Umeå center for Functional Brain Imaging - UFBI

Annual Report 2016

UFBI
Umeå center for
Functional Brain Imaging

UFBI 2016 Annual Report

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Welcome to the Annual Report for 2016!

In honor of the fantastic cover image of this year's report as well as the occasion itself, our 15-year anniversary as a center, I wish I could say that I write this editorial while sipping on a glass of well-chilled champagne. While the truth is closer to cold coffee, I can still vividly recollect the fun conference we had in June to celebrate this UFBI milestone. Many joined us in the audience to listen to a fantastic lineup of international speakers from UK, USA, Norway, Canada, Germany, Israel, and the Netherlands. The speakers were organized around central UFBI themes; a lifespan perspective, cognitive and physical interventions, complex cognition, and future images. We also had poster presentations and a fun conference dinner. As someone said to me during a coffee break; "This must be the best set of speakers ever at a brain-imaging meeting in Sweden"! With regained energy and inspiration, and already looking forward to the celebration of 20 years, we continued to work hard also after the festivities. Some examples are given in this report.

In last year's editorial I mentioned a "record high number of clinical examinations" (1077), and I am happy to now report an even slightly higher number (1084) for 2016. The collaboration with the county council (VLL) continues to work very well. Clinical fMRI is asked for at a steady rate, and may even grow bigger in the future. Our scientific coordinator Johan Eriksson and Micael Andersson contribute much to this important UFBI activity. Also, our new research nurse Rebeca de Peredo Axelsson and her team, notably Hans-Olov Karlsson and Kerstin Englund, continues to be the foundation for all UFBI activities.

Relatedly, many clinical projects are ongoing, and in the present report you can read about using fMRI in relation to Deep Brain Stimulation (DBS). The local DBS unit is among the world-leaders, and we are happy to have close collaboration with them as illustrated in the text by Amar Awad. Another example is measurement of blood flow in the main cerebral arteries. Tora Dunås gives a snapshot of her doctoral thesis work, which gives us important new knowledge and has the potential to result in an application for future clinical use.

A strong aspect of UFBI activities is combining large-scale population-based studies with brain imaging. The Betula project is arguably the best known example, and in this report Lenita Lindgren describes a very interesting project with focus on perceived stress and hippocampus volume. Another example is the Cobra study, in which use of PET to measure the dopamine D2 system is a unique ingredient. In the report, Nina Karalija presents some of her post-doctoral work in a project that recently received support from the Swedish Brain Foundation (Hjärnfonden).

Students at all levels are vital to UFBI activities, not least our PhD students. In September 2016 Fredrik Bergström successfully defended his thesis on non-conscious working memory, and he gives an overview of his dissertation work in the report. Fredrik now has a position as international postdoc in Portugal. Thus, he joins several previous UFBI students in moving out to be an UFBI ambassador in the bigger world. It is highly rewarding to follow such developments and see that our graduates continue to be competitive nationally as well as internationally.

A second PhD defense with UFBI connex took place at Linköping University in the fall of 2016, when Kristoffer NT Månsson successfully defended his thesis, entitled Restructuring the Socially Anxious Brain. One of his supervisors was UFBI group leader CJ Boraxbekk. At UFBI we find it very encouraging to learn that Kristoffer, despite the geographical distance, chose to do his studies at UFBI because he was impressed by our imaging infrastructure. In this report, Kristoffer gives us a summary of their interesting work on social anxiety disorder.

Last but not least, a big thanks goes to project manager Mikael Stiernstedt for his – as always- professional coordination of the production of our annual report.

Lars Nyberg, April 2017
UFBI Director (2001 - Present)

In short

In 2016 the members of UFBI produced:

8
clinical fMRI-scans

11
conference talks / posters

564
fMRI-scans

2
doctoral dissertations

15
original articles

1084
clinical MRI-scans

Research

Automated 4D-flow identification

Automated pipelines for data processing is crucial when working with large amounts of data. This is for example the case with 4D-flow MRI, where an ongoing thesis work by Tora Dunås is aiming to automatically identify the main cerebral arteries and calculating flow values.

This is done using an atlas-based approach where vessels are labeled by comparing their location in a standardized coordinate system to the average location within a population. The atlas was based on data from the COBRA project, including angiographic images from 167 healthy elderly. The images were transformed to a standard coordinate system (MNI-space), the arteries were manually labeled and an average over the population was created, resulting in a probability map describing the spatial distribution of each artery. The atlas includes 16 of the larger cerebral arteries and can be found at: http://www.nitrc.org/projects/brainarteries.

In the identification method, each artery is represented by its centerline. This centerline is constructed by gradually thinning a binary image until a single-voxel-wide skeleton remains.

A function describing the transformation from each individual brain to MNI-space is calculated and used to transform the atlas to match each individual subject. Centerline voxels are then assigned to the artery with the highest probability at the corresponding location in the atlas. The labeled artery is then defined as the longest continuous segment among these labeled voxels.

The next step in the development of this tool is to incorporate flow and area quantification into the identification method.

4D-flow MRI can provide time-resolved flow data within a volume covering the entire head. This means that a variety of parameters can be calculated, such as flow rate volume, pulsatility and morphological parameters such as cross-section area and tortuosity.

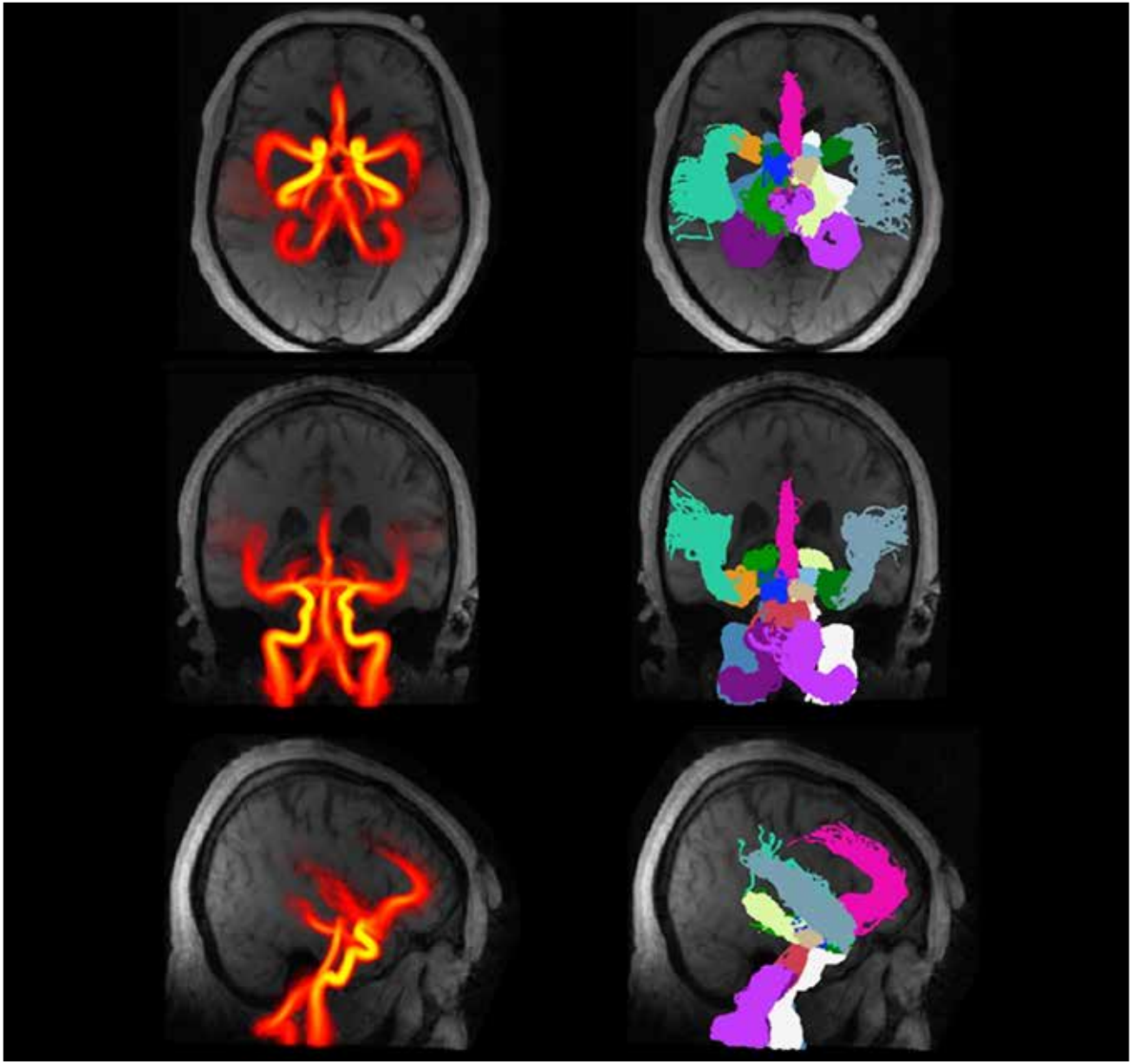
For automating this process, there are two main challenges. First of all, finding the right location for measurements. It's not enough to find the right artery, you want to make sure that you are also at the same location every time, and that the segment is sufficiently straight and does not include any bifurcations.

The second challenge is to separate the vessel from the background. By including or excluding just a few voxels, obtained values can vary greatly, especially for smaller arteries. The identification process is built on a coarse segmentation based on intensity thresholding, which is not sufficient for flow and area quantifications.

In manual processing, there is an additional challenge of placing a double oblique measurement plane in the vessel, but from the direction of the vascular centerline, the angel of this plane can be easily calculated.

This tool is mainly developed for research purposes, where data from a large number of subjects needs to be analyzed at once. But if the tool is fast and stable enough, it could also be used in a clinical situation to assess abnormalities in the distribution of blood flow through the main cerebral arteries.

Tora Dunås



The atlas visualized based on the over all probability of occurrence of the specified arteries (left), and the areas covered by each of the arterial probability maps (right).

Illustration: Tora Dunås

The dopamine-cognition link

The dopamine system is one of the most age-sensitive systems of the brain, and also, implicated in cognitive processes. The dopamine-cognition link is however still elusive, which motivated the initiation of the Cognition, Brain, and Aging (COBRA) project.

In COBRA, 181 healthy, older adults have undergone dopamine D2-receptor assessment with positron emission tomography (PET) and 11C-raclopride, broad-ranged cognitive assessment, and magnetic resonance imaging for measures of brain structure and function during 2012-2014.

I was recently awarded a two-year postdoc scholarship from the Swedish Brain Foundation for a project in which I will examine effects of genetic variation on inter-individual differences in dopamine measures and cognitive performance in the COBRA-sample. Previous studies have assessed effects of genetic variants on either behaviour or dopamine system integrity, but not combined. Obstacle for such studies likely include the combination of large sample sizes (due to low frequency of unusual genetic variants) and the need to use radioactive ligands for in vivo dopamine measurements.

As a first line of this work, I will investigate whether allelic variants of single-nucleotide polymorphisms (SNPs) located in the dopamine D2-receptor gene affect brain D2-receptor measures and cognitive performance. In a first manuscript we have concluded that associations between D2-receptor status and cognitive performance differ between allelic groups of a polymorphism located in the D2 receptor gene (C957T). Due to previous indications of differences in extracellular dopamine levels between these allelic groups, we postulate that the PET-measure is determined by differences in pre- as well as postsynaptic dopamine profiles, and thus by receptor status in a heterogeneous group of individuals. The results are relevant for several fields of research that uses PET and 11C-raclopride, as it may obscure interpretations of results.

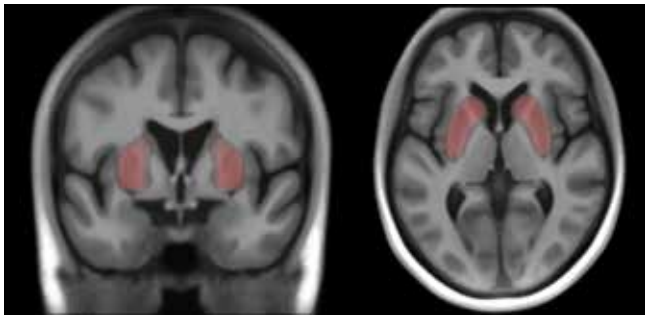


Illustration: Nina Karalija

PET-MR images demonstrating 11C-raclopride binding in the brain (red). D2 receptors are most abundant in the striatum.

Secondly, I will investigate the effects of several SNPs that regulate regional dopamine transmission (striatal and prefrontal) on D2-receptor status and performance in different cognitive tasks. This is motivated by studies demonstrating that hereditary factors are important for dopamine system integrity and explain a considerable amount of age-related cognitive decline at older age. Also, potentiating effects are typically found when considering several genetic variants, rather than one. One hypothesis is that variation in specific dopaminergic functions may underlie performance differences in certain cognitive tasks. This line of research will be conducted during a planned postdoc period in Berlin in 2018, at Professor Ulman Lindenberger's laboratory with methods developed by Dr. Andreas Brandmaier & colleagues.

All in all, the project has the potential to map specific dopamine mechanisms that are associated with an increased risk for cognitive decline in aging.

Nina Karalija

Stress and the hippocampus

Stress-related disorders have increased during the past years. One of the most replicated findings in stress-related disorders, such as depression or posttraumatic stress disorder (PTSD), is a small hippocampal volume.

There is an ongoing debate whether stress causes decrease in hippocampal volume or if a small hippocampus represents a vulnerability factor. Results from experimental animal studies show that stress causes shrinkage of dendrites in hippocampal subfields dentate gyrus, CA1, and CA3. However, such causal relationship has not been found in humans, instead results from twin studies indicate that a small hippocampal volume might be a vulnerability factor.

In a recent study, we examined this issue by relating perceived stress levels to hippocampal volumes in healthy participants aged 18 to 60 years from the Betula longitudinal population-based study. Perceived stress ratings were examined every five years over a fifteen-year period. In addition, the participants were scanned twice. Based on the scores of the perceived stress questionnaire, participants were divided into a moderately-high (n = 35) and low (n = 76) stress group (figure 1). The definition and the cut off for the two groups was based on the results from previous studies. We found that individuals who perceived moderately-high levels of stress over a fifteen-year period had significantly smaller hippocampal volume compared with individuals who perceived low levels of stress. However, no significant changes in total hippocampal volume over a five-year period in either group could be found (figure 2). The results indicate that a small hippocampal volume may be a vulnerability factor for stress-related disorders.

A smaller hippocampus may less efficiently influence the hypothalamic–pituitary–adrenal (HPA) axis, thereby making individuals more vulnerable to different stressors. It is important to further investigate our results and find out why some individuals are more vulnerable to stress than others.

Lenita Lindgren

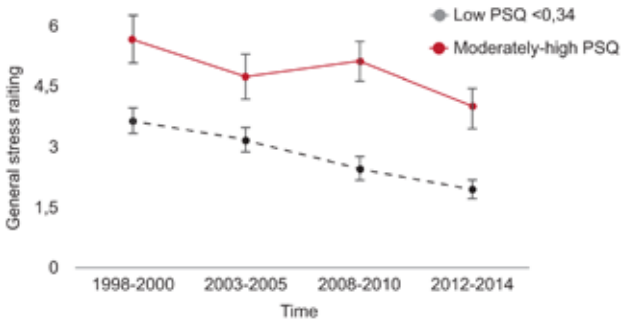


Figure 1. Perceived stress ratings over a fifteen-year period. Individuals in the moderately-high perceived stress group rated significantly higher stress levels at every time point compared with individuals in the low perceived stress group.

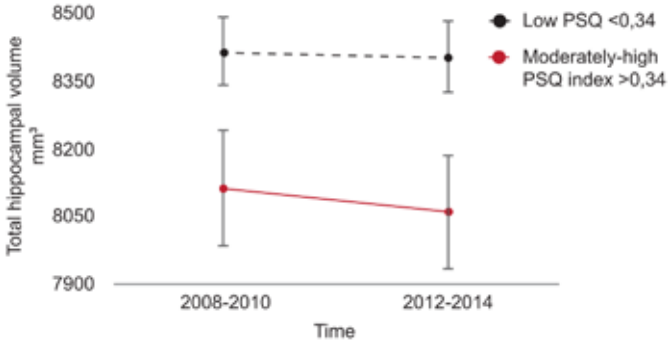


Figure 2. Total hippocampal volume change over a five-year period. The moderately-high perceived stress group had significantly smaller total hippocampal volume compared with the low perceived stress group. There were no significant changes in total hippocampal volume in either group after five years.

Effects of deep brain stimulation in essential tremor explored by fMRI

Essential tremor (ET), characterised by postural and action tremor, is the most common movement disorder. Several brain regions along the cerebello-thalamo-cortical network have been hypothesised to be involved in the generation of tremor oscillations, but the pathophysiology of ET remains poorly understood.

ET can be disabling to the grade of necessitating invasive Deep Brain Stimulation (DBS). DBS in the caudal zona incerta (cZi) is an established and effective treatment that has shown a considerable reduction in tremor for patients with otherwise medically intractable tremor. However, the mechanisms underlying the effects of DBS remain unclear.

At UFBI and in collaboration with the DBS-unit at the university hospital of northern Sweden, we conducted a study to investigate the effects of DBS in 16 patients with ET by using 1.5 T fMRI. During fMRI, the patients executed right-arm tremor-inducing postural holding movements as well as a baseline resting task. Tremor and hand movements were recorded by an MR-compatible single-axis accelerometer attached to the hand. The tasks were performed with the DBS stimulation turned on and off, with the initial stimulation setting (on/off) counterbalanced across patients.

Clear therapeutic effects of cZi-DBS, in terms of tremor reduction, were measured by the accelerometer. fMRI analysis showed effects of DBS in brain regions related to right-arm movement control: the contralateral motor cortex and ipsilateral cerebellum (figure 1 and 2). However, different parts of this network showed an effect of the DBS stimulation depending on what the patient was doing. Specifically two circuits within these areas demonstrated different responses to DBS. Neural activity, expressed as BOLD, in the primary sensorimotor cortex and lobule VIII in the cerebellum decreased when performing postural holding while DBS was turned on (blue). In contrast, neural activity in the supplementary motor area and lobule VI in the cerebellum increased during the resting condition when DBS was turned on (red).

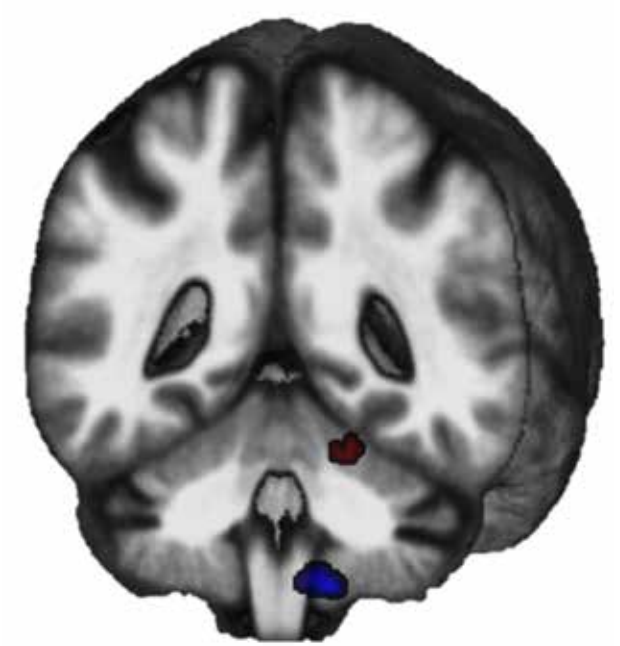


Illustration: Amar Awad

Figure 1: Effects of DBS on brain activity during tremor-inducing postural holding (blue) and during rest (red).

Our results support the notion of DBS acting upon modulation of the cerebello-thalamo-cortical loop in ET. Furthermore, the study shows the complexity of DBS mechanisms by demonstrating different DBS actions depending on the motor state of the patient and in brain areas distant to the stimulated target.

Amar Awad

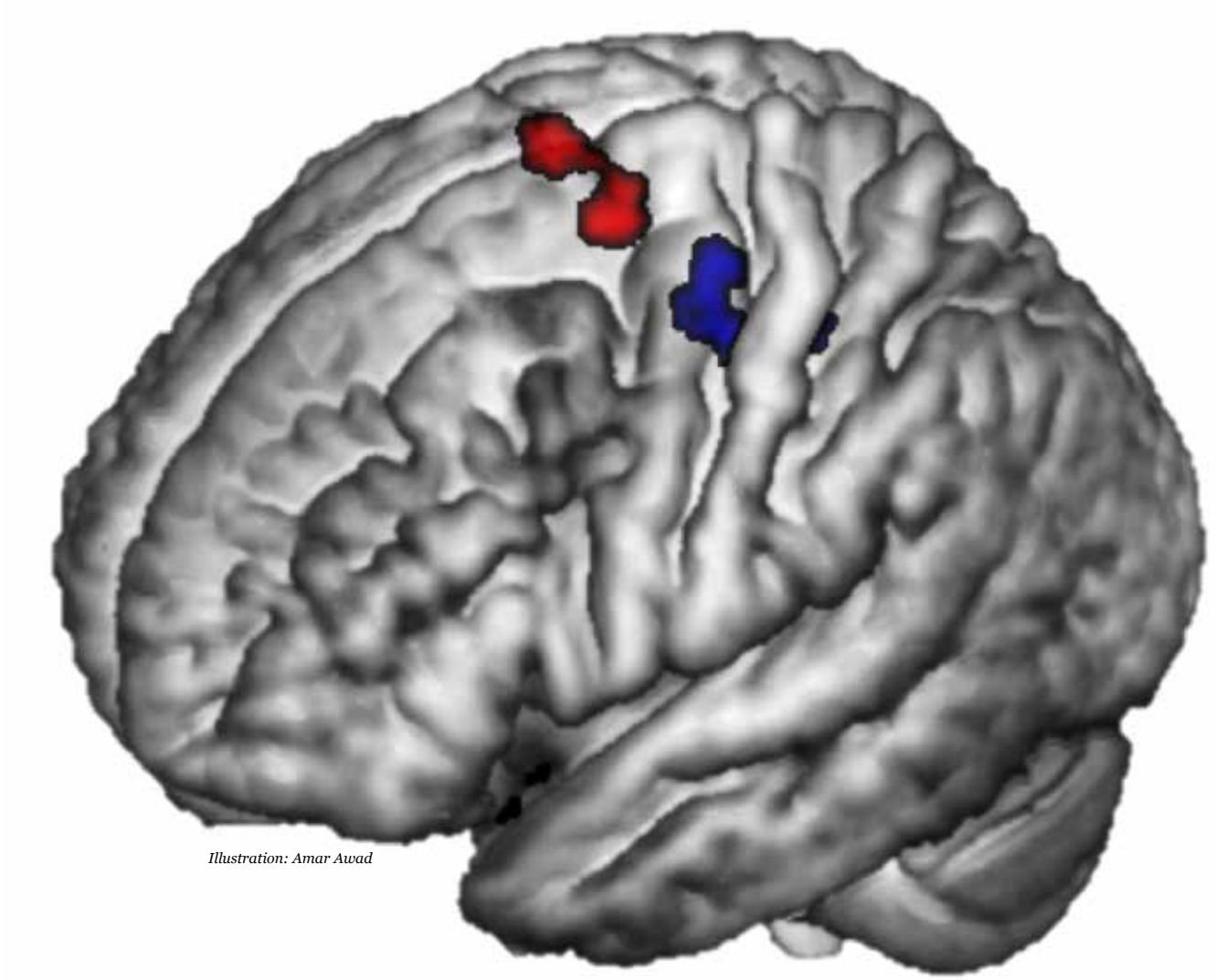


Illustration: Amar Awad

Figure 2: Effects of DBS on brain activity during tremor-inducing postural holding (blue) and during rest (red).

Zooming in

The socially anxious brain

In a collaboration between Umeå centre for functional brain imaging and researchers at Uppsala, Linköping and Stockholm university we focused on a common psychiatric disorder characterized by exaggerated fear of being scrutinized negatively by others, i.e., social anxiety disorder (SAD). Our broad aim has been to explore treatment-induced functional and structural plasticity and the ability of using the brain to predict treatment outcome.

In our first attempt in 2011, we randomized 26 individuals with SAD to cognitive behaviour therapy (CBT) or attention-training control treatment. Twenty-six matched healthy controls were also recruited. Magnetic resonance imaging (MRI) on SAD individuals was performed before treatment, immediately after, and at one-year follow-up. Our functional imaging results showed that amygdala responsivity to self-referential criticism was elevated in individuals with SAD, as compared to controls, and the neural response was attenuated after CBT, relative to an attention control intervention. Structural data, specifically amygdala grey matter (GM) was also related to SAD showing that GM volume is positively correlated with symptoms of anticipatory speech anxiety. Following CBT, reduced symptoms were associated with decreased amygdala GM volume, which potentially mediated the relationship between functional response changes and decreased symptoms of social anxiety. Reduction of amygdala GM volume was evident both at short- and long-term follow-up, which was in contrast to amygdala functional response, which was not reduced at one-year follow-up. Beyond amygdala, we observed that pre-treatment neural response to self-referential criticism in the dorsal anterior cingulate cortex accurately predicted (>90%) the clinical response to CBT using support vector machine learning methods. Thus, we found support for structural and functional changes following effective psychological

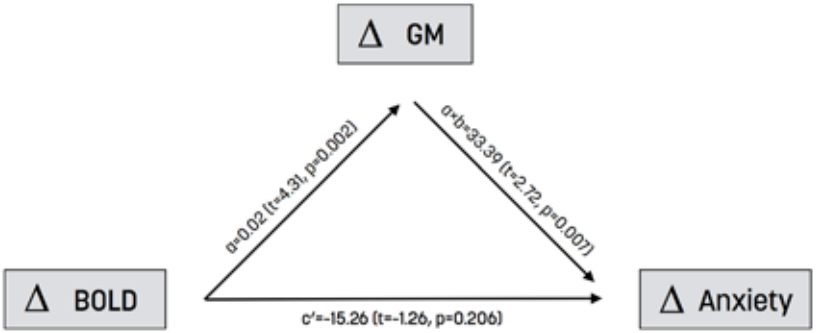


Figure 1. The mediation paths supported reduced gray matter volume as the mediator of the relation between diminished amygdala BOLD responsivity (predictor) and improved anticipatory speech anxiety after cognitive behavior therapy.

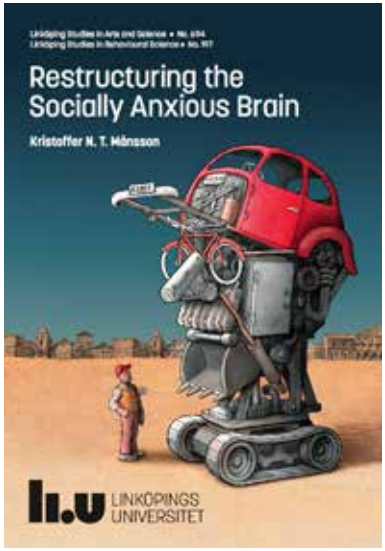


Illustration: Jan Lööf.

Figure 2. PhD-thesis entitled Restructuring the Socially Anxious Brain.

treatment, with a key region being the amygdala.

Our initial findings inspired us to continue with neuroimaging informed studied on SAD and in the VOX [latin: voice] study we recruited 51 SAD individuals and performed MRI at four time points during a period of 18 weeks. Also, 40 matched healthy controls underwent MRI at two times separated by nine weeks. We also collected blood samples at three occasions for SAD individuals and at two occasions for healthy controls. In this study we decided to undertake an alternative approach using multiple baselines, i.e., two baseline MRIs and blood samples before the treatment initiation (CBT for SAD). Using a multiple baseline design we will be able to adjust for effects of repeated testing, as well as time (i.e., test-retest and pre-post assessments are equally separated by 9 weeks). This study is a massive attempt to understand the neural underpinnings of SAD and treatment induced effects. In total we have performed 277 MRIs (including 2% drop-outs and 6% exclusion due to incidental findings) between November 2015 and January 2017.

With VOX, we attempt to draw casual inferences on how morphological and response changes may have different output on emotion and behaviour, and we wish to provide knowledge with the potential for clinical guidelines and the design of novel treatments.

We are looking forward to a busy 2017 starting with quality control and data-analysis. We are sure that in several years to come, our material will have the potential to several strong international publications and conference appearances.

Kristoffer N T Månsson, PhD
Stockholm University
Karolinska Institutet

Non-consious working memory

As I am thinking back on the past few years that led up to my dissertation "The Neural Substrates of Non-conscious Working Memory" in September 2016, I am leaning back in my office chair, glancing at the beautiful Portuguese sunset over Coimbra a warm afternoon in February – a significant contrast to Northern Sweden.

Although still controversial it has been interesting to see how the subfield non-conscious working memory has grown from being practically non-existent to having several related publications from different labs during these past few years.

I was fortunate enough to be able to start my investigations into non-conscious memory as an undergraduate student in 2011 at UFBI, which I later continued as a PhD student. Back then non-conscious memory was still considered synonymous with masked priming and an extremely fleeting phenomenon that was unmeasurable after a few hundred milliseconds. At the time most theories of conscious experience as well as models of working memory postulated that only consciously experienced information could be maintained in working memory.

However, in the first study we reported three modified attentional-blink experiments that showed that visual letters presented non-consciously nonetheless could be retained and affect behavior up to 15 seconds after presentation, showing that non-conscious memory retention can be far from fleeting. The third experiment was conducted in a functional magnetic resonance imaging (fMRI) scanner, and showed that the non-conscious memory retention was associated with an increase in blood flow (BOLD signal change) in the right prefrontal cortex, a hallmark of working memory maintenance. These were interesting findings that contradicted what was previously thought about non-conscious memory. Around this time there were also

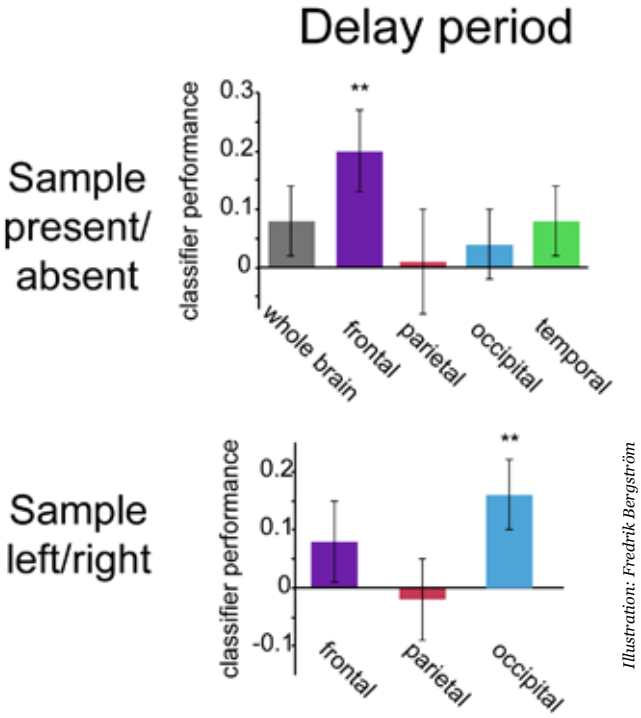


Illustration: Fredrik Bergström

Figure 1. Multivariate classification results. The figure shows classification performance for the different brain regions during the delay period. The top bar chart shows classification performance for presence vs. absence, and the bottom bar chart for spatial position (left vs. right visual field), of the non-conscious memoranda.
** indicates a p-value of < .001.

other publications claiming to have found evidence for non-conscious working memory from David Soto's lab.

In the second study we tried to replicate our previous findings using a new paradigm (continuous flash suppression) and new stimuli material (faces and tools) in two behavioral experiments. We also wanted to determine what kind of non-conscious information that was being retained (object identity and/or spatial

position). We found that non-consciously presented faces and tools were retained for several seconds, and that it was the conjunction of object identity and its spatial position that was being retained for prospective use. Around this time the idea of non-conscious working memory had gathered enough attention to be the topic of a symposia talk at the annual meeting of the Association for the Scientific Study of Consciousness in 2015.

In the third study we used the paradigm from the second study in the fMRI scanner to replicate and extend the neural findings of the first study. Interestingly, the behavioral performance was at chance in the scanner, despite being above chance for the same participants prior to the scanner session. However, with multivoxel pattern classification it was, during the retention period, possible to decode the presence from the absence of non-consciously presented tools using voxels in the frontal lobe, and the spatial position (left from right visual field) using voxels in the occipital lobe. These findings are consistent with working memory, and suggest that the memoranda was maintained as active neural representations (as measured by fMRI). The fact that we were able to decode neural patterns of non-conscious memory representations despite behavioral performance being at chance strengthens the claim that the findings are indeed non-conscious. Most other studies have so far only relied on subjective reports, which can be more unreliable, to determine whether or not the memoranda were consciously experienced. Now there is also a paper from Stanislas Dehaene's lab using classification on magnetoencephalography (MEG) data that also shows maintenance mechanisms of non-consciously presented information, consistent with the studies from UFBI and Soto's lab.

Taken together, these studies suggest that non-consciously presented information can be maintained in working memory by sustained neural activity, and therefore imply that conscious experience is not necessary for working memory.

Figure 2. Fredrik Bergström (to the left) defending his dissertation ("Non-Conscious Working Memory") against the opponent Professor René Marois (to the right) from Vanderbilt University in Nashville, USA.

Since my PhD defense I have moved on to my next adventure as a postdoctoral researcher at the Perception and Recognition of Objects and Actions (PROACTION) Lab, at the University of Coimbra in Portugal. Here I will primarily be using fMRI (but also tDCS) to investigate how information is organized in the cortex, while helping to build up the relatively young lab for (at least) the next three years. More specifically, I will be investigating the functional properties related to object (mainly tool) and action recognition, and how different dimensions of object/action properties are organized in the dorsal and ventral visual streams. Hopefully, there will also be room to apply for funding and start to investigate the neural correlates of conscious experience during this time as well. I will also be maintaining my connection with UFBI and non-conscious working memory to a lesser extent.

Fredrik Bergström

Meetings and seminars

UFBI was formally established in October 2001, but was preceded by initial work starting a few years before the end of the millennium. Back then, scanner access was limited to the Friday afternoon research slot on the 1.5T scanner.

In 2009, thanks to a grant from the Knut & Alice Wallenberg foundation, the current research-dedicated 3T scanner facility was opened. This made it possible to scan a considerably larger volume of participants, enabling the large, longitudinal studies that signify a big part of UFBI research. A year after, the PET-CT and cyclotron facilities were opened at the University hospital of Northern Sweden. The PET center was more recently complemented by a PET-MR, expanding the possibilities to perform cutting-edge brain imaging in Umeå even more. Now, 15 years, some 5500 fMRI scanning hours, and more than 110 research papers later, we took a moment to celebrate this development by arranging a two-day research symposium in mid-June of 2016. Turn-up was fantastic and 15 speakers from around the world accepted the invitation.

The symposium was organized around four topics central to UFBI research. The effects of age on brain and cognition have long been of central interest at UFBI, and in the first session of the symposium, entitled *A lifespan perspective on brain imaging and function*, Kristine Walhovd and Anders Fjell (Oslo), Linda Geerligs and Richard Henson (Cambridge), Trey Hedden (Harvard), and Roberto Cabeza (Duke), talked about their current research on brain and cognition throughout the lifespan.

In the second session, *Effects of cognitive and*






physical interventions on brain structure and function, Kirk Erickson (Pittsburg) and Heidi Johansen-Berg (Oxford) talked about how brain and cognition can change as a function of new experiences in life, and Jason Gallivan (Queen's University, Kingston) talked about action representations.

The third session was called *Complex cognition and the brain*. Gregory Ashby (UC Santa Barbara) talked about "automatic behavior" that he studies by combining mathematical modeling with functional brain imaging. Hauke Heekeren (Free University of Berlin) talked about how affect can influence decision-making, while Rafael Malach (Weizmann Institute) presented recent research on "dual modes" of brain function.

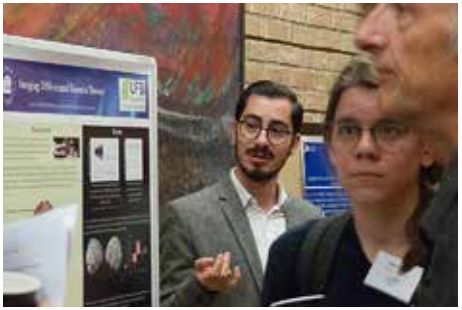
UFBI research hinges on high-quality brain imaging methods, and the last block of the symposium was centered on *Future Images*. Here, Emrah Düzel (University of Magdeburg and University College of London) talked about high-resolution hippocampal imaging, and Oliver Wieben (University of Wisconsin) and Matthias Van Osch (Leiden University) talked about state-of-the-art flow measures.

Throughout the symposium posters displayed some of the current UFBI research. This, combined with lunches and a dinner, provided opportunities for everyone to discuss research – at UFBI and in the world. The quality of the speakers was amazing and made the event highly inspirational and energizing. UFBI has made significant progress during the past 15 years, and we are looking forward to the adventures to come!

Johan Eriksson





Members

In the fall of 2016, Ann-Katrine Larsson retired after being with us from the start of UFBI. We thank her for her hard work and help with planning and collecting our MRI-data. Stepping in as section leader of fMRI at the university hospital is Rebeca de Peredo Axelsson.

Since 2011, Professor Martin Ingvar (KI) has provided UFBI valuable guidance as the chair of the board. We thank him greatly for the insightful input he has provided over the years! From late 2016 and onwards the UFBI board is chaired by Professor Katrine Riklund. Katrine has been a foundational part of UFBI since the inauguration and has extensive experience with organizational leadership. We predict a bright future under her watch!

Ann-Kathrine Larsson

Rebeca de Peredo Axelsson

Photo: Stefan Zimmerman

Martin Ingvar

Photo: Josefin Riklund

Katrine Riklund

Group Boraxbekk

Photo: Angelica Sandström

Name: Carl-Johan Boraxbekk
Discipline: Neuroscience
Research and work: I work as an Associate Professor (Docent) of Neuroscience at the Ageing and Living Conditions Programme (ALC). In my work I am examining how life style factors such as diet and physical exercise may help to preserve brain structure and function across the lifespan.

Name: Frida Bergman
Discipline: Medicine
Research and work: I am a physiotherapist and PhD student who is currently working within a project where we will investigate the effects on cognition, functional brain response and brain structure when decreasing sedentary time and increasing NEAT - that is, everyday exercise – at offices.

Name: Lars Jonasson
Discipline: Cognitive neuroscience
Research and work: I am a PhD student part of the PHIBRA project (Physical Influences on Brain in Aging). We use PET to investigate potential plasticity-induced changes to the brain's dopamine system and cognition following physical activity. This is particularly exciting as the system is associated with multiple aspects of cognition.

Name: Hanna Malmberg-Gavelin
Discipline: Cognitive neuroscience
Research and work: I am a PhD student in the RECO-project (Rehabilitation for Improved Cognition). My main focus concerns the impact of stress on cognition and treatment of cognitive impairments in patients with stress-related illness. The aim is to examine the possibilities of using computer-based cognitive training for improving cognitive functions.

Other people affiliated to group Boraxbekk:
Andreas Stomby (PhD), Peter Lundström (research assistant), Kristoffer Månsson (PhD student).

Group Eklund

Photo: Gudrun Furtenback

Name: Anders Eklund
Discipline: Biomedical engineering
Research and work: I am a professor of Biomedical engineering at Umeå University. My main areas of interest are physiological measurement techniques, with a focus on measuring, modeling and signal processing with applications in neuroscience and ophthalmology.

Photo: Gudrun Furtenback

Name: Anders Wåhlin
Discipline: MR-Physicist
Research and work: I completed my PhD in 2012 at Department of Radiation Sciences, Umeå University, where I specialized in MR based measurements of cerebral blood flow and cerebrospinal fluid dynamics. My post-doc research, funded by the Swedish Brain Foundation, investigates cerebral blood flow in stroke and aging.

Other people affiliated to group Eklund:
Khalid Ambarki (PhD), Jan Malm (professor), Tora Dunås (PhD student), Laleh Zarrinkoob (PhD student).

Group Eriksson

Name: Johan Eriksson
Discipline: Cognitive Neuroscience
Research and work: I am a researcher and scientific coordinator at UFBI and use fMRI to study the neural correlates of consciousness, several forms of memory and other cognitive functions, and to perform preoperative mapping of brain functions.

Name: Amar Awad
Discipline: Clinical Neuroscience
Research and work: I am a medical doctor and a PhD student. My interests revolve around clinically oriented brain imaging research such as exploring the mechanisms of deep brain stimulation in treatment of essential tremor, residual sensory function following spinal cord injury and the clinical impact of white matter hyperintensities.

Name: Fredrik Bergström
Discipline: Cognitive Neuroscience
Research and work: I am a PhD student that uses fMRI to study the neural correlates of consciousness. I am particularly interested in the role of attention and memory for consciousness, and is currently investigating the possibility of working memory without conscious experience and its potential limitations.

Other people affiliated to group Eriksson: Urban Ekman (PhD), Matilda Naesström (PhD student).

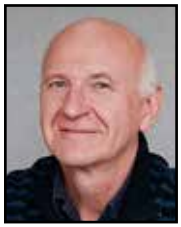
Group Karlsson Wirebring

Name: Linnea Karlsson Wirebring
Discipline: Psychology/Cognitive Science
Research and work: I'm a senior lecturer in Neuropsychology and my research focuses on i) the cognitive neuroscience of human judgment, where I relate cognitive models to fMRI data and ii) educational neuroscience, where I'm interested in the testing effect and mathematical learning.

Name: Linus Andersson
Discipline: Psychology/Cognitive Science
Research and work: I am currently working as a researcher in a project on decision making. It seems like we humans only occasionally follow statistical or logical rules when making judgments. Under what conditions, if any, do we actually behave like the rational beings we think we are? I am peering into the brain using fMRI to find out.

Name: Sara Stillesjö
Discipline: Cognitive neuroscience
Research and work: I am a PhD student studying the neural correlates of judgment and decision making. My main focus is to investigate how people make inferences, and the neural processes related to it. The main methods are fMRI and cognitive modeling. I am also interested in research on learning and memory.

Group Johansson



Name: Roland Johansson
Discipline: Sensorimotor control in humans
Research and work: I am a professor of physiology working with analysis of neural mechanisms supporting planning and control of dexterous object manipulation with emphasis on sensory, mnemonic and predictive mechanisms. I am also a member of the Swedish Royal Academy of Sciences.

Name: Per Nordmark
Discipline: Physiology
Research and work: I am a PhD student and hand surgery resident. My research focuses on functional and structural changes in the central nervous system in persons that have suffered peripheral nerve injury to their upper limb.

Name: Andrew Pruszynski
Discipline: Neurophysiology
Research and work: I completed my PhD in 2011 at Queen's University in Canada where I studied the fast feedback mechanisms that underlie successful motor behavior. My current research, funded by the Swedish Research Council and the Human Frontier Science Program, investigates information processing in human tactile afferent neurons.

Other people affiliated to group Johansson:
Carola Hjältén (project assistant), Anders Bäckström (engineer), Per Utsi (research engineer).

Group Nyberg

Name: Lars Nyberg
Discipline: Cognitive neuroscience
Research and work: I am a professor of Neuroscience and the Director of UFBI. PI for work on cognitive training and imaging within the longitudinal Betula project. I am a member of the Swedish Royal Academy of Sciences. In 2007 I received the Göran Gustafsson award in medicine, and in 2009 I became a Wallenberg scholar.

Name: Nina Karalija
Discipline: Neuroscience
Research and work: I am a postdoc at the Department of Radiation Sciences. The focus of my research is the study of brain structure and function that could be responsible for cognitive decline in the healthy elderly population. My project revolves around investigating changes in the dopamine system by measuring dopamine receptor availability using PET.

Name: Lenita Lindgren
Discipline: Nursing
Research and work: I am a PhD at the Department of nursing. The focus of my research is the study of brain structures and function that are involved in stress and stress inhibition.

Name: Anders Lundquist
Discipline: Statistics
Research and work: I am Senior Lecturer at the Statistics department, my time is split roughly equal between the Stats department and UFBI. My methodological research mainly deals with longitudinal imaging studies with nonrandom dropout, which applies to e.g. the BETULA and COBRA studies. I also do applied research with UFBI researchers

Name: Sara Pudas
Discipline: Cognitive Neuroscience
Research and work: I am a research fellow at the Department of Integrative Medical Biology. My main research interests involve cognitive and brain aging, as well as their lifespan determinants. I currently investigate whether childhood cognitive ability and lifestyle factors interact to determine neurocognitive aging outcomes.

Name: Anna Rieckmann
Discipline: Cognitive Neuroscience
Research and work: I am assistant professor (FOASS) at the Departments of Radiation Sciences and IMB. I study the neurobiological basis of executive functions using a novel multi-modal brain imaging approach that combines PET and fMRI. In 2016, I was awarded an ERC Starting Grant and a VR Young Investigator Award.

Name: Alireza Salami
Discipline: Computational neuroscience
Research and work: I completed my PhD in computational neuroscience in 2012 at Umeå University where I implemented various multivariate and multimodal techniques for analysis of different imaging modalities. I am now a joint postdoctoral researcher at (UFBI) and at Aging Research Center (ARC).

Name: Carola Wiklund-Hörnqvist
Discipline: Psychology
Research and work: I am a PhD investigating how different learning methods are related to successful learning. My main focus is to identify the cognitive processes, particularly memory processes, related to pedagogical methods including elements of testing. The effects will be examined using brain imaging and behavioral data.

Other people affiliated to group Nyberg: Tetiana Gorbach (PhD student), Karolina Kauppi (Post-doc).

Group Riklund

Photo: Josefin Riklund

Name: Katrine Riklund
Discipline: Radiology and nuclear medicine
Research and work: I am a professor/ consultant doctor who works with movement disorders (parkinsonian diseases), imaging of dopamine function, dementia, imaging of brain function, and PET/CT - oncologic applications.

Photo: VLL

Name: Jan Axelsson
Position: PET physics and image analysis
Research and work: I am working with the COBRA and the PHIBRA projects as the PET expert. This involves data acquisition, pharmacokinetic modeling, methodological questions and method development. I have been working with PET physics since 2003.

Other people affiliated to group Riklund:
Kajsa Burström (research nurse), Mats Eriksson (research nurse), Susanna Jakobson Mo (senior lecturer/consultant physician).

MR staff and other UFBI members

Name: Micael Andersson
Discipline: Research engineer
Research and work: I am a diploma engineer and have been working with fMRI since 2004. I make the in-house program DataZ, which is a Matlab-based add-on for the analysis software SPM and is used for batching the analysis and visualizing results. I am also performing the fMRI-analysis for several of the research projects.

Name: Kerstin Englund
Position: X-ray technician/nurse
Assignments: I have been working with MR since 2000. When the new MR-scanner was installed in November 2009, I got the opportunity to start working part time with fMRI. My other workplace is the Interventional Neuroradiology lab at Norrlands University Hospital.

Name: Peter Hägglund
Position: Master of Science in Engineering
Assignments: I am involved in the service and technical support of the MRI scanners at Umeå University and Norrlands University Hospital.

Name: Hans-Olov Karlsson
Position: X-ray technician/nurse
Assignments: I worked with MR between 1993-98, and since 2003 onwards. I then started working part time with fMRI in the autumn of 2009 when the new MR scanner was installed at Umeå University Hospital. When I am not at MR, I work at the Interventional Neuroradiology lab.

Name: Ann-Kathrine Larsson
Position: X-ray technician/nurse
Assignments: I have been working with MR since 1990, and started working with fMRI in 1999. I am currently a research nurse, running logistics for the different studies including method development, creating protocols and making sure that the contacts between the different parts involved in the project are working.

Name: Greger Orädd
Discipline: Physics
Assignments: I have been working as an MR physicist since 2009. On the 3T scanner I take care of quality control and general questions regarding MR physics, including improving protocols and procedures for MRI data collection. I am also involved in the national 7T facility in Lund.

Name: Rebeca de Peredo Axelsson
Position: X-ray technician/nurse, section-leader of fMRI.
Assignments: I have worked with MR since 2009. Between the years 2011 and 2013 I was the section-leader of MR in Lycksele. Since 2016 I have had the opportunity to work as section leader of fMRI here in Umeå.

Name: Matthias Schenkel
Position: Master of Science in Engineering
Assignments: I am involved in the service and technical support of the MRI scanners at Umeå University and Norrlands University Hospital.

Name: Mikael Stiernstedt
Position: Research engineer
Assignments: I am the lab coordinator for UFBI which includes collecting data for different projects, producing the annual reports, handling the UFBI webpage, and other general matters in the lab. I am also involved in the Betula project where I, among other things, are working on the database.

Publications

The list below is focused on journal articles, book chapters, doctoral theses and conference proceedings that were based on structural/ functional MRI data and/or PET data collected within UFBI.

Original articles

Adams, H., ..., Nyberg, L., ..., Thompson, P. (2016) Novel genetic loci underlying human intracranial volume identified through genome-wide association. Nature Neuroscience, 19, 1569-1582.

Boraxbekk, C.-J., Hagkvist, F., & Lindner, P. (2016). Motor and mental training in older people: Transfer, interference, and associated functional neural responses. Neuropsychologia, 89, 371-377.

Boraxbekk, CJ., Salami, A., Wåhlin, A., & Nyberg, L. (2016). Physical activity over a decade modifies age-related decline in perfusion, gray matter volume, and functional connectivity of the posterior default-mode network-A multimodal approach. Neuroimage, 131, 133-41.

Dunås, T., Wåhlin, A., Ambarki, K., Zarrinkoob, L., Birgander, R., Malm, J. & Eklund, A. (2016). Automatic labeling of cerebral arteries in magnetic resonance angiography. MAGMA, 29, 39–47.

Eklund, A., Jóhannesson, G., Johansson, E., Holmlund, P., Qvarlander, S., Ambarki, K., Wåhlin, A., Koskinen, L.-O. D. & Malm, J. (2016). The pressure difference between eye and brain changes with posture. Ann Neurol., 80, 269–276.

Giddaluru, S., Espeseth, T., Salami, A., Westlye, L. T., Lundquist, A., Christoforou, A., Cichon, S., Adolfsson, R., Steen, V., Reinvang, I., Nilsson, L.-G., Le Hellard, S., & Nyberg, L. (2016). Genetics of structural connectivity and information processing in the brain. Brain Structure and Function, 221(9), 4643-4661.

Hedlund, M., Lindström, B., Sojka, P., Lundström, R., & Boraxbekk, C.-J. (2016). Is better preservation of eccentric strength after stroke due to altered pre-frontal function? Neurocase, 22(2), 229-242.

Ikram, M. A., ..., Nyberg, L., ..., Huentelman, M. (2016) Novel genetic loci associated with hippocampal volume. Nature Communications, 8.

Lindgren, L., Bergdahl, J., & Nyberg, L. (2016). Longitudinal Evidence for Smaller Hippocampus Volume as a Vulnerability Factor for Perceived Stress. Cerebral Cortex, 26(8), 3527–3533.

Månsson, K.N.T., Salami, A., Frick, A., Carlbring, P., Andersson, G., Furmark, T., & Boraxbekk, C.J. (2016). Neuroplasticity in response to cognitive behavior therapy for social anxiety disorder, Translational Psychiatry, 6.

Nyberg, L., Karalija, N., Salami, A., Andersson, M., Wåhlin, A., Kabovaand, N., Köhncke, Y., Axelsson, J., Rieckmann, A., Papenberg, G., Garrett, DD., Riklund, K., Lövdén, M., Lindenberger, U., & Bäckman, L. (2016). Dopamine D2 receptor availability is linked to hippocampal-caudate functional connectivity and episodic memory. Proceedings of the National Academy of Sciences, USA, 113, 7918-23.

Qvarlander, S., Ambarki, K., Wahlin, A., Jacobsson, J., Birgander, R., Malm, J. & Eklund, A. (2016). Cerebrospinal fluid and blood flow patterns in idiopathic normal pressure hydrocephalus. Acta Neurologica Scandinavica.

Salami, A., Wåhlin, A., Kaboodvand, N., Lundquist, A., & Nyberg, L. (2016). Longitudinal evidence for dissociation of anterior and posterior MTL resting-state connectivity in aging: Links to perfusion and memory. Cerebral Cortex, 26(10), 3953-3963.

Stomby, A., Boraxbekk, CJ., Lundquist, A., Nordin Adolfsson, A., Nilsson, LG., Adolfsson, R., Nyberg, L. and Olsson, T. (2016). Higher diurnal salivary cortisol levels are related to smaller prefrontal cortex surface area in elderly men and women. European Journal of endocrinology, 175, 117-126.

Zarrinkoob, L., Ambarki, K., Wåhlin, A., Birgander, R., Carlberg, B., Eklund, A. & Malm, J. (2016). Aging alters the dampening of pulsatile blood flow in cerebral arteries. J. Cereb. Blood Flow Metab., 36(9).

Review articles / Book chapters

van den Broek, G., Takashima, A., Wiklund-Hörnqvist, C., Wirebring, L. K., Segers, E., Verhoeven, L., & Nyberg, L. (2016). Neurocognitive mechanisms of the “testing effect”: A review. Trends in Neuroscience and Education, 5(2), 52-66.

Nyberg, L. & Eriksson, J. (2016). Working memory: Maintenance, updating, and the realization of intentions. In Mayford, M., Dudai, Y., & Kandel, E. (Eds.) Learning and memory. Cold Spring Harbor Press.

Dissertations

Bergström, F. (2016). The neural substrates of non-conscious working memory. Doctoral dissertation, Umeå University.

Månsson, K. (2016). Restructuring the socially anxious brain. Doctoral dissertation, Linköping University. [*contains data from UFBI*].

Conference proceedings

Andersson, L., Claeson, A-S., Sandberg, P., 2016. Highlighting the large variation in perceived properties of odors over time. Poster presented at the XXVIth Annual Meeting of the European Chemoreception Research Organization, Athens, Greece.

Jonasson, L. S., Riklund, K., Kramer, A. F., Nyberg, L., Boraxbekk, CJ. (2016). Dopamine D2 receptors are related to physical fitness and exercise: Evidence from an exercise intervention on older adults. Society for Neuroscience, San Diego, USA.

Malmberg-Gavelin, H., Stigsdotter-Neely, A., Stenlund, T., Slunga-Järvholm, L., Boraxbekk, CJ. (2016). Effects of a process-based cognitive training intervention for patients with stress-related exhaustion – an fMRI study. Cognitive Neuroscience Society, New York.

Stomby, A., Boraxbekk, CJ., Otten, J., Ryberg, M., Nyberg, L., & Olsson, T. (2016). Increased hippocampal activity after a lifestyle intervention in Type 2 diabetes – Brain derived neurotrophic factor as a potential mediator. Endocrine Society's 98th annual meeting, Boston.

Awad, A. (2016, October). Functional Brain Imaging of DBS-treated Essential tremor. Poster presented at XXII Congress of the European Society for Stereotactic and functional neurosurgery (ESSFN), Madrid, Spain.

Flodin, P. (2016, September). Influences of physical exercise on resting-state brain activity - an intervention study among healthy, older adults. Poster presented at 5th Biennial conference on resting state and brain connectivity, Vienna, Austria.

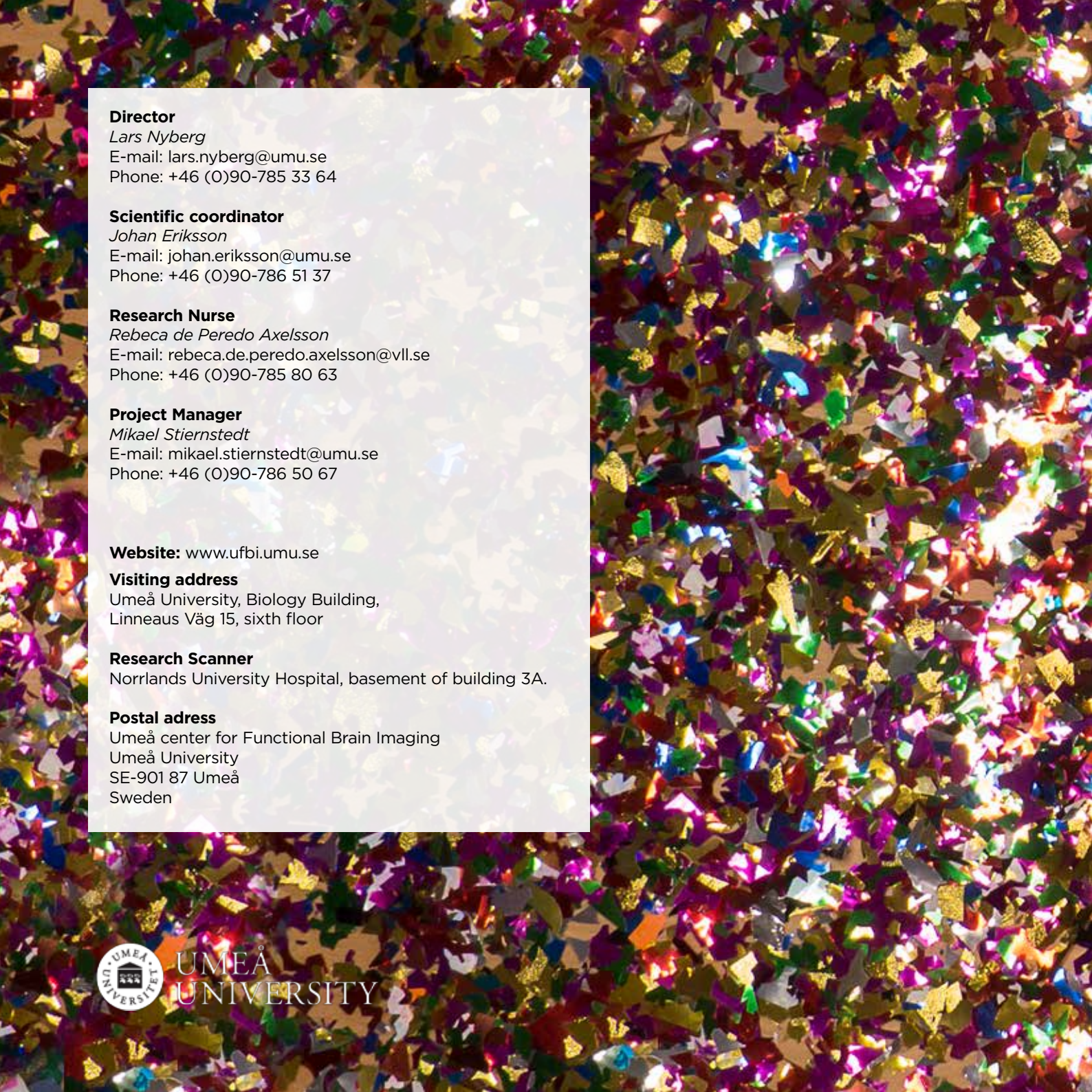
Kaboodvand, N., Salami, A., Bäckman, L., Nyberg, L. (2016, September). Intrinsic Functional Connectivity between Hippocampus and Retrosplenial Cortex: Links to Episodic Memory and Striatal Dopamine D2 Receptor Density. Poster presented by Alireza Salami at 5th Biennial conference on resting state and brain connectivity, Vienna, Austria.

Karalija, N. (2016, September). Dopamine D2-receptors and striatal-hippocampal interactions predict episodic memory performance in older adults. Poster presented at Dopamine 2016, Vienna, Austria.

Pereira, B., Bäckman, L., Nyberg, L., Salami, A. (2016, September). Age-related differences in dynamic functional connectivity between task-positive networks and the default mode network during rest and an interference task. Poster presented by Alireza Salami at 5th Biennial conference on resting state and brain connectivity, Vienna, Austria.

Nyberg, L. (2016, March 17). Multimodal brain imaging of memory functioning in adulthood and aging. Keynote address presented at Joint meeting of the British neuropsychological society with société de neuropsychologie de langue française, Clinical Neurosciences Centre, London, England.

Nyberg, L. (2016, March 2). Introduction to resting state fMRI and functional connectomics. Talk presented at ECR 2016 European Society of Radiology, Vienna, Austria.



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