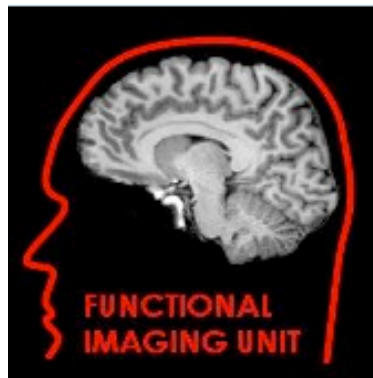


# Functional Imaging Unit Annual Report 2010



Functional Imaging Unit,  
Department of clinical physiology and nuclear medicine /  
Department of radiology  
Glostrup Hospital, Glostrup  
Denmark

## Table of Contents

<b>Methodological Studies</b>	<b>3</b>
<i>T1-based perfusion studies, AIF</i>	3
<i>Multimodal imaging of Brain Perfusion</i>	3
<i>Variability in Brain Perfusion</i>	4
<i>Dynamic T1-mapping.</i>	4
<b>Basic Neuroscience</b>	<b>5</b>
<i>The visual system: a comparison between neurophysiological and vascular activation patterns.</i>	5
<i>fMRI of the somatosensory system</i>	5
<i>Effect of physical exercise (FINE)</i>	6
<i>Pharmacology of the cerebral circulation</i>	6
<b>Clinical Neuroscience</b>	<b>6</b>
<i>Optic Neuritis - fMRI and the visual system</i>	6
<i>Optic Neuritis - OCT and structural CNS changes</i>	7
<i>The Effect of PACAP38 on Cerebral Hemodynamics</i>	7
<i>Functional connectivity studies in middle aged subjects.</i>	7
<b>Psychiatry</b>	<b>9</b>
<i>Reward mechanisms in first-episode schizophrenics (PECANS)</i>	9
<i>Dopaminergic mechanisms in first-episode schizophrenics (PECANS)</i>	9
<i>MR studies of prodromal patients (NEURAPRO)</i>	10
<i>Sensory gating - an fMRI study of P50 suppression</i>	11
<b>Clinical Studies</b>	<b>12</b>
<i>Tourette Syndrome in childhood</i>	12
<i>Brain Tumours: Can Dynamic T1-Weighted Perfusion MRI differentiate Recurrence from Radiation Necrosis?</i>	12
<b>List of Publications</b>	<b>14</b>
<i>Full papers</i>	14
<i>Abstracts</i>	15

## Methodological Studies

### T1-based perfusion studies, AIF

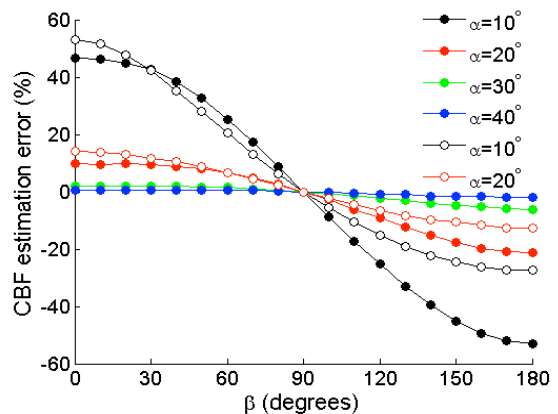
Investigator: Adam Espe Hansen, MSc, PhD; Henrik Pedersen, MSc, PhD

**Background:** MR perfusion measurements based on dynamic contrast enhanced (DCE) T1

weighted imaging can accurately quantify cerebral blood flow (CBF). Due to the rapid imaging needed for bolus-tracking, the magnetisation might not have time to reach a steady state. Therefore, the MR signal equation needed for estimation of contrast agent concentration might be inaccurate; ultimately leading to faulty estimation of CBF.

**Status:** We carried out simulations of the Bloch equation during the bolus passage, to investigate the error in CBF estimates using various signal equations and MR parameters. The results indicate that steady state effects can have a significant impact on CBF estimates; however, errors are generally small if a large MR flip angle is used.

Part of this study was given as an oral presentation at the ISMRM 2010, Stockholm.

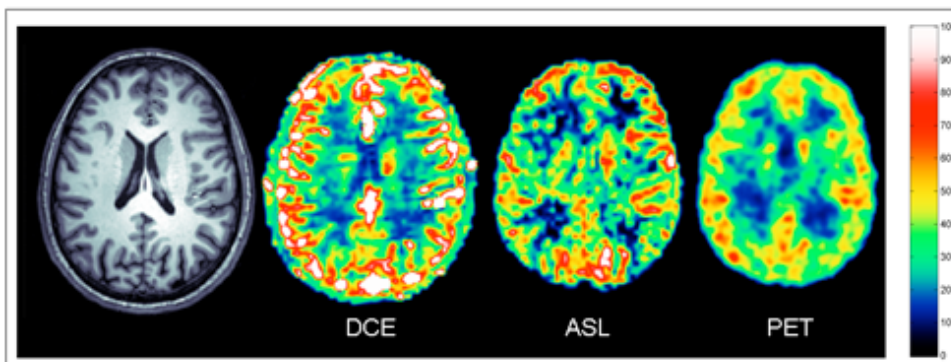


Error of CBF estimates as function of the effective saturation prepulse angle  $\beta$ , for values of the  $\alpha$  pulse as given in the legend. Closed circles are for centric, open circles for linear phase encoding. A signal equation assuming perfect saturation is used.

### Multimodal imaging of Brain Perfusion

Investigator: Otto Henriksen, MD, PhD student

**Background:** Quantitative measurement of cerebral blood flow (CBF) is an important tool both in the clinical setting and in neuroscience. A range of quantitative MRI perfusion techniques has become available in recent years. In order to correctly interpret CBF measurements using these methods both methodological precision and between subject variability must be established. The aims of the project are both to validate the novel MR



Multimodal imaging of human brain perfusion using contrast based (DCE) or non-invasive (ASL) MRI, and  $H_2^{15}O$  PET-scanning.

techniques for measurement of CBF and to investigate the sources of variability in CBF measurements using various modalities.

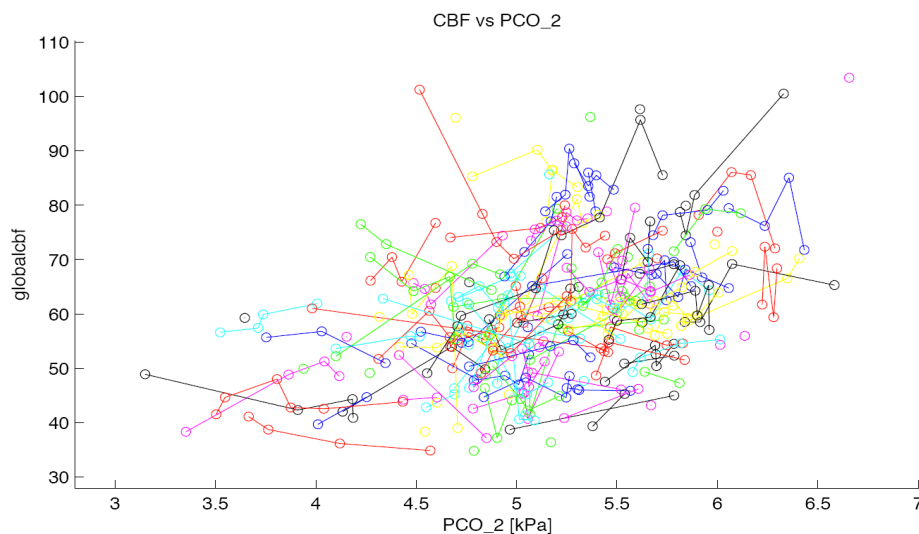
**Status:** The first study has been completed. In that study within subject variability of CBF measured by different MR techniques was studied in 18 healthy subjects during resting conditions. Manuscript has been submitted. Future studies will apply MRI perfusion

measurements to healthy elderly subjects in order to investigate the determinants of resting CBF and cerebral vascular reactivity.

## Variability in Brain Perfusion

**Investigator:** Otto Henriksen, MD, PhD student

**Background:** Measurement of cerebral blood flow (CBF) is of great importance both for clinical use and for neuroscience. Although CBF is considered relatively constant, studies using different techniques typically demonstrate intersubject variability by a factor of 2. To which extent this is caused by methodological imprecision or true between subjects differences has not been investigated in large studies.  $^{133}\text{Xe}$  Single Photon Emission Computed Tomography has been used for CBF measurements in the past 25 years.



Global perfusion measured in 154 subjects vs.  $P_{\text{ETCO}_2}$  levels. Data from individual subjects are connected with lines.

**Status:** Retrospective analysis of 439 resting  $^{133}\text{Xe}$  SPECT studies performed in 154 healthy subjects from 1998 to 2007. Preliminary analysis confirms a significant between subject variability in CBF measurements that cannot only be attributed to two known major determinants of resting CBF (Hct and  $P_{\text{ETCO}_2}$ ). Future studies will address the potential genetic, metabolic and physiological causes of this residual variability.

## Dynamic $T_1$ -mapping.

**Investigators:** Bryan Haddock (MSc in physics)

**Background:** Conventional functional imaging is based on a very indirect detection of oxygenation change using the BOLD technique, and devising a new method based on more direct effects of oxygen would be highly interesting. In the present study we are investigating the properties of  $T_1$ -imaging during modulation of brain oxygen levels. While the BOLD effect is due to complex field inhomogeneities around the microvasculature, the  $T_1$ -effect may be more directly related to oxygen levels in the vasculature and tissue, and thus provide a better basis for quantitative assessment of oxygen metabolism.

**Status:** Studies using a dynamic  $T_1$ -weighted technique were conducted in 11 healthy subjects during hyperoxic conditions (inhalation of 100%  $\text{O}_2$ ). The results clearly confirm oxygen related signal increases globally in the brain. We are currently comparing this to conventional BOLD results to determine differences in the origin of the signal.

## Basic Neuroscience

### The visual system: a comparison between neurophysiological and vascular activation patterns.

**Investigator:** Dan Fuglør, MD, PhD student

**Background:** Functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) are two common methods to measure brain activity non-invasively. EEG measures neuronal electrical activity whereas fMRI measures the following hemodynamic response using the Blood Oxygenation Level Dependent (BOLD) signal. EEG and fMRI are acquired at a high temporal and spatial resolution respectively and by combining fMRI and EEG one could ideally get neuronal activation maps with a high spatial and temporal resolution and thereby a more complete understanding of brain function and the neurovascular coupling than could be provided by either method alone. The main purpose of this study is to investigate which single-trial EEG features can predict the BOLD response during visual stimulation.



**Status:** We have carried out simultaneous EEG-fMRI during visual stimulation in ten healthy subjects. In general the response to visual stimulation was well described with a simple square-wave reference function. However, specific EEG-derived parameters were found to explain some additional variation not explained by the simple reference function. This suggests that spontaneous variations in neuronal activity patterns may contribute to the BOLD response, even during a simple visual paradigm. The results have been submitted for publication.

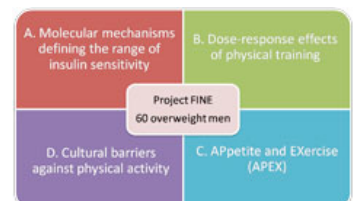
### fMRI of the somatosensory system

**Investigator:** Katharina Schäfer (PhD student)

**Background:** This project is dealing with the neurophysiological basis of the negative Blood Oxygenation Level Dependent (BOLD) signal in functional Magnetic Resonance Imaging (fMRI). In recent years, it has been shown that a negative BOLD signal can be reliably induced by electrical hand stimulation in the ipsilateral primary somatosensory cortex (SI). We used this paradigm during fMRI and Positron Emission Tomography (PET) recording in order to directly study the relationship between the negative BOLD signal and regional blood flow changes. In addition, we performed a psychophysical experiment to investigate possible attenuating effects of the inhibitory processes on sensory function. Our aim is to develop a model for concurrent analysis of PET and fMRI data.

**Status:** fMRI scans have been performed at Glostrup, PET scanning performed at the Rigshospitalet together with Ian Law and Julie M. Grüner. Scanning sessions are now completed. The same applies to the psychophysical experiments. We now analyse the data supported by Felix Blankenburg from the Bernstein Center for Computational Neuroscience in Berlin.

We found the expected negative BOLD signal in ipsilateral SI. Additionally, the PET-data showed a decrease in regional blood flow in the same anatomical location. Furthermore, positive BOLD signaling in contralateral SI and secondary somatosensory cortex (SII) was accompanied by perfusion increase with high spatial congruence. The psychophysical experiment returned detection thresholds that were significantly higher during concurrent median nerve stimulation than without



## Effect of physical exercise (FINE)

**Investigator:** Thorkil Ploug (MD, assoc. professor), Egill Rostrup

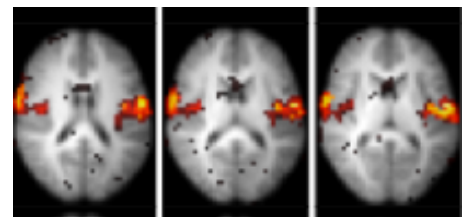
**Background:** Physical exercise has a beneficial effect on many risk factors, such as cholesterol levels and insulin sensitivity, generally in a dose-dependent manner. The present study investigates the detailed relation between controlled levels of physical training and the effect on a range of physical parameters and performance tests. Three groups of young overweight subjects are investigated with either no, moderate or high-intensity physical training during 12 weeks. Before and after the training period the subjects undergo an extensive MR investigation to quantify changes muscle as well liver fat, and additionally looks at changes in cerebral structure and function during the trial period.

**Status:** By the end of 2010 the two first waves each of 20 volunteers were investigated during baseline and follow-up. The last group of subjects will be investigated in 2011, and analysis will commence thereafter.

## Pharmacology of the cerebral circulation

**Investigator:** Kim Zillo Rokamp, MD

**Background:** Evidence for cholinergically mediated vasodilatation is reported in human peripheral vessels for which atropine blocks the exercise-induced decrease in vascular resistance of the non-exercising forearm and abolishes the exercise-induced increase in tooth pulp blood flow. However, the importance of cholinergically mediated vasodilatation for regulation of cerebral perfusion during exercise in humans remains unknown. In cerebral vessels, the vasodilatory effect of acetylcholine is attenuated by the muscarinic blocker atropine, but since atropine crosses the blood brain barrier atropine may affect cerebral metabolism. Glycopyrrolate is a muscarinic blocker that do not cross the blood brain barrier and Seifert et al. 2010 found that during hand- and cycling exercise, glycopyrrolate abolished the exercise induced increase in cerebral blood flow as measured by transcranial Doppler sonography. To test if this finding could be repeated, we used fMRI (ASL and BOLD) to measure cerebral bloodflow, with and without glycopyrron, during rest and handgrip exercise with visual light stimulation.



Example of spontaneous activity in motor networks investigated during rest and glycopyrron stimulation

**Status:** We have from september 2010 tested 10 subjects and need to include two more subjects too complete the data collecting part, this is scheduled to occur spring 2011.

## Clinical Neuroscience

### Optic Neuritis - fMRI and the visual system

**Investigator:** Dan Fuglør, MD, PhD-student

**Background:** Optic neuritis (ON) is an acute inflammatory condition of the optic nerve. It is the presenting symptom in 20% of patients with MS and the 15 year risk of developing MS after ON is about 50%. Following ON the functional activation of visual cortex (as well as visual acuity) is known to be deficient, but the precise relationship to structural changes is not well described. The aim of the study is to investigate how the retinal thickness is

related to the cortical response in the visual cortex in patients with acute and recovered ON.

**Status:** A total of 41 patients and 19 controls were investigated at baseline (acute phase for the patients) and after 6 months. While the length of the optic nerve lesion was correlated to the BOLD response in the acute phase, the retinal thickness was found to be a predictor of the response magnitude in the chronic phase. These results have been accepted for publication in Neurology.

### Optic Neuritis - OCT and structural CNS changes

**Investigator:** Klaus Kallenbach, MD, PhD

**Background:** There has been increasing emphasis on axonal loss in the field of MS to elucidate the reasons for the permanent neurologic damage experienced by patients with MS. In this project patients with optic neuritis, which is a frequent initial symptom of MS, were analysed to investigate axonal loss in the earliest phase of possible MS. Patients were investigated by Optical Coherence Tomography (OCT) and MRI to measure axonal loss of the retina and brain atrophy, respectively.

**Status:** One was accepted for publication in "Multiple Sclerosis", one publication is currently submitted, and one PhD degree based on the project.

### The Effect of PACAP38 on Cerebral Hemodynamics

**Investigator:** Faisal Amin, MD, PhD-student, Messoud Ashina, MD, PhD, Dr.MSc

**Background:** Pituitary adenylate cyclase-activating polypeptide-38 (PACAP38) is neurotransmitter in the VIP/glucagon super family. PACAP38 is a well known vasodilator and it causes headache in healthy volunteers and migraine-like attacks in patients. The mechanisms behind PACAP38s headache/migraine provoking ability are not fully understood. We designed randomised, double blind and placebo controlled MR study including 14 healthy volunteers to enlighten the effect of PACAP38 on cerebral hemodynamic.

We performed several MR scans over 6 hours to examine the effect of PACAP38 on 1) cerebral arteries circumference using MR-angiography, 2) neuronal activity using functional MRI (resting state) and 3) the cerebral blood flow using artery spin labelling (ASL).

**Status:** MR-angiography data has been analysed and a paper is written. We found that PACAP38 caused headache and sustained dilatation of the middle meningeal artery (MMA) over almost 5 hours after the infusion. We found no changes of the middle cerebral artery (MCA) circumference at all. Furthermore some of the participants were treated with the migraine specific abortive drug sumatriptan. Sumatriptan selectively contracted the MMA but not MCA.

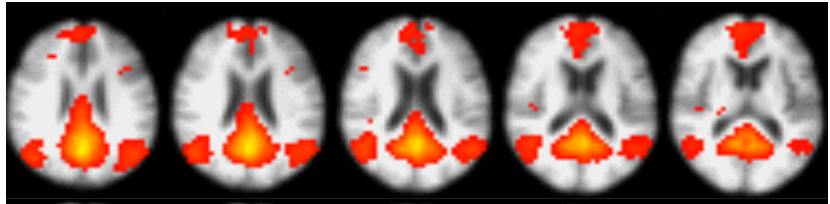
The functional MRI and perfusion data are currently under processing.

### Functional connectivity studies in middle aged subjects.

**Investigator:** Naja Liv Hansen, MD

**Background:** Spontaneous fluctuations in MR BOLD signal are organized into characteristic patterns, so-called Intrinsic Connectivity Networks (ICN). In a resting but

awake subject several such networks will typically appear, each of them consisting of anatomically distinct brain areas with synchronized oscillations of BOLD signal, reflecting connectivity of the underlying neural activity. It is believed that at least some ICN's might be involved in

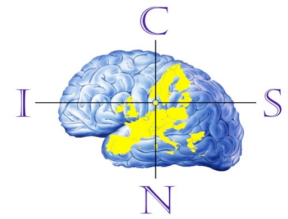


The Default Mode Network, believed to be related to higher-level cognitive functions like episodic memory and self-referential mental representations (pooled data from 22 healthy participants).

advanced information processing during higher-level cognitive processes. ICN activity and connectivity has shown to be altered in several psychiatric or neurodegenerative diseases, including Mild Cognitive Impairment and Alzheimers Disease. As a part of the Center for Healthy Aging at Univ. of Copenhagen, we explore 1) the correlation between ICN and a number of specific cognitive functions and ICN in 200 middle-aged subjects, and 2) the correlation between hæmodynamic parameters such as CBF and carotid flow, and ICN in the same subjects.

Status: 28 subjects have been successfully examined so far.

# Psychiatry

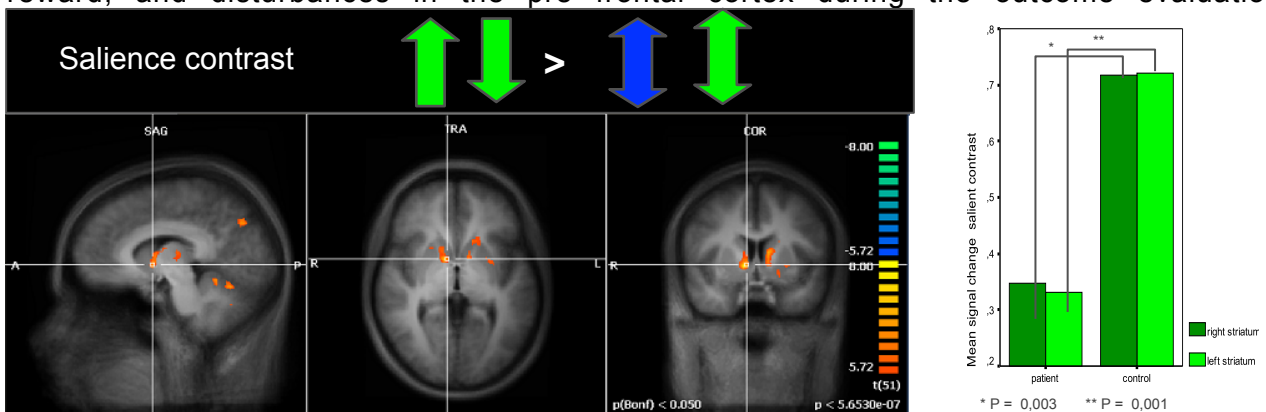


## Reward mechanisms in first-episode schizophrenics (PECANS)

**Investigator:** Mette Ødegaard Nielsen, MD, PhD student

**Background:** PECANS is a project, where we aim to look at different endophenotypes and candidate endophenotypes in 60 antipsychotic naïve schizophrenic patients. In the fMRI part of the PECANS study, we use a validated reward paradigm to look at disturbances of the brain reward system in antipsychotic naïve schizophrenic patients before and after treatment with antipsychotic medication.

We expect to find disturbances in the activation of ventral striatum during the anticipation of a reward, and disturbances in the pre frontal cortex during the outcome evaluation.



Figures showing the salience contrast in the whole group, and the group comparison of the BOLD response in Ventral Striatum

**Status:** 30 antipsychotic naïve schizophrenic patients have been scanned at baseline and 22 have by now had their 6 weeks follow up scan as well. Further more 28 healthy controls matched on age, gender and parental socio-economic status have been scanned at baseline and follow up. Baseline data on 26 patients and 26 controls are currently being analysed, and we find a significant reduced BOLD response in the ventral striatum of the patients as expected. Preliminary results have been presented in a talk at the Capital Region Psychiatric Research Day and as a poster at the Danish Psychiatrist Society congress, the Schizophrenia International Research Society Congress, the Copenhagen University PhD day and the Robert summer symposium.

## Dopaminergic mechanisms in first-episode schizophrenics (PECANS)

**Investigator:** Sanne Wulff, MD, PhD student

**Background:** It is well known, particularly dopamine dysregulation plays an important role in psychosis. Dopamine is also known to be involved in the reward system.

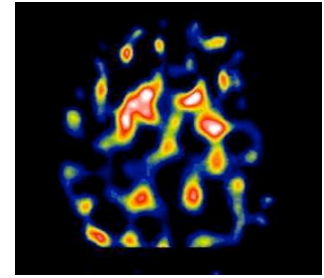
In this part of the PECANS study we plan to link striatal dopamine D<sub>2</sub>/D<sub>3</sub> binding potentials (measured with SPECT) to the reward processing abnormalities (measured with fMRI) and psychopathology in antipsychotic-naïve first-episode schizophrenia patients.

Furthermore, we will explore how these disturbances are modulated by 6 weeks of treatment with a dopamine D<sub>2</sub>/D<sub>3</sub> antagonist (amisulpride).

We use SPECT with <sup>123</sup>IBZM (123-I labeled iodbenzamid) as radioligand to examine the binding potential (BP<sub>p</sub>) of dopamine D<sub>2</sub>/D<sub>3</sub> receptors in the striatum.

Co-registration is done between MRI and SPECT images. Predefined volumes of interest (VOIs) will subsequently be identified automatically on the MRI image and directly transferred to the co-registered SPECT image.

**Status:** Currently we have fMRI and SPECT data from 13 patients at baseline, 8 at follow-up and 8 healthy controls. Data monitoring and analyses are ongoing. Aiming for 30 participants in each group.



IBZM SPECT image showing strong uptake of the ligand in the basal ganglia.

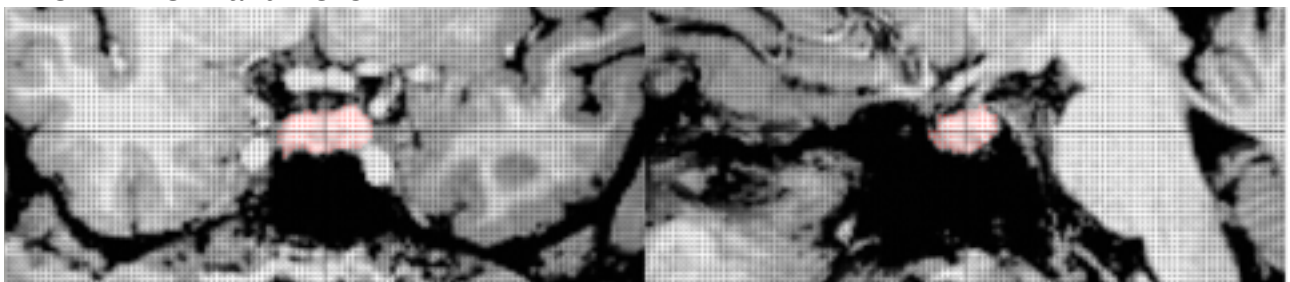
### MR studies of prodromal patients (NEURAPRO)

**Investigator:** Dorte Nordholm, MD, PhD-student

**Background:** Cortisol seems to be an important factor in the biology of psychoses, in particular patients with acute psychotic symptoms show hyperactivity of the HPA axis, as demonstrated by increased levels of cortisol, non-suppression at the dexamethasone depression test and an enlarged pituitary volume. It also seems that the increased volume of the pituitary gland is not only present at the first episode of psychosis, but even just prior to the onset of psychosis, and according to some studies, it predicts the future onset of psychosis. Such findings suggest that HPA axis activity could be used to monitor the future course of the disorder. The relationship between cortisol levels, the diurnal variation of cortisol, volume of the pituitary gland, cognitive function and psychopathology has been studied very little in schizophrenic patients.

In this study we measure the volume of the pituitary gland by manual tracing on structural MRI scans, and relate this to the salivary cortisol (6 samples from awakening until evening), and psychopathology in subjects at risk for schizophrenia (prodromal syndrome). We compare these patient with healthy controls and psychotic patients (included in the PECANS study).

In 2011 some of the patients are going to be included in the multicenter studies: NEURAPRO-E and EU-GEI.



The image shows the stereological measurement of the sagittal and coronal view of the pituitary gland in MEASURE.

**Status:** The investigator underwent training in measuring the pituitary gland at the IOP (Institute of Psychiatry) in London. We are using stereology in the programme: MEASURE. We have included 20 patients fulfilling the criteria's for being at risk of developing psychosis (UHR: Ultra High Risk); we are planning to recruit 40 patients.

## Sensory gating - an fMRI study of P50 suppression

**Investigator:** Nikolaj Bak, MSc, PhD student

**Background:** Reduced sensory gating appears to be among the core features in schizophrenia. The sources of sensory gating however are largely unknown. The aim of the current study was to identify the sources in the brain that are involved in P50 suppression and which areas are involved in the deficient gating in schizophrenia. In order to do so, P50 suppression was assessed both in an EEG setting, as well as in an fMRI setting (concurrent assessment of fMRI and EEG) using identical paradigms. The paradigm was specifically designed for this purpose, utilising electrical stimuli instead of the classical auditory stimuli. We aimed to combine the high temporal resolution of EEG source localisation with the high spatial resolution of fMRI methodology to determine the areas involved in P50 suppression. To our knowledge, in this is the first study which P50 suppression is assessed with EEG and fMRI concurrently.

**Status:** Twenty healthy subjects and 23 patients with schizophrenia have been assessed; data has been processed and analysed. One manuscript based on the healthy subjects was published in Neuroimage (in press). A second manuscript based on the schizophrenia patients is planned.

## Clinical Studies

### Tourette Syndrome in childhood

Investigators: Nanette Mol Debes, MD, PhD

**Background:** Tourette syndrome (TS) is a hereditary, chronic, neurobiological disease, characterised by the presence of motor and vocal tics and it is often accompanied by co-morbid disorders. The two best-known co-morbidities are Obsessive-Compulsive Disorder (OCD) and Attention Deficit Hyperactivity Disorder (ADHD). There is evidence that the cortico-striato-thalamo-cortical pathways are involved in the pathophysiology of TS. Previous imaging studies have suggested long-term activity-dependent plastic changes caused by the lifelong presence of tics in subjects with TS. No longitudinal studies have yet been performed in persons with TS so far to examine these long-term activity-dependent changes prospectively. From 2006-2008 we have examined a large medication-free clinical cohort with 22 children with TS-only, 17 children with TS and ADHD and/or OCD, and 39 healthy controls. We have used diffusion-tensor imaging (DTI), functional MRI (fMRI) during the performance of three neuropsychological tasks, and volumetric analyses. From spring 2011 we will scan the same group of subjects again with the same methods in order to visualise the longitudinal changes over time in the same subject. With this study we hope to contribute to a better understanding of the pathophysiology of TS.

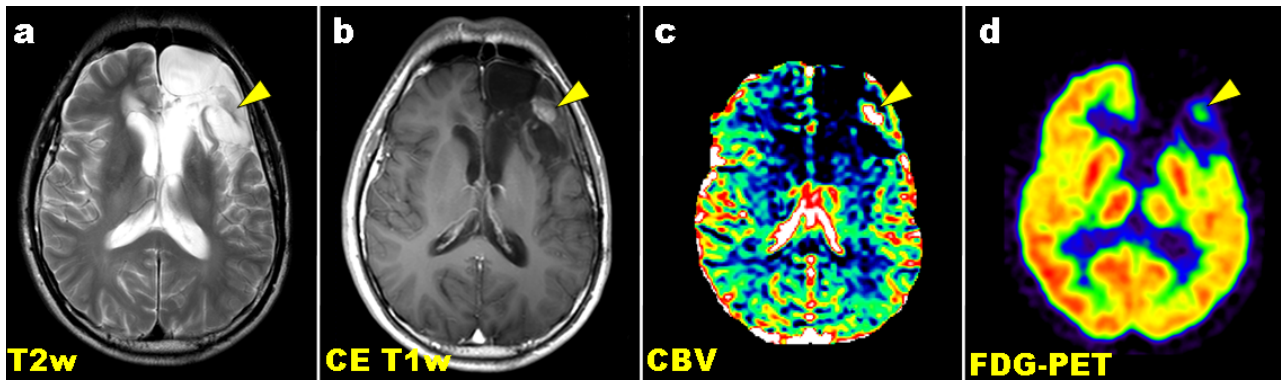
**Status:** In the fMRI study we have found statistically significant activation patterns correlated to OCD score in areas of the brain known to be involved in OCD and psychiatric disorders (temporal gyrus and cingulated gyrus). These results were accepted for publication in the Journal of Child Neurology. The analyses of DTI data and volumetric data are ongoing.

### Brain Tumours: Can Dynamic T1-Weighted Perfusion MRI differentiate Recurrence from Radiation Necrosis?

Investigators: Vibeke Andrée Larsen, MD, PhD

**Background:**

In patients who have been treated for malignant brain tumours using surgery and radiation therapy, a frequent clinical question is whether contrast enhancement represents tumour recurrence or radiation damage. Currently, FDG-PET is the most common investigation to diagnose recurrence, but several studies have suggested that MR-perfusion imaging may provide the same information, by evaluating the cerebral blood volume in the area of contrast enhancement. A new method for perfusion imaging based on contrast enhanced T1-effects has been developed in the Functional Imaging Unit, and is being compared to FDG-PET and clinical follow-up in patients with possible radio necrosis. This project is performed in collaboration with the dep. of neurosurgery and the PET-unit at Rigshospitalet.



*We show an example of a patient treated with operation and radiation of a malignant glioblastoma. The clinical MRI is shown in (a-b). There is a contrast enhancing lesion in the area of former surgery (b). MR T1 perfusion shows elevated CBV (c) and FDG-PET shows increased glucose metabolism (d) in the lesion indicating tumor recurrence. This was confirmed by the MRI follow-up.*

**Status:** A total of 18 patients have been examined and data analysis is ongoing. Preliminary results have been presented at the ISMRM 2010 in Stockholm and at the Symposium Neuroradiologicum, Bologna, 2010.

## List of Publications

### Full papers

1. Asghar, M S, A E Hansen, T Kapijimpanga, R J van der Geest, P van der Koning, H B W Larsson, J Olesen, and M Ashina. 2010. "Dilation by CGRP of middle meningeal artery and reversal by sumatriptan in normal volunteers.." *Neurology* 75 (17) (October 26): 1520–1526. <http://dx.doi.org/10.1212/WNL.0b013e3181f9626a>.
2. Eriksen, N, E Rostrup, K Andersen, M J Lauritzen, M Fabricius, V A Larsen, J P Dreier, A J Strong, J A Hartings, and B Pakkenberg. 2010. "Application of stereological estimates in patients with severe head injuries using CT and MR scanning images." *The British journal of radiology* 83 (988) (April 1): 307–317. <http://dx.doi.org/10.1259/bjr/18575224>.
3. Kallenbach, K, H Simonsen, B Sander, B Wanscher, H Larsson, M Larsen, and J L Frederiksen. 2010. "Retinal nerve fiber layer thickness is associated with lesion length in acute optic neuritis.." *Neurology* 74 (3) (January 19): 252–258. <http://dx.doi.org/10.1212/WNL.0b013e3181ca0135>.
4. Laustsen, Søren Ravn, Preben Sørensen, Torben Fründ, Henrik B W Larsson, Thorkil Christensen, and Elna-Marie Larsson. 2010. "[Preoperative functional magnetic resonance imaging in patients with brain tumors].." *Ugeskrift for læger* 172 (35) (August 30): 2370–2376.
5. Lunde Larsen, L S, H B W Larsson, and J L Frederiksen. 2010. "The value of conventional high-field MRI in MS in the light of the McDonald criteria: a literature review.." *Acta Neurologica Scandinavica* 122 (3) (September): 149–158. <http://dx.doi.org/10.1111/j.1600-0404.2010.01403.x>.
6. Nielsen, Mette Ødegaard, Egill Rostrup, and Birte Glenthøj. 2011. "Forstyrrelser i reward-systemet ved skizofreni." *Best Practice, Psykiatri og Neurologi* 11 (November 1): 5.
7. Paulson, Olaf B, Steen G Hasselbalch, Egill Rostrup, Gitte Moos Knudsen, and Dale Pelligrino. 2010. "Cerebral blood flow response to functional activation.." *Journal of cerebral blood flow and metabolism : official journal of the International Society of Cerebral Blood Flow and Metabolism* 30 (1) (January): 2–14. <http://dx.doi.org/10.1038/jcbfm.2009.188>.
8. Petersen, Esben Thade, Kim Mouridsen, Xavier Golay, and all named co-authors of the QUASAR test-retest study. 2010. "The QUASAR reproducibility study, Part II: Results from a multi-center Arterial Spin Labeling test-retest study." *NeuroImage* 49 (1): 104–113. <http://dx.doi.org/10.1016/j.neuroimage.2009.07.068>.
9. Schmidt, Reinhold, Stefan Ropele, José Ferro, Sofia Madureira, Ana Verdelho, Katja Petrovic, Alida Gouw, et al. 2010. "Diffusion-weighted imaging and cognition in the leukoariorosis and disability in the elderly study.." *Stroke; a journal of cerebral circulation* 41 (5) (May): e402–8. <http://dx.doi.org/10.1161/STROKEAHA.109.576629>.

## Abstracts

*NB, list may be incomplete*

Dynamic Contrast-Enhanced T1 -Weighted Perfusion MRI Differentiates Tumor Recurrence from Radiation Necrosis: Relative Cerebral Blood Volume Measurements and FDG-PET Validation  
Larsen, Vibeke Andrée; Simonsen, Helle Juhl; Law, Ian; Pedersen, Henrik; Larsson, Henrik B. W.; Espe Hansen, Adam.  
In Proc Joint Annual Meeting ISMRM-ESMRMB 2010, Stockholm, Sweden

Feasibility of Whole-Brain Dynamic Contrast Enhanced (DCE) MRI Using 3D K-T PCA  
Pedersen, Henrik; Hansen, Adam E.; Kozerke, Sebastian; Larsson, Henrik B. W.  
In Proc Joint Annual Meeting ISMRM-ESMRMB 2010, Stockholm, Sweden

High Resolution 3D Cardiac Perfusion Imaging Using Compartment-Based k-T PCA  
Vitanis, Viton; Manka, Robert; Pedersen, Henrik; Boesiger, Peter; Kozerke, Sebastian.  
In Proc Joint Annual Meeting ISMRM-ESMRMB 2010, Stockholm, Sweden

Highly Accelerated Cine Phase-Contrast Flow Measurements Using k-T PCA with Spatial Compartments  
Giese, Daniel; Knobloch, Verena; Pedersen, Henrik; Schaeffter, Tobias; Kozerke, Sebastian  
In Proc Joint Annual Meeting ISMRM-ESMRMB 2010, Stockholm, Sweden

Steady State Effects on Cerebral Blood Flow Measurements Using Dynamic Contrast-Enhanced Perfusion MRI: A Simulation Study  
Hansen, Adam E.; Pedersen, Henrik; Larsson, Henrik B. W.  
In Proc Joint Annual Meeting ISMRM-ESMRMB 2010, Stockholm, Sweden

Dynamic Contrast Enhanced T1-Weighted Perfusion MRI for Measuring Cerebral Perfusion Increase After Visual Stimulation  
Berg, Hilde Kjeldstad; Goa, Pål E.; Haraldseth, Olav; Larsson, Henrik B. W.  
In Proc Joint Annual Meeting ISMRM-ESMRMB 2010, Stockholm, Sweden

Stability of Quantitative CBF Measurements Using the T1-Based DCE Approach  
Henriksen, Otto Mølby; Larsson, Henrik B. W.; Hansen, Adam E.; Rostrup, Egill  
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Perfusion Measurement with T1 Weighted Magnetic Resonance Imaging in Patients with Primary Brain Tumors – Evaluation of Radiation Necrosis and Tumor Recurrence  
V.A.Larsen, H.J.Simonsen, I. Law, H.B.Larsson and A.E.Hansen  
Oral presentation at XIX Symposium Neuroradiologicum, The World Congress of Neuroradiology, Bologna, 2010