalogram (EEG) Recording

EEG recording of cortical electrical activity will be captured using Ag/AgCl - sintered electrodes mounted in an elastic Quik-Cap (Compumedics Neuroscan; Herndon, VA) at 32 scalp sites using the international 10/20 placement system (Fp1, Fp2, F7, F8, F3, F4, FT7, FT8, FT9, FT10, T3, T4, FC3, FC4, C3, C4, CP3, CP4, TP7, TP8, T5, T6, P3, P4, O1, O2, Fz, FCz, Cz, CPz, Pz, Oz) including ground references linked to the ears (A1- A2/2). To achieve a baseline cortical measure, participants were instructed to sustain eight alternating one-minute intervals in which they were asked to maintain their eyes open (O) or eyes closed (C) in alternating intervals (O, C, O, C, O, C) as adapted from Harmon-Jones and Allen (20).

Frontal asymmetry scores were calculated for overall alpha power (8-12 Hz)by subtracting left alpha power scores from right alpha power scores at frontal electrode pairs (e.g., ln[alpha power at F4 electrode] – ln[alpha power at F3 electrode, creating the F43 asymmetry score). The asymmetry score is thought to represent increased brain activity with negative scores suggesting greater relative right hemisphere EEG activity and positive scores suggesting greater relative left activity (34).

Procedures

All study procedures took place in the Cognitive Neuroscience Laboratory located within the Department of Psychology. Prior to engaging in the study, potential participants were screened and each eligible participant independently read and reviewed an informed consent document approved by the University Policy and Review Committee on Human Research. Once consent was established and the documents signed, each participant was administered a battery of self-report measures including a brief demographic record form and a series of personality and behavioral measures. Following the administration of the self-report measures, participants were prepped for the EEG recording. Once prepped, participants were provided basic instructions about the recording process followed by an eight minute recording of baseline cortical activity using the procedure described in the previous section. After the completion of the study, participants were disconnected from the equipment, debriefed, and dismissed.

Results

Statistical analyses were conducted using SAS JMP 10.0 statistical software package (SAS Institute Inc.; Cary, NC). Raw data were inspected for missing data and normality. The results for evaluation of assumptions of normality indicated a positively skewed leptokurtic distribution of resting frontal asymmetry activity, which was corrected with natural logarithmic transformations.

Table 1. ***Zero-Order Correlations and Simple Descriptive Statistics for Overall Sample (N = 36)***

	Zero-Order Correlations								
	A	H	VA	PA	BIS	BAS-D	BAS-FS	BAS-RR	BAS-TOT
H	.635****								
VA	.758****	.520***							
PA	.507***	.319	.573****						
BIS	-.307	.060	-.347*	-.531***					
BAS-D	.405*	.111	.290	.143	.097				
BAS-FS	.317	.070	.114	-.022	.001	.409***			
BAS-RR	-.021	-.063	-.078	.100	.239	.390*	.297		
BAS-TOT	.325	.059	.161	.102	.144	.824****	.735****	.716****	
M	14.92	19.22	13.56	20.83	18.22	11.92	12.86	18.42	43.19
SD	5.51	5.79	4.31	7.71	2.31	2.39	1.97	1.90	4.79

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

AHA! Inter-correlations

Directional correlation analyses were performed in order to determine the relationships, if any, among AHA! subscales of the Buss-Perry Aggression Questionnaire, BIS/BAS subscales, and resting asymmetry for frontal electrode pair sites (FP21, F87, F43, and FT87). Table 1 provides basic descriptive statistics and zero-order correlation coefficients between the BIS/BAS subscales and AHA! subscales. All subscales of the Buss-Perry Aggression Questionnaire were inter-correlated with one another. Self-reported Anger (M = 14.92, SD = 5.51) was significantly and positively correlated with self-reported Hostility (M = 19.22, SD = 5.79), r = .635, n = 36, p <.0001, 95% CI [0.387, 0.797], Verbal Aggression (M = 13.56, SD = 4.31), r = .758, n = 36, p <.0001, 95% CI [0.572, 0.870], and Physical Aggression (M = 20.83, SD = 7.71), r = .507, n = 36, p = .0010, 95% CI [0.215, 0.717]. Self-reported Hostility was significantly and positively correlated with Verbal Aggression, r = .520, n = 36, p = .0004, 95% CI [0.231, 0.725]. Further, Verbal and Physical Aggression subscale scores were also correlated with one another, r = .573, n = 36, p = .0003, 95% CI [0.301, 0.759]. The relationships noted among these variables highlight the related underpinnings for these typically associated constructs, but also show the interdependent nature of the often negatively perceived underlying cognitive pattern (hostility), emotional state (anger), and behavior (verbal and physical aggression).

BIS/BAS Inter-correlations

Examination of the correlations among the BIS/BAS subscales (also observed in Table 1) found that several individual subscales were correlated. Self-reported scores of the BAS-Drive (BAS-D) subscale (M = 11.92, SD = 2.39) were significantly and positively correlated with BAS-Fun Seeking (M = 12.86, SD = 1.97), r = .409, n = 36, p = .013, 95% CI [0.092, 0.650], BAS-Reward Responsiveness (BAS-RR) subscale (M = 18.42, SD = 1.90), r = .390, n = 36, p = .019, 95% CI [0.071, 0.637] and BAS-Total (BAS-TOT) scale (M = 43.19, SD = 4.79), r = .824, n = 4, p <.0001, 95% CI [0.680, 0.907]. Self-reported BAS-FS was also significantly and positively correlated with the BAS-TOT scale, r = .735, n = 36, p <.0001, 95% CI [0.536, 0.857]. Meanwhile, BAS-RR was significantly and positively correlated with BAS-TOT, r = .716, n = 36, p <.0001, 95% CI [0.506, 0.845]. These findings lend support to the hypothesized unitary motivational or approach-related construct underlying the behavioral activation system. Individuals reporting increased behavioral activation were likely to report so for items related to all BAS subscales.

AHA! and BIS/BAS Relationships

Significant correlations were also noted among the various AHA! and the BIS/BAS subscales (observed in Table 1). Specifically, self-reported Anger was significantly and positively correlated with BAS-D subscale, r = .405, n = 36, p =.014, 95% CI [0.088, 0.647]. In contrast, self-reported Behavioral Inhibition (BIS) was significantly and negatively correlated with Verbal Aggression, r = -.347, n = 36, p = .038, 95% CI [-0.606, -0.202], and Physical Aggression, r = -.531, n = 36, p = .0009, 95% CI [-0.732, -0.246]. These relationships provide evidence to suggest the emotional state of Anger, although frequently perceived as negative, may be a driving or motivational experience that aids in obtaining goals. These findings lend support to the hypothesis that persons reporting higher amounts of inhibition, as captured by the BIS subscale, are less likely to report engaging in either verbal or physical aggression, thus highlighting those characteristics of BIS associated with inhibition and behavioral withdraw.

AHA!, BIS/BAS, and resting asymmetry

Table 2 and Table 3 provide descriptive statistics and zero-order correlation coefficients for alpha asymmetry scores, BIS/BAS subscales, and AHA! subscales for averaged eyes open and eyes closed conditions respectively. Correlational analyses examining the relationships among self-reported AHA!, BIS/BAS, and resting asymmetry for the eyes open condition found significant and positive correlations between EO_F87 (M = .3344, SD = .3706) and Anger, r = .414, n = 36, p = .012, 95% CI [0.099, 0.654], and between EO_F87 and BAS-FS, r = .409, n = 36, p = .013, 95% CI [0.093, 0.650]. A relationship was also noted for EO_F43 (M = .0839, SD = .1479) and BAS-FS, r = .487, n = 36, p = .003, 95% CI [0.188, 0.703]. There were also identified significant positive correlations among several of the electrode pair sites, including EO_FP21 (M = .0949, SD = .1355) and EO_F87, r = .421, n = 36, p = .011, 95% CI [0.108, 0.659], and EO_F43, r = .355, n = 36, p = .034, 95% CI [0.030, 0.612]. Additionally, EO_F87 was significantly and positively correlated with EO_F43, r = .756, n = 36, p < .0001, 95% CI [0.569, 0.869], and EO_FT87 (M = .3414, SD = .3890), r = .680, n = 36, p < .0001, 95% CI [0.452, 0.824].

Additional correlational analyses examining the relationships among self-reported AHA!, BIS/BAS, and resting asymmetry for the eyes closed condition identified significant and positive correlations between EC_F87 (M = .4409, SD = .4200) and Anger, r = .438, n = 36, p = .008, 95% CI [0.128, 0.670], and between EC_F87 and BAS-FS, r = .403, n = 36, p = .015, 95% CI [0.085, 0.646]. EC_F87 was also found to have a significant and negative relationship with self-reported BIS, r = -.334, n = 36, p = .047, 95% CI [-0.597, - 0.006]. There were only two electrode pair sites found to be correlated with each other. EC_F87 was significantly and positively correlated with EC_FT87 (M = .4464, SD = .4204), r = .829, n = 36, p < .0001, 95% CI [0.688, 0.910].

Table 2. ***Zero-Order Correlations and Simple Descriptive Statistics for Eyes Open Condition, Sample (N = 36)***

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

$^{*}p$ <.05, $^{**}p$ <.01, $^{***}p$ <.001, $^{****}p$ <.0001

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

Table 3. ***Zero-Order Correlations and Simple Descriptive Statistics for Eyes Closed Condition Sample, (N = 36)***

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

$^{*}p$ <.05, $^{**}p$ <.01, $^{***}p$ <.001, $^{****}p$ <.0001

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

Discussion

Electroencephalogram studies investigating resting asymmetry associated with Carver and White's BIS/BAS Scales (29) have consistently demonstrated a significant positive relationship between motivation for approach related behavior, positive affect, left cortical activity to the BAS scale; whereas, withdraw related behaviors, negative affect, and right frontal cortical activity are noted to be associated with the BIS scale. Results from the current study showed that greater relative left cortical baseline activation was positively related to BAS scores, specifically the BAS-Fun Seeking subscale. BAS-Fun Seeking, which is thought to encompass elements of impulsiveness not contained in other BAS subscales, was positively correlated with greater relative left hemisphere asymmetry. This occurred during both the eyes open and eyes closed conditions for establishing baseline asymmetry. Moreover, the current results also found BIS scores to be significantly correlated with greater relative right hemisphere asymmetry during the eyes closed baseline acquisition period, falling just short of significance for the eyes open condition.

These findings lend support to prior research suggesting individuals with high BAS and BIS scores to be related to greater left and right cortical activation, respectively (35).

The current study also further demonstrates the relationship between self-reported anger with BAS and left frontal cortical asymmetry. The experience of anger is often thought of as being a negatively valenced emotional state. Thus, when subsuming the emotional experience of anger in current models emphasizing the roles of behavioral activation (comprising approach related behaviors and positive affect) and behavioral inhibition (encompassing withdrawal related behaviors and negative affect) it was originally hypothesized that anger would likely fall within the framework of behavioral inhibition. However, some research has demonstrated the opposite. Individuals with higher self-reported anger demonstrate greater left frontal cortical activity as compared to their non-angry counterparts (26, 20). Results from the current study corroborated previous findings by revealing consistent significant relationships among self-reported anger with BAS and left frontal cortical activation.

As such, these results also lend support to the notion that the construct of emotion should be expanded to consider likely behavioral outcomes in addition to intensity and valence. Anger is often characterized as negative because it is largely unpleasant and often is associated with aversive outcomes. These findings demonstrate, however, the phenomenon of anger is more complex than a traditional valence based model can capture.

For example, we might consider the significance of the observed relationship between BAS Fun Seeking and Anger. While anger may be negatively valenced, its respective relationships with BAS Fun Seeking and left frontal asymmetry demonstrate that it is likely associated with approach related behaviors. As previously mentioned, BAS Fun Seeking is thought to capture an individual’s tendency toward impulsivity and sensation seeking. Several studies have observed clear links between BAS Fun Seeking, impulsivity, and aggression (36, 37). Aggressive behaviors are approach related, and present findings demonstrate strong relationships between anger and multiple forms of aggression. The complexities underlying the multidimensionality of emotions, particularly anger, highlight the need for future research in providing a fuller explanation of the relevant cognitive and behavioral components of overall emotional experiences.

Although less research is available on this construct, *dominance* as another dimension that is associated with anger has been described (38). Demaree and colleagues suggest that dominance is associated with approach-related behavior as well as anger. Thus, the findings in the current study of the relationship between left-frontal activity and anger may in part be attributable to added dimension of dominance. Dominance associated with anger (and presumably left-frontal activity) may lead to improved behavioral outcome for the individual who experiences anger.

Limitations of the Present Study and Suggestions for Future Research

Due to variability in defining the constructs of anger, hostility, and aggression, the terms may be misinterpreted and misused when analyzing results. The construct of hostility is often interchangeably used in conjunction with anger and aggression. However, hostility is typically described as an all-encompassing negative attitude or underlying cognitive trait portrayed toward others, anger as an emotional state and aggression as an overt physical or verbal manifestation (39). For the purposes of this study, the construct of hostility was defined using a broader and integrated cognitive, behavioral, and affective characterization, which included an underlying disposition and thinking pattern (hostility) and both anger (affective) and aggressive (behavioral) components. As research in the area of anger, hostility, and aggression continues to develop, it will be important to further define each of the aforementioned domains ensuring greater construct validity.

Another potentially limiting aspect regarding the current study was sample size. The sample size of a study greatly influences the amount of statistical power in the analysis process. Because of this study’s purpose, time constraints, and limited population (undergraduate participant pool), a larger sample was not feasible, thus influencing the power of the current study. Meanwhile, other factors including electroencephalogram artifact and computer recording errors contributed to missing data which were ultimately deleted from the study. Related, the limited sample size did not permit for appropriate analysis of potential sex-related differences in the aforementioned constructs. It is acknowledged that this is an important area of study and should be a target for future research.

Concluding Remarks

An increased understanding of anger, hostility, and aggression has major implications in our understanding of emotional, cognitive, and behavioral contributions to our health and neuropsychological underpinnings. As such, this research has attempted to elucidate much of the confusion underlying the constructs of anger, hostility, and aggression by examining their place within varying areas of psychological research. The present research highlighted the relationships among AHA! with negative health behaviors and associated personality traits, yet also explored the psychophysiological and attentional processes that potentially underlie such phenomena and its application to greater understanding of the human experience. While much research exists exploring anger, hostility, and aggression, future research needs to further develop this understanding and apply it toward a better theoretical model for understanding these experiences and investigate the potential of clinical applications.

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