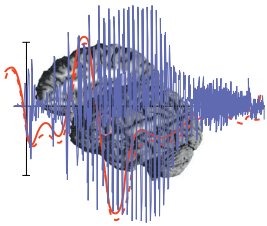

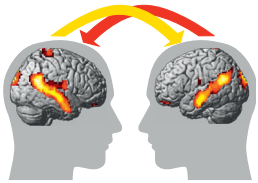

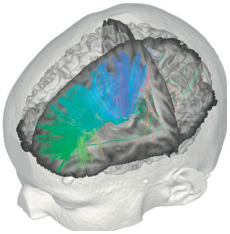

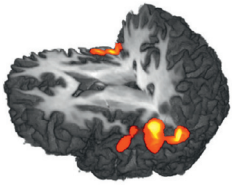

8th IMPRS NeuroCom Summer School

NeuroCom

26–28 June 2018
Leipzig, Germany

MAX PLANCK INSTITUTE FOR HUMAN COGNITIVE AND BRAIN SCIENCES LEIPZIG

UNIVERSITÄT LEIPZIG

UCL

Max Planck Institute for Evolutionary Anthropology

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on Neuroscience of Communication:
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Venue

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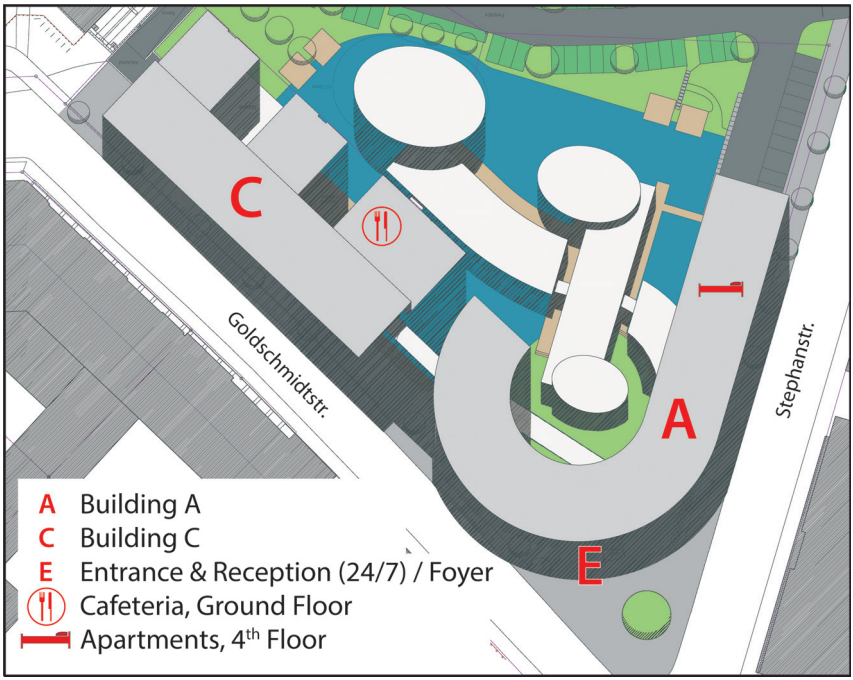
Stephanstr. 1A
04103 Leipzig

Location Finder

Registration	Foyer, Building **A**, **E**ntrance & Reception
Lectures	Lecture Hall, Building **C**, 1st and 2nd Floor
Poster Sessions	Foyer, Building **A**, Ground Floor
Coffee Breaks	Area in front of Lecture Hall, Building **C**, 1st / 2nd Floor
Lunch Breaks	Cafeteria, Building **C**, Ground Floor
Welcome Barbecue	Cafeteria, Building **C**, Ground Floor



Schedule

Tuesday, 26 June

8:30 – 9:15	Registration
9:15 – 9:30	Opening Remarks: **Arno Villringer**
Session I: *Tools and Techniques in Cognitive Neuroscience: Part I* Chair: Arno Villringer	
9:30 – 10:00	**Arno Villringer** *Dept. of Neurology,* Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany ***The role of different tools in cognitive neuroscience***
10:00 – 10:45	**Nikolaus Weiskopf** *Dept. of Neurophysics,* Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany ***Probing the functional and anatomical meso- and microstructure of the human brain with magnetic resonance imaging (MRI)***
10:45 – 11:15	Coffee Break
11:15 – 12:00	**Maria Angela Franceschini** Harvard Medical School, Massachusetts General Hospital, Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, USA ***NIRS: Recent advances and future prospects***
12:00 – 12:45	**Vadim Nikulin** *Dept. of Neurology,* Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany ***Neural oscillations in EEG / MEG research***
13:00 – 14:15	Lunch

Session I:	
Tools and Techniques in Cognitive Neuroscience: Part II Chair: Arno Villringer	
14:15 – 15:00	Alfred Anwander Dept. of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany *From DTI to the human connectome: Diffusion MRI in cognitive neuroscience*
15:00 – 15:45	Til Ole Bergmann Department of Neurology & Stroke, and Hertie Institute for Clinical Brain Research, University Hospital Tübingen, Eberhard Karls University of Tübingen, Tübingen, Germany *Transcranial brain stimulation and its combination with EEG/MEG*
15:45 – 16:15	Coffee Break
16:15 – 17:00	Moritz Grosse-Wentrup Max Planck Institute for Intelligent Systems, Tuebingen *Brain-Computer Interfacing: Moving from the lab into the wild*
17:00 – 17:15	Arno Villringer *Dept. of Neurology,* Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany *Conclusions*
17:30 – 18:45	Poster Session I
19:00 – 21:30	Welcome Barbecue

Wednesday, 27 June

Session II: *Social Interaction* Chair: Pascal Vrticka	
9:30 – 10:15	Giacomo Rizzolatti Istituto di Neuroscienze, Consiglio Nazionale delle Ricerche – CNR, Parma, Italy and Dipartimento di Neuroscienze, Università di Parma, Parma, Italy *The "mirror brain"*
10:15 – 11:00	Tobias Grossmann Department of Psychology, University of Virginia, USA *How to build a helpful baby: Neurodevelopmental precursors of altruistic behavior in infancy*
11:00 – 11:30	Coffee Break
11:30 – 12:15	Victoria Leong Department of Psychology, Cambridge, UK *Eye contact and social connectedness with infants*
12:15 – 13:00	Kristina Musholt Leipzig University, Leipzig, Germany *Varieties of understanding self and others*

13:00 – 14:15	Lunch
Session III: *Aging* Chair: Veronica Witte	
14:15 – 15:00	**Veronica Witte** *Dept. of Neurology,* Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany ***Impact of lifestyle factors on the aging brain***
15:00 – 15:45	**Joseph Castellano** Icahn School of Medicine at Mount Sinai, New York, USA Department of Neuroscience, Friedman Brain Institute Ronald M. Loeb Center for Alzheimer's disease ***Systemic aging as a model to study neurodegenerative diseases***
15:45 – 16:15	Coffee Break
16:15 – 17:30	**Poster Session II**
17:30 – 18:45	**Poster Session III**

Thursday, 28 June

Session IV: *Modeling the Mind* Chair: Thomas Knoesche	
9:30 – 10:15	**Roshan Cools** Radboud University, Nijmegen, NL ***Chemistry of the adaptive mind***
10:15 – 11:00	**Uri Hasson** Princeton University, Princeton, USA ***How the brain accumulates and communicates memories as life unfolds over time?***

11:00 – 11:30	Coffee Break
11:30 – 12:15	**Shinji Nishimoto** Center for Information and Neural Networks CiNet, National Institute of Information and Communications Technology, Osaka, Japan Graduate School of Medicine, and Graduate School of Frontier Biosciences, Osaka University ***Modeling internal representations in the brain***
12:15 – 13:30	Lunch
Session V: *Big Data and Neuroethics* Chair: Arno Villringer	
13:30 – 14:00	**Paul Matthews** FRCP, FMed Sci, Imperial College London, UK ***Ethical considerations in clinical imaging research***
14:00 – 14:30	**Philipp Kellmeyer** University of Freiburg, Germany ***Big Brain Data: Ethical, legal and social challenges from big data and advanced machine learning in neuroscience***
14:30 – 15:00	**Danilo Bzdok** Uniklinik RWTH Aachen, Aachen, Germany ***The advent of big data in neuroscience: Implications for science and society***
15:00 – 15:30	Panel Discussion
15:30 – 16:00	Coffee Break
16:00 – 16:30	Award of Poster Prizes, Poster Talks and Final Remarks

Lectures

Tools and Techniques in Cognitive Neuroscience

Tuesday, 26 June, 9:30 – 10:00

The role of different tools in cognitive neuroscience

Arno Villringer

Dept. of Neurology, MPI for Human Cognitive and Brain Sciences, Leipzig, Germany

In the last few decades a plenitude of new neuroimaging and neurostimulation methods have been developed to study the human brain non-invasively. While often researchers (have to) choose the method which "is most easily available to them", ideally, the most adequate method for the specific study question is employed. Obviously, the study setting is highly relevant, whether it is for example a clinical study, a large cohort study, or a study in children. For an optimal selection of a tool, it is furthermore crucial to know its (i) underlying neurophysiological, biochemical, and/or anatomical correlate, (ii) temporal and spatial resolution, its (iii) flexibility and mobility, and (iv) potential risks to exposed subjects. In this talk, I will categorize the various tools according to these features, provide some general "rules" from which selections can often be derived, and give some recommendations which simultaneous or sequential combinations of methods are useful.

Tuesday, 26 June, 10:00 – 10:45

Probing the functional and anatomical meso- and microstructure of the human brain with magnetic resonance imaging (MRI)

Nikolaus Weiskopf

Dept. of Neurophysics, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Understanding the normal and diseased human brain crucially depends on reliable knowledge of its anatomical microstructure and functional micro-organization.

Even small changes in this microstructure can cause debilitating diseases. To date, the microstructure can only be reliably determined using invasive methods, e.g., ex-vivo histology. This limits neuroscience, clinical research and diagnosis.
I will discuss how an interdisciplinary approach developing novel MRI acquisition methods, image processing methods and integrated biophysical models aims to achieve quantitative histological measures of brain tissue, leading to the emerging field of in vivo histology using MRI and fMRI of mesoscopic structures (e.g., cortical layers). In particular, I will present recent methodological advances in quantitative MRI and related biophysical modelling using the latest 7T and 3T high-gradient Connectom MRI platforms.
Examples will include the characterization of cortical myelination and its relation to function, and ultra high resolution fMRI of mesoscopic structures. I will also address some of the major challenges of this ambitious goal, such as the limited specificity of conventional MRI measurements and the lack of comprehensive reference data (e.g., from post-mortem histology).

Tuesday, 26 June, 11:15 – 12:00

NIRS: Recent advances and future prospects

Maria Angela Franceschini

Harvard Medical School, Massachusetts General Hospital, Boston, USA
Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, USA

Functional Near-Infrared Spectroscopy (fNIRS) is an established neuroimaging methodology which enables neuroscientists to study brain activity by non-invasively monitoring hemodynamic changes in the cerebral cortex. In the last decade, the use of fNIRS has increased significantly with the formation of a society (fnirs.org), with an exponential growth of users and publications, and with an increasing number of available commercial instruments. fNIRS generally uses continuous wave (CW) light sources at two or more wavelengths in the red and near-infrared to continuously record oxy- and deoxy-hemoglobin concentration (HbO and HbR) changes. Our and other groups have shown that by sending light with different features we can extract more information than just changes in absorbance and improve fNIRS capabilities. In particular, with diffuse correlation

spectroscopy (DCS), by using long coherence length light sources and detecting the speckle fluctuations generated by moving scatterers we can measure functional changes of cerebral blood flow (CBF). Moreover, by operating DCS in the time domain (TD-DCS) we can double the sensitivity to the brain, and, for the first time using non-invasive diffuse optical methods, we can achieve higher sensitivity to the brain than to superficial tissues. I will review these and other recent technological advances and summarize the application areas that are experiencing rapid growth as fNIRS begins to enable routine functional brain imaging.

Tuesday, 26 June, 12:00 – 12:45

Neural oscillations in EEG / MEG research

Vadim Nikulin

Dept. of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Neuronal oscillations are ubiquitous in the human brain being present both in cortical and subcortical structures. Moreover, oscillatory activity has been shown to be relevant for sensory, motor and cognitive brain operations. In this lecture we will provide a basic description of neuronal oscillations, their relevance for the understanding of behavior, evoked responses, neurological and psychiatric disorders. A particular emphasis will be placed on the investigation of neuronal oscillations with non-invasive techniques such as EEG and MEG. An integrative function of neuronal oscillations will be related to the neuronal interactions both within and across different frequency ranges. Temporal aspects of the oscillatory activity will be discussed in terms of critical dynamics. In addition, we will briefly outline main approaches for the extraction and analysis of neuronal oscillations.

Tuesday, 26 June, 14:15 – 15:00

From DTI to the human connectome: Diffusion MRI in cognitive neuroscience

Alfred Anwander

Dept. of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Diffusion MRI is used extensively to analyse the relation between white matter microstructure and cognitive function. It allows to image the local orientation of the white matter and to reconstruct the fibre pathways connecting the different parts of the brain. Those connections build the network in the brain which implements the cognitive functions. Additionally it gives a quantitative measure of white matter coherence which is extensively used to study brain development, plasticity and diseases.
After a short introduction into diffusion MRI, I will give an overview of the different methods to analyse diffusion MRI which were developed in the last years and show the main applications in cognitive neuroscience. I will focus on the main achievements of the method and show recent advances in the field. The presentation will also include the major challenges and limitations of the method.
The lecture will show what we can do with diffusion MRI, what we can expect from the method and how it influences neuroscientific research. It will conclude with future perspectives of diffusion MRI to study of the brain as a network, the connectome.

Tuesday, 26 June, 15:00 – 15:45

Transcranial brain stimulation and its combination with EEG/MEG

Til Ole Bergmann

Department of Neurology & Stroke, and Hertie Institute for Clinical Brain Research, University Hospital Tübingen, Eberhard Karls University of Tübingen, Tübingen, Germany

Electrophysiological recording methods, such as electro- and magnetoencephalography (EEG/MEG), serve well to study spontaneous or task-related neuronal

activity in humans. However, the information obtained with these techniques remains correlative. Transcranial magnetic stimulation (TMS) and transcranial direct/alternating current stimulation (TDCS/TACS) allow to non-invasively manipulate brain activity in humans and thereby reveal the causal contribution of specific brain networks and activity patterns for cognition. TMS and TCS can be combined with EEG and MEG, either concurrently (online) or consecutively (offline), to measure and manipulate brain activity. Online approaches, assessing the immediate neural response to stimulation, can be used to (i) quantify neuronal network properties such as excitation, inhibition, or connectivity, (ii) interfere with ongoing spontaneous or task-related activity and thus affect behavioral performance, or (iii) modulate the level and timing of neuronal activity, e.g., trying to mimic neuronal oscillations in behaviorally relevant manner. In contrast, offline approaches can be utilized to either (iv) inhibit or (v) facilitate local neuronal excitability via the induction of synaptic plasticity, assessing its subsequent effects on neuronal activity and behavior. In this talk I will cover the basics of TMS and TCS, give examples for their combination with EEG and MEG, and introduce the novel approach of brain state-dependent brain stimulation (BSDBS). BSDBS allows to trigger TMS/TCS in real-time by specific oscillatory states, providing a unique opportunity to causally interact with ongoing neuronal oscillations to study its role in information processing and synaptic plasticity.

Tuesday, 26 June, 16:15 – 17:00

Brain-Computer Interfacing: Moving from the lab into the wild

Moritz Grosse-Wentrup

Max Planck Institute for Intelligent Systems, Tuebingen, Germany

Research on brain-computer interfacing (BCI) has advanced to the point where severely paralyzed subjects can routinely communicate with their environment and control multi-dimensional end-effectors. Despite these tremendous advances, we do not yet see BCI systems deployed outside of well-controlled laboratory environments. In my lecture, I will present the current state-of-the-art in invasive and non-invasive BCI systems, and discuss open problems that need to be overcome to deploy BCI systems on a large scale. In particular, I will cover technologies for recording brain activity, machine learning tools to translate brain activity into control commands, user interfaces, and data privacy.

Social Interaction

Wednesday, 27 June, 9:30 – 10:15

The "mirror" brain

Giacomo Rizzolatti

Istituto di Neuroscienze, Consiglio Nazionale delle Ricerche – CNR, Parma, Italy and Dipartimento di Neuroscienze, Università di Parma, Parma, Italy

Mirror mechanism is a basic neural mechanism that transforms sensory representations of others' actions into motor representations of the same actions in the brain of the observer. In the first part of my talk I will describe the functions of the mirror mechanism located in the parieto-fontal network of monkeys and humans. I will show that this mechanism enables one to understand others in an immediate, phenomenological way, without recourse to cognitive inferential processing. In the second part of my talk I will discuss the role of the mirror mechanism in understanding basic Darwinian emotions. I will focus on disgust, fear and happiness and will demonstrate the role of the mirror mechanism in empathic experience of these emotions, contrasting it to their mere cognitive recognition. The data on emotions will lead me to the last part of my talk where I will present stereo-EEG data on action and emotion recognition. Stereo-EEG allows one to go beyond the static three-dimensional maps obtained with fMRI providing a four dimensional picture (space plus time) of brain activations during different types of actions.

Wednesday, 27 June, 10:15 – 11:00

How to build a helpful baby: Neurodevelopmental precursors of altruistic behavior in infancy

Tobias Grossmann

Department of Psychology, University of Virginia, USA

One of the most enduring puzzles in biology and psychology is why humans engage in acts of altruism towards genetically unrelated individuals. I will ar-

gue in this talk that other-oriented emotional processes play an important role in guiding altruistic behavior from early in ontogeny. In particular, the ability to show concern for others in need and distress is a vital building block for altruistic tendencies among humans. I will first present recent research supporting the view that infants genuinely care about others in need and distress. Importantly, I will also show evidence for a caring continuum, which underpins variability in infant prosocial action. Specifically, I will present results from a longitudinal study in which we demonstrate that differences in attentional and brain responses to viewing others in distress (fearful faces) at 7 months predict altruistic behavior at 14 months of age. This research sheds light on the ontogenetic roots of altruism and attests to infants' affective competency in engaging prosocially.

Wednesday, 27 June, 11:30 – 12:15

Eye contact and social connectedness with infants

Victoria Leong

Department of Psychology, Cambridge, UK

Eye contact is one of the earliest and most powerful communicative signals within the social repertoire of human infants. Well before language is acquired as a communicative tool, infants already eloquently exchange eye gaze signals with adults in a temporally-contingent and meaningful manner. This early synchronisation of gaze patterns (through joint attention and gaze-following) creates social connectedness within parent-infant dyads, which is strategic for early survival. It is perhaps unsurprising then, that even from birth, neonates already prioritise the neural processing of eye gaze cues from adult partners. In fact, it is now known that infants can seek and create their own earliest social networks, using gaze to flag their own, and others' attentional status. But what exactly happens when infants "go online" to engage with adult partners - and why is this state of social connectedness important? In this talk, I will demonstrate how dyadic EEG can be used to peer into the neuro-social network of infants, where connections occur not just within brains, but also between brains. Observed through this intimate social lens, eye contact between partners is found to trigger powerful bursts of dyadic neural coupling – an effect that is not evident when brain activity is assessed alone, without reference to the partner. Further, when adult and infant brains are locked in close temporal alignment, infants' own communicative ef-

forts are stimulated and released, and the stage is set for effective social learning. I will conclude by discussing the future potential offered by, and challenges inherent in, this deep merging of social and neuroscience methods into a new coherent science of interpersonal cognition.

Wednesday, 27 June, 12:15 – 13:00

Varieties of understanding self and others

Kristin Musholt

Leipzig University, Leipzig, Germany

It is often assumed that the ability to interact with others is based on the possession of a theory of mind, that is on the ability to ascribe mental states to them in order to predict and explain their behavior. In this talk I will first argue that this view is too simplistic and that there is a variety of ways of understanding and interacting with others, only some of which are based on the explicit ascription of mental states. Second, I will outline how, during ontogeny, these different ways of relating to others contribute to an emerging sense of self. I will aim to show that the development of self-consciousness is a gradual process that goes hand in hand with the development of an understanding of others, and that it is a process in which both children and adults actively participate. In particular, adults provide important forms of "social scaffolding" which are crucial for the development of self-consciousness (and thinking more generally).

Aging

Wednesday, 27 June, 14:15 – 15:00

Impact of lifestyle factors on the aging brain

Veronica Witte

Dept. of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

The trajectories of cognitive abilities across the adult lifespan differ from person to person and are most likely open to change dependent on internal and external factors. While common cardiovascular risk factors such as obesity, hypertension and smoking have been linked to accelerated brain aging, healthy lifestyle habits such as physical exercise and a healthy diet might exert protective effects. However, the underlying mechanisms of how modifiable factors impact human brain structure and function are far from understood. In my talk I will discuss recent findings, controversies and future perspectives.

Wednesday, 27 June, 15:00 – 15:45

Systemic aging as a model to study neurodegenerative diseases

Joseph Castellano

Icahn School of Medicine at Mount Sinai, New York, USA
Department of Neuroscience, Friedman Brain Institute
Ronald M. Loeb Center for Alzheimer's disease

Aging drives changes in neuronal and cognitive function, the decline of which is a major feature of Alzheimer's disease (AD). With the aged population accumulating in the coming decades and in light of numerous clinical trial failures, there is need for novel molecular targets to combat the scourge of this disease. An emerging avenue is to interrogate the molecular communication occurring between the systemic environment and the brain. Recent work by our group and others found that exposure to young blood counteracts aspects of age-related

decline, accelerating the search for molecular factors mediating cognitive "rejuvenation". We analyzed human umbilical cord plasma as a proteomic reservoir of youthful rejuvenating factors, which led to the identification of tissue inhibitor of metalloproteinases 2 (TIMP2) as a putative mediator. We found that TIMP2 is necessary for the hippocampus-dependent cognitive improvements conferred by cord plasma. TIMP2-expressing hilar neurons decline gradually with age, and paired with the observation that TIMP2 acting directly within the hippocampus is important for robust long-term potentiation (LTP), our data argue that blood-borne factors may play a role in directly shaping synaptic plasticity. This seminar will review tools and common molecular and functional markers associated with aging that we have found to be revitalized by exposure to systemic factors. Recent work on TIMP2 and its relationship to synaptic plasticity will be highlighted, and the present work will be placed in the context of current efforts to explore the role of TIMP2 and other blood-borne factors in AD pathology in pathways both dependent and independent of amyloid.

Modeling the Mind

Thursday, 28 June, 9:30 – 10:15

Chemistry of the adaptive mind

Roshan Cools

Radboud University, Nijmegen, NL

A failure to adapt to novel or changing environmental demands is a core feature of a wide variety of neuropsychiatric disorders as well as the normal states of stress and fatigue. I will review the neurochemistry of flexible cognitive control, which has been associated primarily with frontostriatal circuitry. Many drugs affect the functioning of this circuitry, but the direction and extent of drug effects vary across individuals and tasks. Apparently paradoxical effects are often observed, where the same medication causes both cognitive enhancement as well as cognitive side effects. I will present neurobiological research that is beginning to elucidate the nature of these contrasting effects and the factors underlying the large variability across individuals and behaviours. For example, I will illustrate

how we are starting to resolve the large variability in catecholaminergic drug effects by going beyond classic models of prefrontal cortex and building on recent advances that highlight a role for the catecholamines in the flexibility-stability tradeoff as well as value-based learning and decision making. The work has considerable implications for the understanding of and treatment development for abnormalities characterized by compulsivity such as Parkinson's disease and addiction.

Thursday, 28 June, 10:15 – 11:00

How the brain accumulates and communicates memories as life unfolds over time?

Uri Hasson

Princeton University, Princeton, USA

Cognition materializes in an interpersonal space. At present, little is known about the neural substrates that underlie our ability to communicate with other brains in naturalistic settings. In the talk I will introduce novel methodological and analytical tools for characterizing the neural responses during production and comprehension of complex real-life speech. By directly comparing the neural activity time courses during production and comprehension of the same narrative, we were able to identify areas in which the neural activity is correlated (coupled) across the speaker's and listener's brains during communication. Furthermore, the listener brain activity mirrors that of the speaker with a constant delay of three seconds. This neural coupling was eliminated when the communication signals were misaligned. Finally, the stronger the speaker-listener coupling the greater listener comprehension. I will demonstrate how the observed coupling of production and comprehension-based processes serves as a mechanism by which brains share information as well as episodic memories.

Thursday, 28 June, 11:30 – 12:15

Modeling internal representations in the brain

Shinji Nishimoto

Center for Information and Neural Networks CiNet, National Institute of Information and Communications Technology, Osaka, Japan
Graduate School of Medicine, and Graduate School of Frontier Biosciences, Osaka University

In our daily lives, our brains continually process diverse, complex, and dynamic sensory information to generate appropriate inferences regarding the world and ourselves. Elucidating how the brain works under such a complex flow of information is a fundamental goal of systems neuroscience. Toward this goal, we build quantitative models that explain the relationship between natural experiences and brain activity, measured using various techniques, including functional magnetic resonance imaging and single-cell recordings. By utilizing sufficiently high dimensional feature spaces that mediate brain activity and sensory information, we have built models that can be generalizable to arbitrary novel natural experiences. Such models can be used to reveal visual and semantic representations of the brain, to quantify how cognitive demands warp the representations, and to decode objective and subjective experiences from brain activity. In this lecture, I will introduce methodology and recent advancements in this field.

Big Data and Neuroethics

Thursday, 28 June, 13:30 – 14:00

Ethical considerations in clinical imaging research

Paul Matthews

FRCP, FMed Sci, Imperial College London, UK

The ethics of any big data human research project is based on recognition of morally relevant interests of participants and the society in which they and the

investigator live. They must balance a commitment to autonomy of participants (part of the broader expectation of respect for persons) and preserving any fundamental human rights with the pursuit of a "common good". Imaging is almost unique amongst clinical tests for its salience to participants. Best management of unexpected incidental findings on imaging examinations of people participating in research protocols outside of the context of their medical care demands involvement of all of those potentially involved – participants, radiographers and research colleagues and medical care-givers who address the problems posed by follow up investigations and any treatments. This will be discussed with support from data prospectively acquired in the UK Biobank Imaging Enhancement that sought to frame the relative benefits and risks of actively seeking to identify potential unexpected pathology for participants in the scanning protocol. This highlighted ways in which this balance is grounded in participant expectations and society's values as they are reflected in the medical system. It also suggests why the optimal balance differs between societies, research environments and over time.

Thursday, 28 June, 14:00 – 14:30

Big Brain Data: Ethical, legal and social challenges from big data and advanced machine learning in neuroscience

Philipp Kellmeyer

University of Freiburg, Germany

The technological convergence of big data and advanced machine learning, particularly artificial neural networks for 'deep learning', facilitates a number of potentially transformative applications in basic and clinical neuroscience. Yet, the collection of large amounts of biomedical data, particularly brain data, and the ability to extract highly personal information from these data, produces significant ethical, legal and social challenges. Apart from the question of data security and the legal and moral accountability of 'black-box' medical AI systems, the talk will also address the question of whether brain data should be considered as a special class of biomedical data and develop ideas on the effective regulation and governance of intelligent systems in basic and clinical neuroscience.

Thursday, 28 June, 14:30 – 15:00

The advent of big data in neuroscience: Implications for science and society

Danilo Bzdok

Uniklinik RWTH Aachen, Aachen, Germany

Neuroimaging datasets are constantly increasing in resolution, sample size, multi-modality, and meta-information complexity. This opens the brain imaging field to a more data-driven machine-learning regime (e.g., minibatch optimization, structured sparsity, deep learning), while analysis methods from the domain of classical statistics remain dominant (e.g., ANOVA, Pearson correlation, Student's t-test). Special interest may lie in the statistical learning of scalable generative models that explain brain function and structure. Instead of merely solving classification and regression tasks, they could explicitly capture properties of the data-generating neurobiological mechanisms. Python-implemented examples for such supervised and semisupervised machine-learning techniques will be provided as applications to the currently biggest neuroimaging dataset from the Human Connectome Project (HCP) data-collection initiative as well as the prospective epidemiological UK Biobank. The emphasis will be put on the feasability of deep neural networks and semisupervised architectures in imaging neuroscience. The successful extraction of structured knowledge from current and future large-scale neuroimaging datasets will be a critical prerequisite for our understanding of human brain organization in healthy populations and psychiatric/neurological disease, while raising new ethical concerns for our society.

Poster Presentations

Poster Session I

Tuesday, 26 June 17:30 – 18:45, Foyer MPI CBS

Poster Number	Speaker	Title
Neuroimaging Physics and Signal Processing		
I-01	Brammerloh, M.	Biophysical modelling of iron-induced MRI contrast in the brain
I-02	Devi, R.	Respiratory and cardiac noise removal from fMRI data: Evaluation of retrospective methods
I-03	Gast, R.	PyRates - A Python framework for rate-based neural simulations
I-04	Haenelt, D.	Mapping colour-selective columns in V2 across cortical depth using GE-EPI and SE-EPI
Brain Computer Interfaces, Big Data, and Statistics		
I-05	Hohmann, M.R.	A large platform for Big-Data neurophysiology
I-06	Jayaram, V.	MOABB: A platform for brain-computer interface meta-analyses
I-07	Scharf, F.	Principles behind variance missallocation in temporal exploratory factor analysis for ERP data: Insights from an inter-factor covariance decomposition
Language and Communication		
I-08	Adamson, H.	Structural brain changes associated with second language learning
I-09	Chien, P.J.	Neural networks for lexical tone and intonation in Mandarin Chinese
I-10	Just, A.C.	Paralinguistic use of prosody in Mandarin Chinese and German: Is intention transmission affected by tone?

Poster Number	Speaker	Title
I-11	Lutz, C.	Wor(l)ds apart – does the N400 reflect bilingual language distance and meaning in translation? An ERP study of the effects of L1-L2 distance and translation direction in German-English and Cantonese-English bilinguals.
Auditory Perception and Music		
I-12	Chien, S.-C.	Deviance detection: On and off responses, omission response, and mismatch negativity
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Neuroimaging Physics and Signal Processing

I-01

Biophysical modelling of iron-induced MRI contrast in the brain

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Pathologic iron accumulation in the human brain is a biomarker and a potential cause of several neurodegenerative diseases. In Parkinson's disease (PD), iron overload in dopaminergic preceeds neuron loss in substantia nigra. Also in Alzheimer's disease (AD) and Multiple Sclerosis (MS), iron is connected to the pathogenesis.

Magnetic Resonance Imaging (MRI) provides a promising method for non-invasive brain iron quantification in vivo. Accumulation of paramagnetic iron is revealed by changes in the transverse (R2) and effective transverse relaxation rates (R2*). A quantitative understanding of iron's effect on these MRI parameters could be used to develop early stage biomarkers for AD, PD and MS. However, thus far only simplified models have been used for iron quantification in vivo, disregarding the chemical form of iron and its microscopical distribution.

We developed a model of iron-induced R2* contrast in substantia nigra as a step toward diagnosing PD. This model predicts contributions of different chemical forms of iron and different cellular populations to R2 and R2*. It was informed by quantitative iron maps obtained with ion-beam microscopy and validated with MRI on post mortem samples of human brain tissue. It could be shown that the linear exponential part of static dephasing relaxation is a possible biomarker for iron in dopaminergic neurons. Furthermore, iron in different chemical forms contributed in different patterns to R2*, suggesting that prior models are an oversimplification.

A generalization of the developed model to further areas and pathologies as well as its translation to in vivo will be the next steps.

I-02

Respiratory and cardiac noise removal from fMRI data: Evaluation of retrospective methods

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Physiological signals of non-neuronal origin have been seen to hamper the identification of cognition related activity in blood oxygenation level dependent (BOLD)-contrast functional magnetic resonance imaging (fMRI) data. A gold standard method for the removal of such nuisance signals however doesn't yet exist; its identification mainly hindered by indirect nature of BOLD contrast fMRI. In the present work, an attempt has been made to identify such a standard by comparing the performance of three commonly used retrospective physiological noise correction methods: RETROICOR (Retrospective image based correction), aCOMPCOR (anatomical image- Component based noise correction) and PICA (Probabilistic independent component analysis) on simulated noisy data sets, degraded by the same amount of physiological noise (tCNR = 0.5). The t-statistic values of peak activated voxels and the number of significant voxels per cluster ($p < 0.001$) were used as the parameters for comparison, with the parameters obtained from the statistical analyses of noiseless datasets serving as the standard.
Noise correction methods of RETROICOR and aCOMPCOR, which involves modeling of physiological noise were found to perform better at the selected tCNR than PICA based noise classification, with RETROICOR performing the best in terms of the number of significant voxels detected per cluster.

I-03

PyRates - A Python framework for rate-based neural simulations

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In neuroscience, computational modeling has become an important source of insight into brain states and dynamics complementary to classic experiments. This is due to the potential to observe and manipulate variables in models that are difficult to assess in the living brain. Neural mass models (NMMs) are computationally efficient models for simulating large-scale brain dynamics as observable with neuroimaging techniques such as EEG/MEG or fMRI [1]. They model dynamic interactions between large, lumped populations of different cell types at the meso- and macroscopic scale. In this work, we present PyRates, a Python framework for building NMMs and simulating their dynamic behavior within a well defined mathematical structure. To ensure a highly customizable neural mass design, we provide both an differentio-differential approach for maximal computational efficiency and an integro-differential approach that allows for a flexible implementation of various neurobiological features. We show via numerical simulations how PyRates can replicate and extend established NMMs like the popular Jansen-Rit model [2], and build novel NMMs based on the same formal skeleton. Finally, we discuss the framework's interface to other neuroimaging and network analysis tools and conclude, that PyRates makes a substantial contribution to open and reproducible neuroscience by providing a unified, fully tested and well documented neural simulation framework.

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I-04

Mapping colour-selective columns in V2 across cortical depth using GE-EPI and SE-EPI

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Using ultra-high field fMRI makes in vivo examinations of columnar and laminar structures in the human cerebral cortex feasible. However, it is still under debate which acquisition technique is optimal for high-resolution fMRI. Typical acquisition protocols at lower field strengths use GE-EPI , which possesses high BOLD sensitivity but lacks specificity due to large draining veins. Because of the anisotropic macrovascular distribution in the cortex, the needed specificity towards microvascular contributions does also depend on whether columnar or laminar structures are of interest. Here, we compare single-shot 2D GE-EPI and SE-EPI at 7 T in their ability and specificity to delineate colour-selective stripes in extrastriate cortex V2. Participants performed multiple sessions at different days. In single sessions, stimuli consisted either of chromatic or achromatic sinusoidal moving gratings shown in different blocks. GE-EPI and SE-EPI were acquired on different days. V2 was defined based on retinotopy and layers were estimated according to the equi-volume approach. With both sequences, stripes can be reliably identified. The column width across cortical depth is used as a measure for tangential spread. The analysis shall shed light on the issue if GE-EPI is significantly affected in tangential blurring towards the pial surface by delineating cortical columns.

Brain Computer Interfaces, Big Data, and Statistics

I-05

A large platform for Big Data neurophysiology

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Neurophysiological research has come under scrutiny for being underpowered due to inadequate sample sizes. This limitation is particularly profound in research on rare neurological diseases like Amyotrophic Lateral Sclerosis, which only affects approx. 2 in 100.000 people in Europe. One reason for this limitation is the necessity to conduct studies in a controlled lab environment as the setup is complicated, expensive, and prone to environmental influences.

Our goal is to provide a platform that breaks with this limitation. By developing a smartphone application with a state-of-the-art user-interface and pairing it with a low-cost Electroencephalogram (EEG), we aim to enable patients to participate in controlled, neuroscientific experiments, from wherever they are, whenever they want.

In a pilot study, we evaluated the first prototype of our smartphone application with 30 subjects. We could show that subjects were able to self-administer the full experimental session by only following the instructions that the smartphone application provided. Subjects were able to repeatedly fit the EEG headset onto their heads by following feedback from a life signal-quality display. Lastly, data quality of the acquired EEG signals was sufficient to distinguish between the performed cognitive tasks in an offline analysis. Our results indicate that that careful application design with a focus on psychological factors that drive acceptance of new technology has the potential to make lab-technology accessible to everyone, and it may help to break with the existing limitations of neuroscientific research.

I-06

MOABB: A platform for brain-computer interface meta-analyses

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BCI algorithm development has long been ham-pered by two major issues: Small sample sets and a lack of reproducibility. We offer a solution to both of these problems via a software suite that streamlines both the issues of finding and pre-processing data in a reliable manner, as well as that of using a consistent interface for machine learning methods. By building on recent advances in software for signal analysis implemented in the MNE toolkit, and the unified framework for machine learning offered by the scikit-learn project, we offer a system that can improve BCI algorithm development. To validate this system, we analyze of a set of state-of-the-art decoding algorithms across 12 open access datasets, with over 250 subjects. Our analysis confirms that different datasets can result in very different results for identical processing pipelines, highlighting the need for trustworthy algorithm benchmarking in the field of BCIs, and further that many previously validated methods do not hold up when applied across different datasets, which has wide-reaching implications for practical BCIs.

I-07

Principles behind variance missallocation in temporal exploratory factor analysis for ERP data: Insights from an inter-factor covariance decomposition

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Temporal exploratory factor analysis (EFA) is commonly applied to ERP data sets to reduce their dimensionality and the ambiguity with respect to the underlying components. However, the risk of variance missallocation (i.e., the incorrect allocation of condition effects) has raised concerns with regard to EFA usage. Here, we show that variance misallocation occurs because of biased factor covariance estimates and the temporal overlap between the underlying components. For

example, a direct consequence of our expositions is that researchers should use oblique rather than orthogonal rotations. Furthermore, researchers should be aware of the implicit assumptions about factor time courses inherent in any factor rotation method. A Monte Carlo simulation confirms our results by showing, for instance, that characteristic biases occur only for orthogonal Varimax rotation but not for oblique rotation methods such as Geomin or Promax. We outline the practical implications of our results.

Language and Communication

I-08

Structural brain changes associated with second language learning

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Second language (L2) acquisition necessitates a reorganisation of the brain, however, unlike motor skill and visuospatial training, it remains unclear precisely how these plastic changes occur as an individual becomes increasingly bilingual. Research on multilingualism has primarily focused on comparing monolinguals to bilinguals, with few longitudinal studies following the same learners. Moreover, most have not tried to tease apart the structural changes associated with different aspects of learning. Evidence suggests specific elements of language (e.g. syntax, semantic, phonology, oral production) may have localized structural correlates in both connections and nodes within the language network. We hypothesized that structural adaptations in these areas should co-occur and correlate with changes in specific aptitude measurements in these different domains. We therefore collected longitudinal scans over the course of 1.5 years (3 months intervals, 6 time-points total) during L2 acquisition to investigate the dynamic plastic changes associated with language learning. Fifty-six Arabic native speakers were taught German using two different teaching methods, one focused on syntax, one on semantics. To assess structural network changes, high

resolution diffusion MRI scans were acquired and fractional anisotropy (FA) was computed as a measure of white and grey matter microstructural organisation. To assess behavioural changes, a battery of language aptitude tests were administered. Voxel-based statistics were used to examine whole brain changes over time, differences between teaching groups, and the correlation of FA change with specific language aptitude measures. Our preliminary data demonstrate widespread and non-linear structural adaptations of brain regions involved in attention, memory, learning, in addition to the primary language processing areas. Subcortical and medial temporal lobe regions show an initial change during the first 6 months, while more frontal cortical regions only display plastic changes over the last 6 months. The correlation analysis revealed associations of behaviour with changes in the arcuate fascicle, internal capsule, medial temporal lobe, and superior longitudinal fascicle. These early results provide the first steps in profiling the dynamic recruitment and maintenance of plastic changes across the brain during L2 learning.

I-09

Neural networks for lexical tone and intonation in Mandarin Chinese

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In Mandarin Chinese (henceforth Mandarin), pitch information can both indicate lexical meanings (Chao, 1968) and intonational modulations (Yuan et al., 2002). This dual function of pitch leads to an intriguing question on how Mandarin speakers process the two types of pitch information. Previous research suggests similar cognitive mechanisms in the two processes by showing behavioural interferences (Liu et al., 2016) and overlapping neural activations (Gandour et al., 2004). Nevertheless, the underlying neural correlates specific to tone and intonation remain unclear, and methodological limitations of the previous work also preclude conclusions.

The current study aims to identify and compare the neural networks for tone and intonation in Mandarin speakers. We first plan a behavioural experiment examining pitch processing at the psychophysical level and then an fMRI experiment investigating the neural correlates.
Our pilot tests adopted monosyllabic word stimuli morphed across tone (tone 2, tone 4) and intonation (statement, question) and had participants judge one of these dimensions in separate blocks. The results consistently revealed participants' categorical perception in tone but not in intonation, suggesting that the long-term representation of intonation in Mandarin speakers might be weaker than that in non-tonal language speakers (Sammler et al., 2015). Meanwhile, with the stimuli well-controlled in acoustic cues, the results suggest that pitch information might not be the dominant cue in Mandarin intonation. While the previous studies might have taken the assumption that pitch information essentially signals statement-question in Mandarin, this finding importantly calls the attention to cross-cultural diversity in research (Jack et al., 2018).

I-10

Paralinguistic use of prosody in Mandarin Chinese and German: Is intention transmission affected by tone?

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Speech prosody – our vocal tone – is a crucial channel in conversations as it conveys social information about the speaker's mind. A recent study showed robust evidence that German speakers use conventionalized prosodic forms to communicate their interpersonal intentions such as criticism, suggestion or wish, irrespective of the semantic meaning of the utterance (Hellbernd & Sammler, 2016). But how does this prosodic channel of communication work across cultures? Are there culture-specific aspects of prosody that may lead to in-group advantages for listeners of the same native language, but may cause cross-cultural misunderstandings as proposed by the dialect theory of emotion recognition (Elfenbein & Ambady, 2002)?

We addressed this question by comparing the ability of 20 German and 21 Mandarin Chinese native listeners to recognize communicative intentions in the prosody of their native and the respective other culture's language. Mandarin Chinese is an interesting case because it is a tonal language where pitch variations carry lexical meaning which might interfere with the recognition of communicative intentions, particularly in German listeners.
Listeners performed a six-alternatives forced-choice classification on disyllabic words uttered by four German and four Mandarin Chinese native speakers in six different intentions. As expected, results show an in-group advantage in German listeners who performed significantly better on German than Mandarin Chinese prosody. Surprisingly, performance of Chinese listeners was equally low for both German and Mandarin Chinese prosody, although significantly higher than chance levels, suggesting that prosody may be a less important cue for communicative intentions for Chinese listeners.

I-11

Wor(l)ds apart – does the N400 reflect bilingual language distance and meaning in translation? An ERP study of the effects of L1-L2 distance and translation direction in German-English and Cantonese-English bilinguals

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Globalization. Interconnection. Bilingualism. More and more people grow up bi- or multilingual. Research on differential language processing in bilinguals suggests that similar languages cause more interference and consequently activate more control brain structures. We investigate the process of overt translation and differences between two contrasting language combinations and translation directions. 23 Cantonese-English and 23 German-English bilinguals translated 140 single words from L1 to L2 and vice versa, while reaction time (RT) and EEG were recorded. Mixed effects models (MEM) was used as statistical methodology.
Accuracy was lower in forward translation for Chinese bilinguals. RT was slower in forward than backward translation, and was responsive to translation direction, stimulus valence, target familiarity, and direction-group-pro-

ficiency interactions. We report modulation of N400 by main effects of group, electrode location, concreteness and several interactions. Notably, N400 amplitude overall was larger in German-English than Cantonese-English speakers and greater for forward translation in Cantonese. Use of MEM changed our RT interpretations, correcting for influencing factors. The findings of N400 are in accordance with a hypothesis of greater influence and thus greater cognitive control for overlapping languages. However, RT and accuracy do not reflect this, since forward appears more effortful than backward translation in Cantonese natives. Upon closer examination, Cantonese-English feature higher negativity in frontal areas in forward translation. These difficulties might arise due to script properties or due to difficulty in L2 word retrieval, but many answers remain elusive. Thus, it seems that with (language) distance does not necessarily come clarity, at least not in translation.

Auditory Perception and Music

I-12

Deviance detection: On and off responses, omission response, and mismatch negativity

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The omission response, elicited by an expected but omitted stimulus, has been interpreted by existing computational models as different from the typical mismatch negativity (MMN). From the viewpoint of prediction-based models, the omission response purely reflects prediction signals rather than prediction error. For adaptation-based models, the omission response can be treated as the rebound response of neural oscillators. However, both interpretations cannot explain the experimental observation that the omission response shows stronger amplitude than the responses evoked by the standard stimuli. In this simulation study, we propose to treat MMN as a mixture of the On response to the deviant and the Off response to the omitted standard. In this case, the omission response is regarded as the Off response that is time-locked to the omitted stimulus. We created an auditory cortex model consisting of connected excitatory and inhib-

itory neural populations. The model has a two-layer structure, where only the first layer receives direct thalamic inputs. In the demonstration, the model reproduces various types of cortical On/Off responses and the cortical omitted-stimulus responses, where the response latencies are proportional to the stimulus onset asynchrony. The simulation results suggest that the Off response produced by the two-layer structure along with the sustained resonance in the first layer representing the temporal regularity can account for the omission response. To conclude, with a goal of a unifying framework of MMN generation, we provided a new solution to interpret the omission response as a same neural mechanism as MMN generation.

I-13

Neural bases of interpersonal coordinated behaviour during music performance

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Coordinated interactions like speaking, dancing, or playing music in ensemble are important elements of human social behaviour. Those behaviours are increasingly associated with brain-to-brain coupling, i.e. patterns of similar neural oscillations unfolding in the brains of two collaborating individuals. The present poster will outline a dual-EEG experiment aimed to investigate the psychological and neurophysiological mechanisms that underlie coordinated interpersonal behaviour. The project particularly strives to pinpoint mechanisms of interbrain synchronization during coordinated joint action planning in piano duos. Pairs of pianists will jointly perform simple music excerpts while planning a (cued) tempo change that will be played with disabled audio (i.e. mute) feedback. The resulting tempi will be congruent or incongruent between players. This manipulation will allow the examination of coordinated motor planning between the pianists (i.e. planning of synchronous / asynchronous tempi) and its effect on the quality of behavioural coordination. Notably, the analysis of coupling between players' EEG signals recorded during a silent planning phase will allow us to eliminate the confounding influence of (shared) auditory and sensorimotor input on brain-to-

brain coupling, a limitation of previous research investigating this topic. It is expected that brain-to-brain coupling and behavioural synchrony will be stronger during the planning of congruent, as compared to incongruent, tempo changes. Additional analyses will also allow us to explore which neural oscillations play the key role in interpersonal coordination.

I-14

Joint action in music: An fMRI study

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To date, research on joint action has mainly followed two seemingly mutually exclusive theoretical frameworks: one with focus on interpersonal synchronisation, the other with focus on internal co-representations of others' actions. Recent efforts have started to integrate both approaches into a coherent framework (Colling & Williamson, 2014) by showing that joint actions are characterized by a fine balance between synchronisation and co-representation depending on situational demands (Novembre, Sammler, & Keller, 2016). In the present project we adopt this view and investigate the underlying neural networks using fMRI. Pianists perform previously rehearsed Bach chorales together. Thereby, one pianist plays only the (right hand) melodies in the MRI, while the other pianist plays only the (left hand) basslines outside of the MRI. To manipulate pianists' co-representation of their partner's actions, they are either motorically familiar with their partner's part (i.e. they trained it before) or unfamiliar. Simultaneously, the pianists' task is to adapt to either the same or a different tempo in the second half of the pieces, which influences interpersonal synchronisation as previously shown (Novembre et al. 2016). In this way, we expect to shed new light on the neural mechanisms underlying joint action.

I-15

Hierarchy of musical action planning - revisited

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Playing music requires complex action planning processes. These processes were proposed to be hierarchical in that the sequence-level planning regards the musical structure (i.e., harmonic relationships) and guides the planning of single-act movement kinematics (i.e., fingering). So far, this action hierarchy has been shown in production tasks in which pianists imitated hands playing chord sequences depicted in pictures or videos (Bianco et al., 2016; Sammler et al., 2013). What remains unclear, however, is whether this hierarchical planning generalizes to production regardless of the source of musical input (e.g., whether it is hands imitation or scores reading). We addressed this question by asking 22 expert pianists to play chord sequences on a muted keyboard by reading scores with fingering notations. Sequence-level planning of the final chords was either strong or weak depending on whether they were embedded in long (5 chords) or short sequences (2 chords), respectively. Final chords were structurally expected or unexpected and had to be played with conventional or unconventional fingering, lending insights into planning of musical structure and movement kinematics, respectively. Preliminary results confirm sequence-level planning of musical structure, but also reveal strong sequence-level planning of movement kinematics, indicating that the hierarchy of musical action planning might be more complex than previously thought. Possibly, music performance based on scores speeds up structural planning allowing to also plan movement kinematics ahead. In order to investigate the time course of the reaction cycle more thoroughly, EEG should be performed in the future.

I-16

An investigation of entrainment and visual processing in toddlers using eye tracking

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Music is a multi-dimensional, strong temporal form of art. Temporal structures, such as beats and meters, play an important role to human brains in sensory, motor, and cognitive processes. Entrained neuronal oscillations are observed in adults when attention is allocated to an ongoing periodic event stream. In line with Jones' Dynamic Attending Theory, there is a strong link between entrainment and the enhanced performance of visual attention tasks. This experimental study aims to employ a wearable eye tracker to investigate whether i) visual processing is enhanced by music; whether ii) unattended beats in or out-of synchronization with visual stimuli, and iii) fast or slow tempi, affect the visual search performance of toddlers with different background of exposure to music. The study features two experiments that employ methods modified from extant research. Two groups of toddlers will be recruited from conventional and music-based day care centers. Three hypotheses are (a) compared to silent phase, visual processing is enhanced by periodic auditory stimuli, (b) when the visual stimuli are synchronized with unattended auditory beats, it will increase the efficiency of visual search, and (c) compared to slow tempi, fast tempi will enhance the quality of visual search skills.

Social Cognition and Emotion

I-17

The development of sensitivity to social traits of faces

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The ability to discriminate social signals from faces is a fundamental component of human social interactions. So far, only a few studies have investigated the de-

velopmental origins of the sensitivity to these fine-grained characteristics of faces, focusing only on explicit trustworthiness judgements.
In this study, a group of 5-year-old and 7-year-old children and a group of adults performed two tasks aimed to measure their implicit perceptual sensitivity to physical cues to trustworthiness (oddmanout task) and their ability to make explicit trustworthiness judgments (pairwise preference). In the oddmanout task, participants observed three simultaneously presented faces and selected the one they judged to be more different from the others. In the pairwise preference task, participants selected the face they trusted more among two simultaneously presented faces. For both tasks, the stimuli consisted of 7 variations of the same female face identity varying along a continuum of expressed trustworthiness. Preliminary results show that 5-year-old children perform significantly worse than both 7-year-olds and adults in both tasks. Nevertheless, multidimensional scaling (MDS) analyses performed on dissimilarity scores derived from the oddmanout task show that already at the age of 5 children represent faces in memory as a function of the level of trustworthiness they express, and provide explicit judgments favouring the face that display more intense physical cues to trustworthiness. This overlap between implicit and explicit judgements for younger as well as older children suggests that sensitivity to social signals from faces is already present early in the development and specializes in time.

I-18

The processing of laughter in people with autism

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Background: Laughter is a universal non-verbal emotional vocalisation in human beings. As a social vocal emotion, the engagement of mentalising ability is crucial in the processing of laughter's social functions and using it as a social signal in daily interaction, resulting in a long-term benefit in people's social life well-being.
Aims: To investigate laughter processing in people with autism would extend our knowledge of the role laughter plays in establishing and maintaining social bonds. Moreover, it is essential for the characterisation of the relationship between cognitive and affective mentalising and social interactions in autism.
Methods: Behavioural studies are proposed to investigate the implicit and explicit processing of laughter in people with autism and matched groups of neuro-typ-

ical controls. Future research will investigate the role the mentalising system and orofacial mirror system plays in the processing of laughter in people with autism using neuroimaging techniques (e.g. fMRI).
Results: In the process of collecting data. However, in my previous MSc project, we found that relative to TD adults, ASD adults performed less well in distinguishing the spontaneous and social laughter. In addition, the perceived contagion of laughter by ASD adults is less influenced by the type of laughter.
Conclusion: We predicate that autistic individuals have difficulties in processing spontaneous and social laughter relative to neuro-typical people, suggesting that a high level of cognitive skill such as mentalising ability is crucial in social emotion perception.

I-19

Individuals with high fear of negative evaluation show greater learning for self-negative evaluation

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Fear of negative evaluation (FNE) is a core feature of social anxiety disorder. People who are highly fearful of negative evaluation display biased processing of social-evaluative information when related to the self. They select fewer positive words when asked to predict how another agent would evaluate them, but display no bias when making predictions about an unknown other agent. However, it is unclear whether this effect arises from a reduced ability to learn from positive information or from an enhanced learning from negative information, a distinction that has important therapeutical implications. We aimed to investigate the mechanism underlying the negative self-bias in high FNE individuals using computational modelling. Data from a probabilistic social learning task (n=100) (Button et al., 2015), completed by participants that varied along a continuum of low to high FNE, was modelled using adapted Rescorla-Wagner reinforcement learning models. The winning model contained separate learning rates for self-negative and self-positive information but a single learning rate for other information, indicating that the updating of information for the self is valence spe-

cific, whereas for others it is the same across valences. Learning rates were higher overall for self-positive information, indicative of an optimism bias. Crucially, high and low FNE individuals show the same ability to learn from self-positive information, but high FNE individuals have higher learning rates for self-negative information. Therapeutical targets for social anxiety might therefore focus on reducing this bias towards negative information.

I-20

Subsequent recollection reveals oscillatory patterns of sentence encoding: Effects in the theta, alpha, and gamma bands

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Animals form groups to avoid being eaten by the predators, which is known as "safety in numbers" rule. Humans also benefit from collective acts in many ways. We know, for instance, that people attribute less blame, hence less regret to themselves when they cause a collective harm (i.e. avoiding first-party punishment). But we don't know if, by collective acts, individuals also avoid less punishment from an impartial third-party observer. To the best of our knowledge, no study so far investigated if someone who is not directly involved in a collective harm also attributes less punishment to them (i.e. third-party punishment) which is analogous to the so-called "safety in numbers" rule but in humans and for punishment. Psychological and brain imaging studies have shown that attribution of punishment is a dual process, composed of two distinct neuro-cognitive components: intention inference (did they mean to harm?) and outcome monitoring (what was the consequence of the harm?). It was expected that the amount of punishment would be reduced in a collective harm in comparison to the individual harm, in general. Since the intention inference component of the dual-process theory is more cognitively demanding, we also expected that in the collective harm, the punishment would be more reduced in case of negative outcome rather than the negative intention (i.e. failed attempted harm). To test these hypotheses, we asked the participants to attribute punishment to "X" in two different conditions: i) "X" belongs to a group of 3 and ii) "X" does the harm individually.

Clinical Neuroscience

I-21

Predicting alien/anarchic limb syndrome in corticobasal syndrome by structural magnetic resonance imaging

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Alien limb phenomenon is a rare syndrome associated with a feeling of non-belonging and disowning toward one's limb. In contrast, anarchic limb phenomenon leads to involuntary but well-executed movements of the limb. Alien/anarchic limb phenomena are frequent in corticobasal syndrome (CBS), an atypical parkinsonian syndrome characterized by rigidity, akinesia, dystonia, cortical sensory deficit, and apraxia.

The structure-function relationship of alien/anarchic limb was investigated in multi-centric structural MRI data. Whole-group and single-subject comparisons

were made in 25 CBS and eight CBS-alien/anarchic limb patients vs. controls. Furthermore, support vector machine learning was used to see if CBS patients with and without alien/anarchic limb syndrome could be distinguished based on underlying structural MRI patterns.
Whole-group comparison of CBS vs. controls revealed asymmetric frontotemporal gray matter density differences. CBS with alien/anarchic limb syndrome vs. controls showed differences in frontoparietal gray matter density including the supplementary motor area contralateral to the side of the affected limb. Classification of CBS patients yielded accuracies of 79%. CBS with alien/anarchic limb syndrome was differentiated from patients without alien/anarchic limb syndrome with an accuracy of 81%. Predictive differences were found in the cingulate gyrus spreading to frontomedian cortex, postcentral gyrus, and temporoparietoocipital regions.
We present the first analysis on alien/anarchic limb in corticobasal syndrome identifying syndrome-specific atrophy based on structural MRI with support vector machine classification. Results pave the way for individual clinical syndrome prediction and allow understanding the underlying neurocognitive architecture.

I-22

Predicting individual dopaminergic treatment response in Parkinson's disease with structural MRI

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Objective: We aimed at testing the potential of biomarkers in predicting the individual patient response to dopaminergic therapy (DT), the most common symptomatic treatment for Parkinson´s disease (PD). Methods: Treatment efficacy was assessed in 30 PD patients as the motor symptoms improvement between the unmedicated and the medicated state as assessed by the Unified Parkinson's Disease Rating Scale score III. A multiple regression was implemented to test the prediction accuracy of age, disease duration and treatment dose

and length. Patients were stratified into weak and strong responders according to the individual treatment response. Univariate voxel-based morphometry was applied to investigate differences between the two groups on age-corrected T1-weighted magnetic resonance images. Finally, multivariate support vector machine classification was used to predict individual treatment response based on structural neuroimaging data. Results: Increasing age, but neither disease duration nor treatment dose and duration, predicted a weaker DT response. In addition, weak responders showed greater brain atrophy in left supplementary motor area, superior frontal gyrus, and left temporoparietal operculum. Support vector machine classification revealed that gray matter volume in these brain regions, including additionally the cerebellum and primary motor cortex, was able to differentiate weak and strong DT responders with 74% accuracy. Conclusions: Results suggest that both increasing age and reduced gray matter volume are valid and independent predictors of DT response in PD. By predicting individual treatment response with clinical data/biomarkers our results will pave the road to future applications in the framework of personalized medicine in clinical routine.

I-23

"Post-stroke depression"? Depressive symptoms before and after first-incidence stroke

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Observations of high levels of depressive symptoms in stroke survivors have fuelled the assumption that stroke can lead to depression – a notion reflected in the term "post-stroke depression". Indeed, DSM-V lists stroke as one of the few direct causes of depression. However, there is some evidence to suggest that vice versa, depression increases the risk of stroke. Thus, stroke patients may suffer from increased levels of depressive symptoms even before an acute insult. The extent to which stroke induces changes in depressiveness therefore remains unclear. Here, we used longitudinal data from a large cohort study in the United States (MIDUS) to test the hypothesis that stroke accelerates an increase in depressive symptoms. During the course of MIDUS, N = 89 participants reported a

first-time incidence of stroke. Using propensity matching, we generated a control group of non-stroke participants with similar demographic and cardio-vascular risk factors. Multi-level models will be applied to compare changes in depression between the stroke and non-stroke group. We will also examine whether changes in depressiveness are specific to stroke or also occur in patients with other cardio-vascular diseases (e.g. myocardial infarction) or different life-threatening illnesses (e.g. cancer), respectively. Lastly, we will explore the potential role of physical disability as a driving factor for depressive symptoms post-stroke and other diseases. The results will contribute to a better understanding of the concept of "post-stroke depression" and may also provide insights into the aetiology of mood disturbances following stroke.

I-24

Relating MRI to histopathological surrogate biomarkers in frontotemporal dementia

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Background: Frontotemporal dementia (FTD) comprises a spectrum of clinical syndromes of which four main subtypes are recognised: behavioural-variant FTD (bvFTD), semantic dementia (SD), progressive non-fluent aphasia (PNFA), and logopenic progressive aphasia (LPA). Clinical diagnosis is hampered by disease heterogeneity and reliable methods to diagnose and monitor FTD are lacking. Both changes in the concentration of proteins from cerebrospinal fluid (CSF) or blood and regional atrophy patterns could serve as disease biomarkers.
Objective: To relate disease-specific atrophy patterns, as measured with magnetic resonance imaging (MRI), in FTD subtypes to commonly studied proteins from CSF/blood.
Methods: We compared CSF concentrations of total-tau, phosphorylated-tau, β-amyloid 1-42, progranulin, ubiquitin, neurofilament light chain (NfL) and phosphorylated neurofilament heavy chain (pNfH) in 152 FTD patients (75 with bvFTD, 22 with SD, 36 with PNFA and 19 with LPA), and 40 Alzheimer's disease (AD) patients. We also compared NfL serum concentrations in an additional 29 FTD patients, 5 AD patients and 23 healthy controls. For each disease, we correlated protein concentrations with volumes of disease-affected brain regions.

Results: AD and LPA exhibited similar protein concentration profiles. Serum NfL was higher in SD compared with all other groups, except PNFA. Significant correlations between protein concentrations and brain volume loss were seen for CSF NfL in AD and bvFTD, and CSF pNfH in bvFTD and SD.
Conclusion: The data indicate that proteins from CSF and blood have potential to differentiate between FTD subtypes and AD, and elevated levels of neurofilament proteins may reflect greater atrophy.

Memory and Attention

I-25

Observation of whole-body movement sequences: Memory encoding, retrieval, and the influence from higher cognitive functions

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Working memory (WM) for human actions plays an important role in not only social interactions but also the observation-imitation process of motor skill learning due to an unavoidable time delay between visual perception and motor output. However, how the spatial and temporal information of a complex whole-body movement sequence are encoded, retained and retrieved from the WM remains unclear. In Experiment 1, to differentiate between the perception and memory processes during action observation, we manipulated the retention interval (RI) of a delayed discrimination task, in which participants watched two sequentially displayed movement sequences (different in spatial and/or temporal domains) and made a same/different judgment. The results showed robust spatial but weak temporal representations of movement sequences in both short RI (perception) and long RI (memory) conditions. In Experiment 2, we manipulated both the movement length and the RI to further investigate how the effects of memory load and maintenance delay influence memory performance. The results showed a non-decaying, near-perfect recognition performance of movement trajectory, while the recognition of rhythm (i.e., pattern of movement durations) was jointly influenced by memory load and maintenance delay. When the memory load was low, performance remained high if RI was short, but deteriorated if

RI was lengthened, illustrating a time-based forgetting. On the contrary, when the memory load was high, performance remained low across all RIs, indicating that the memory load might have surpassed the limited capacity of WM. Future studies will focus on the effect of attention and potential interactions between different information streams.

I-26

The modulation of episodic recollection by conceptual knowledge in Alzheimer's Disease and Autism Spectrum Disorder: Examining the role of the hippocampus.

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Memory is central to many cognitive processes, impacting in future decisions for a better social adaptation. For example, every day when we wake up, we plan our day based on long-term memories, as our previous experiences (episodic memory) and also as our general knowledge (semantic memory). Long-term memory theories suggest that the hippocampus sustains memories formation, but disagree upon the participation of this structure in all types of declarative memories. Also, the idea that hippocampus areas supports the development of an abstract (semanticized) version of episodic memory traits in cortical areas remains in debate.

In healthy-individuals, the conceptual knowledge (i.e., schemas and item-typicality) enhances memory formation (episodic traits). However, in Autism-Spectrum-Disorder (ASD) and Alzheimer's Disease (AD) there is no benefit from conceptual knowledge, specially item-typicality, when forming episodic memories. The possible explanation is because both clinical groups have hippocampus compromised.

This project examines the role of encoding schema (abstract mental representation) and item-typicality (goodness of an exemplar to represent it category)

on declarative memories systems. We will contrast typical developmental (TD) adults with ASD-group as well as comparing AD-group with TD-elderly group in a recognition memory task with remember-know paradigm. The innovativeness of this proposal rests on indirectly comparing the neurocognitive profile of two clinical groups with robust behavioral and EEG source localization and connectivity estimates. The project is likely to clarify the semantic-episodic system relationship, particularly the role of the hippocampus-cortical network, and to uncover neurocognitive signatures in these clinical populations for earlier diagnosis and rehabilitation purposes.

I-27

Forgiveness and cognitive control - provoking revenge via theta-burst-dtimulation of the dLPFC

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Forgiveness is a highly relevant process in the daily social life. Based on theoretical models and correlational evidence, it has been suggested that forgiveness relies on inhibition as a sub-function of cognitive control. We combined an ultimatum game (UG) and a dictator game (DG) with inhibitory, continuous theta-burst stimulation (cTBS; verum vs. placebo, within-subjects design) of the right dorsolateral prefrontal cortex (rDLPFC) to examine the effect of reduced cognitive control on forgiveness behavior. After an inhibitory theta-burst stimulation we expect lower rates of forgiveness behavior. Participants first played an UG against fair and unfair opponents, where they had to accept or refuse (fair and unfair) monetary offers, and then received a cTBS before playing a DG against the same opponents with reversed roles. The participants now had the opportunity to forgive the unfair opponents (distribution of a fair amount of money) or to take revenge. Following verum cTBS, participants allocated significantly less money to unfair opponents than in the placebo cTBS condition. Additionally, reaction

times (RTs) as well as neural activation in the right DLPFC differed significantly between verum and placebo cTBS for unfair opponents (higher RTs and lower DLPFC activation following verum stimulation). For fair opponents, no differences were found between stimulation conditions. These results powerfully indicate that cognitive control (with a key player within the rDLPFC) is a central requirement for overcoming unwanted emotional responses and regulating one's actions when displaying pro-social behavior.

Poster Session II

Wednesday, 27 June 16:15 – 17:30, Foyer MPI CBS

Poster Number	Speaker	Title
Neuroimaging Physics and Signal Processing		
II-01	Movahedian Attar, F.	Towards optimisation of a dedicated preprocessing pipeline for intra-cortical fibre and sub-cortical U-fibre mapping using diffusion MRI
II-02	Rose, D.	Informing delay in neural mass models with estimates of myelination and axonal diameters based on quantitative structural and diffusion-weighted MRI
II-03	Vaculčiaková, L.	Towards high resolution cortical myelination mapping
II-04	Waschke, J.	Detection of unlabeled cells in 3D bright-field images
Language and Communication		
II-05	Maran, M.	The neural basis of phrasal building
II-06	Musiolek, L.	Modeling the N400 as semantic bayesian surprise
II-07	Numssen, O.	Localization and uncertainty of TMS effects during motor cortex stimulation
II-08	Qi, T.	Gray matter structural covariance changes during language comprehension development
II-09	Rysop, A.U.	Modulating neural network dynamics of Speech comprehension – the role of the angular gyrus

Poster Number	Speaker	Title
Social Cognition and Emotion		
II-10	Linz, R.	Changes in serum BDNF levels during acute psycho-social stress negatively relate to salivary cortisol
II-11	Ma, R.	Real-life social contact increases emotional well-being, relates to amygdala volume and interacts with early adversity
II-12	Nguyen, T.	Brain-to-brain synchrony during mother-child interactions: The role of maternal caregiving and attachment
II-13	Overbye, K.	Development of ERN and Pe from childhood to adulthood: A multimodal EEG and MRI study
Clinical Neuroscience		
II-14	Gong, R.	Movement control task for detecting voluntary movement impairment of Parkinson disease
II-15	Herzog, N.	Shared and differential neurocognitive mechanisms in obesity and binge eating disorder
II-16	Eken, A.	Task-based functional connectivity based classification of fibromyalgia using fNIRS
II-17	Hidalgo-Lopez, E.	Differential effects of menstrual cycle and individual inhibitory control on activation and connectivity of the basal ganglia during a stop signal task
II-18	Maier, C.A.	The impact sex hormones on reward sensitivity in women
Perception, Action, and Movement		
II-19	Lubinus, C.	The role of action-based and temporal predictability in sensory attenuation on a behavioural and neural level

Poster Number	Speaker	Title
II-20	MacIntyre, A.D.	P-centres, beats, and the rhythms of movement
II-21	Murali, S.	The reciprocal relationship between eye blinks, perceptual changes and motor responses in the visual and auditory modality
II-22	Wen, S.	Preferences for motor acts are matched for execution and observation in a subpopulation of F5 mirror neurons
II-23	Tolstova, E.	The influence of physical activity on psychophysical characteristics of the subject within virtual environment
II-24	Wheatley, S.	Measuring oscillatory behaviour of the primary visual cortex following saccadic eye movements
Memory and Attention		
II-25	Meyer, A.-K.	Tracking the impact of retrieval suppression on individual memory representations
II-26	Paulus, P.	Episodic simulations reveal the structure of affective representations in ventromedial prefrontal cortex
II-27	Szabo, D.	Human-analogue resting-state networks in the dog brain

Neuroimaging Physics and Signal Processing

II-01

Towards optimisation of a dedicated preprocessing pipeline for intra-cortical fibre and sub-cortical U-fibre mapping using diffusion MRI

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Intra-cortical fibres and sub-cortical U-fibres are highly susceptible to distortions in diffusion MRI (dMRI) due to location in the brain and small size. Distortions in dMRI arise primarily from scanner gradient non-linearity, eddy-current (EC) and magnetic field susceptibility effects and appear in the form of geometric image distortions and variable tissue diffusion-weighting. Acquisition of sub-millimetre spatial resolution in vivo dMRI as required for short fibre mapping is facilitated by the strong (300mT/m) imaging gradients of the Connectom scanner and the highly sensitive superficial flexible coils that boost the signal-to-noise ratio (SNR). The strong and highly non-linear Connectom gradients, sub-millimetre spatial resolution acquisition and short fibre characteristics together introduce new challenges in dMRI preprocessing design and optimisation. The current preprocessing design involves optimisation of dMRI acquisition in terms of the number and distribution of diffusion-weighting gradients, phase-encoding directions and acquisition block design in addition to characterisation of Connectom gradient non-linearity and EC terms. The core of the distortion correction pipeline consists of the application of FSL topup for susceptibility-induced field estimation and FSL eddy for motion and EC parameter estimation. The major contribution of this work is the inclusion of gradient non-linearity as an extra step in the preprocessing pipeline, a step so far neglected due to complexity. Here, we demonstrate the current state of the dMRI preprocessing pipeline in terms of its constituent components via characterisation and subsequent correction of each source of distortion potentially affecting intra-cortical fibre and sub-cortical u-fibre mapping using both in vivo and phantom data analysis.

II-02

Informing delay in neural mass models with estimates of myelination and axonal diameters based on quantitative structural and diffusion-weighted MRI

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Computational neural network models (NNM) have become a popular tool to investigate mechanisms of brain dynamics. By constructing a NNM, a hypothesis about brain structure is translated into a computational model of brain function. This study aims to investigate the relationship between quantitative structural markers of white matter and subject-dependent delay in visual processing. High-resolution quantitative structural and diffusion-weighted MRI will be acquired, applying the Multi-Parameter-Mapping protocol and AxCaliber model in a 7T Magnetom and 3T Connectom system, respectively. The MRI data will be used to estimate myelin content and axonal diameter distribution in the optic radiation. These physiological measures are combined to infer axonal transmission delay. A computational NNM of visual processing is employed to relate subject-dependent transmission delay to expected evoked response. Simulated activity is then compared to MEG measurements within the same subjects to compare simulated and observable delay in the visual evoked response. By combining computational models and in vivo physical measurements, this study helps to understand how an MRI-based physiological marker relates to behavioral differences in individuals. This may allow for novel research paradigms, e.g. to establish a model for the process of aging or to disentangle individual differences in physiology from external influences like drugs.

II-03

Towards high resolution cortical myelination mapping

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Anatomical magnetic resonance imaging (MRI) provides rich structural information about the human brain, with contrast between different tissue types arising from diverse MR parameters. Quantification of these parameters enables the separation of contrast-generating metrics and offers the potential to distinguish tissue components. Certain parameters have been shown to exhibit anisotropic behaviour - i.e., the values change with the orientation of fibres with respect to the main magnetic field, B0. Aiming at cortical myelination mapping, special focus is given to T1 contrast as a marker of the myelin sheath, which is rich in lipid and macromolecule content.

The presented study investigates the orientation dependence not only of the already reported T2* and MT contrasts, but also of T1 relaxation which is hypothesized to be invariant to the orientation of myelinated fibres in white matter. For this purpose, a tailor-made rotational sample holder was used to automatically position an ex-vivo sample at desired angles on one principal axis inside the 9.4T MRI scanner.

Moreover, an inversion recovery balanced steady state precession (IR-bSSFP) sequence was implemented for 7T scanner to assess whether the theoretical prediction of SNR increase when bSSFP readout is used, would translate into higher precision T1 measurement and hence be beneficial for in-vivo cortical myelination mapping.

By combining more precise high resolution myelin mapping with more understanding of the orientational dependence of diverse MR parameters, this multi-stranded project will provide greater insight into how myelin constitutes the observed MR signal.

II-04

Detection of unlabeled cells in 3D bright-field images

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Live cell imaging enables observation of cell behavior over a period of time in a spatio-temporal manner and is a growing field in modern cell biology. Analysis of the spatio-temporal dynamics of heterogeneous cell populations in 3D microenvironments will contribute a better understanding of cell-cell and cell-matrix interactions for many biomedical questions of physiological and pathological processes. We present an automated quantitative, label-free 3D single cell tracking technique using standard bright-field microscopy and affordable computational resources for data analysis. The new technique provides a valuable platform for long-term studies of single cell behavior in 3D settings with minimal cell manipulation. It is implemented as a standalone software tool, which offers the aforementioned automated tracking solution, and additionally supports manual processing of microscope data with a user-friendly interface.

Language and Communication

II-05

The neural basis of phrasal building

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Syntactic rules determine which sequences of grammatical categories in a language are legal or not, for example a determiner can be followed by a noun, correctly building a phrase but not by a verb, which would result in syntactic error. Recent fMRI studies provided evidence for a role of Broca's area (BA44) in building

minimal syntactic structures, like two-word phrases (e.g. "Dieser Apfel/this apple"). The aim of my research is to test the causal role of BA44 in phrasal building and to investigate if its activation reflects the generation of top-down syntactic predictions triggered by the first word (e.g. after a determiner, a prediction for a noun is generated) or bottom-up application of grammatical rules (e.g. after having processed a determiner and a noun, BA44 binds them into a phrase). These two hypotheses will be tested combining online TMS and EEG, while subjects process correct (e.g. "Ein Falter) and incorrect ("Ein mustert") two-word phrases. In two different studies, BA44 will be stimulated during the processing of the first or the second word. We expect that, if BA44 role in phrasal building is generating syntactic predictions, its stimulation during the first word should alter EEG and behavioral markers of phrasal building. Specifically, stimulation in BA44 would affect early ERP components reflecting syntactic errors and it possibly increase RTs in a grammaticality judgment task. On the contrary, if its role is bottom-up application of syntactic rules, the markers of phrasal building should be disrupted when BA44 is stimulated during the second word.

II-06

Modeling the N400 as semantic Bayesian surprise

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Although the most well-established and widely used ERP component in semantic processing, the computational mechanism underlying the N400 is still debated. Recently, N400 amplitudes have been successfully simulated with neural network models as reflecting a semantic prediction error corresponding to Bayesian surprise at the level of meaning (Rabovsky & McRae, 2014; Rabovsky, Hansen, & McClelland, 2016). Here, we apply this concept to single-trial N400 amplitudes measured during a mismatch roving paradigm, which has been previously used to measure Bayesian surprise in somatosensation (Ostwald et al., 2012) and which we modified to measure Bayesian surprise at the semantic level. Specifically, we present participants with a series of German nouns from different semantic categories. The words were chosen such that their semantic features (in this case, their hypernyms or overcategories) overlap to varying degrees with the other words. A Bayesian learning algorithm uses previously presented words to adapt

the probabilities for the next words' semantic features. If a word's semantic features are very different from those of the previous word, the update of the feature probability distributions (or Bayesian Surprise) is large, as should be the N400 in a human reader. We compare this Bayesian Surprise measure to other linguistic and computational variables as a predictor of N400 mean amplitude, thus hoping to make a valuable contribution to the ongoing „Bayesian Brain" discussion, and further testing the account of N400 amplitudes as reflecting Bayesian surprise at the level of meaning.

II-07

Localization and uncertainty of TMS effects during motor cortex stimulation

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Transcranial magnetic stimulation (TMS) allows for non-invasive electrical stimulation of the human cortex. However, its exact neurophysiological mechanisms remain elusive and it is difficult to predict which neuronal populations are actually stimulated, leading to considerable variation in the observed effects. We used biophysical forward modeling of the head and the TMS coil to relate the TMS induced electric field E to the motor evoked potentials (MEP) by evaluating their mutual information. Thereby, we were able to localize the stimulated cortical regions and to reveal the involvement of radially and tangentially oriented cell compartments. Furthermore, we analyzed the effect of uncertain model parameters, such as electrical conductivities of major head tissues, TMS coil positions,

and variations in behavioral response. The uncertainty and sensitivity analysis was performed using the non-intrusive generalized polynomial chaos technique (gPC). To predict E for each condition and trial, the finite element method (FEM) was used. For each condition, an individual gPC was evaluated considering the electrical conductivities as uncertain, thus rendering E also as uncertain.

II-08

Gray matter structural covariance changes during language comprehension development

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Language comprehension, especially the comprehension of syntactically complex sentences, is supported by functional interactions between left inferior frontal and left temporal regions in the adult brain. In contrast, children demonstrate reduced intra-hemispheric fronto-temporal functional connectivity during syntactic processing. From the perspective of structural covariance, the language-related gray matter covariance between frontal and temporal brain regions has also been shown to change across development. Here, we examined the developmental changes of the structural covariance network relevant for syntactic processes and whether this network depends on individual differences in language comprehension. Structural covariance networks were cross-sectionally obtained in preschool children, school age children, and adults based on the cortical thickness seeding from the language relevant seeds - the left inferior frontal gyrus (IFG) and the left posterior superior temporal gyrus/sulcus. In addition to examining developmental changes of structural covariance networks across age groups, we also correlated preschooler's structural covariance with their language comprehension abilities. Our results demonstrated that the cortical thickness of language-relevant seeds co-varied with the contralateral homologous regions in preschoolers, while in school age children and adults a more distributed pattern

with increased left intra-hemispheric long-range fronto-temporal covariance was found. Furthermore, preschooler's structural covariance between the left IFG and left temporal regions was positively associated with sentence comprehension abilities, suggesting that preschool children with enhanced sentence comprehension abilities are more likely to show the adult-like intra-hemispheric fronto-temporal covariance pattern. These findings provide anatomical evidences for developmental changes in the structural language network from the perspective of cortical thickness co-variation.

II-09

Modulating neural network dynamics of speech comprehension – the role of the angular gyrus

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Speech comprehension is often challenged by acoustically adverse listening conditions (e.g. background noise) but can be facilitated by rich semantic context (e.g. "The ship sails the sea" vs. "Paul discussed the sea"). In previous imaging studies, this behavioural comprehension gain was accompanied by increased activity in a left-hemispheric fronto-temporo-parietal network centred on the angular gyrus (AG) (Obleser et al., 2007; Obleser and Kotz, 2010). Moreover, a recent TMS study has provided causal evidence for the functional relevance of the AG in processing spectrally degraded speech (Hartwigsen, Golombek, & Obleser, 2015). However, it is unclear how the left AG interacts with other network nodes engaged in the successful comprehension of degraded speech. In the planned fMRI-experiment, we aim to reveal key regions which are involved in processing speech in challenging listening conditions and investigate the effective connectivity within this network.
In line with previous studies (e.g. Obleser & Kotz, 2010; Obleser, Wise, Dresner & Scott, 2007) we expect AG activation to be strongest when confronted with highly predictable but intermediately degraded sentences under the control

condition. Also, with decreasing signal quality we expect an adaptive increase in fronto-parietal and cingulo-opercular control and monitoring networks to help maintaining speech comprehension.

Social Cognition and Emotion

II-10

Changes in serum BDNF levels during acute psycho-social stress negatively relate to salivary cortisol

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Brain-derived neurotrophic factor (BDNF) is a potent facilitator of neuronal plasticity. Counteracting the adverse effects of excessive stress-induced glucocorticoid signaling, BDNF has been implicated in resilience to psychopathology caused by chronic stress. Despite substantiated interest in their relation and in contrast to this established long-term antagonism of BDNF and glucocorticoids, insights into the effects of acute stress on peripheral BDNF levels in humans are both rare and inconclusive. Further, evidence on the short-term interplay of BDNF and cortisol in humans responding to stress is lacking.
In the current study, we investigated serum BDNF levels in response to an acute psychosocial stress paradigm (Trier Social Stress Test, TSST) in a sample of 301 healthy participants. We further associated BDNF to stress-induced increases in several physiological markers (cortisol, alpha-amylase, heart-rate and heart-rate variability) and to subjective-psychological perceptions of stress.
We show that BDNF is stress-reactive, characterized by a significant increase in serum BDNF levels in response to the TSST and a significant decline after recovery.

We further find initial indications for an antagonistic association of BDNF and cortisol during acute stress: BDNF peaks after stress were positively associated with faster cortisol recovery while higher cortisol increases after stress were associated with a faster BDNF decline. Providing novel evidence on the dynamic short-term interaction of BDNF and cortisol, our findings highlight the critical need to better understand involved molecular mechanisms in order to obviate stress chronification and its consequential health risks.

II-11

Real-life social contact increases emotional well-being, relates to amygdala volume and interacts with early adversity

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Social support is a protective factor for mental and physical health buffering against the effects of stressful events. Across species, larger social networks relate to increased amygdala volume, a brain area important for social-emotional functioning. Here, we combined smartphone-based ecological momentary assessment (EMA) with structural magnetic resonance imaging (MRI) to assess the impact of social contact on emotional well-being in real-life ("social emotional gain") and explore associations with amygdala volume in healthy adults. Additionally, we investigated interactions with early childhood adversity, a risk factor for social-emotional dysfunction.

Across 7 consecutive days, 209 participants (77 males, age: 23 ±3) rated their emotional well-being (well/unwell, satisfied/not satisfied), and reported on social contact (in company vs. alone) using smartphone-diaries (9-24 prompts/day). Early childhood adversity was assessed using a brief self-report instrument. Additionally, a subsample (n=103) underwent structural MRI. In a random-intercept random-slope multi-level model, well-being was increased during social contact ($p<.001$), indicating social emotional gain. Higher subclinical early childhood adversity was linked to increased social emotional gain ($p=.03$). Voxel-based

morphometry showed that individuals with higher social emotional gain have significantly larger amygdala volumes (pFWE-ROI = 0.035/0.042).
Our findings suggest that the propensity to benefit from social contact in real life relates to amygdala structure, which has previously been associated with protective social influences. Our findings further highlight the consequences of even mild forms of early childhood adversity on emotional well-being in adulthood and identify social contact as an important beneficial factor for the emotional well-being of individuals at risk for psychiatric illness.

II-12

Brain-to-brain synchrony during mother-child interactions: The role of maternal caregiving and attachment

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Behavioral and affective attunement between caregiver and child are considered essential for attachment and emotion regulation (Stern, 1985). Especially sensitive caregiving is associated with behavioral and physiological synchrony during mother-infant interactions (Leclère, 2014). Brain-to-brain synchrony, proposed to facilitate communication between mothers and infants (Leong et al., 2017), is only recently being addressed in developmental research. Here, we present a dual functional near-infrared spectroscopy (fNIRS) study looking at 36 mother-child dyads to investigate whether maternal caregiving and attachment affect brain-to-brain synchrony and the quality of mother-child interaction during a problem-solving task. Wavelet transform coherence is used to assess the cross-correlation between the two fNIRS time series. Preliminary results from linear-mixed model analyses reveal a significant increase in brain-to-brain synchrony in the dorsolateral prefrontal cortex (dlPFC) and tempo-parietal junction (TPJ) when mother and child solved the task in collaboration in comparison to individual problem solving. Further decoding brain-to-brain synchrony in the col-

laboration condition, synchrony in both areas is associated with less time needed to solve one template. We further found that dyads display higher brain-to-brain synchrony in temporal areas and lower brain-to-brain synchrony in frontal areas when they behave more reciprocally. Dyads with more anxiously attached mothers, assessed by a self-report questionnaire, display the opposite pattern, such that brain-to-brain synchrony is lower in temporal areas and higher in frontal areas. The findings highlight the complexity of neuro-behavioral synchronization between mother and child. The results will be further discussed in relation to attachment theory.

II-13

Development of ERN and Pe from childhood to adulthood: A multimodal EEG and MRI study

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We investigated age-related differences in Error Related Negativity (ERN) and Error Positivity (Pe). ub a cross sectional sample af adolescents 8-19 years (n=88). Participants completed a flanker task while high-density EEG was recorded. Cortical surface area and thickness were estimated from T1-weighthed MRI. Group-level blind source separation was used to decompose the EEG data. Strength of the extracted components were compared across age groups as well as to cortical thickness and area of the cingulate cortex.

Clinical Neuroscience

II-14

Movement control task for detecting voluntary movement impairment of Parkinson disease

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Transcranial magnetic stimulation (TMS) is receiving increasing attention as a non-invasive stimulation technique for treating Parkinson's disease (PD), given its superior safety profile and lower cost as compared to invasive deep brain stimulation (DBS). However, TMS-based treatment responses vary considerably between patients, limiting its clinical application. Knowing what brain activity is actually modulated by TMS would be essential for improving therapy. Recently, beta-broad gamma phase amplitude coupling (PAC) has been recognized as a biomarker of the Parkinsonian state that could be used as the control signal of TMS therapy. But this excessive coupling has only been found in cortical LFPs and its dynamic modulation during movement is still obscure. Therefore, our purpose is to non-invasive detect specific symptom-related oscillatory activity during movement by electroencephalography (EEG) technique. A movement control task based on repetitive self-initiated finger tapping was designed to detect voluntary movement impairment of PD patients. During the task, color feedback will continuously show up according to previous tapping amplitude, indicating the subjects to adjust their performance. The percentage of numbers in correct tapping amplitude, the time differences between two successive taps and the interval variability are estimated for distinguishing the Parkinsonian state compared with healthy subjects, and also the difference between fast tapping rate and slow tapping rate. Meanwhile, with optimized EEG experimental setting-up, we are expecting to detect movement-related gamma band activity during the task, as well as the interaction between beta band and gamma band which could be in correlation with the Parkinson motor symptoms.

II-15

Shared and differential neurocognitive mechanisms in obesity and binge eating disorder

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Individuals suffering from obesity and binge eating disorder (BED) repeat health-damaging decisions, a maladaptive behaviour associated with both enormous subjective suffering and high economic burden for health systems. Very recently, neurocognitive research employing task-based functional neuroimaging has begun to uncover deficits of these patients in making flexible goal-directed decisions. These findings largely originate from adult samples, but both disorders typically show a steep increase in prevalence during adolescence1, a period marked by profound changes in the cognitive processes thought to be clinically relevant. So far, the differential neurocognitive mechanisms of obesity and BED in adolescence and adulthood have not been studied systematically, despite there being an indication that neurocognitive markers could serve to foster our understanding of and distinguish between the disorders, and thus crucially inform therapeutically relevant decisions. In this study, we address this gap by investigating decision-making during functional neuroimaging in a cohort of adolescent and adult obesity patients with and without BED. We also assess working memory, the core capacity to maintain and update stimuli from the environment, as it can substantially interfere with the ability to act in goal-directed manner. Because alterations in dopaminergic signalling have previously been implicated in goal-directed decision-making as well as BED and obesity, we further probe whether inter-individual differences in our neurocognitive measures are associated with genetic proxies of prefrontal and striatal dopamine turnover. Finally, we seek to establish whether these measures predict clinical outcome at a one-year follow-up.

II-16

Task- based functional connectivity based classification of fibromyalgia using fNIRS

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Fibromyalgia (FM) is a chronic widespread painful syndrome that its underlying mechanism is still unknown. Its diagnosis is generally performed by using American College of Rheumatology criteria. However, reliability of this diagnosis based on these criteria is controversial due to depending tender point count and duration of pain sensation. In this study, 17 healthy controls and 19 age, gender and menstruation phase-balanced FM patients were participated to this study. We applied machine learning methods (SVM, k-nn, LDA) to extracted Functional Connectivity maps by using four different metrics (seed based correlation, cross-correlation with maximum lag, Dynamic Time Warping distance) from three different experiments. (1) Painful stimulation with TENS (2) median nerve stimulation with TENS (3) finger tapping task. Also, we utilized self-report data that includes right and left pain threshold and BDI score data to classify FM. After, this process we also combined the features extracted from FC maps of three different experiment and combined this new feature set with features that includes self report. Our results indicated that combined features extracted from FC maps and self-report together caused higher accuracy (% 97+/- %0,5) than other trained classifiers. These results revealed that both self-report and hemodynamic data can be used together to classify FM disease.

II-17

Differential effects of menstrual cycle and individual inhibitory control on activation and connectivity of the basal ganglia during a Stop Signal Task.

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Endogenous fluctuations of sex hormones along the menstrual cycle are known to affect women's brain and cognition, including inhibitory control. Response inhibition can be assessed with the Stop Signal Reaction Time (SSRT), used as a clinical index in several disorders and addictive behaviour. Subcortical structures, and specifically basal ganglia are involved in the regulation of the response inhibition and are known to change in structure, activation and connectivity along the different cycle phases. Therefore, we aimed to investigate the basal ganglia activation and connectivity patterns related to inhibitory control across the menstrual cycle.

Thirty-six naturally cycling women aged 18-35 y.o. were scanned three times (menses, pre-ovulatory and luteal), locked to their menstrual cycle. During each session they performed a Stop Signal Task in order to assess inhibitory control. Saliva samples were collected before and after the session to analyse hormonal levels.

We found changes in the activation and connectivity of the bilateral putamen across the menstrual cycle, dependant of the SSRT of women, and related to progesterone levels. During menses the BOLD-response was higher for women with longer SSRT compared to women with shorter SSRT; whereas during the luteal phase this pattern was reverted. Furthermore, this interactive effect was observed in the connectivity between the left putamen and the ACC, and between the right putamen and the left middle occipital gyrus. We suggest that across the menstrual cycle different mechanisms are involved in the control of response inhibition depending on women's individual inhibitory control and related to sex hormone levels.

II-18

The impact of sex hormones on reward sensitivity in women

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Oral contraceptives (OCs) are the most commonly used method to prevent pregnancy with more than 200 million users worldwide. Given recent alarming reports suggesting an association of depression with OCs, a better understanding of the mechanisms underlying this substantial psychological impact of synthetic sex hormone administration in young women is of critical interest. Accumulating evidence suggests that depressive symptoms are associated with major alterations within the brain's reward circuitry, which normally serves to guide our attention towards consumption of rewards. Endogenous sex hormones, i.e. hormones naturally fluctuating across the menstrual cycle, have been shown to significantly influence reward sensitivity: in particular fluctuating levels of estrogen. However, the impact of synthetic sex hormones, i.e. OCs, on reward sensitivity remains unclear. Because OCs modulate the internal hormone production, an influence of OCs on women's reward sensitivity is likely and is the overall aim of the here proposed project. Based on previous findings, we expect women taking combined OCs to show enhanced reward sensitivity compared to women not using OCs. Naturally cycling women are assessed during their periovulatory phase, i.e. when estrogen levels are high; in OC-taking women, estrogen levels will be down-regulated and thus, constantly low. To assess reward sensitivity, we use a value-based decision-making battery. We test our hypothesis (1) in a behavioural, cross-sec-

tional design, and then use insight from the behavioural study to build (2) a neuronal, longitudinal study design using fMRI. Here, we present first behavioural results together with an overview of the planned fMRI study.

Perception, Action, and Movement

II-19

The role of action-based and temporal predictability in sensory attenuation on a behavioural and neural level

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Sensory consequences of one's own action are usually perceived as less intense, and lead to reduced neural responses, compared to externally generated stimuli. It has been thought that this sensory attenuation is due to the efference copy. However, active and passive conditions differ not just with regard to the presence of the efference copy, but also in the temporal predictability of stimulus appearance, which could – at least partly – be responsible for the reported difference in stimulus processing. Here, we investigated the influence of both action based predictability and temporal predictability on the visual perception of stimulus intensity.

During fMRI data acquisition, participants had to judge which one of two visual stimuli was brighter. In active trials, participants caused the appearance of the stimuli by a button press. In the passive condition, the stimuli were presented automatically. In predictable blocks, the stimuli appeared temporally aligned with the button press (active) or aligned with an automatically generated cue (passive). In unpredictable block stimuli were presented with a variable delay after button press/cue respectively.

Self-generated stimuli were perceived darker and showed less neural activation in visual areas as their passive counterparts, indicating sensory attenuation for self-generated stimuli. An effect of temporal predictability was not found for either of the conditions or modalities. Therefore, our results do not support the claim that differences in temporal predictability are primarily responsible for sen-

sory attenuation in active vs. passive conditions. In our experiment, differences between conditions were primarily driven by action based predictive mechanisms.

II-20

P-centres, beats, and the rhythms of movement

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Many human activities can be characterised as precisely timed sequences of movements. Notable examples include speech, dance, and music-making, but complex temporal patterning emerges even during walking or doing chores. Rhythm, as this patterning is known, is increasingly regarded as fundamental to neurocognitive and behavioural function; however, the study of rhythm is largely transected by historical disciplinary boundaries, such as the demarcation between prosaic speech and music. In every-day life, these and similar distinctions are frequently either ignored or irrelevant. Rather, we combine spoken, musical, and dance rhythms; we repeat a phrase as though it were music to remember it later; and we draw on the flow of a spoken mnemonic to make sense of non-verbal movements (for example, a kick-boxing sequence). Despite this cross-domain blending and borrowing of rhythms, most empirical research has adopted a reductionist approach, studying speech, music, and other types of rhythms in isolation.

The current project is motivated to examine and compare how movements are timed within and across traditionally defined domains of human behaviour. Specifically, rhythm is conceptualised here as a basic property of motor planning and execution, one which is also integral to perceiving and understanding the actions of others, as well as many naturally occurring environmental stimuli. Within this framework, mixed methods (including behavioural and neurophysiological measures) and cross-triangulation strategies will be applied to better describe how various expressions of rhythm are alike or differ, and how humans may exploit regularities within such rhythms to anticipate, and coordinate their behaviour with, others.

II-21

The reciprocal relationship between eye blinks, perceptual changes and motor responses in the visual and auditory modality

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A co-occurrence between button presses and blinks has been reported repeatedly and this link seems to be influenced by cognitive factors. Additionally, perceptual changes have been ascribed to blinks mainly in ambiguous perceptual situations. The study at hand further investigates the relationship between perception, blinking and the motor act of responding. First, we compared blinking behavior in a temporal order judgement task (visual or auditory). While blinking was, as expected, higher in the auditory task, the temporal relationship between the trial timing and blinks was similar for the tasks in the different modalities. For auditory as well as visual tasks, blink rates were consistently increased after the offset of trials. Additionally, the blink rate was higher for those trials, which led to an incorrect response compared to a correct response. In a second step, we investigated the influence of blinking on the prevalent percept while viewing the ambiguous plaid stimulus. Our results show a tight temporal relation between a blink and a perceptual switch but only for switches to diamonds. The same effect was found for blanking of the screen, mimicking the visual input during blinking, however, the temporal evolution was different. A perceptual switch to stripe movements showed no link to blinks or blanks. This suggest a specific influence of blinking and blanking on the perceptual interpretation of ambiguous stimuli that goes beyond the undirected triggering of a perceptual switch. Overall, our results indicate that there is a reciprocal influence between the sensory input, the perceptual outcome and blinks.

II-22

Preferences for motor acts are matched for execution and observation in a subpopulation of F5

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The simulation theory posits that understanding the action of others is achieved by simulating observed actions with one's own motor system. Mirror neurons in premotor area F5 are seen as key players in this simulation network.
Although at the core of the theory, our knowledge of the degree of congruency of neuronal responses in F5 between observed and executed actions is quite limited. It is based on early studies performed in a naturalistic setting in which mainly responses to grasping, holding and releasing an object were considered. Recent studies of F5 mirror neurons have focussed on the role of a number of cognitive
variables while largely ignoring the potential relevance of them for the congruency of neuronal responses.
Here we report an experiment conceived to reassess the congruency with more rigorously controlled stimuli, differing with respect to the particulars of the motor acts involved while not differing in potentially confounding factors such as the visual properties of the object and the expected reward

II-23

The Influence of physical activity on psychophysical characteristics of the subject within virtual environment

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The significance of physical activities for the virtual environment trainings is a new and poorly studied field of scientific research which is potentially helpful for the future therapeutic and rehabilitation techniques. There is a sufficient number of clinical studies dedicated to the influence of moderate physical activity on psychophysical state of schizophrenia and dementia patients. However, there is very little evidence on any effects of the virtual environment trainings in healthy subjects. In this study, we evaluated the influence of physical activities on specific psychophysical characteristics of the subjects in two groups: (1) after a training course within virtual environment; (2) after a physical training course alone, using contrast sensitivity and evoked potential tests. We found a number of significant effects of the virtual environment trainings on psychophysical state of the subjects, whereas physical activities alone didn't show any impact. Our results clarify the view on the effects of physical activities on healthy population.

II-24

Measuring oscillatory behaviour of the primary visual cortex following saccadic eye movements

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A visual percept called 'phosphene' is a flash or flicker of light in the visual field which can be elicited by activation of the visual cortex by means of non-invasive brain stimulation. Phosphenes are perceived despite the absence of stimuli, i.e. in darkness. In this study, primary visual cortex (V1) excitability was tested by assessing the rate at which blindfolded participants perceived phosphenes during self-paced saccades.

Following the eye movements to the left or right, transcranial magnetic stimulation (TMS) was applied to V1 at 21 time delays (20-580 ms) after saccade onset. Participants then reported whether they perceived phosphenes or not. Eye movements were recorded using electrooculography alongside the behavioural data. The aim of this experiment was to investigate the excitability of the early visual cortex as indexed by phosphene perception rate and modulated by saccadic eye movements. Furthermore, by testing V1 excitability as function of the delay from saccade onset, we aimed at testing the role of brain oscillations in controlling sensory area activity during eye movements.

Memory and Attention

II-25

Tracking the impact of retrieval suppression on individual memory representations

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When we experience aversive events, these often turn into unwanted memories. Simple reminders can then trigger the involuntary retrieval of these memories. However, prior evidence indicates that we can intentionally suppress the retrieval process to prevent unwanted memories from entering awareness. Such suppression can render memories less vivid and eventually cause forgetting. Here, we test the hypothesis that retrieval suppression weakens memories by compromising their unique neural representations. In an fMRI study, Participants learned associations between reminders and aversive scenes. They were then repeatedly presented with the reminders. For some of these, participants were instructed to suppress the retrieval of the associated scene. Suppression was associated with increased activation in the right dorsolateral prefrontal cortex and a concomitant decrease in hippocampal and parahippocampal activation, a pattern that has been linked to the top-down inhibition of retrieval processes. Critically, we assessed the distributed activity patterns of individual memories (as a proxy for their neural representations) both before and after suppression. Using representational similarity analysis, we could thus track changes in the specificity of the

neural representations. We observed that memories became less vivid after suppression, and that a stronger decline in vividness was associated with a greater reduction in the specificity of memory representations in the parahippocampal gyrus. These preliminary results support the hypothesis that suppression deteriorates memories by compromising their unique neural representations.

II-26

Episodic simulations reveal the structure of affective representations in ventromedial prefrontal cortex

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The ventromedial prefrontal cortex (vmPFC) has been associated with mnemonic processing as well as with valuation. Here, we test the hypothesis that this region supports these seemingly disparate functions by representing affective associations of our environment. That is, we suggest that the vmPFC codes for elements from our environment (e.g., for personally familiar people and places) such that the representational geometry of those elements is determined by (i) the relative position of the elements within their network (e.g., how central a person is to an individual's social sphere), (ii) the degree of knowledge about those elements, and (iii) their affective value. To test this hypothesis, participants provided names of personally familiar people and places. They then arranged the names on a two-dimensional surface to indicate how strongly they associate these elements with each other (indexing degrees of centrality). Participants also indicated how familiar they are with each person and each place (indexing degrees of knowledge), and how much they like them (indexing affective value). We then aggregated centrality, familiarity, and liking to estimate the structure of participants' unique affective associative representations. In a following functional MRI session, participants vividly imagined interacting with each person and place, which allowed us to assess each element's neural representation. Using representational similarity analysis, we then examined the representational geometry of these elements. Preliminary analyses support our hypothesis: the structure of the neural representations in the vmPFC indeed seems to reflect the cognitive structure of the estimated affective representations.

II-27

Human-analogue resting-state networks in the dog brain

Szabó, D.[1], Czeibert, K.[1], Kettinger, Á.[2,3], Gácsi, M.[1,4], Andics, A.[1,5], Miklósi, Á.[1,4], & Kubinyi, E.[1]

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Resting-state networks are spatially distributed, functionally connected brain regions. Studying these networks gives us information about the large-scale functional organization of the brain and alternations in these networks are considered to play a role in a wide range of neurological conditions and aging. To investigate the evolutionary origin of resting-state networks' organization, we scanned 22 awake, unrestrained companion dogs and carried out spatial independent component analysis to explore whole-brain connectivity patterns. Using resting-state functional magnetic resonance imaging (rs-fMRI), we describe multiple resting-state networks in dogs, which closely resemble the pattern found in humans. Results showed high correspondence with the following human networks: default mode network (DMN), visual network (VIS), sensorimotor network (SMN), combined auditory (AUD)-saliency (SAL) network and cerebellar network (CER). The DMN, similarly to Primates, but unlike the previous studies in dogs, showed antero-posterior connectedness with involvement of hippocampal and lateral temporal regions. The level of similarity in the topology of human and dog resting-state networks suggests that the basic pattern for resting-state networks was already present in the brain of the Boreoeutherian ancestor, preceding the evolutionary split between ancestors of humans and dogs 100 million years ago. The results give us insight into the resting-state networks of awake animals from a taxon beyond rodents through a non-invasive method, supports the notion that resting-state networks are a well conserved aspect of brain functional organization, and introduces a new model species to rs-fMRI research.

Poster Session III

Wednesday, 27 June 17:30 – 18:45, Foyer MPI CBS

Poster Number	Speaker	Title
Neuroimaging Physics and Signal Processing		
III-01	Zarubin, G.	Development of a tACS-EEG closed loop system in order to understand and utilize the neuromodulatory role of tACS
III-02	Zoraghi, M.	An integrated approach to layer-specific analysis of multi-resolution MRI data
III-03	Jamshidi Idaji, M.	A novel framework for the detection of non-linear interactions in the human brain
III-04	Kalloch, B.	Semi-automated generation of individual surface-based computational models of the human head and torso from MR images
Language and Communication		
III-05	Tippmann, J.	Developmental changes in neuronal processing of irregular morphosyntactic rules during childhood
III-06	Villar González, P.	Brain lateralization of a whistled language
III-07	Sandoval, M.	To dub or not to dub - that is the question!
III-08	Tromp, J.	Combining virtual reality and EEG to study pragmatic language processing in a naturalistic environment
III-9	Shcherbakova, O.	Unconscious detection of verbal and non-verbal ambiguous stimuli

Poster Number	Speaker	Title
Social Cognition and Emotion		
III-10	Schleihauf, H.	Dual-mode model for over-imitation
III-11	Schliephake, L.	The role of the lateral geniculate nucleus in autism spectrum disorder
III-12	Verim, B.	The relationship between Theory of Mind (ToM) deficits and neurocognitive functions in euthymic patients with bipolar disorder
III-13	Swidrak, J.	The virtual midas touch in the ultimatum VR game
III-14	Tetereva, A.	Resting state functional connectivity of amygdala followed the extinction training after fear learning
III-15	Liu, T.	The role of arousal in pro-social behavior after exposure to relaxing music: Evidence with self-report and physiological measures
III-16	Langeloh, M.	Is learning all about Theta? Infants encode unexpected events at the 4 Hz theta rhythm
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Neuroimaging Physics and Signal Processing

III-01

Development of a tACS-EEG closed loop system in order to understand and utilize the neuromodulatory role of tACS

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We develop a closed-loop tACS-EEG system to better understand mechanisms of tACS and further increase effects by tuning adaptively parameters such as onset time, phase, amplitude, frequency and duration of the stimulation to each individual. Here we present our model with phase-locking in alpha band, phase prediction results from offline data and pilot experimental measurements. The system consist of following elements: EEG device, application in C++, DAQ device for transmitting stimulation signal, tACS device. Taking into account fast dynamics of alpha phase changes, we consider short intervals (<1 sec) for imaging and stimulation. The system runs in cycles: getting EEG data (imaging interval), extraction phase values and determining optimal phase shift for stimulation (optimization), sending signal (stimulation) through DAQ device on stimulator, inter-trial interval. We evaluated three different methods for phase prediction with two modes of stimulation – "In Phase", "Opposite Phase". The results are presented in terms of following measurements: "Relative accuracy" (based on relation to optimally possible stimulation), "Degree Deviation" (from optimal phase), "Phase Locking Value" (PLV) and "Phase Synchrony" (based on entropy). Optimization time (< 15 msec) allows applying methods in real time closed-loop experiments adaptively to alpha phase dynamic. Presented model is currently in a process of experiments on potential alpha-phase-dependent effects. According to work of Strüber et al., conventional tACS does not lead to any significant after effects within short intermittent procedure. Our further results from group of participants, should demonstrate whether phase-locked tACS with similar or another design can have substantial effects.

III-02

An integrated approach to layer-specific analysis of multi-resolution MRI data

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Cortical layers are believed to play an essential role in brain development and function, as well as connectivity. Studying growth patterns and layer organizations can provide us with more insight into the underlying diseases involving brain function. The cortical gray matter consists of 6 layers that differ in their cyto- and myeloarchitecture. High resolution Magnetic Resonance Imaging (MRI) has emerged as a non-invasive tool to investigate the myelo and cytoarchitecture of cortical layers in the human brain. However, due to the small thickness of the cortex (2-4mm) and layers with some regions thinner than 200 µm, it is not possible to resolve all layers directly by MRI as the highest achievable resolution by in-vivo methods are approximately 400um which is far from the required resolution for accurate layer characterization. As a consequence two or more layers will be present in each measured voxel which is termed partial volume effect (PVE). PVE remains as the main constrain for cortical layer investigations. Our goal is to extend existing methods for cortical layering by integrating complementary data-driven approaches and a refined biophysical model or cortical geometry into a common Bayesian framework.

The major goal is to build a probabilistic method for computing an intracortical coordinate system that integrates geometric information and measured signal intensities. A probabilistic framework will further allow us to quantify the uncertainty in different processing steps and use this information when estimating positions of layers in the cortex. Taking into account this uncertainty, that arises from imperfect image segmentation, registration, and distortion correction etc., will improve the reliability of subsequent analysis. It will allow us to compute robust pre-layer statistics by weighing down from regions with less accurate information. We further modify the geometric model used in the estimation of cortical layering, by modeling the cerebral gray matter as a hyperelastic material.

III-03

A novel framework for the detection of non-linear interactions in the human brain

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Cross-frequency neuronal interactions reflect a mechanism through which brain can integrate information distributed across different frequency ranges. There is, however, a lack of methods decomposing the data into interacting components. We propose a novel framework for detecting such interactions in Electro- and Magnetoencephalography, which we refer to as Nonlinear Inter- action Decomposition (NID).

The linear mixture of two non-linearly dependent gaussian processes is non-gaussian. Bene- fiting from this fact, our proposed method is able to untangle non-linearly interacting sources of linearly mixed signal and is used for extracting cross-frequency coupled sources in EEG data. The algorithm performs dimensionality reductions, e.g. with Spatio-Spectral Decomposition. Projected components are then used for maximizing the non-gaussianity of their weighted sums through In- dependent Component Analysis, in order to find cross-frequency coupled pairs.

We have tested our method with simulated 64-channel EEG obtained with realistic head modeling. Our algorithm leads to the reliable extraction of interacting components even with SNR of -10db, with different number of pairs. In this case, the median error over 1000 runs is < 0.05.

Former methods in this context optimize a function of phases/amplitudes of the two frequencies. Our method, however, introduces a novel framework for detection of cross-frequency interactions, in the sense that it has no assumption about the kind of coupling, but only about the sources being non-linearly coupled. Thus, it can detect various forms of cross-frequency coupled sources at different frequencies. Importantly, the algorithm can be generalized for finding triplets of the interacting components.

III-04

Semi-automated generation of individual surface-based computational models of the human head and torso from MR images

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Computational modeling studies become increasingly important in human brain sciences since they allow examining mechanisms or properties which would be impossible to investigate in-vivo. The models employed in these studies include complex geometries that can resemble the actual shape of human tissue very closely and therefore enable to study inter-subject variability or explore specific anatomical phenotypes. We introduce a processing pipeline for creating individualized surface-based models of the human head and torso from MRI data. All steps from image acquisition, segmentation to generation of triangulated surfaces of the segmented tissues are covered. We segment scalp, skull and enclosed air cavities, CSF, gray matter (GM), white matter (WM) and the ventricles from a 3D gradient-echo (GE) scan of the subject's head in a fully automated manner. A separate segmentation of the body includes the spinal cord, CSF, bones, lungs and a merged class of all other tissues and is obtained from multiple consecutive 2D GE scans of the head and torso. Segmentation images are post-processed to correct segmentation errors, ensure a continuous external boundary and eliminate the boundary to the adjacent internal structure where physiological reasonable, yielding so called segmentation masks. Finally, surface triangulations of the single boundaries of these masks are obtained. The resulting surface-based models represent individual differences well and are suitable for further use in simulation software.

Language and Communication

III-05

Developmental changes in neuronal processing of irregular morphosyntactic rules during childhood

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Processing of regular and irregular verb inflection is subject to developmental changes. Dual-Route models describe a systematic rule application for regular verb inflection and unsystematic lexical entries in the mental lexicon for irregular verbs (Regel et al., 2015). The question arises whether more lexically oriented or syntactically based processing mechanisms are active in such a context. By using event-related brain potentials (ERPs), Opitz et al. (2013) report a modulated ERP-response to a stepwise violation of irregular verb forms in adults, concluding that subregularities are computed in the morphosyntactic processing system. We investigate whether children show the same ERP-responses to gradually incorrect forms as reported for adults and from which age onwards these morphological principles are internalized. 6-7- and 8-9-year olds listened to inflected, irregular German verbs embedded into natural sentences including a correct version of the past tense, a partially consistent, and a not attested version. The older age group shows an adult-like P600 component suggesting morphosyntactic processes. The largest amplitude was visible for the partially consistent condition and not for not attested inflections as in adults. Younger children show a parametric modulation manifesting in a broad negativity. These findings indicate that younger children might have not yet internalized the morphosyntactic rule and instead proceed with a more lexically oriented processing while older children already initiate adult-like mechanisms.

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III-06

Brain lateralization of a whistled language

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Left-hemispheric language dominance is a well-known characteristic of the human language system; however, this dominance decreases dramatically when people communicate with a whistled language. Whistled languages present a transformation of a spoken language into whistles, facilitating communication over great distances. In order to investigate the laterality of Silbo Gomero, a form of whistled Spanish, we used a dichotic listening task in a sample of 75 healthy Spanish speakers separated into three groups according to whistle experience: a non-whistling control group, a learners group and an advanced whistlers group. All three groups showed clear left hemisphere dominance for the recognition of spoken syllables. However, this dominance was drastically reduced for whistled syllables, reaching hemispheric symmetry in advanced whistlers, but still showing leftward asymmetry in the learners group. This finding supports the idea that whistled languages alter brain asymmetries, but shows that experience plays an important role in this process.

II-07

To dub or not to dub - that is the question!

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Behavioural research has shown that foreign language users make substantially more utilitarian decisions when presented with moral dilemmas in a second language (L2). This might be due to a reduced emotional response elicited by the foreign language, even when proficiency levels are high. Neuroscientific evidence argues for the existence of two independent networks which seem to work in parallel: one that is characterized by ventral ACC, associated with moral and emotional judgments; and another network represented by left ventro-

lateral PFC (Broca's area) and dorsomedial/dorsal ACC, associated with utilitarian judgements. This pattern of brain activations coincides with the areas involved in L2 processing; imaging studies on L2 processing show an overlap between language regions and regions of utilitarian judgements.
This pilot study investigated, with fMRI, whether emotional processing differed between a native and a foreign language. We used emotional (funny) and neutral clips extracted from the TV series Silicon Valley in participants with an advanced level of English. This was done in an attempt to simulate conditions in movie theatres where original versions are screened, so as to approach the debate about the appropriateness of dubbing films or screening them in the original version with subtitles. We hypothesised a reduced engagement of regions associated with emotional processing such as insula and ACC as well as more activation of semantic processing while watching English funny videos. We found that funny videos in an L2 activated less brain regions associated with emotional processing in favour of the recruitment of more cognitive areas.

III-08

Combining Virtual Reality and EEG to study pragmatic language processing in a naturalistic environment

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In natural conversation we often mean something more than what we literally say. For example, if the sentence "My soup is cold" is spoken to a waiter in a restaurant, the waiter might understand this as a request to warm up the soup, rather than just a literal remark about the soup. We used Virtual Reality (Experiments 1 & 2) and EEG (Experiment 2) to investigate how people use context to understand indirect meaning.
In both experiments, participants were immersed in a virtual restaurant with virtual restaurant guests that produced either a possible indirect request (e.g., "My soup is cold") or a control statement (e.g., "My soup is nice"). Additionally, participants were assigned a role before the start of the experiment, namely to be a waiter or a restaurant critic. This was done by means of a short instruction and a mirror in the virtual restaurant, in which participants saw themselves in the outfit appropriate for the role. The task of the participant was to briefly reply to what the restaurant guest said.

The results of both experiments revealed that waiters understood the possible requests as request and the statements as statements, while the restaurant critics understood both sentence types as statements. In addition, Experiment 2 revealed a difference in the electrophysiological brain response during sentence processing depending on whether the participant was a waiter or a restaurant guest in the experiment. Finally, we demonstrated the feasibility of using VR to study language processing in a more naturalistic environment.

III-09

Unconscious detection of verbal and non-verbal ambiguous stimuli

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Ambiguity plays an important role in our cognitive experience. Since the 1980s, the neural bases for the perception of ambiguous information have been investigated but remain poorly understood. This experiment aimed to understand the relationship between the error related negativity (ERN) component arising from jokes and ambiguous figures mistaken for non-humoristic texts and non-ambiguous figures.

Fourteen participants went through two similar experimental procedures with 36 ambiguous and 36 non-ambiguous figures; 14 verbal jokes and 14 similar but non-humoristic short stories. Firstly, participants were presented with figures of both types and asked to identify whether each figure was ambiguous or non-ambiguous. We recorded ERPs that were time-locked to each answer about ambiguity/non-ambiguity of the figure presented. Secondly, participants were presented with the verbal stories and asked to identify whether each story was a joke/non-joke. In this case, ERPs were time-locked to each answer about the key phrase of a joke/non-joke presented word-by-word on the computer screen after the whole text.

We found an increase of the ERPs' negativity in ambiguous figures that were mistaken for non-ambiguous ones in the ERN time window (Fz ($F(3,622) = 12,6$; $p < 0.00$) and Cz ($F(3,625) = 6,96$; $p < 0.00$)). The results revealed no increase of the

ERPs' negativity in verbal jokes that were mistaken for non-jokes in the ERN time window; they show that participants appeared to be sensitive (without awareness) to ambiguous figures that were identified as non-ambiguous ones. The level of this unconscious sensitivity is eflected by the increases in negativity.

Social Cognition and Emotion

III-10

Dual-mode model for over-imitation

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Children and adults tend to imitate actions that are irrelevant to accomplishing a goal, they "overimitate". It has been discussed that humans overimitate either because of erroneous causal reasoning, meaning that they do not recognize demonstrated actions as being irrelevant or because of social motivations, e.g., because they want to follow a norm or want to affiliate with the demonstrator. Recent findings give reason to think that one of these accounts standing alone is insufficient to explain the phenomenon. Therefore, I would like to introduce a dual-mode model for overimitation. One the mode of blanket copying, irrelevant actions are copied independent of contextual differences. While copying in a blanket fashion, children copy irrelevant actions without questioning their necessity. This mode is triggered by actions which involve physical contact with the testing object, because it is harder to recognize such actions as being irrelevant. In the mode of reflective copying, copying of irrelevant actions is context depended. If children overimitate is dependent on their goals in a certain situation. This mode of copying is triggered by actions that do not involve physical contact with the testing object are therefore easily recognized as being causally irrelevant. According to this integrative framework, overimitation can occur with different underlying motivations.

III-11

The role of the lateral geniculate nucleus in autism spectrum disorder

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Most neuropsychological theories and experiments focus on social and motivational processes to explain the communication deficits in Autism Spectrum Disorder (ASD). However, ASD is also associated with visual sensory deficits, including difficulties with the perception of motion or with the aggregation of local elements into a global whole. The neurobiological mechanisms of these visual sensory deficits and their relation to communication functions in ASD are unclear. The central aim of my PhD thesis is to test the hypothesis that visual sensory deficits in ASD might result from a dysfunction of the lateral geniculate nucleus (LGN). The LGN is part of the visual pathway and operates as relay station between retina and visual cortex. To investigate whether ASD is associated with an LGN dysfunction and to further characterise the nature of such a dysfunction, I will first deploy ultra high-field functional magnetic resonance imaging (fMRI) and paradigms designed to precisely map the LGN and its subdivisions. Second, I will use diffusion-weighted imaging (dMRI) to test whether the fibre-pathways between LGN and visual motion areas (i.e. V5) are altered in ASD. Third, I will administer a comprehensive neuropsychological test battery to investigate how the potential fMRI and dMRI differences relate to visual sensory dysfunction in ASD. This study represents a first step in the direction of understanding the role of subcortical sensory structures, such as the LGN, in ASD and might challenge existing theoretical approaches that assume higher-order and cerebral cortex processes to be responsible for visual and communication impairments in ASD.

III-12

The relationship between Theory of Mind (ToM) deficits and neurocognitive functions in euthymic patients with bipolar disorder

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Introduction: Bipolar disorder (BD) is a chronic psychiatric illness associated with social and neurocognitive impairment. Social cognition has been shown to exert a mediating role between social functioning and cognitive functions. However, the relationship between neurocognition and the two aspects of social cognition, the mental state decoding and the mental state reasoning in BD is yet to be explored.

Methods: Performance on measures of neurocognitive and theory of mind (ToM) tests was investigated among 24 euthymic patients with BD (mean age: 42.33 ± 10.12 years; mean education: 13.08 ± 3.3 years; 66.6 % females). ToM assessment instruments were the "Reading the Mind in the Eyes Test (RMET)" which is known as a mental state decoding task and the "Hinting Task" as a mental state reasoning task. Participants also underwent a series of neurocognitive tests assessing executive functions, verbal, visuospatial and working memory, psychomotor speed, response inhibition, attention and information-processing speed. The correlation between social and neurocognitive test performances was assessed using Pearson's correlation analysis.

Results: The "Hinting Task" performance was significantly correlated with performance in verbal memory, response inhibition, attention and executive functions domains whereas the "RMET" correlated significantly with categorical fluency, short-term memory and capacity for information processing domains in addition to the abovementioned neurocognitive domains.

Conclusions: Our results show that both mental state decoding and reasoning are significantly correlated with neurocognitive performance in a wide range of domains in euthymic BD patients which points at the importance of neurocognition in social cognition, therefore social functioning.

III-13

The virtual midas touch in the ultimatum VR game

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The Midas touch effect is a well-known social influence technique - touching briefly one's arm increases compliance to requests. We developed a new, fully immersive version of the ultimatum game to verify whether a virtual human's touch can influence behaviour in the same say as a real human's touch does. We found out that:

1. Participants playing Ultimatum VR were behaving similarly to the classical version of the game.
2. Virtual interpersonal touch increases immediate compliance, but not delayed generosity.
3. The psychophysiological reaction (facial EMG, HR, EDA) to touch was different for low- and high-status virtual humans.
4. The illusion of embodiment of a virtual body increases the effect of touch.

III-14

Resting state functional connectivity of amygdala followed the extinction training after fear learning

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Functional connectivity (FC) of amygdala changes after fear learning (FL). Several fMRI studies showed increased FC of amygdala in the resting state (RS) after differential protocol of fear conditioning. Our aim was to describe possible changes in FC of amygdala after multi-cued differential protocol of FL and immediate extinction training in RS across 1 week after fear learning.

Fourteen (24,5±4,36; 4 f) healthy right-handed voluntaries participated in the study. All they took part in five sessions of fMRI acquisitions (T2*-weighted EPI (300 volumes, TR = 2 s, TE= 20 ms, 42 slices, slice thickness - 2.6 mm, FoV-200 mm, matrix size- 98x98): 1) RS before FL, 2) fear extinction, 3) RS after FL, 4) RS after in

24 hours, and 5) RS in 7 days. We analyzed fMRI activation during fear extinction and FC of the left and right amygdala seeds with voxels of the whole brain and compared values of FC between sessions.
We found increased activation in the right amygdala and several cortical areas replicating the previous findings of fMRI studies on FL and extinction. Remarkably, FC of the left amygdala with limbic structures was more stable in 7 days after FL and extinction than immediately after and in 1 day after FL.
Unlike as it was shown in the previous studies, our data indicate that FC of the left amygdala during RS persisted and even increased in one week after fear learning and extinction training.
Research is supported by the Russian Science Foundation grant №16-15-00300.

III-15

The role of arousal in pro-social behavior after exposure to relaxing music: Evidence with self-report and physiological measures

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Previous research has shown that the arousal plays an important role in human beings' pro-social behaviors, according to the framework of the General Learning Model and Tend and Befriend Theory. The current study explores how relaxing-music influences people's arousal level in different stressful situations and the later pro-social behaviors. A 2 (with or without stressful situation) * 2 (with or without relaxing-music) * 2 (male or female) between-subjects design experiment was conducted. Overall, fifty-five students participated in the study while each participant was randomly assigned to one condition. The arousal level has been tested by both self-report and physiological measurement. The pro-social behavior was measured by a spontaneous helping task. Results indicate that the stressful situation increased self-reported and physiological arousal as well as fostered pro-social behavior. On the contrary, exposure to relaxing music led to fewer self-reported and physiological arousal as well as decreased pro-social behavior. However, gender difference was not observed. Mediational pathways showed that only self-reported arousal fully mediated the relationship between different conditions and pro-social behaviors. Theoretical and practical implications of findings are discussed, and recommendations have been made for future research.

III-16

Is learning all about Theta? Infants encode unexpected events at the 4 Hz theta rhythm

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Infants form representations about the physical and social world from very early on (Spelke & Kinzler, 2007). Their expectations are commonly measured by behavioral responses to violations of expectations (VOE; e.g., in looking times). VOE offer a special learning opportunity and increase infants' information-seeking and exploration behavior (Stahl & Feigenson, 2015). Yet, the neuronal learning mechanisms in the infant brain are poorly understood.

Here, we look at infants' brain responses when observing unexpected outcomes to test learning. We presented 9-month-olds (N = 33, 14 girls) with sequences of four core knowledge domains (social action, number, solidity and cohesion) demonstrating a physically or socially expected or unexpected outcome (e.g., food is put on the head instead of in the mouth). We flickered these sequences at infants' Theta (4 Hz) or Alpha frequency (6 Hz, control condition).

Specifically, we selected the Theta and the Alpha rhythm to elucidate the functional role of these frequency bands by entrained steady state visually evoked potentials (SSVEPs) responses.

We found an increase in Theta SSVEP power for unexpected compared to expected outcomes, $t(32) = -2.53$, $p = .017$, but no effect in Alpha SSVEP power, $p = .928$. Thus, we provided first evidence for a functional role of the 4 Hz Theta rhythm in infants' encoding of unexpected events potentially reflecting a learning mechanism elicited for novel, unexpected outcomes. Furthermore, we showed that SSVEPs are a robust measure to investigate the functional role of neuronal rhythms in infants' learning by rhythmic visual brain entrainment.

III-17

Can a nine-month contemplative mental training intervention increase your lifespan?

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Telomeres - protective nucleotide sequences located at the tips of chromosomes - have gained interest as a marker of our biological lifespan. Telomeres shorten with each cell division, which is considered a key mechanism underlying the cellular aging process, since shorter telomeres are linked to increased disease and mortality rates. Recent research suggests the possibility of maintaining telomere length (TL) through contemplative practices: healthy long-term meditators have longer telomeres than age-matched controls, and four- to eight-week-long mindfulness-based training interventions were found to slow telomere shortening in recovering cancer patients and even increase TL in healthy participants. However, particularly the intervention-based findings rely on short interventions compared to long-term meditation, and comprise relatively small sample sizes. As part of the large-scale longitudinal ReSource Project, we investigated in 332 healthy, middle-aged (40.7 +/-9.2 years) participants whether three types of 3-month-long training modules focusing on attention, compassion, or perspective-taking had differential or cumulative effects on TL. As expected, participants showed shorter telomeres with increasing age. Additionally, we found a novel negative association between self-reported physical complaints in the "Freiburger Beschwerdenliste" (FBL) and TL. We did, however, not observe any training-related change in TL over the course of the 9-month study period. These findings suggest that in a healthy population, it may take longer or more intense training before contemplative practices affect TL, as observed in long-term meditators. In the next steps of this project we will investigate whether TL can predict age-related differences in brain structure.

Clinical Neuroscience

III-18

PRESS & MEGA-PRESS: Proof of Concept for Imaging GABAergic & Glutamatergic Metabolism at 3T

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Micro dialysis-findings in animals, as well as data from healthy humans and stroke patients provide evidence for a role of monoaminergic facilitation of motor learning. However, most of this effect has been attributed to noradrenaline and dopamine. Despite several lines of evidence indicating an important role of serotonin for improving motor function in rodents, healthy humans and stroke patients, this is more controversial. Nevertheless, a possible mechanism for serotonin to modulate motor function has been proposed to occur via neuroplasticity. This may potentially take place via altered GABA and glutamate signalling. This suggests that a change in intrinsic excitation and inhibition may be underlying this effect. In order to test this, we aim to use both Point Resolved Spectroscopy (PRESS) and Mescher-Garwood PRESS (MEGA-PRESS) to quantify the effects of escitalopram administration on glutamate and GABA concentrations respectively, in both the primary motor (M1) and anterior cingulate (ACC) cortices. Using MEGA-PRESS, we expect a decrease in GABA in M1 and, using PRESS, an increase in glutamate in the ACC and M1.

III-19

Integrity of neurocognitive networks in dementing disorders as measured with functional and metabolic neuroimaging

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Functional magnetic resonance imaging (fMRI) studies reported altered integrity of large-scale neurocognitive networks (NCNs) in dementing disorders. However, findings on specificity of these alterations in Alzheimer's disease (AD) and behavioral variant frontotemporal disease (bvFTD) are still very limited. Since recently, NCNs can be also captured using positron emission tomography with F18-fluordesoxyglucose (FDG-PET). Here, we measured integrity of NCNs in AD and bvFTD using simultaneous imaging with fMRI and FDG-PET. In either modality, an independent component analysis revealed four major NCNs: the anterior default mode network (aDMN), posterior DMN (pDMN), salience (SN) and right central executive network (CEN). For each fMRI-based network, we quantified a goodness-of-fit to standard network templates. For PET-based networks, a so-called loading coefficient, a degree of network expression in each subject, was calculated. Thus, indices of network integrity were available for each subject, network, and imaging modality. In fMRI data, integrity of the pDMN was found to be significantly reduced in both the AD and bvFTD groups relative to controls. In the AD group the aDMN and CEN appeared to be additionally affected. In the PET data, only integrity of the aDMN in AD was reduced, while three remaining networks appeared to be affected only in bvFTD. A correlation between fMRI- and FDG-PET-based indices of network integrity was low (max. r=0.33). Thus, fMRI and FDG-PET capture partly different aspects of network integrity. A higher disease specificity of NCNs as measured with PET data supports a valuable role of metabolic imaging in the field of brain connectivity.

III-20

Effects of child maltreatment on adolescent brain structure and function: Roles of threat and deprivation

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Childhood maltreatment gives rise to numerous deleterious physical and psychological sequelae. Despite ample evidence for various structural and functional brain alterations following maltreatment, much heterogeneity exists in the specific brain regions detected across studies. Recent theory proposes that this heterogeneity derives from the distinct influence of two maltreatment dimensions: threat and deprivation. To test this theoretical prediction, we will conduct a structural and functional magnetic resonance imaging study with 80 maltreated adolescents aged 12-15 years and 40 age- and gender-matched non-maltreated controls (N=120). The participants will perform a reversal learning task assessing cognitive flexibility in two motivational contexts, reward versus punishment, as well as a social exclusion paradigm ("Cyberball") testing neural correlates of social rejection. Participants' maltreatment experiences will be examined using child- and parent-reports and Child Protection Services records (if applicable). With this research project, we aim to contribute to a better differentiation between global and dimension-specific effects of maltreatment on adolescents' brain structure and function. At the 8th IMPRS NeuroCom Summer School we will present the detailed procedure of the study proposed above.

III-21

Mechanisms of body weight gain in patients with Parkinson´s disease after deep brain stimulation: A study design presentation

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Background: Deep brain stimulation (DBS) of the subthalamic nucleus (STN) is a highly effective treatment for managing motor symptoms of advanced Parkinson's disease (PD). As a side effect, a remarkable weight gain has been consistently reported after STN-DBS, which - at least in part - counteracts the positive effects of motor improvement following this treatment. The aim of this study is to prospectively assess the underlying pathophysiological mechanisms of body weight gain after STN-DBS, while focusing on interactions between mechanisms, especially in the context of brain-adipose tissue-crosstalk.
Design: Fifteen subjects undergoing STN-DBS (n=15) will be assessed before (T0) and repeatedly at 3 (T1), 6 (T2) and 12 (T3) month post-surgery. For control purposes, PD patients not undergoing STN-DBS (n=15) and healthy subjects (n=15) will also be enrolled in this study and assessed to corresponding time points (T0-T3). At T0 and T2 the following parameters will be assessed: body composition, resting energy expenditure and energy expenditure during walking, gait analysis and balance. Impulsivity and the neural response to food and neutral stimuli are being assessed by means of functional magnetic resonance imaging and electroencephalography. In addition, comprehensive analyses of glucose homoeostasis, hunger and satiety regulating hormones, thyroid hormones and hormones of the HPA axis will be performed both, in serum and cerebrospinal fluid.
Outlook: Our study will promote a better understanding of the pathogenesis of body weight gain in PD following STN-DBS and could provide the basis for future development of tailored therapies to prevent obesity and metabolic disorders after surgery.

III-22

Hormone-mediated network changes driving depression susceptibility across the female lifespan

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Estrogen and progesterone undergo major fluctuations across the female lifespan. While several studies have shown an association between changes in mood and ovarian hormone levels, we lack a detailed understanding of the specific neurobiological mechanisms underlying the relationship between mood and hormonal transitions. We aim to explore the interplay of ovarian hormones and brain structural and functional connectivity, and the subsequent effects on mood and cognition. Specifically, we use the Leipziger Research Center for Civilization Disease (LIFE) dataset to build a model of these interactions, and then use the Leipzig Study for Mind-Body-Emotion Interactions (LEMON) cohort to replicate and validate this model. Our preliminary findings already reflect a protective role of estrogen and progesterone on grey matter network organization. We will use the insight gained from these analyses to build a longitudinal model to investigate causal mechanisms in perimenopausal women. Perimenopause is defined by extreme fluctuations in estrogen, and this period is associated with an elevated risk of depression. Fluctuations in estrogen have also been linked to excessive weight gain, particularly in terms of visceral adipose tissue (VAT)—a decisive risk factor for inflammation, grey matter atrophy, and cognitive decline. If we understand the causal mechanisms behind hormone and brain changes in perimenopause, this will present a powerful opportunity to intervene before a vulnerable state develops into a diseased state in later life. This work will have fundamental implications on future intervention and prevention research, especially in how to design and individualize treatment during specific times of hormonal transitions.

III-23

Increasing ecological validity in neuroscientific measurements

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Ecological validity of neuroscientific measurements can be increased by more realistic measurement contexts. Functional near-infrared spectrocopy is a method contributing to this development by measuring cortical hemodynamics in subjects with natural body positions (e.g., sitting or standing) and allowing small movements. This is highly relevant when context effects affect the outcome measures, e.g., during extinction learning. Investigations on extinction learning are relevant for substance use disorders to increase efficacy of interventions for relapse prevention. We analyzed extinction learning in terms of an in vivo smoking cue-exposure in smokers and non-smoking control participants. The results revealed a significant increase of functional connectivity between OFC and dlPFC in smokers. In a subsequent study, we additionally observed effects of transcranial direct current stimulation on functional connectivity. The results of the presented studies have implications for current developments in neuroscientific paradigms and therapy of substance use disorders, which will be discussed accordingly.

Memory and Attention

III-24

Neural correlates of verbal working memory: An ES-SDM meta-analysis

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Working memory (WM) is a cognitive system for temporarily maintain and process information. Numerous functional neuroimaging studies addressed the neural correlates of WM. However, there is little agreement on specific aspects, such

as the representation of verbal stimuli, or task-effects on neural organization. The aim of this study was to conduct a coordinated-based meta-analysis over 42 fMRI studies on verbal WM in healthy subjects. The studies were obtained after an exhaustive literature search on PubMed, ScoPus, Web of Science, and Brainmap database. We analyzed regional activation differences during fMRI tasks with the anisotropic effect-size version of seed-based d mapping software (ES-SDM). The results were further validated by performing a jackknife sensitivity analysis. We investigated the effects of numerous influencing factors by fitting corresponding linear regression models. The main effect (i.e., verbal WM) demonstrated consistent activation of a bilateral fronto-parieto-cerebellar network, the left insula and right putamen and right globus pallidus. Meta-regression analyses showed that age and reaction time of the performance was associated with the grey matter changes in the whole-brain meta-analysis in some brain regions. No such effects were found for task type or gender. In sum, present results corroborate the involvement of fronto-parieto-cerebellar networks as well as the basal ganglia in verbal WM processing and demonstrate the relevance of specific influencing factors which future studies may take into account when it comes to study design and result interpretation.

III-25

Do conditioned threat responses generalize according to pre-existing relational organization of episodic memories?

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Threat memory acquired via Pavlovian conditioning can integrate with pre-existing memories leading to generalization of conditioned threat responses. For example, stable organization of semantic memory affects threat generalization such that transfer of conditioned threat responses is preferential to exemplars of the same category as the cue paired with the aversive event. Here, we investigate whether pre-existing episodic-like memory organization, where neutral cues are

differentiated as more or less related to one another, selectively promotes threat generalization.
Participants are trained to associate novel and perceptually dissimilar images with one another to form a linear associative memory graph. The next day, they are threat conditioned to two stimuli located at the opposite ends of the memory graph where only one of the stimuli is paired with electrical shocks. In a subsequent generalization test, they are exposed to all images from the memory graph while their skin conductance and pupil diameter are collected to measure conditioned threat responses. We predict that the closer a stimulus is on a memory graph to the stimulus predicting electrical shock, the higher the conditioned threat response.
Threat generalization due to the pre-existing organization of episodic memories would suggest that generalization is an active process of learning and memory that integrates aversive experiences with memory for the stable structure of one's environment. Detecting potential danger based on a map-like memory representation might be a mechanism by which (mal-)adaptive fear is expressed.

III-26

Attention performance in dyads: Insights from dual-EEG

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Humans are constantly engaged in similar tasks in the presence of other performing individuals, often paying attention towards the same location with them. It has been suggested that attending to the world with others could have a special importance for us, enhancing performance in general (e.g. Shteynberg, 2015). However, this may not be always the case. Previous evidence has suggested that when two persons (a dyad) paid attention to the same spatial location in a sustained visual attention task (dual attention), the attention effect was reduced in reaction times (He & Avendaño Diaz, in prep.). Dual-EEG data recorded from 32 participants performing the same dual-attention task suggested that the attention effect was enhanced at the sensory level (P1 component), and that the reduced attention effect in behaviour was the outcome of a top-down cognitive control process (N2b component). Further analyses examined the alpha band

activity (8-14 Hz) at posterior lateral electrode sites. Our data replicated past research by showing reduced alpha activity over the posterior region contralateral to the attended location (Sauseng et al., 2005). This suppression, however, was significantly weaker around 200-350ms, when the dyads directed attention towards the same spatial location than towards different locations. We speculate that the changes in the induced alpha activity across attention sharing conditions could be a result of higher-order prefrontal processing, and that the overall attention reduction effect could be driven by a feedback process from prefrontal to parieto-occipital areas. This discussion will be complemented by ongoing intra and inter-brain connectivity analysis.

III-27

Probing cortical excitability with somatosensory evoked potentials

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Cortical excitability varies over time affecting stimulus perception in the visual, auditory, and somatosensory domain. This leads to variability in perception of identical stimuli, pointing to the existence of so-called "perceptual cycles" and "windows of opportunity". These phenomena are typically investigated analyzing oscillatory patterns in EEG and MEG data, such as pre-stimulus power spectra as well as oscillatory phase before stimulus onset.
However, the analysis of oscillatory activity lacks the direct link between ongoing brain activity and cortex excitation. Therefore, we propose a new (complementary) approach to observe changes in cortical excitability over time, by probing the ongoing brain activity with somatosensory stimuli (i.e., median nerve stimulation). The N20 component of the somatosensory evoked potential (SEP) in the EEG reflects the first excitatory post-synaptic potentials (EPSPs) arriving from the thalamus to the cortex thus giving us a direct measurement of cortex excitation when the stimulus enters primary sensory areas. As pilot recordings showed, fluc-

tuations in the N20 amplitude can be consistently observed on single-trial level applying canonical correlation analysis These N20 amplitude fluctuations were characterized by long-lasting auto-correlations which are consistent with the hypothesis that neuronal circuits in primary somatosensory areas operate at the critical state.

We plan to establish this new method in no-task conditions ("resting-state") as well as in selective attention tasks to shed new light both on natural rhythms of cortical excitability and on its potential modulation by higher cognitive processes.

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