Increased brain perfusion following an acute dose of alcohol

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INTRODUCTION

Alcohol is a central nervous system depressant, and intoxication manifests through change in behavior already at low dosages. Recent functional magnetic resonance (fMRI) studies have shown decrease in neuronal activation after alcohol consumption in different functional brain areas (e.g. [1]). There is, however, a lack of knowledge on the acute dose effect of alcohol intake on brain hemodynamics, especially in the normal functioning brain. Dynamic contrast perfusion, T2*, was applied with a within subject design in eight healthy volunteers. The prefrontal and cingulated cortices were of particular interest due to their role in impulse control, mood and emotions, which are key behavioral factors affected by alcohol.

METHODS

Sample: Eight right-handed, healthy male volunteers (27 ± 4 years, 82 ± 12 kg), social drinkers but not dependent on alcohol or nicotine, were scanned twice; i) after consumption of a soft drink (BAC 0%), ii) after alcohol consumption (BAC 0.082 ± 0.005 %). Acquisition protocol: Siemens Symphony 1.5T; three orthogonal localizers to anatomically orient subsequent imaging, a 3D-T1 weighted volume acquisition (MPRAGE; TE/ TR/ TI = 3.93 ms/ 2040 ms/ 1100ms, flip angle 15, image matrix 256x256x256), a 2D axial, double echo acquisition (TE1/ TE2/ TR = 14 ms/82 ms/2380 ms, slice thickness 5 mm, echo train length 5, flip angle 150, image matrix 512 x 408, number of slices 11, Field of View 230 mm) and a gradient-echo echo planar imaging sequence (GE-EPI) for dynamic perfusion imaging (TE/ TR=1.31 ms/46 ms, slice thickness 5 mm, flip angle 90, image matrix 128 x 128, number of slices 11, Field of View 230 mm). Contrast agent: Gadovist, Schering, Germany. Dose according to body weight (0.1 ml/kg). Data analysis: Three methods were applied to estimate hemodynamic parameters (blood flow, mean transit time, blood volume, time-to-peak); a) no deconvolution b) deconvolution using manually selected arterial input function and singular value decomposition (SVD) ([2], [3]), c) blind deconvolution [4]. Software; nICE, NordicNeurolab AS, Norway, with the blind deconvolution method added. The methods were compared to look for possible quantitative differences due to selection of arterial input functions.

RESULTS

All three methods gave significant increase ($p < 0.005$ two-tailed, paired t-test) in mean cerebral blood flow in gray matter after alcohol consumption (Fig. 1, $p < 0.005$), though not in cerebral blood volume or mean transit times. Template normalization was performed (SPM2) allowing a voxelwise comparison between imaging sessions and subjects. Regional changes were seen in areas in the frontal-, temporal- and parietal lobes and in the cingulated cortex, SVD in Fig 2.

DISCUSSION

Previous studies involved CT or SPECT, and showed only global changes after alcohol intake (e.g. [5]). Selecting dynamic contrast perfusion MRI had several advantages, including repeated measurements in the same subjects as no radiation was involved. It also allowed several hemodynamic parameters to be assessed simultaneously. The high spatial resolution allowed segmentation in gray and white matter, and possible fMRI data acquisition in the same imaging session. An interesting point of discussion is the permeability of the blood brain barrier in these studies; the small molecular size of ethanol allows alcohol to easily get into the blood stream, and also to cross the blood brain barrier. The exogenous contrast agent, however, remains intravascular in the presence an intact blood brain barrier.

REFERENCES

[1] Calhoun et al 2004 [2] Østergaard et al 1996, [3] Smith et al 2004, [4] Grüner, Taxt 2006 [5] Mathew, Wilson 1986.

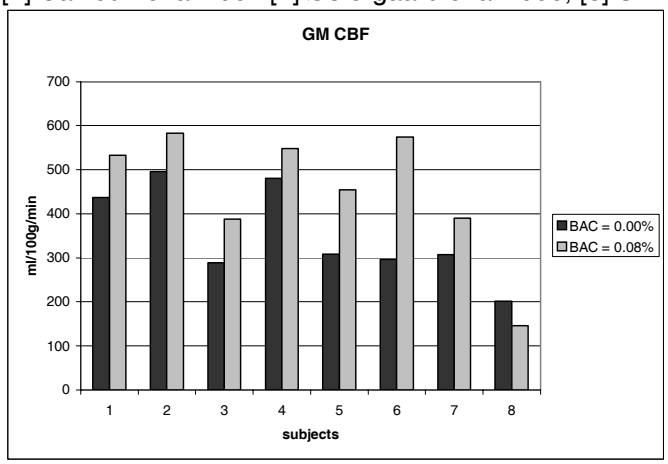

Fig. 1 Differences in mean blood flow in gray matter.

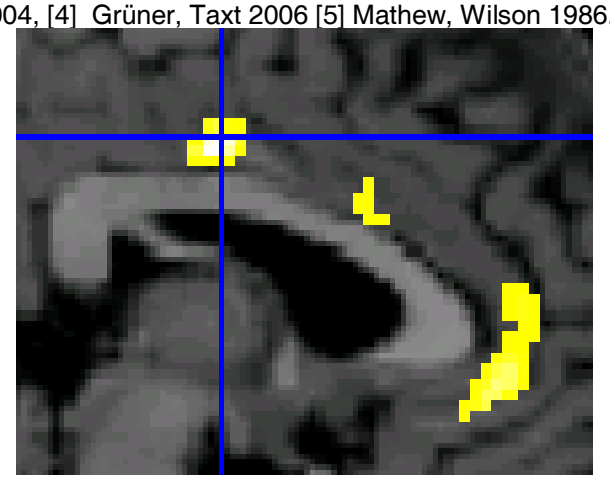

Fig. 2 Regional increase in blood flow after alcohol consumption in the cingulated cortex.