Available online at www.sciencedirect.com

SCIENCE DIRECT®

International Journal of Psychophysiology 55 (2005) 85–94

INTERNATIONAL JOURNAL OF PSYCHOPHYSIOLOGY

www.elsevier.com/locate/ijpsycho

Trait anxiety impact on posterior activation asymmetries at rest and during evoked negative emotions: EEG investigation

Ljubomir I. Aftanas*, Sergey V. Pavlov

Psychophysiology Laboratory, State-Research Institute of Physiology, Siberian Branch, Russian Academy of Medical Sciences, Timakova str. 4, 630117, Novosibirsk, Russia

Received 14 October 2003; received in revised form 15 June 2004; accepted 16 June 2004
Available online 24 July 2004

Abstract

The main objective of the present investigation was to examine how high trait anxiety would influence cortical EEG asymmetries under non-emotional conditions and while experiencing negative emotions. The 62-channel EEG was recorded in control (n=21) and high anxiety (HA, n=18) non-patient individuals. Results showed that in HA subjects, the lowest level of arousal (eyes closed) was associated with stronger right-sided parieto-temporal theta-1 (4–6 Hz) and beta-1 (12–18 Hz) activity, whereas increased non-emotional arousal (eyes open, viewing neutral movie clip) was marked by persisting favored right hemisphere beta-1 activity. In turn, viewing aversive movie clip by the HA group led to significant lateralized decrease of the right parieto-temporal beta-1 power, which was initially higher in the emotionally neutral conditions. The EEG data suggests that asymmetrical parieto-temporal theta-1 and beta-1 EEG activity might be better interpreted in terms of Gray's BAS and BIS theory.

Keywords: EEG; Emotion; EEG band power; Hemispheric asymmetry; Behavioral inhibition system; Withdrawal motivation; Personality; Anxiety trait

High trait anxiety is a complex phenomenon that includes a range of distinct attentional, emotional and somatic reactions as well as cognitive efforts to conceptualize apparent cause of anxious feelings (Heller and Nitschke, 1998; see also Borkovec et al., 1983; Barlow, 1988; Gruzelier, 1993). Findings from EEG studies show that one of the most indicative peculiarities of the high trait anxiety consists in different laterality patterns of regional brain activity at rest as well as in response to negative emotion-evoking stimuli/events (see Shankman and Klein, 2003 for review).

Popular models of dispositional affect and psychopathology have led to a growing number of investigations addressing the issue of cortical laterality,

* Corresponding author. Tel.: +7 3832 334387; fax: +7 3832 324254.
E-mail address: aftanas@iph.ma.nsc.ru (L.I. Aftanas).

0167-8760/$ - see front matter © 2004 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijpsycho.2004.06.004

emotion and personality (see Heller and Nitschke, 1998; Davidson, 1998; Cacioppo and Gardner, 1999; Shankman and Klein, 2003; Wacker et al., 2003 for review). Briefly, Davidson proposed that there exist two fundamental motivation systems underlying approach- and withdrawal-related behavior and some forms of positive and negative affect. Certain regions within the left prefrontal cortex are a part of a circuit that implements approach-related behavior and positive affect while symmetrical regions of the right prefrontal cortex are a part of a circuit implementing withdrawal-related behavior and negative affect (Davidson, 1998, 2002). However, recent accounts on anterior models of negative affect show that asymmetrical frontal cortical activity is due to motivational direction and not affective valence (Harmon-Jones, 2003). An extension of Davidson's model by Heller (Heller et al., 1997; Heller and Nitschke, 1998) adds the arousal dimension, associated with the right parietal cortex activity. Davidson's approach and withdrawal systems are somewhat similar to Gray's behavioral activation and inhibition systems (BAS and BIS, respectively) (Gray, 1994; Wacker et al., 2003). The BAS is hypothesized to control appetitive and goal-directed behavior and becomes activated in response to incentive, reward, and other positive stimuli. The BIS is designed to inhibit ongoing goal-directed behavior. Activation of the BIS is believed to increase the arousal associated with anxiety as well as vigilance to environmental stimuli (Kring and Bachorowski, 1999), and in general, an overactivation of the BIS is proposed as being etiologically related to anxiety (Fowles, 1994; Gray, 1994; Davidson, 2002). The lateralization model makes clear predictions regarding EEG activation asymmetries in high anxiety assuming relatively more active right frontal cortex due to negative affect and motivational avoidance (Davidson, 2002) as well as activation of right parietal cortex due to anxious arousal (Heller and Nitschke, 1998).

In this study, we will focus on the relation between anxiety and EEG asymmetry in non-patient population under emotionally neutral conditions and while experiencing positive and negative emotions. The surprising thing is that there have been few researches on the point. These studies yielded contradictory findings. For resting EEG asymmetries, greater frontal left than right hemisphere activity was reported in high anxiety participants classified on the basis of worry (Carter et al., 1986). Tomarken and Davidson (1994) found no significant differences in frontal laterality measures between low and high anxiety groups. Heller et al. (1997) have reported that individuals high on trait anxiety measure showed a hemispheric asymmetry in favor of the left hemisphere relative to non-anxious individuals. However, in this study, the asymmetry was due to a decrease in right frontal activity rather than the hypothesized increase in left frontal activation. In another investigation from Heller's team (Nitschke et al., 1999), neither a frontal asymmetry in individuals preselected to be high on worry (and not on arousal) nor a posterior asymmetry in subjects preselected to be high on anxious arousal (and not on anxious apprehension) were found. This failure might have been due to the small sample sizes. Two studies were devoted to the perception of emotion in anxiety. Aftanas et al. (1996a) found that during emotional gambling procedure, high anxiety individuals were marked with relatively larger left hemisphere activation over central and parietal regions. High anxiety subjects manifested right prefrontal theta hypoactivation favoring left hemispheric activity while viewing both threatening and pleasant pictures (Aftanas et al., 2003). All these reports are inconsistent with Davidson's (2002) hypothesis that increased right frontal activity is a biological marker for anxiety. In turn, documented relative left hemispheric activation in anxiety (Carter et al., 1986; Heller et al., 1997; Aftanas et al., 1996a, 2003) is likely to reflect cognitive dimension of anxiety termed as verbally mediated worry/anxious apprehension (Borkovec et al., 1983; Gruzelier, 1993; Heller and Nitschke, 1998). Findings on experience of emotion in high anxiety are heterogeneous, too. Stronger right-sided frontal theta activity was observed in high anxiety subjects than in low anxiety in neutral and emotional (imagery about pleasant and unpleasant personal memories) conditions, suggesting higher overall emotionality (Stenberg, 1992). Isotani et al. (2001) reported that individuals hypnotically induced into a state of anxiety demonstrated increased activation of right frontal regions. Heller et al. (1997) found that individuals high on trait anxiety showed increased right parietal activity while listening to anxious arousal producing narratives but not happy or neutral