EEG coherence correlates of emotional states induced during oral reading

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Introduction: Investigation of the brain mechanisms of emotional states is important for fundamental and applied psychophysiology. One possible way to do such investigations is to intentionally induce emotional states. In our previous studies, positive and negative emotional states were induced with silent autobiographical recalls, scenic recalls, and imagined situations (Danko et al., 2003a,b, 2004, 2005, 2007). Recently, oral reading was used in a special way for emotion induction; results concerning EEG power dynamics have been presented (Danko et al., 2010). The most pronounced EEG power effects sensitive to emotional valence factors and personal factors could be seen in beta2 and gamma frequency bands. Here, we present results of an EEG coherence study that used the same kind of oral reading for induction of emotions.

Methods: The main test tasks included reading aloud with the technique "self-regulative utterance" (TSU – the author L.V. Gratcheva), used in actors' training, a a) text of neutral emotional valence; b) personal texts — recollection with either a positive or a negative emotional valence; c) literary texts with similar emotional dominants. The following states were used for reference: calm wakefulness with closed and open eyes; silent reading of a text of a neutral emotional valence; habitual reading aloud of a text of the same kind.

The 28 subjects were healthy first-year acting students. EEGs were recorded with a 10–20 electrode system (earlobes referentials) and processed to evaluate EEG coherence in frequency bands from delta to low gamma (30–40 Hz). Face muscles and eye movements were controlled with EMG and EOG respectively.

Results: EEG coherence in the states of TSU reading of emotional texts differ from those in the state of TSU reading of a non-emotional text in all comparisons and frequency ranges, although there is variation of the differences of the patterns and intensities in different comparisons. Differences in the EEG coherence between TSU reading of texts with positive and negative valences are most explicit in the gamma and beta2 frequency ranges. States of reading emotionally-positive texts are characterized by an increase in the coherence in these ranges, as compared to emotionally negative texts. The emotional valence quantitatively is more expressed in EEG coherence changes during the reading of literary texts, as compared with personal texts.

Conclusions: In spite of inevitable facial motor activity with the vocal activity, the multiple system revealed statistically significant differences between EEG coherence, which are dependent on the emotional valence and the personal component of the text read with TSU. So, obtained results demonstrate that TSU can be considered as a way to modulate emotional states. Reading of emotionally colored texts with opposite valences leads to activation of widespread brain systems where various cerebral zones are synchronized on various EEG frequencies. The main findings are in line with previous data based on other methods of emotion induction (Danko et al., 2003a,b, 2004, 2005, 2007; 2010). Probably, found distinctions in EEG coherence during the text reading with different emotional valences are also related to activation of protective brain mechanisms against influence of negative emotions on an individual (Danko et al., 2003) and with an advantage of pleasant content in brain processing of healthy individuals (Herbert, 2010).

Interaction of anger with anxiety and responses to emotional facial expressions

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The ability to understand emotional information conveyed by facial expressions of other people is crucial for building interpersonal relationships, careers, and, sometimes, even survival. Some personality traits, such as aggressiveness and anxiety, are associated with biases in the perception of emotionally loaded stimuli, particularly such socially significant stimuli as emotional facial expressions (Hall, 2006; van Honk et all., 2001; Larkin et all., 2002; Derryberry, Reed, 2002; Fox, 2002; Weinstein, 1995; Dimberg, Thunberg, 2007). In Gray's original theory, the BIS and the BAS are postulated to underlie the personality dimensions of anxiety and impulsivity (Gray, 1987). However, the exact nature of BAS-related personality traits is still a matter of debate. Although some authors propose that BAS is associated with extraversion (Depue, Collins, 1999; Smillie, Pickering, Jackson, 2006), considerable evidence suggests its association with anger (Harmon-Jones, 2004; 2007; Smits, Kuppens, 2005). Corr (2002) has put forward a "joint subsystems" hypothesis of BIS/BAS effects which postulates that the BIS and BAS exert two separate effects on behaviour: (1) facilitatory (BIS – punishment, BAS – reward), and (2) antagonistic (BIS – reward, BAS – punishment). This means that the two systems interact with each other and the final effect of one system on outcome behaviour depends on activity of the other system. In this study, we aimed to investigate the interaction between anger and anxiety, which we treated as BAS and BIS proxies, and their influence on the perception of emotional facial expressions and, associated with this perception, their influence on oscillatory cortical responses.

The sample included 84 healthy subjects (age range 17 to 32 years). Subjects filled out the Buss-Perry aggression scales (1992) and the Spielberger's State Trait Anxiety Inventory (1970). A median split was applied to divide subjects into high and low anger and anxiety groups. As stimulation, we used an ensemble of the photographs presented by Ekman and Friesen (1976) with 3 different facial expressions (angry, happy, and neutral). Subjects were instructed to evaluate emotional expression of each presented face on an analogue scale ranging from −100 (very hostile) to 100 (very friendly). In 44 subjects (22 men and 22 women), EEG was recorded from 32 electrodes referred to linked mastoids during the procedure of face presentation. For time–frequency representation of EEG data, we chose a version of Morlet wavelet. To assess face-evoked changes in spectral power, event-related spectral perturbations were calculated using EEGLAB toolbox (http://www.sccn.ucsd.edu/eeglab/). Correction for multiple comparisons was done using the False Discovery Rate method.

Repeated measures ANOVA of estimates of hostility-friendliness of faces revealed a marginally significant interaction of anger x trait anxiety x emotional face category ($F = 3.7$, $df = 1.3$, $p = 0.048$). In low anxiety subjects, anger is negatively related to estimates of friendliness of happy faces and to estimates of hostility of angry faces. In high anxiety subjects, this effect disappears. The mass-univariate analysis of face presentation-related spectral perturbations revealed a significant group effect for theta band between 310 and 650 ms after stimulus onset in the central and posterior cortical regions. In the low anxiety group, anger scores were positively related to the extent of face presentation-related theta synchronization. In the high anxiety group, this effect was not significant. Thus, anxiety moderated the effect of anger both on estimates of angry and happy faces and on face