

## Frontal EEG asymmetry and sensation seeking in young adults

Diane L. Santesso<sup>a</sup>, Sidney J. Segalowitz<sup>a,\*</sup>, Andrea R. Ashbaugh<sup>b</sup>,  
Martin M. Antony<sup>d,e</sup>, Randi E. McCabe<sup>c,e</sup>, Louis A. Schmidt<sup>b,\*</sup>

<sup>a</sup>Department of Psychology, Brock University, St. Catharines, Ontario, Canada

<sup>b</sup>Department of Psychology, Neuroscience & Behaviour, McMaster University, Hamilton, Ontario, Canada

<sup>c</sup>Department of Psychiatry and Behavioural Neurosciences, McMaster University, Hamilton, Ontario, Canada

<sup>d</sup>Department of Psychology, Ryerson University, Toronto, Ontario, Canada

<sup>e</sup>Anxiety Treatment and Research Centre, St. Joseph's Healthcare, Hamilton, Ontario, Canada

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### Abstract

Sensation seeking has been characterized as a desire to seek novel, intense sensations, and the willingness to take risks in pursuing them. In two separate studies of young adults, we examined the relation between measures of sensation seeking and the pattern of resting frontal EEG asymmetry, thought to reflect a biological predisposition to approach new experiences. As predicted, high sensation seeking was related to a greater relative left frontal activity at rest in both studies, which may be specific to men. How greater relative left frontal cortical activity at rest is related to a tendency to engage in sensation-seeking and risky behaviors is discussed.

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Sensation seeking is a personality trait that can be described as the seeking of “novel, complex, and intense sensations and experiences, and the willingness to take physical, legal, social and financial risks for the sake of such experiences” (Zuckerman, 1979, 1994). Those high in sensation seeking show an aversion to monotony and express the desire to engage in activities such as risky sports (e.g., mountain climbing, skydiving), promiscuous sexual activity, and alcohol and illicit drug use (Kopstein et al., 2001; Roberti, 2004). High sensation seekers are more likely to perceive risk-taking behaviors as less risky and anticipate positive arousal from such risks compared with low sensation seekers (Hovrath and Zuckerman, 1993; Zuckerman, 1979). Not surprisingly, sensation seeking is related to personality traits such as impulsivity, reward sensitivity, sociability, and aggression (Acton, 2003; Zuckerman and Kuhlman, 2000). Several studies have independently shown that sensation seeking is positively associated with risk-taking behaviors, positive outcome expectancies from engaging in such activities and reward sensitivity (Johnson, 1989;

Lagrange et al., 1995; Santesso et al., 2004; Staiger et al., 2007; Zuckerman, 1994). Sensation seeking and risk-taking tendencies occur most frequently during late adolescence and young adulthood and are more robust in men (Arnett, 1991, 1996; Bradley and Wildman, 2002; Byrnes et al., 1999; Greene et al., 2000; Gullone et al., 2000). Although researchers have argued that some degree of novelty seeking during adolescence and young adulthood is both statistically normative and psychologically adaptive, because it may encourage a sense of independence (Baumrind, 1987; Hurrelmann, 1990; Shedler and Block, 1990), some individuals may develop maladaptive forms of risk-taking (e.g., alcoholism), posing threats to the individual's (and others') health and safety.

One way to conceptualize individual differences in sensation seeking may be along an approach-avoidance framework. High sensation seekers may have stronger approach tendencies in general, as characterized by more interest in exploring their environment, and stronger orienting reactions to novel stimuli compared with low sensation seekers (Zuckerman and Kuhlman, 2000). For these individuals, novel stimuli may elicit approach reactions because novelty may be a source of reward and is associated with positive affective arousal (Zuckerman, 1990). Seeking out novel or intense stimuli may also be a means of reducing dysphoria or coping with stress (Smith et al., 1992).

\* Corresponding authors.

E-mail addresses: [sid.segalowitz@brocku.ca](mailto:sid.segalowitz@brocku.ca) (S.J. Segalowitz), [schmidtl@mcmaster.ca](mailto:schmidtl@mcmaster.ca) (L.A. Schmidt).

A number of studies have used ongoing frontal electroencephalogram (EEG) alpha activity to measure individual differences in approach-avoidance tendencies, personality, and emotion in adults, children, and infants (see Coan and Allen, 2004 for a substantive review). These studies rely on the assumption that less alpha power is indicative of more cortical activity in the underlying region(s) (e.g., Allen et al., 2004a; Davidson, 1988). Davidson proposed that distinct patterns of asymmetric activity in the prefrontal cortex are associated with behavioral approach and behavioral withdrawal/inhibition (see Davidson, 1995, 2000, for reviews). Specifically, individuals with greater left than right prefrontal activity use their resources for goal-approaching behaviors and positive affect (Sutton and Davidson, 1997). Individuals with greater right than left prefrontal activity engage in withdrawal behaviors and experience negative affect. Moreover, the pattern of resting frontal EEG asymmetry may reflect a predisposition (i.e., a trait marker) to experience and express positive or negative emotions in response to novelty or mild stress, individual differences in approach-avoidance tendencies, and affective style (Davidson, 2000).

Several lines of evidence support this model of resting frontal EEG activity and individual differences in affective style. For example, Sutton and Davidson (1997) found that adults with greater relative right frontal activity during baseline conditions reported higher levels of behavioral inhibition, whereas adults with greater relative left frontal activity reported higher levels of behavioral approach. Davidson and his colleagues (Tomarken et al., 1992) also reported that adults whose baseline EEG measures showed extreme stable left frontal activity reported more dispositional positive affect and less dispositional negative affect than those with stable right frontal activity. However, the role of left frontal activity in the maintenance of approach-related behaviors appears to have multiple meanings.

Urry et al. (2004) found that the greater left than right frontal EEG activity was associated with higher eudaimonic well-being (i.e., purpose, mastery, strong-relationships, self-acceptance) and hedonic well-being (i.e., satisfaction with life and work, frequent pleasant emotions). The authors concluded that the left frontal region was more important than the right for the well-being as left frontal individuals are more likely than right frontal individuals to “take an active role in life and appropriately engage sources of appetitive motivation” (p. 370). Pizzagalli and his colleagues examined frontal EEG asymmetry in relation to incentives in young adults (Pizzagalli et al., 2005). Participants performed a verbal memory task under three incentive conditions: neutral, reward, punishment. The authors reported that the greater left frontal cortical activity (specifically the dorsolateral prefrontal and medial orbitofrontal regions) was associated with higher reward bias (i.e., defining an ambiguous stimulus as a target when reward was involved). Greater left resting activity was associated with approach-related behaviors manifested through increased reward responsiveness. Harmon-Jones and Allen (1998) noted a relation between left frontal EEG asymmetry and anger affective styles despite anger being a negatively valenced

emotion which is usually associated with relative right frontal activity. Harmon-Jones and Allen argued that left frontal asymmetry was associated with the approach-related motivations that characterize anger but not its affective components. Still most recently, others have reported a relation between left frontal asymmetry and two approach-related components of social desirability, self-deceptive enhancement and impression management (Pauls et al., 2005).

In the present study, we examined whether the pattern of left frontal EEG activity at rest previously noted in other approach-related behaviors extended to the personality style of sensation seeking that has been characterized as comprising both positive affect and approach motivations. Although the results of these earlier studies suggest that the pattern of resting frontal EEG activity may be a useful tool to explain approach-related tendencies and disinhibition toward the unfamiliar, there appear to be no studies that have examined individual differences in sensation seeking specifically in relation to resting frontal EEG alpha activity. Accordingly, two studies were conducted that examined the relation between sensation seeking and the pattern of resting frontal EEG activity in young adults. The studies were conducted in separate laboratories with different sample compositions. Study 1 comprised a mixed convenience sample of males and females who were part of a larger study examining the psychophysiology of personality; Study 2 followed up from the results of the first study in which a limited number of male participants appeared to be responsible for the statistical effects noted. In Study 2, there was a larger sample of only males. We predicted that high sensation seeking would be related to greater relative left frontal EEG activity at rest.

## 1. Study 1

### 1.1. Method

#### 1.1.1. Participants

Participants included 37 (28 women, 9 men) right-handed young adults between the ages of 18 and 26 years ( $M = 19.5$  years,  $S.D. = 1.4$ ) who were recruited from undergraduate psychology classes at McMaster University. A majority of the students were Caucasian and from middle class homes. All students were part of a larger study examining the psychology and physiology of social behavior. Students received course credit for their participation. One of the measures completed by the participants was the Sensation Seeking Scale Form V.

#### 1.1.2. Self-report measures

**1.1.2.1. Sensation-seeking scale.** Sensation seeking was assessed using the 40 items from the Sensation Seeking Scale Form V (SSS-V; Zuckerman, 1994). This scale is designed to measure four factors of sensation seeking (10 items each): thrill and adventure seeking, experience seeking, disinhibition, and boredom susceptibility. The thrill and adventure seeking factor comprises the desire to engage in physically risky activities such as risky sports; experience seeking comprises the need to seek experience through the mind and senses, as accomplished through music or art; disinhibition comprises the desire to seek social stimulation in uninhibited social activities, such as parties; and boredom susceptibility comprises an aversion to monotony and preference for the unpredictable (Kopstein et al., 2001). Examples of items on this scale include “I would like to learn to fly an airplane” (Thrill seeking); “I like to try new foods that I have never tasted before” (Experience seeking); “I like wild, uninhibited parties” (Disinhibition); and “I have no patience with dull or boring persons” (Boredom susceptibility). Participants are asked to indicate whether a

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