



# Emotional processing and frontal asymmetry in impulsive aggressive individuals



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## ABSTRACT

Right frontal cortical activity, thought to reflect increased activity in withdrawal-related systems, has been observed in angry and anxious samples. The current study attempted to examine this effect in impulsive aggressive individuals (IAs) and nonaggressive controls. Impulsive aggression is a reactive violent response characterized by loss of behavioral control and previous physiological studies have found IAs have sensory and informational processing deficits. In Study 1, undergraduate volunteers ( $n = 10$  IAs,  $n = 14$  controls) completed a resting EEG and IAs showed more right frontal cortical activity than controls at rest. In Study 2, we replicated this result with undergraduate males ( $n = 15$  IAs,  $n = 15$  controls) and demonstrated that not only did IAs have more right frontal activity at rest than controls, controls were able to switch between the behavioral inhibition system (BIS) and behavioral activation system (BAS) depending on exposure to affective stimuli, whereas IAs could not. Results indicated IAs likely have an overactive BIS, and thus have difficulty recognizing emotional stimuli, suggesting a dysfunction in emotional arousal. Future directions are discussed.

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## 1. Introduction

Impulsive aggression involves unplanned, immediate, violent responses to minimal provocation (Stanford, Greve, & Gerstle, 1997) and is considered reactive and emotional, accompanied by poor regulation of physiological arousal as well as loss of behavioral control (Barratt, 1991; Houston, Stanford, Villemarette-Pittman, Conklin, & Helfritz, 2003). Neuropsychological findings have demonstrated that impulsive aggression is correlated with executive dysfunction (Chambers, 2010), including a lack of impulse control (Stanford et al., 1997) and deficits in verbal strategic processing (Villemarette-Pittman, Stanford, & Greve, 2002). Along with executive functioning problems, individuals with impulse control disorders frequently have comorbid anxiety as well (Black, Shaw, McCormick, Bayless, & Allen, 2012; Carli et al., 2013; Kashyap et al., 2012). Additionally, impulsive aggressors have a tendency to see most situations as threatening (Helfritz, 2006), thus likely experience anxiety in both reinforcing and non-reinforcing situations.

One of the most difficult tasks humans often face is making motivational choices in response to reinforcing or nonreinforcing situations. Stimuli in emotionally charged situations are often ambiguous, and even if not, choices among behavioral alternatives

in response to those stimuli are uncertain in their outcomes—especially for impulsive aggressors. Gray (1978), Gray (1982), Gray (1990), Gray and McNaughton (2000) proposed three separate biological motivational control systems to underlie human behavioral tendencies. Within the Reinforcement Sensitivity Theory (RST), the degree to which a person finds specific stimuli reinforcing drives their individual propensity to use each system: the Behavioral Inhibition System (BIS; the tendency to approach negative stimuli), the Behavioral Approach System (BAS; the tendency to approach positive stimuli), or the Fight Flight Freeze System (FFFS; the tendency to avoid negative stimuli) (Gray & McNaughton, 2000). Both the FFFS and BIS are involved in defensive responses, but the FFFS is activated more selectively when threat is to be avoided, whereas the BIS activates whenever a potentially threatening situation is encountered (McNaughton & Corr, 2000; McNaughton & Corr, 2004; Perkins, Kemp, & Corr, 2007). More simply, McNaughton and Corr (2004) use the terms *defensive avoidance* when the FFFS is engaged and *defensive approach* when the BIS is activated.

The current study attempted to assess Gray's RST using the physiological measurement of frontal resting electroencephalogram (EEG) activity in an attempt to shed light on the motivational underpinnings of impulsive aggressors. Frontal resting EEG activity is mainly used to study individual differences related to trait or trait-like measures in order to make inferences about emotional processes (Davidson 1993; Davidson, 1998a; Davidson, 1998b;

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Davidson, Schwartz, Saron, Bennet, & Goleman, 1979). Davidson and colleagues proposed that a difference in frontal symmetry at rest is indicative of a predisposition to approach a stimulus (and engage the BAS) if there is increased left frontal activity, or tendency to withdraw from a stimulus (and engage the BIS) if there is increased right frontal activity. No studies have attempted to measure frontal resting EEG activity in impulsive aggressors, although Jaworska et al. (2012a) found that adults with dysfunctional anger showed increased right frontocortical activity at rest. Because anger and aggression are closely related (Buss & Perry, 1992; Jensen-Campbell, Knack, Waldrup, & Campbell, 2007) and impulsive aggressors generally have more anxiety than controls, in the current study we hypothesized that impulsive aggressors should have psychological measurements similar to individuals with anxiety disorders or dysfunctional anger (Fowles, 1988; Gray, 1982; Jaworska et al., 2012a; Ross, Keiser, Strong, & Webb, 2013) and thus have increased right activity.

## 2. Study 1

### 2.1. Methods

#### 2.1.1. Subjects and criteria

Recruited via posted print advertisements on a large private university campus, participants first completed an online prescreening evaluation that solicited information about participants' age, handedness, and medical history including previous major head injuries and current use of psychoactive medications. A total of  $n = 365$  participants aged 17–34 ( $M = 20.24$ ,  $SD = 3.36$ ) completed the prescreening battery of self-report measures and  $n = 24$  participants were invited to participate in the psychophysiological measurement portion of the experiment (described below). Exclusion criteria included head injuries or history of an Axis I disorder. Additionally, because handedness has been hypothesized to affect asymmetry (e.g., Propper, Pierce, Geisler, Christman, & Bellorado, 2012), only right hand-dominant participants were used. The Institutional Review Board at Baylor University reviewed and approved the experimental protocol.

#### 2.1.2. Participant selection

To determine eligibility for participation in psychophysiological measures, individuals completed an online prescreen survey. The Impulsive Aggression Quick Screen (IA-QS; Stanford, Greve, & Dickens, 1995) is a short semi-structured interview that combines

DSM-IV-TR criteria for Intermittent Explosive Disorder and self-identification of discrete episodes of aggression to determine categorization into groups. To be classified as an Impulsive Aggressor (IA), individuals must have: (1) Identified several episodes of behavioral impulsive aggression with loss of behavioral control in the previous six months; (2) The reported aggressive act(s) was disproportionate to the provocation; (3) At least 2 impulsive aggressive acts occurred during the previous 30 days; and (4) A score of 8 or higher on the Irritability subscale of the Buss-Durkee Hostility Inventory (Buss & Durkee, 1957). This measure assesses an individual's overall impression of his/her aggressive behavior in the preceding six months and resultantly classifies their aggression as predominately impulsive in nature (e.g., Helfritz & Stanford, 2006; Stanford et al., 1997). The categorization was used to include participants who demonstrated marked problems related to their impulsiveness evidencing a variety of outbursts not solely related to one social situation (e.g., relationships, school stressors, etc.). Age- and gender-matched controls reported no episodes of aggression in the past six months and self-reported a score of 3 or less on the Irritability subscale. The online survey also contained self-report measures to compare personality traits of the respective samples including the Buss-Perry Aggression Questionnaire (BPAQ; Buss & Perry, 1992), the Life History of Aggression Questionnaire (LHA; Coccaro, Berman, & Kavoussi, 1997) and the BIS/BAS Scales (Carver & White, 1994), along with substance use measures including the Alcohol Use Disorders Identification Test (AUDIT; Babor et al., 2001) and the Drug Abuse Screening Test (DAST-20; Skinner, 1982).

#### 2.1.3. EEG and data reduction

Those who met basic criteria for either the IA or control group were invited to the lab for an in-person electroencephalogram (EEG). Subjects chose partial course credit or a \$25 VISA gift card as compensation for participation.

Physiological recordings were obtained between 3:00 and 6:00 PM. Participants' scalps were prepared with rubbing alcohol and a slightly abrasive gel (NuPrep) to increase scalp conduction. Their heads were fitted with a Neuroscan Quick-Cap with 64 tin electrodes (International 10–20 system) with standard and intermediate positions, along with four eye electrodes measuring blink and one on each mastoid for referencing. Participants sat in a padded chair in a shielded and anechoic chamber during all EEG recording. Resting EEG was recorded for eight minutes with one-minute blocks of eyes open (O) or closed (C) in one of two

**Table 1**  
Group differences in self-report measures in Study 1.

Measure	Controls <i>M</i> ( <i>SD</i> )	IAs a <i>M</i> ( <i>SD</i> )	<i>t</i> (22)	<i>p</i>	Cohen's <i>d</i>
<i>BPAQ</i>					
Physical	14.36 (4.83)	32.50 (6.24)	−8.04	<.001	3.25
Verbal	10.86 (3.06)	19.10 (4.23)	−5.56	<.001	2.23
Anger	10.36 (3.30)	23.40 (4.40)	−8.32	<.001	3.35
Hostility	14.36 (5.40)	26.00 (8.00)	−4.27	<.001	1.71
Total	49.93 (13.83)	101.00 (14.94)	−8.63	<.001	3.55
<i>LHA</i>					
Aggression	3.57 (2.24)		−9.61		
Self-Directed	0.29 (0.83)	14.50 (3.34)	−3.31	<.001	3.84
Consequences	0.36 (0.63)	2.40 (1.90)	−5.43	.007	1.44
Total	4.21 (2.72)	3.80 (1.93)	−10.16	<.001	2.40
		20.90 (4.65)		<.001	4.38
<i>BIS/BAS</i>					
BIS	13.10 (3.48)	15.00 (2.86)	1.47	.156	0.60
BAS Reward	7.60 (2.22)	8.50 (2.57)	0.90	.381	0.38
BAS Drive	8.50 (1.43)	9.21 (1.89)	1.01	.326	0.42
BAS Fun-Seeking	6.10 (1.66)	8.64 (1.91)	3.39	.003	1.03

Note. Buss-Perry Aggression Questionnaire (BPAQ; Buss & Perry, 1992), Life History of Aggression (LHA; Coccaro et al., 1997), Behavioral Inhibition Scale/Behavioral Activation Scale (BIS/BAS; Carver & White, 1994). Negative *t* statistics indicate IAs reported higher scores on that measure than controls.

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