Activation changes of sensomotor brain areas after intake of ethanol

C. Klingner[1], J. Bernarding[2]

[1]Medical Informatics, Otto-von-Guericke University, Magdeburg, Germany, [2]Medical informatics, Otto-von-Guericke University, Magdeburg, Germany

Synopsis:

The influence of ethanol intake on the motor system was monitored with functional magnetic resonance imaging (fMRI). Single activation of the dominant and the non-dominant hemisphere as well as synchronous activation was studied. A decrease of the activation in the sensomotor cortex (SMC) was found after intake of alcohol. The decrease was stronger in the non-dominant hemisphere. The supplementary motor area (SMA) exhibited a less significant activation decrease.

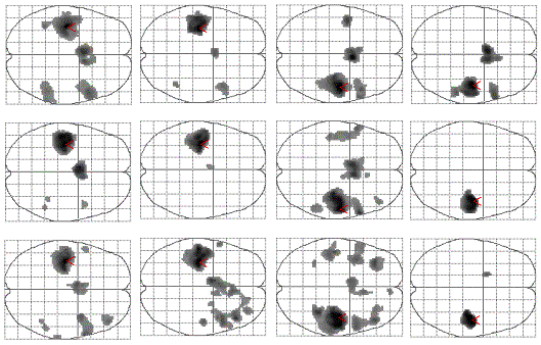
Problem:

Depending on the individual metabolism and the consumed amount ethanol usually reduces brain functions such as sensomotor control, control of the visual system, speech, and attention. fMRI may be used to directly monitor the localization and degree of changes of cortical activations under different activation paradigmata. However, only few examinations on alcohol-induced changes of brain functions have been performed exhibiting an impairment in the visual and acoustic system [1,2]. We studied the influences of ethanol on the activation of sensomotor brain areas including the motor coordination.

Methods:

12 right-handed volunteers and 5 controls performed a motor paradigma consisting in pushing a button with the left index finger, then pushing a second button with the right index finger, and finally pushing both buttons synchronously with both index fingers. The press rate was 1 Hz, 2 Hz, and 3 Hz. A block paradigma was used (10 measurements activation, 10 measurements rest) for each activation task. The cycle was repeated another 2 times. The change of frequency was indicated to the subject using a red flashing light diode. After the first set of measurements the subject left the MR scanner and received a glass of orange juice containing 0.7 ml alcohol per kg body weight. The control group received the same amount of orange juice without alcohol. After 40 minutes the motor para-digmata of the first measurement cycle were repeated. The imaging protocol included high spatial resolution 3D MRI (MPRAGE), and single-shot EPI (16 slices, 5 mm slice thickness). A self-developed optically decoupled mechanism was used to record button pressing signals. Triggering of the MR scanner and recording of the button signals were conducted by a self-written program via an digital input/output unit. Image and patient reaction data were transferred to an external PC and postprocessed using the statistical software package SPM (SPM 99b**,** Matlab R6.12) and further self-developed programs. Data were evaluated with respect to the statistically relevant ($p<0.005$) differences between reactions under alcohol vs. non-alcohol.

Results:



a b c d

Fig. 1: right hand task (dominant hemisphere) without (a) and with alcohol (b) as well as left hand task without (c) and with (d) alcohol. Rows show the push button frequencies 1 Hz (upper), 2 Hz (middle), and 3 Hz (lower row).

Fig. 1 and 2 show results of the randomized group analysis.

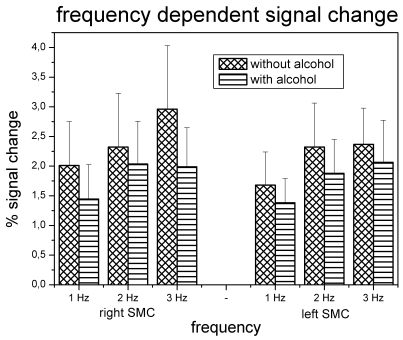


Fig. 2: Frequency dependence of the mean signal in the region of the maximum-activated sensomotor area.

The signal change in the non-dominant hemisphere was more pronounced than in the dominant hemisphere. After intake of alcohol a significantly reduced activation in the sensomotor cortex (SMC) was detected while the activation decrease in the supplementary motor area (SMA) was less significant. After alcohol intake, the SMA activation after left-hand task for 2 Hz and 3 Hz frequencies could no longer be detected. The subjects denied a reduced motor ability but reported an altered mental perception. The results agree with the reduced activation of the visual and the acoustic system after administration of alcohol [1,2].

Conclusions:

The motor paradigma allowed to use fMRI to directly detect alcohol-induced changes in the activation of sensomotor areas in the brain. A decrease of activation was found similar to other functional systems [1,2]. Changes of the coordination between both hemispheres reflected by altered SMA activation as well as the contribution of altered neuro-vascular coupling under alcohol has to be investigated in a larger study using a randomized motor paradigma to exclude habituation and priming effects.

References:

[1] JM Levin et al., Psych Res 82, 1998, 135-46 ; [2] E Seifritz et al., Psych Res 99, 2000, 1-13