Department of Neuropsychology and Behavioral Neurobiology

Proposal Master Thesis

Advisor: PD Dr. Thorsten Fehr

An EEG-study on brain oscillatory correlates in the context of developing decision-preparation of approach or withdrawal behaviour in the face of reactive aggressive scenarios

Although research on neural correlates of cognitive processing has been proceeded for over 40 years, emotion research is always a challenge to researchers. Scientists developed processing-models of emotion and defined the term *aggression* (Selg 1988; Gross 2008). Additionally, numerous studies using electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) addressed neural correlates of cognitive, perceptual and emotional processing (Klimesch et al., 1997, 2007, 2008, 2010; Sarnthein et al., 1998; Volf et al., 1999; Weiss et al., 2000; Kolev et al., 2001; Mathiak & Weber, 2006; Güntekin et al., 2007; Fehr et al., 2007; Sauseng et al., 2008; Garcia-Garcia et al., 2008; Yang et al., 2009; Koles et al., 2010; Fehr et al., in preparation). Several approaches using EEG were designed to analyze brain oscillations; it was suggested that alpha and theta activity components are differentially related to cognitive and perceptual processing entities. In comparison to resting state EEG, alpha power decreased, whereas theta power increased during cognitive and perceptual task performance (Klimesch et al., 1997, 2007; Sarnthein et al., 1998; Weiss et al., 2000; Kolev et al., 2001). There is also a discussion about gender differences in the cerebral processing of emotional entities (e.g., Strüber et al., 2008; McClure et al., 2004; Mathiak & Weber, 2006). For example, dorsal anterior cingulated cortex activity was discussed to be increased in men during the confrontation with aggression-related stimuli (McClure et al., 2004; Mathiak & Weber, 2006), and women showed larger brain responses in orbito-frontal cortex when confronted with aversive stimuli (Fichtenholz et al., 2004; McClure et al., 2004; Lithari et al., 2010).

The here included stimuli consisted of short video clips, which were filmed from a first person perspective (BRemen Aggression INventory, BRAIN; e.g., Fehr et al., 2007). There were three stimulus categories considered in the present work: Reactive aggressive, social positive and neutral situations. Each stimulus displays an initial phase, during which a

scenarios develops, a stop picture following the initial phase and a final phase during which the consequences of the individual´s decision is displayed. The study participant is asked to spontaneously respond when the scenario freezes right after the initial phase and the corresponding stop picture is presented. If they choose to approach the situation, a go clip will be presented; if they choose to withdraw the situation, a No-Go clip will be presented.

Based on former studies and hypothetical model assumptions, women are expected to show larger slow and/or fast oscillatory brain responses over lateral-ventral prefrontal areas than men, while men are expected to produce larger responses over dorsolateral prefrontal areas than women during the development of a decision and preparation of motor-responses while faced with a presumably threatening scenarios potentially affording a reactive aggressive response. It might also be expected that males compared to females rather tend to approach reactive aggression-related situations.

References

Fehr, T., Strüber, D., Lück, M., Herrmann, M., Roth, G. (2007). Neural Correlates of Perceiving Aggressvie Behavior. In: Herrmann, M., Thiel, C.M. (Eds.), Topics in Advanced Neuroimaging, bis-publishers, Oldenburg, Germany, pp. 27-30.

Fehr, T., Roth, G., Herrmann, M., Strüber, D. (in revision). About the neural representation of human aggression – An fMRI investigation based on items of the BRemen Aggression INventory (BRAIN).

Fichtenholtz HM, Dean HL, Dillon DG, Yamasaki H, McCarthy G, LaBar KS. (2004) Emotion-attention network interactions during a visual oddball task. Brain Res Cogn Brain Res. 20, 67-80

Garcia-Garcia M, Domínguez-Borràs J, SanMiguel I, Escera C. (2008) Electrophysiological and behavioral evidence of gender differences in the modulation of distraction by the emotional context. Biol Psychol. 79, 307-16.

Gross, James. Emotion Regulation. 2008. Chap. 31 p. 499-500

Gu□ntekin, B., Başar, E., (2007) Brain oscillations are highly influenced by gender differences. Int. J. Psychophysiol. 65, 294-9.

Klimesch, W, Doppelmayr, M, Pachinger, Th., Ripper, B. (1997) Brain oscillations and human memory: EEG correlates in the upper alpha and theta band. NeurosciLett. 238, 9-12.

Klimesch, W., Schack, B., Schabus, M., Doppelmayr, M., Gruber, W., and Sauseng, P. (2004) Phase-locked alpha and theta oscillations generate the P1–N1 complex and are related to memory performance. Brain Res Cogn Brain Res.19, 302-16.

Klimesch, W., Hanslmayr, S., Sauseng, P., Gruber, W.R. and Doppelmayr, M. (2007) P1 and Traveling Alpha Waves: Evidence for Evoked Oscillations. J Neurophysiol. 97, 1311-8.

Klimesch, W., Paul Sauseng, P., Hanslmayr, S., Gruber, W. and Freunberger, R. (2007) Event-related phase reorganization may explain evoked neural dynamics NeurosciBiobehav Rev. 31, 1003-16.

Klimesch, W., Freunberger, R., Sauseng, P.,Gruber, W. (2008) A short review of slow phase synchronization and memory: evidence for control processes in different memory systems? Brain Res. 1235, 31-44

Klimesch, W., Freunberger, R., Sauseng, P. (2010) Oscillatory mechanisms of process binding in memory.NeurosciBiobehav Rev. 34, 1002-14

Koles ZJ, Lind JC, Flor-Henry P. (2010) Gender differences in brain functional organization during verbal and spatial cognitive challenges.
Brain Topogr. 23, 199-204

Mathiak K, Weber R. (2006) Toward brain correlates of natural behavior: fMRI during violent video games. Hum Brain Mapp. 27, 948-56.

McClure EB, Monk CS, Nelson EE, Zarahn E, Leibenluft E, Bilder RM, Charney DS, Ernst M, Pine DS. (2004) A developmental examination of gender differences in brain engagement during evaluation of threat. Biol Psychiatry. 55, 1047-55.

Sarnthein J, Petsche H, Rappelsberger P, Shaw GL, von Stein A. (1998) Synchronization between prefrontal and posterior association cortex during human working memory. Proc Natl Acad Sci U S A. 95, 7092-6.

Sauseng, P., Klimesch, W. (2008) What does phase information of oscillatory brain activity tell us about cognitive processes? NeurosciBiobehav Rev. 32, 1001-13

Selg, Herbert u.a.:Psychologieder Aggressivität. Hogrefe, Göttingen 1988, p. 1-8

Siegel, D. J. The developing mind: Toward a neurobiology of interpersonal experience. 1999, New York: Guilford.

Strüber D, Lück M, Roth G. (2008) Sex, aggression and impulse control: an integrative account. Neurocase. 14, 93-121.

Volf NV, Razumnikova OM. (1999) Sex differences in EEG coherence during a verbal memory task in normal adults.Int J Psychophysiol. 34, 113-22.

Weiss S, Rappelsberger P. (2000) Long-range EEG synchronization during word encoding correlates with successful memory performance. Brain Res Cogn Brain Res. 9, 299-312.

Willis ML, Palermo R, Burke D, McGrillen K, Miller L. (2010) Orbitofrontal cortex lesions result in abnormal social judgements to emotional faces. Neuropsychologia. 48, 2182-7.

Yang CY, Decety J, Lee S, Chen C, Cheng Y. (2009) Gender differences in the mu rhythm during empathy for pain: an electroencephalographic study. Brain Res. 1251, 176-84