



Seventh International Conference on the
FUNCTIONAL ARCHITECTURE OF MEMORY
20th-22nd May 2026

SPEAKERS

Nora Abrous (Neurocentre Magendie, Bordeaux Univ., FR)
Jozsef Csicsvari (Inst. of Science and Technology, Klosterneuburg, AT)
Svenja Brodt (MPI Tübingen, DE)
Paul Frankland (SickKids/Univ. of Toronto, CA)
Lisa Genzel (Donders Centre for Neuroscience, Nijmegen, NL)
Marion Inostroza (University of Tübingen, DE)
Pierre Lavenex (University of Lausanne, CH)
Anne Maass (DZNE/OvGU Magdeburg, DE)
Hannah Monyer (DKFZ/Heidelberg Univ. Hospital, DE)
Rosanna Olsen (The Rotman Research Institute, Toronto, CA)
Stefan Remy (Leibniz Inst. for Neurobiology/OvGU Magdeburg, DE)
Magdalena Sauvage (Leibniz Inst. for Neurobiology/OvGU Magdeburg, DE)
Noam Shemesh (Champalimaud Found., PT /Weizmann Inst. of Sci., ISR)
Menno Witter (Kavli Inst./NTNU, Trondheim, NO)
Motoharu Yoshida (Leibniz Inst. for Neurobiology/DZNE Magdeburg, DE)

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Sponsors

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General information

1. Registration/ Badge pick-up

The check-in for the conference and the respective badge pick-up on May 20th starts at 8:30 am.

2. Venue



Address:

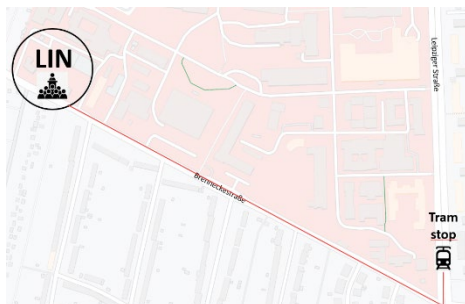
Leibniz Institute for Neurobiology (LIN)
Brenneckestr. 6
39118 Magdeburg

Coming by car:

Coming from Berlin or Hannover via A2 use exit *Magdeburg-Zentrum* and follow the city highway. Use the exit *Leipziger Straße*, choose left lane and then follow the road for around 600m.

Coming from Halle/Leipzig via A14 exit at *Magdeburg-Sudenburg/Magdeburg-Zentrum* and follow the city highway. Use the exit *Leipziger Straße*, choose right lane and then follow the road for around 600m.

Public transport from the main station:



From Magdeburg main station use the tram station *Hauptbahnhof/Willy-Brandt-Platz* and take the tram line 9 (direction: *Reform*). Get off the tram at stop *Brenneckestraße* (12 min drive). Turn right and take a 10 min walk along *Brenneckestraße* to the institute's yellow brick building. Tram routes and tickets are available via the app FAIRTIQ.

3. Wifi

Eduroam
LIN-Conference (Access Code: meet@LIN)

4. Lunch

During the breaks, snacks and coffee will be provided. There is also a vending machine in the Atrium of the LIN where you can purchase snacks, coffee etc. Alternative options are either on the campus of the University Hospital or in walking distance (10min).



5. Students/speakers sessions 1pm (50 min)

Each day after lunch students and postdocs (no PIs) have the opportunity to get feedback from the speakers of the day. We strongly encourage students to take advantage of this unique opportunity to ask the questions they never 'dared' to.

6. Conference Dinner (Thursday May 21st; 7pm)



The conference dinner will be held at **Kloster Unser Lieben Frauen**. The monastery is located in the city center and can be easily reached by tram.

Take tramline 3 or 9 from the stop *Brenneckestraße*, switch to line 2 at *Hasselbachplatz* (direction *City Carré*) and get off at *Leiterstraße*. From here it's a 5 min walk to the monastery. Alternatively, you can call a cab on own expenses (0049 391 73737).

No specific evening events are organized for Wednesday 20th or Friday 22nd.



Emergency numbers

Police 110

Fire Department 112

Medical on-call service 116117

Taxi 0049 391 73737

Useful websites and apps

Train connections <https://www.bahn.com/en>

Tram connections in Magdeburg <https://www.mvbnet.de/>

Tram tickets <https://fairtiq.com/de/> (available on the AppStore and Google play)



Program

Time	Wednesday May 20th	Time	Thursday May 21st	Time	Friday May 22nd
09:00 - 09:05	Moderator: Halia Mullis-Osman "Welcome" by Prof. Dr. Sauvage	09:30 - 10:10	Moderator: Wikitka Gorburow Menno Witter (Kavli Inst./NTNU, NO) Evolutionary preserved connective patterns in the cortico-entorhino-hippocampal network	09:30 - 10:10	Moderator: Yacine Brahimi Pierre Lavenex (Univers. of Lausanne, CH) Development and lesion-induced plasticity in the primate medial temporal lobe
09:05 - 10:20	Data Blitz Session Part I	10:10 - 10:50	Magdalena Sauvage (LIN/OVGU, DE) Entorhinal Cortex Subnetworks and Memory Recall Across the Lifespan	10:10 - 10:50	Marion Inostroza (University of Tübingen, DE) Sleep-dependent memory formation in the developing brain
10:20 - 10:50	Coffee	10:50 - 11:20	Coffee	10:50 - 11:20	Coffee
10:50 - 12:00	Data Blitz Session Part II	11:20 - 12:00	Hannah Monyer (DKFZ/Heidelberg Univ. Hospital, DE) Shared early impairments of medial entorhinal cortex function across distinct Alzheimer's disease etiologies	11:20 - 12:00	Paul Frankland (Stekklids/University of Toronto, CA) Neurobiological mechanisms underlying the developmental emergence of episodic memory
12:00 - 13:00	Lunch Break	12:00 - 13:00	Lunch Break	12:00 - 13:00	Lunch Break
13:00 - 13:50	Students/ Speakers Round Table	13:00 - 13:50	Students/ Speakers Round Table	13:00 - 13:50	Students/ Speakers Round Table
14:00 - 14:40	Lisa Genzel (Donders Centre for Neuroscience, NL) Semantic Memory and Multi-Trial learning	14:00 - 14:40	Jozsef Csicsvari (Institute of Science and Technology, AT) Representational Dynamics in the Hippocampus and Medial Prefrontal Cortex during Spatial Learning	14:00 - 14:40	Rosanna Olsen (The Rotman Research Institute, CA) Are medial temporal lobe subregions "specialized" for particular classes of visual stimuli?
14:40 - 15:20	Svenja Brodt (MPI for Biological Cybernetics, DE) Rapid neocortical learning – systems memory consolidation or parallel encoding?	14:40 - 15:20	Motokharu Yoshida (LIN/DZNE, DE) Active single-cell memory	14:40 - 15:20	Nora Abrous (Neurocentre Magendie, Bordeaux University, FR) Role of adult-born dentate neurons in successful cognitive aging
15:20 - 15:40	Coffee	15:20 - 15:40	Coffee	15:20 - 15:40	Coffee
15:40 - 16:20	Noam Shemesh (Chapman Foundation, PT & Weizmann Institute of Science, ISR) Ultrafast fMRI for revealing information flow in the brain	15:40 - 16:20	Stefan Remy (LIN/OVGU, DE) Medial septal circuits in exploratory locomotion: cellular correlates of brain state changes	15:40 - 16:20	Anne Maass (DZNE/OVGU, DE) Medial temporal lobe network changes in aging and early Alzheimer's disease
16:20 - 17:00	Open Discussion	16:20 - 17:00	Open Discussion	16:20 - 17:00	Open Discussion
		19:00 - 22:00	Conference Dinner „Science and the March of Time“ by Menno Witter (Kavli Inst./NTNU, NO)		

Data Blitz Sessions Overview

09:05 - 10:20	Data Blitz Session Part I (talk: 5mins; questions: 1min)
	<p><i>Filamin A regulates dendritic morphology and hippocampal function</i> Yunus Emre Demiray (OvGU, Magdeburg)</p>
	<p><i>Learning reorganizes dendritic and stabilizes axon initial segment inhibitory synapses in CA1 pyramidal neurons</i> Alessio Attardo (LIN Magdeburg/DZPG/CBBS)</p>
	<p><i>Network excitability dynamics in CA1 hippocampal and cortical networks in HCN1-DEE mice</i> Liudmila Sosulina (LIN Magdeburg/DZNE Bonn, Germany)</p>
	<p><i>Movies of our minds: Patterns of hippocampal subfields during event, scene, and object construction</i> Pitschaporh Leelaarporn (Univ. Hosp. Bonn/DZNE Bonn, Germany)</p>
	<p><i>Decoding Layer-Specific Memory and Context Signals in the Medial Temporal Lobe and Visual Cortex with 7T fMRI</i> Dingrong Guo (Goethe Univ. Frankfurt, Germany)</p>
	<p><i>Emergence of distinct cortical anatomy associated with subregions of the hippocampal–entorhinal system in the first two years of human life</i> Daniel Reznik (Max Planck Inst. for Human Cognitive and Brain Sciences, Leipzig, Germany)</p>
	<p><i>Human hippocampal and entorhinal neurons encode the temporal structure of experience</i> Davide Ciliberti (OvGU, Magdeburg)</p>
	<p><i>Where goals meet space: Neocortical-Hippocampal interactions on cheeseboard learning tasks</i> Sofia Barros Alves Tavares Taveira (Inst. of Science and Technology Austria)</p>
	<p><i>Peripheral vision as an entry window into the middle temporal lobe of primates</i> Michael Ortiz-Rios (OvGU, Magdeburg)</p>
	<p><i>Modulation of spatial navigation performance by transcranial temporal interference stimulation</i> Serena Reverberi (Neuro-X Inst., Switzerland)</p>
	<p><i>Mesoscale 7T functional connectivity in the medial temporal lobe moderates the association of episodic</i> Larissa Fischer (DZNE, Magdeburg)</p>
	<p><i>Cue Degradation and Distortion Impact Pattern Completion and Separation in Aging</i> Bradley Buchsbaum (Rotman Research Inst. Baycrest, Toronto, Canada)</p>
	<p><i>Improving memory using cognitive training across the lifespan</i> Erika Atucha (LIN Magdeburg)</p>

Data Blitz Sessions Overview

10:50-12:00	Data Blitz Session Part II (talk: 5mins; questions: 1min)
	<p><i>Hippocampal tail integrity predicts memory precision independent of early AD pathology: a 7T MRI study</i> Panagiotis Iliopoulos (OvGU, Magdeburg)</p>
	<p><i>Contextual modulation of spatial memory consolidation in patients with right hippocampal lesion</i> Greta Melega (Charité Universitätsmedizin Berlin)</p>
	<p><i>Consolidation of spatial memory across resection of the medial temporal lobe</i> Deetje Iggena (Charité/School of Mind and Brain/Berlin Inst. of Health, Berlin)</p>
	<p><i>The anterior insular cortex is recruited during recent but not remote spatial memory retrieval</i> Mateus Prates Rodrigues (Univ. of Tübingen, Germany)</p>
	<p><i>Prefrontal Glucocorticoid Receptors Gate Long-Term Fear Network Reorganization to Promote Generalized Remote Fear</i> Moisés Dos Santos Corrêa (LIN Magdeburg)</p>
	<p><i>Schema memory consolidation requires hippocampal activity in adult rats</i> Rafaela Polancozyk (Univ. of Tübingen, Germany)</p>
	<p><i>Hunger and sleep use different brain systems for forming spatial memory</i> Enea Tosadori (Univ. of Tübingen/Univ. of Stuttgart, Germany)</p>
	<p><i>Rearing behavior reveals the opposing roles of the hippocampus in spatial memory consolidated during sleep and hunger states</i> Anuck Sawangjit (Univ. of Tübingen/DZPG, Germany)</p>
	<p><i>Hippocampal pattern separation of memories overlapping in conceptual space</i> Attila Keresztes (HUN-REN Research Centre for Natural Sciences / ELTE Eotvos Lorand Univ, Budapest, Hungary)</p>
	<p><i>Ripple activity in the MTL is modulated by prior knowledge during memory encoding and recall</i> Maria Alcobendas (Charité/School of Mind and Brain/Berlin Inst. of Health, Berlin)</p>
	<p><i>Assessing semantic mediator representations in the hippocampus during the encoding and recall of pretested word pairs</i> Zsuzsanna Némecz (Univ. of Regensburg, Germany)</p>
	<p><i>Rehearsal drives the rapid formation of semantic and detail-rich memory representations in the neocortex</i> Lena Schröder (Max Planck Inst. for Biological Cybernetics, Tübingen)</p>



Data Blitz Session Abstracts

Filamin A regulates dendritic morphology and hippocampal function

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²Institute of Molecular and Clinical Immunology, Otto-von-Guericke University, Magdeburg, Germany

³Center for Behavioral Brain Sciences, Magdeburg, Germany

Dendritic architecture, which determines the specificity and capacity of synaptic input, is a critical determinant of neural computation. During neural development, integrin-mediated cell interactions, together with intracellular signaling and the cytoskeleton, regulate where and when dendritic arborization occurs. Filamin A (FlnA) is a key integrator of these processes and is involved in integrin activation, actin filament crosslinking, mechanosensing, as well as modulation of intracellular signaling. Here, we show that both increasing and decreasing FlnA expression in hippocampal neurons significantly alter dendritic arborization, albeit through distinct mechanisms. While FlnA knockdown-induced hypertrophy critically depends on integrin inside-out activation, FlnA overexpression induces similar effects in an integrin-independent but actin cytoskeleton-dependent manner. Our data suggest a differential regulation of dendritic growth through FlnA level-dependent modulation of integrin-actin interactions. Finally, we show that FlnA thereby critically controls hippocampal information processing and behavior, as demonstrated *in vivo* using CRISPR/Cas9-mediated knockout, which disrupts synaptic transmission in the CA3 subregion of the mouse hippocampus and impairs pattern completion during fear conditioning. Together, our findings from both *in vitro* and *in vivo* approaches identify FlnA as a regulator of hippocampal morphology and circuit function, linking the control of dendritic branching to synaptic transmission and behavior.

Supported by the German Research Foundation (ST0488/4-1) and European Funds for Regional Development (ZS/2023/12/182069, Junior Research Group Translational Engram Technology).

Learning reorganizes dendritic and stabilizes axon initial segment inhibitory synapses in CA1 pyramidal neurons

Klimmt H.^{1,2§}, Kuhn F.^{1§}, Kappel D.³, Murthy B.^{1,4}, Ulivi A.F.¹, Argunşah A.Ö.⁵, Vieweg S.¹, Huettl R.E.⁶, Remy S.^{1,7,§} and Attardo A.^{1,7*}

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⁶Max Planck Institute of Psychiatry, Munich, Germany

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Structural synaptic plasticity underlies the changes in brain connectivity required for learning and memory. Inhibitory synapses (INS) target all subcellular domains of excitatory pyramidal neurons (PNs), including dendrites, somata and axon initial segments (AIS). These subcellular domains have distinct molecular, structural and physiological profiles which underlie their functions. How structural plasticity of INS supports these functions as well as emerging properties such as memory is largely unknown. To tackle these questions, we tracked INS on basal dendrites, somata and AIS of PNs in the dorsal hippocampal CA1 area of mice over two weeks. Size and temporal dynamics of INS showed a strong compartmentalization. Trace fear conditioning led to reorganization of dendritic INS and to stabilization of AIS INS. Finally, mathematical modelling allowed us to probe the mechanisms underlying stabilization of INS upon learning.

Network excitability dynamics in HCN1-GD mice

Liudmila Sosulina^{1,2}, Hiroshi Kaneko¹, Victoria Shumkova^{2,3}, Ricardo Neves^{2,3}, Stefan Remy^{1,5}, Dirk Isbrandt^{2,3,4}

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Hyperpolarization-activated cyclic nucleotide-gated (HCN) channels are expressed in brain and heart cells and are involved in the regulation of fundamental processes such as neuronal excitability, theta oscillations, and dendritic integration, which serve as a substrate for learning and memory formation in the medial temporal lobe. Several pathological conditions are related to HCN channelopathies, including neurodegenerative diseases and developmental and epileptic encephalopathies (DEEs). We investigated neuronal excitability changes at both cellular and network levels in the hippocampal and cortical slices using the knock-in mouse model, *Hcn1*^{G380D/+} mice, harboring a patient-derived point mutation in the S6 domain of the HCN1 subunit. *Hcn1*^{G380D/+} mice show spontaneous convulsive seizures and comorbid behavioral changes such as increased locomotor activity and impaired memory performance (Merseburg et al, 2022).

As *Hcn1*^{G380D/+} mice showed paradoxical seizures in response to sodium channel blocker treatment, reminiscent of Dravet syndrome and indicative of PV interneuron dysfunction, we performed complementary measurements of the miniature inhibitory postsynaptic currents (mIPSCs) in the CA1 hippocampus and changes in intrinsic excitability in Layer 5 of somatosensory cortex using the whole-cell patch clamp technique. Consistent with excitability changes in CA1, layer V neurons were depolarized, with a reduced sag ratio and altered excitability. Expressed presynaptically in PV interneurons (Buss et al., 2023), HCN1 subunits contribute to the control of the inhibition/excitation balance within neuronal networks in hippocampal and cortical structures. However, mIPSCs recordings did not show significant changes in *Hcn1*^{G380D/+} mice in CA1 pyramidal neurons. Taken together, the mutation represents "gain of aberrant function" phenomenon, causing continuous sodium influx, depolarizing neurons, and changing neuronal excitability in both excitatory and inhibitory neurons.

Movies of our minds: Patterns of hippocampal subfields during event, scene, and object construction

Pitshaporn Leelaarporn

Clinic for Geriatric Psychiatry and Cognitive Disorders, University Hospital Bonn,
Bonn, Germany,

German Center for Neurodegenerative Diseases (DZNE), Bonn, Germany

Episodic scene construction, the process of mentally generating and manipulating spatially coherent scenes from past experiences, is a critical function of the hippocampus. However, the specific contributions of hippocampal subfields to different forms of construction—object-, scene-, and scenario—remain unclear. Emerging evidence suggests distinct roles for different subfields, highlighting the role of the pre-/parasubiculum in scene-based cognition and memory recall. Additionally, separate neural circuits within the hippocampus may underlie object-based recognition, spatial scene construction, and the temporal organization of scenarios. Understanding these functional specializations is essential for elucidating the neural mechanisms engaged during visual mental imagery.

Using ultra-high field functional magnetic resonance imaging, we examined the activation of the five hippocampal subfields (DG/CA4, CA1, CA2/3, subiculum, and pre-/parasubiculum). We presented a novel experimental paradigm in which participants engaged in three forms of mental imagery: single objects (e.g., “a science-fiction book”), single scenes (e.g., “a library”), and extended scenarios (e.g., “taking an exam”). While greater activations were observed in both CA2/3 and pre-/parasubiculum during scenario and scene conditions, Tukey’s multiple-comparison test revealed significant difference of percentage signal change between CA2/3 and the pre-/parasubiculum, with a trend between DG/CA4 and the pre-/parasubiculum. Within the hippocampal anterior body, the pre-/parasubiculum showed greater percentage signal change than the other subfields during scene and scenario constructions compared to object.

Our findings suggest that the pre-/parasubiculum plays an important role during scene imagery compared to object imagery, while CA2/3 exhibited the strongest activation during scenario imagery, highlighting their engagement in constructing complex mental representations.

Decoding Layer-Specific Memory and Context Signals in the Medial Temporal Lobe and Visual Cortex with 7T fMRI

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²Mind, Brain and Behaviour Research Center (CIMCYC); Department of Experimental Psychology, University of Granada, Granada, Spain

Perception of the visual environment requires the integration of incoming contextual information with stored memories and prior knowledge. Predictive processing theories propose that this integration is supported by the hierarchical and laminar architecture of the visual cortex and its interactions with the medial temporal lobe (MTL), particularly the hippocampus and entorhinal cortex (EC). To examine the neural mechanisms underlying this process, we acquired ultra-high-field 7T fMRI data using an occluder paradigm that dissociates memory signals from signals driven by concurrent contextual cues. In this two-day experiment, participants (N=33) first learned cartoon scenes depicting real-world locations with specific target objects. Twenty-four hours later, during fMRI scanning, they were shown the learned scenes with the target objects occluded and asked to mentally retrieve the missing objects. Analyses include layer-specific decoding and representational similarity analysis to identify distinct memory signals across cortical layers in early visual cortex and MTL subregions. Preliminary results showed that context information could be decoded from the hippocampal subiculum, whereas feedback, memory-related information could be decoded from the deep layers of the early visual cortex and hippocampal CA2/3. These findings provide new insight into how perceptual predictions arise from interactions between sensory input and memory-based representations.

Emergence of distinct cortical anatomy associated with subregions of the hippocampal-entorhinal system in the first two years of human life

Daniel Reznik

Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Episodic memory in humans and animals critically depends on the hippocampus and the entorhinal cortex. Despite a rapid developmental change in human episodic memory during the first two years of life, little is known about the developmental trajectory of the hippocampal-entorhinal circuitry during this critical time period. In the current study we collected high-quality, precision fMRI data from five typically developing infants over the time period between 1 and 2 years of life and examined in great anatomical detail the developmental profile of distinct parts of the infant hippocampal-entorhinal system and their coupling with distinct cortical networks. We show that the parietal memory network and subdivisions of the canonical default network follow differential developmental trajectories of their association with different parts of the hippocampal long-axis and subdivisions of the entorhinal cortex during the second year of life. Specifically, already at around 10 months of age the default network A associates with the infant anterior hippocampus and medial entorhinal band, and the parietal memory network associates with the posterior hippocampus and lateral entorhinal band. Associations of the default network B with the infant anterior hippocampus and the intermediate entorhinal band emerge only towards the end of the second postnatal year, mirroring critical developmental changes in mnemonic and social functions. Our results point to a developmental mechanism potentially underpinning the emergence of episodic memory during the first two years of life and suggest that potentially unique properties of human hippocampal-entorhinal circuitry emerge latest in development.

Human hippocampal and entorhinal neurons encode the temporal structure of experience

Davide Ciliberti

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Germany

German Center for Neurodegenerative Diseases (DZNE), Magdeburg, Germany

Extracting the underlying temporal structure of experience is a fundamental aspect of learning and memory that allows us to predict what is likely to happen next. We recorded from single neurons in human participants who have been implanted with intracranial electrodes for clinical reasons, and show that human hippocampal and entorhinal neurons gradually modify their activity to encode the temporal structure of a complex image presentation sequence. These findings demonstrate that neurons in the hippocampus and entorhinal cortex integrate the 'what' and 'when' information to extract durable and predictive representations of the temporal structure of human experience.

Where goals meet space: Neocortical-Hippocampal interactions on cheeseboard learning tasks

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Institute of Science and Technology Austria, Klosterneuburg, Austria

Recent research has highlighted the PPC's involvement in spatial cognition by revealing place- and goal-coding activity. Due to its connectivity, PPC (posterior parietal cortex) has also been suggested to transform allocentric maps into self-referential egocentric maps. However, the mechanism by which PPC neurons interact locally and with the hippocampus (HC-CA1) to support spatial coding and map transformations is not understood. Here, freely foraging rats performed a dual-reference-frame cheeseboard memory task (and subsequent sleep) while simultaneously monitoring cross-area activity in PPC and CA1. In the allocentric frame of the task, both regions exhibited spatial tuning, with hippocampal cells providing a stronger spatial signal. Population rate maps showed position-modulated activity that collectively tiled task trajectories. PPC cells also formed spatial maps surrounding goals. Goal-related PPC activity flexibly scaled with behavioral context in the task, but it indicated a more drifty code than CA1.

As for next steps, we will probe task-related dynamics within the body-centered frame of the cheeseboard task, aiming to analyze latent variables that influence both population codes during awake/sleep states.

Peripheral vision as an entry window into the middle temporal lobe of primates

Michael Ortiz-Rios

Otto von Guericke University, Institute of Biology, Magdeburg, Germany

Spatial navigation often involves optic flow of visual information and active orientation, a sensorimotor process that often engages occipitoparietal and middle temporal networks. A translational framework from human to non-human primates, might aid understanding of how visual optic flow processes enable ego-centric encoding of visual scenes during spatial navigation. We began a fast (5-minute) fMRI mapping of orienting networks in human and monkeys during naturalistic free-viewing of ego-motion scenes. These experiments revealed a frontoparietal and posteriomedial orienting network that involved the parahippocampus and cerebellum. Our findings support the notion of a 'self-anchoring' process that might depend on the continuous flow of visual information towards the periphery during active visual exploration.

Modulation of spatial navigation performance by transcranial temporal interference stimulation

Serena Reverberi¹, Sophie Caroni², Léa Kim-mi Ho Dac¹, Stavriani Skarvelaki¹, Pablo Maceira-Elvira³, Hyuk-June Moon⁵, Greta Carnevali¹, Sofia Pasquale², Pawel J. Matusz^{2,4}, Michela Bassolino^{2,4}, Friedhelm Hummel^{1,6}

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Investigations of the hippocampus' role in spatial navigation have been limited in the past by the depth-focality trade-off of traditional non-invasive brain stimulation techniques. The newly developed transcranial temporal interference stimulation (tTIS) consists of high-frequency (HF) current delivered through two pairs of electrodes. The application of a small frequency shift (Δf) between the two electrode pairs results in a modulated envelope, oscillating at Δf , which is able to influence neuronal activity and can be steered to target deep brain regions while minimizing stimulation of overlying tissue. tTIS delivered to the hippocampal-entorhinal complex (HC-EC) was recently demonstrated to improve spatial navigation abilities in healthy individuals (Beanato et al., 2024, Science Advances; Zhao et al., 2025, Nature Communications). Our currently ongoing study aims to extend these findings to traumatic brain injury patients, a population that commonly reports spatial navigation impairments. We deliver intermittent theta-burst patterned tTIS (iTBS-tTIS), continuous TBS-tTIS (cTBS-tTIS), or HF control stimulation to the HC-EC while patients and healthy age-matched controls first encode and then recall the location of objects in a virtual arena. During tTIS+task performance, as well as during resting state preceding and following tTIS+task, high-density EEG is additionally recorded. Consistent with previous literature, pilot data (N=2 healthy young adults) demonstrate reduced trial time during iTBS versus HF (relative improvement pilot1: 18%, pilot2: 8%) or iTBS versus cTBS (pilot1: 17%, pilot2: 12%). This study will deliver novel knowledge on the behavioral and neural correlates of hippocampal tTIS on spatial navigation.

Mesoscale 7T functional connectivity in the medial temporal lobe moderates the association of episodic memory performance and tau PET burden

Larissa Fischer¹, Niklas Vockert¹, Joseph Hoepker Fernandes¹, Berta Garcia-Garcia^{1,2}, Sebastian Roemer-Cassiano^{3,4,5}, Nicolai Franzmeier^{4,6,7}, Helena Gellersen^{1,8,9}, Beate Schumann-Werner^{1,10}, Niklas Behrenbruch^{1,11}, Svenja Schwarck^{1,10}, Eóin N. Molloy^{1,2}, Gusalija Behnisch¹², Constanze Seidenbecher¹², Björn H. Schott^{12,13,14}, Bárbara Morgado^{13,14}, Hermann Esselmann¹³, Jens Wiltfang^{13,14}, Henryk Barthel^{15,16}, Osama Sabri¹⁵, Michael C. Kreissl^{1,2}, Emrah Düzel^{1,10}, Stefanie Schreiber^{1,17}, Esther Kuehn^{18,19} and Anne Maass¹,

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The medial temporal lobe (MTL) is important for episodic memory but vulnerable to early tau pathology with aging. MTL tau might propagate along functional pathways from superficial entorhinal cortex (ERC) to superficial CA1 layers, and from CA1 and subiculum deep layers to retrosplenial cortex. Using ultra-high field imaging at 7 Tesla (T), we uniquely studied subfield- and layer-specific functional connectivity (FC) alterations in relation to individual local tau burden.

We analyzed 7T resting-state MTL FC data in 55 cognitively unimpaired older adults (71±6years, 24female, 13APOE4+) with cognitive, serum



biomarker, and dynamic [18F]PI-2620 PET data measuring tauMTL burden. We investigated associations of FC and tau and interactions of tau with APOE4 status and glial fibrillary acidic protein (GFAP) levels. We also tested the effect of tau on episodic memory performance and its moderation by FC. TauMTL showed no overall relation to FC, but was negatively associated with FC at low GFAP and positively at higher GFAP levels within a cluster involving superficial ERC, CA1, and subiculum (cluster-pFDR=0.013, le\ hemisphere). Further, the negative association between tauMTL and episodic memory ($\beta=-0.28, t(49)=-2.16, p=0.036$) was weaker with higher FC between CA1 and subiculum in hippocampal head ($\beta=0.26, t(49)=2.04, p=0.047$).

We provide novel evidence that early tauMTL burden, in the presence of higher astroglial reactivity, is linked to heightened mesoscale FC between MTL subregions showing early tau pathology. Furthermore, our results indicate that higher FC between anterior CA1 and subiculum may represent an initial compensatory mechanism against tau-related subtle cognitive deficits. However, longitudinal studies are needed for stronger evidence.



Cue Degradation and Distortion Impact Pattern Completion and Separation in Aging

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Pattern completion and pattern separation are fundamental memory processes that decline with age, yet the specific cue properties that constrain these processes in aging remain poorly understood. Previous work has typically used intact or partially occluded cues, leaving open the question of how cue distortion— independent of information loss—affects memory retrieval. Here, we examined how cue completeness (degradation) and spatial configuration (scrambling) influence pattern completion and pattern separation in 5146 younger (18–34 years) and 5145 older adults (65–79 years). Participants studied intact scenes and were tested with dynamic cues that varied in degradation (40%, 70%, 85%, or 95% occluded) and spatial integrity (intact or scrambled). We applied drift diffusion modelling to disentangle mnemonic contributions (drift rate) from perceptual encoding demands (non-decision time). For pattern completion (target recognition), older adults showed impaired accuracy at high degradation levels and were disproportionately affected by spatial scrambling, whereas younger adults maintained high performance across conditions. Critically, these age differences were driven by reductions in drift rate rather than increases in non-decision time, indicating that cue degradation and distortion impair mnemonic evidence accumulation, not solely perceptual encoding. For pattern separation (lure discrimination), both groups performed poorly, but younger adults succeeded at low degradation while older adults remained at chance across all conditions. Unexpectedly, older adults' drift rates were above zero despite chance accuracy, suggesting that non-mnemonic factors may contribute to age-related pattern separation deficits. These findings demonstrate that both the amount and spatial configuration of cue information are critical determinants of memory retrieval in aging, and highlight the value of computational modelling for isolating mnemonic contributions to recognition performance

Improving memory using cognitive training across the lifespan

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It is widely accepted that the brain's resources are not used to their full potential. Yet, it remains unclear how cognitive performance can be enhanced and which neural mechanisms are involved. In this talk, we show that memory can be improved through cognitive training in both young and older mice, in a rate-dependent manner, and that this improvement coincides with the engagement of distinct hippocampal-prefrontal subnetworks.

Hippocampal tail integrity predicts memory precision independent of early AD pathology: an 7T MRI study

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The hippocampal long axis is thought to support distinct memory operations, with the posterior hippocampus (tail) implicated in fine-grained representations critical for memory discrimination. Yet, the specific contribution of the hippocampal tail to memory precision in aging—and whether this is independent of early Alzheimer's disease (AD) pathology—remains poorly understood. Ultra-high field 7T MRI enables precise delineation of hippocampal subfields that conventional methods cannot reliably resolve.

We examined 68 cognitively unimpaired older adults (aged 60–78) using 7T MRI (T1w 0.6mm isometric; T2w 0.4×0.4×1mm). Hippocampal subfield and entorhinal cortex volumes were derived using ASHS. Memory precision was assessed via an object-scene discrimination task; spatial navigation via a cognitive mapping task. Plasma pTau217 indexed early AD pathology. Brain-behavior associations used robust regression with FDR correction. Hippocampal tail volume strongly predicted memory precision (partial $R^2=.338$, $p<.001$) across both object and scene conditions, suggesting a domain-general discrimination mechanism. This association persisted after covarying for pTau217. Entorhinal cortex volume was selectively associated with spatial navigation (left hemisphere: partial $R^2=.132$, $p=.006$) but not memory precision. Plasma pTau217 was associated with entorhinal cortex volume (right hemisphere, $p=.007$) but not hippocampal volumes.

These findings reveal a double dissociation within the MTL: hippocampal tail integrity supports memory discrimination precision independent of early tau pathology, while entorhinal cortex tracks spatial navigation and shows earliest AD vulnerability. This positions the hippocampal tail as a promising candidate for better understanding mnemonic discrimination and preserving memory aging and underscores the value of combining 7T subfield imaging with blood-based biomarkers.

Contextual modulation of spatial memory consolidation in patients with right hippocampal lesion

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Successful spatial navigation depends on the interaction of several cognitive processes, including perception, memory, decision-making, and attention to environmental features and landmarks. The hippocampus contributes to the binding of these environmental features, or contextual information, that supports spatial memory formation and the ability to effectively navigate through the space.

In this project, we investigated spatial memory and navigation patients with right hippocampal lesions using an immersive virtual reality (VR) environment that allowed free movement while electroencephalography (EEG) was recorded. Across two consecutive days, participants learned and recalled object–location associations that varied depending on context, operationalized as day or night within the same spatial environment.

Patients with right hippocampal lesions showed reduced accuracy in memory-guided navigation and reduced precision compared to healthy controls, revealing that patients were less able to maintain distinct representations of overlapping contexts in comparison to controls. In addition, both groups demonstrated decreased performance on the second day. Principal component analysis of behavioural navigation metrics revealed that navigation efficiency predicted memory performance both on the day of learning and on the day after, revealing that more efficient navigation also impacts the memory for the objects. Preliminary analyses of the simultaneously recorded EEG suggest contextual and navigational-related neural dynamics during retrieval, particularly in the theta band and particularly in the patient’s cohort.

These findings highlight the contribution of the hippocampus to context-dependent spatial memory and demonstrate the value of combining immersive VR navigation paradigms with EEG to investigate the neural mechanisms supporting memory-guided navigation.

Consolidation of spatial memory across resection of the medial temporal lobe

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The processing of spatial memory over time relies on a complex brain network, with the medial temporal lobe playing a central role. In particular, damage to the entorhinal-hippocampal circuit impairs the formation of new cognitive maps, while older maps generally remain intact. How long this circuit remains involved in memory consolidation is still debated: growing evidence suggests that the underlying neural reorganization processes can span days to years.

Ten subjects undergoing surgery for temporal lobe epilepsy were trained to localize distinct objects against various backgrounds at two separate preoperative time points. The first training occurred at least 36 hours before surgery, and the second 12 hours prior. The interval between these sessions was a minimum of 24 hours, designed to target different phases of memory consolidation. After the partial resection of the medial temporal lobe, subjects were tested at two comparable postoperative intervals to evaluate their verbal memory of the object-background associations and their spatial memory on object locations.

We found no significant differences in performance between verbal object-background associations and spatial object-location associations consolidated over 12 hours versus those consolidated at least 36 hours before medial temporal lobe lesions, indicating that the memories exhibited the same level of robustness against interference. Our results suggest that critical steps in memory consolidation involving hippocampal-neocortical reorganization are completed within 12 hours after acquisition.

The anterior insular cortex is recruited during recent but not remote spatial memory retrieval

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Research on episodic memory has largely focused on external contextual information, but experiences are also accompanied by internal bodily states. Processed via the interoceptive system, these states constitute an internal context that may influence memory processes. The Insula Cortex (IC) is a central hub of the interoceptive system. Particularly its anterior portion is reciprocally connected to frontal regions, such as the anterior cingulate and medial prefrontal cortices, suggest a role in integrating interoceptive and cognitive processes. However, the contribution of interoceptive processing to memory retrieval remains poorly understood.

Therefore, in this exploratory study, we investigated whether the Insula Cortex is recruited during spatial memory retrieval in a standard spatial memory task, without directly manipulating interoceptive states.

We quantified c-Fos expression in the IC of adult rats following Object-place recognition (OPR) task performance at recent (90 minutes) and remote (two months) time points. Analyses focused on anterior (+3.24 mm) and posterior (−1.80 mm) IC regions relative to bregma

Animals successfully expressed memory at the recent but not at the remote time point. Consistent with this behavioral pattern, c-Fos expression in the IC was increased following recent retrieval, but not after remote interval. Notably, this effect was restricted to the anterior IC.

Together, these findings suggest that the anterior IC is recruited during recent spatial memory retrieval, supporting the idea that interoceptive processing may contribute to memory expression in a time-dependent manner and may function as an internal contextual component of episodic memory.

Prefrontal Glucocorticoid Receptors Gate Long-Term Fear Network Reorganization to Promote Generalized Remote Fear

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Glucocorticoid signaling in prefrontal–hippocampal–amygdala circuits is thought to shape the balance between contextual fear discrimination and generalization, but the underlying network mechanisms remain unclear. Here, we combined local pharmacology, endocrine profiling, behavior, and c-Fos-based network analyses to test how dorsomedial prefrontal cortex (dmPFC) glucocorticoid receptors (GRs) regulate recent and remote contextual fear memory in rats. Intra-dmPFC infusion of the GR antagonist mifepristone after contextual fear conditioning accelerated corticosterone recovery without altering overall hormone exposure. Mifepristone-treated rats showed similar freezing to vehicle 2 days after conditioning, but exhibited increased overall freezing to both novel context and training contexts at 14 days, indicating stronger, generalized remote fear memory. Brain-wide c-Fos mapping revealed treatment- and delay-dependent changes in activity within dmPFC, ventral CA1, basolateral amygdala, and anterior insular cortex that correlated with corticosterone dynamics and fear behavior. Subnetwork analyses of c-Fos co-activation showed that mifepristone enhanced long-range coupling between hippocampus and neocortex, as well as within-hippocampal and hippocampus–amygdala connectivity at the remote time point, whereas amygdala–neocortex coupling changed little. Graph-theoretical analyses further demonstrated that vehicle networks became sparser and less strongly clustered over time, whereas mifepristone networks maintained or strengthened connectivity, shifted hub regions toward ventral hippocampus and cortical nodes. These findings indicate that dmPFC GR signaling gates the long-term evolution of fear-related network architecture, linking efficient glucocorticoid recovery and strengthened hippocampal-centered subnetworks to the emergence of a distributed cortical–hippocampal–amygdala ensemble that supports stronger, generalized remote fear and may contribute to maladaptive overgeneralization in stress-related disorders.

Schema memory consolidation requires hippocampal activity in adult rats

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Schemas are cognitive frameworks that support the incorporation of new information into pre-existing knowledge structures. According to active systems consolidation theory, this updating process relies on coordinated interactions between the hippocampus and cortical regions, through which newly encoded information is gradually transferred from the hippocampus to the cortex. For instance, pharmacological inhibition of the prefrontal cortex has been shown to impair the retrieval of both recent and remote schema memories. However, it remains unclear whether the hippocampus directly contributes to schema-related consolidation during post-encoding sleep, since most studies rely on multi-day training paradigms that restrict direct manipulation of hippocampal activity during sleep. We therefore sought to determine whether schema memory consolidation depends on the hippocampus by inhibiting hippocampal activity during post-schema-encoding sleep. To test this, male rats received a single infusion of Designer Receptors Exclusively Activated by Designer Drugs (DREADDs) into the dorsal hippocampus. After recovery, they were trained in an adapted object-place recognition task that enabled abstraction of a spatial rule across eight encoding episodes. Following encoding, animals received deschloroclozapine to activate DREADD receptors and suppress hippocampal activity during post-encoding sleep, whereas control animals received saline. Schema memory was assessed 24 hours later. Our findings showed that DREADD-mediated hippocampal inhibition during post-encoding sleep disrupted schema memory formation, demonstrating that schema consolidation is dependent on hippocampal activity.

Hunger and sleep use different brain systems for forming spatial memory

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The slow consolidation of newly encoded memory is known to use sleep driving long-term memory formation in a hippocampus-dependent active systems consolidation process. However, evidence suggests that long-term memory can be formed also in the wake state when the animal is starving. Here, we show in rats that hunger consolidates spatial long-term memory that, unlike sleep-dependent consolidation, does not rely on hippocampal traces. After a 24-hour food deprivation period, rats encoded object locations on a standard object-place recognition (OPR) task with encoding followed by a 2-consolidation interval, during which the rats either received food and slept (Sleep-Full) or were awake (Wake-Full), or remained hungry and were awake (Wake-Hunger). At a retrieval test 24 hours later, the Wake-Hunger rats, like the Sleep-Full rats, exhibited full-blown object-place memory, whereas Wake-Full rats failed to show any memory. Inhibiting pharmacologically hippocampal function during the retrieval or consolidation phase, respectively, nullified expression of object-place memory after sleep-consolidation but left intact the memory consolidated in the hungry condition. Optogenetic hippocampal suppression during encoding, likewise, specifically spared hunger-dependent consolidation. Conversely, pharmacological inhibition of retrosplenial cortex during retrieval abolished spatial memory consolidated during hunger but not sleep-consolidated memory. The findings provide first-time evidence that the brain uses different systems and representations for forming spatial long-term memory dependent on the brain-state: i.e., sleep versus hunger.

Rearing behavior reveals the opposing roles of the hippocampus in spatial memory consolidated during sleep and hunger states

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The hippocampus plays a central role in memory and navigation. In rodents, rearing (i.e. standing on the hind legs) is a key component of spatial sampling and forming internal representations of the environment, with the hippocampus being actively involved in this behavior. Building on our previous finding that hunger can support the formation of spatial memory independently of the hippocampus, we investigated how different brain states (i.e. hunger versus sleep) influence the exploratory strategies required for successful memory retrieval. Here, we examined rearing behavior in rats during the object-place recognition (OPR) task under sleep- and hunger-dependent consolidation conditions. Rats that underwent sleep-dependent consolidation showed a marked reduction in rearing duration from encoding to retrieval, suggesting that long rearing bouts are not required when a stable memory of distal cues is available. In contrast, rats that underwent hunger-dependent consolidation produced a significant increase in rearing at retrieval. Importantly, when the hippocampus was inhibited during OPR retrieval, the rearing pattern reversed: rats that underwent sleep-dependent consolidation no longer showed a decrease in rearing duration, which was accompanied by OPR memory deficits. In contrast, rats that underwent hunger-dependent consolidation exhibited a reduction in rearing duration. These results suggest that, in sleep-dependent consolidation, hippocampal activity supports the retrieval of spatial distal representations, whereas it interferes with such representations in spatial memories consolidated in a hungry state. Overall, these findings reveal distinct exploration strategies for spatial memories consolidated during sleep and hunger, and suggest a bidirectional role for the hippocampus in spatial memory processing across brain states.

Hippocampal pattern separation of memories overlapping in conceptual space

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Hippocampal pattern separation supports orthogonalization of overlapping neural inputs into non-overlapping representations. In humans, pattern separation has been suggested to support memory specificity. Recent neuroimaging studies and data from neuropsychological patients suggest that the hippocampus accesses and manipulates semantic information. However, it is unclear whether hippocampal pattern separation can target such semantic representations. Here, we tested multiple neural and behavioural proxies of pattern separation using high-resolution functional magnetic resonance imaging and a version of the mnemonic similarity task where similarity of representations in a multidimensional conceptual space was manipulated using word-embeddings. Thirty young adults (Mage = 21.1, 16 females) saw adjective-noun compounds (e.g., ‘exotic zoo’) once, then repeated either as exact repetitions (e.g., ‘exotic zoo’) or modified with semantically similar adjectives (e.g., ‘strange zoo’). We presented repeats during both encoding and recognition, to assess neural pattern separation and behavioural mnemonic discrimination, respectively. Results supported the hypothesis that the hippocampus performs pattern separation as a function of similarity in conceptual space: (1) Repetition suppression was attenuated for modified repeats in repetition sensitive clusters of the dentate gyrus and subiculum. (2) This attenuation was characterized by a power function of similarity. (3) At the individual level, neural signature of pattern separation correlated with mnemonic discrimination. (4) Repetition sensitive clusters identified during encoding differentiated between lures and foils at recognition. These results support the view that hippocampal pattern separation helps laying down specific representations overlapping in semantic memory.

Ripple activity in the MTL is modulated by prior knowledge during memory encoding and recall

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We learn against the backdrop of past experiences: how well new information fits with what we already know shapes how we will learn and remember it. At the neural level, ripple oscillations are brief high-frequency bursts of activity that have been linked to memory consolidation and retrieval. However, whether ripples play a different role for information that fits with prior knowledge versus information that does not is still unknown. We recorded intracranial EEG from epilepsy patients with electrodes in the medial temporal lobe (MTL) and prefrontal cortex (PFC) while they encoded and recalled word pairs that were either semantically congruent or incongruent, and we examined ripple rate in these brain regions. We expected that if learning and retrieval of congruent and incongruent information rely on different neural processes, this would be reflected in different ripple rates and ripple coupling between the MTL and PFC regions. Preliminary findings suggest that congruency modulates ripple rate, with incongruent word pairs driving higher ripple rates in MTL during recall. Future analyses will also examine ripple coupling between the MTL and PFC.

Assessing semantic mediator representations in the hippocampus during the encoding and recall of pretested word pairs

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Tests can enhance long-term memory even when administered before the initial study phase—a phenomenon known as the pretesting effect. The semantic mediator account proposes that when the learner makes an attempt to answer a pretest question, a semantically related, plausible response is generated, which later serves as a mediator between the question and correct answer. Here, 35 participants underwent functional magnetic resonance imaging (fMRI) while studying and later recalling weakly associated word pairs. On half of the study trials, participants were prompted to covertly generate a plausible target based on a cue (e.g., handyman – ?, pretest condition) before viewing the intact pair (e.g., handyman – hammer), whereas on the other half of study trials, there was no prior target generation (study-only condition). In a third, semantic mapping phase, participants read words semantically closely related to the cue words (semantic mediators), in addition to all cues and all true targets. Univariate subsequent memory analyses revealed that successful encoding of pretested word pairs, relative to study-only pairs, was associated with greater activation in semantic, language-related, as well as prefrontal regions. Preliminary results of the ongoing representational similarity analysis (RSA) suggest that in the precuneus, the neural representations of cues resemble the semantic mediators more in the pretest than the study-only condition. We will conduct further RSA to compare representations across the study, recall, and semantic mapping phases. We hypothesise that the hippocampus, a key structure in binding multidimensional information, represents semantic mediators during the encoding and recall of pretested cue-target pairs.

Rehearsal drives the rapid formation of semantic and detail-rich memory representations in the neocortex

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Repeatedly rehearsing information can accelerate systems memory consolidation by shifting memory systems contributions towards the neocortex. However, it remains unclear whether rehearsal differentially affects specific aspects of memory, and where these are represented in the cortex. Here, we used functional MRI to assess the effects of repeated and one-time learning on semantic (category-level) vs. detail-rich (exemplar-level) memory aspects.

Healthy, young adult participants (preliminary n=33) encode and recall unique associations between two visually presented objects either once (single items) or four times (rehearsed items) during fMRI. We test memory for category and exemplar information after 60min and 72h.

Behaviorally, rehearsal globally facilitates short-term and long-term retention. During encoding, rehearsal rapidly increases functional activity in the precuneus, while the hippocampus and ventral visual stream show decreasing activity. Accordingly, the ventral visual stream displayed lower activity for rehearsed vs. single items across both retention intervals specifically during exemplar recall and activity changes were linked to better memory for details. In the precuneus, higher activity for rehearsed vs. single items emerged specifically for category recall at the 60min and 72h time points, while increasing activity during encoding mirrored increasing performance during exemplar recall.

Together, rehearsal benefits the retention of semantic as well as detail-rich memory and induces rapid, long-lasting, and behaviorally relevant changes in neocortical networks. While changes in the ventral visual stream seem to specifically support memory for perceptual detail, the precuneus might contribute to category as well as detail-level memory.



Invited Talks Day 1

Semantic Memory and Multi-Trial learning

Lisa Genzel

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Adapting to environmental changes is critical for our survival. The brain's ability to build up knowledge about the world that enables us to benefit from our previous experience has been a long-standing, central topic in psychology and neuroscience. However, research into the neurobiology underlying knowledge build-up and updating is now just beginning. In my lab we develop new rodent tasks (e.g. Object Space Task and the HexMaze) to tap into how animals' build-up knowledge from experiences. We also use one session learning tasks (e.g. watermaze) for translation applications in humans and rodents. We combine these tasks with electrophysiology, pharmacology, functional MRI and immediate early gene expression analysis to investigate how memories become long lasting and which role location specific plasticity and sleep has in the process. This approach has revealed surprising results. The hippocampus optimizes but is not necessary for multi-trial memory and the cortex is an independent, fast but adaptive learner. In our semi-naturalistic memory task setting, the 9x5m HexMaze, spatial memory and navigation persist without the hippocampus – only necessary for one-session learning and computations like sophisticated path optimization. These optimizations occur during sharp-wave ripple oscillations, when hippocampal and cortical circuits engage in a bidirectional exchange.

Rapid neocortical learning – systems memory consolidation or parallel encoding?

Svenja Brodt

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Rapid neocortical learning – systems memory consolidation or parallel encoding?

Recent evidence suggests that there are conditions under which the neocortex can establish declarative memory traces much more rapidly than traditionally assumed by systems consolidation theories. My lab's aims to better understand these conditions in the human brain by identifying learning-induced changes in activation and microstructure with the help of functional, diffusion-weighted and quantitative MRI. In this talk, I will show how memory reactivation benefits neocortical memory formation across the cortical hierarchy, from early sensory to highest-order association cortex, and for different aspects of memory, from perceptual detail to concept formation. Finally, I will discuss the contribution of hippocampal activity to these rapidly emerging neocortical memories

Ultrafast fMRI for revealing information flow in the brain

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Functional MRI (fMRI) has transformed neuroscience, but it is still most often acquired with relatively low temporal resolution ($TR \approx 1-2$ s). This provides ample information on *where* activity occurs, yet the coarse sampling makes it difficult to infer on dynamics and timing of activity across regions – which can be essential for understanding information flow through neural circuits. Here, we present ultrafast fMRI experiments in rodents at high magnetic field, that sample BOLD signals at tens of milliseconds resolution, thereby enabling direct estimation of BOLD timing parameters. These timings reveal ordered sequences of regional engagement following sensory stimulation, providing an *in vivo* readout of the circuit's neural information flow. We further show that BOLD timing offers unique sensitivity to aberrant circuitry in a model of visual plasticity. Furthermore, we demonstrate how ultrafast fMRI can provide insight into spontaneous activity: intrinsic oscillatory modes can be uncovered from resting-state data, providing a complementary view of spontaneous brain activity beyond static correlation maps. In addition, we show that canonical visual representations (e.g., retinotopy) are captured in ultrafast resting-state signals, and that layer-resolved ultrafast fMRI can separate feedforward from feedback components of processing, and reveal subcortical plasticity eg following ischemia. Finally, we discuss how advanced fMRI paradigms, validated with electrophysiology and behavioral measurements, can be leveraged to dissect the mechanisms underlying the continuity illusion. Our work suggests promising vistas for future applications of ultrafast fMRI in health and disease.



Invited Talks Day 2

Evolutionary preserved connectional patterns in the cortico-entorhino-hippocampal network

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An often-used model for episodic memory is strongly anchored in splitting the entorhinal cortex into medial and lateral subdivisions and their respective connectivity patterns along the transverse and radial axes of the hippocampus. Functional studies, partially complemented by patterns of cortical connectivity, provided arguments to present this 'Dual-Stream model' as handling spatial versus non-spatial streams or alternatively allocentric versus egocentric streams of information. This model has found support in a variety of species, though it is mainly based on rodent and to a lesser extent non-human primate data.

What has become 'neglected' is a previously described organizational principle of the mammalian entorhinal cortex into rostro-caudal band-like zones, based on intrinsic connectivity patterns associated with connections along the hippocampal long axis.

In my talk I will present data from a variety of different species, including humans, supporting this band-like organization into at least three parallel zones, leading to a revised anatomical blueprint, which has been remarkably preserved in mammalian phylogeny. This provides support for a more complex functional framework of the entorhinal-hippocampal circuitry, allowing for a more flexible view on hippocampal-dependent functions, particularly addressing the complexity of conscious memory as representing integrated factual, emotional and social aspects.

Entorhinal Cortex Subnetworks and Memory Recall Across the Lifespan

Magdalena Sauvage

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The entorhinal cortex (EC) is among the first brain regions affected in Alzheimer's disease, and its functional connectivity with the hippocampus is altered during aging. The medial and lateral EC differentially process spatial and non-spatial information; however, their specific contributions to memory recall remain poorly understood. Moreover, it is still unclear how EC subregions contribute to memory recall across the lifespan, whether these dynamics differ from those of prefrontal cortical areas, and how they evolve over timescales relevant to human memory.

Our studies demonstrate that selective spatial and non-spatial dentate gyrus-dependent memory deficits can be traced to the innervation of distinct EC subregions, extending beyond the classical medial-versus-lateral EC distinction. Furthermore, longitudinal analyses of memory recall over one year in mice reveal a circuit-specific and time-dependent reconfiguration of cortico-entorhino-hippocampal networks. These findings identify the EC, alongside the prefrontal cortex, as a dynamic hub for remote memory recall.

Shared early impairments of medial entorhinal cortex function across distinct Alzheimer's disease etiologies

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The medial entorhinal cortex (MEC) harbors diverse spatially and object-tuned cell types essential for spatial coding and episodic memory, and is among the earliest regions affected in neurodegenerative diseases. Here, we examined how early neurodegeneration alters MEC cellular coding, network dynamics, and behavior in two Alzheimer mouse models of distinct etiology. Specifically, we performed *in vivo* electrophysiology, immunohistochemistry and behavioral assays in models that reflect the manifestation of a tauopathy and amyloidopathy, respectively, to identify common impairments. In both models, the earliest deficits manifested as instability of spatial context representations at the cellular and behavioral level. These impairments preceded model-specific disruptions in grid cell coding and altered theta oscillations. We further identified reduced parvalbumin-positive (PV+) septal projections as a likely contributor to MEC dysfunction. In contrast, object-vector coding remained intact, highlighting spatial context instability as an early marker of MEC impairment.

Representational Dynamics in the Hippocampus and Medial Prefrontal Cortex during Spatial Learning

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We recorded neural activity from hippocampal area CA1 and the medial prefrontal cortex (mPFC) in rats performing two spatial tasks on a radial eight-arm maze: a combined spatial reference and working memory task and a cue-guided association task. Using a combination of tetrodes and Neuropixel probes, we tracked individual cell activity and population-level manifolds across multiple days of learning and task execution. The results described below apply to both paradigms.

At the single-cell level, we identified a form of flickering in which neurons transitioned between discrete alternative firing fields across trials. In CA1, this flickering was primarily learning-induced; as animals reached task proficiency, these cells transitioned systematically toward stable, single-field representations. In contrast, mPFC cells exhibited persistent, random flickering that remained uncoordinated across the population and did not diminish with increased task familiarity.

Population-level manifold analysis using UMAP further differentiated these regional dynamics. In CA1, manifolds primarily encoded spatial variables, such as arm identity and position. In the mPFC, however, manifolds better differentiated task-relevant variables, including relative arm location and trial progression. However, as animals gained experience, mPFC representations of trial progression weakened, while spatial decoding improved, suggesting a shift in representational priority.

These results indicate that representational change in the hippocampus and mPFC follows distinct trajectories. While the hippocampus undergoes a structured stabilization of spatial maps during learning, the mPFC maintains a persistent flexibility. This divergence suggests that the mPFC may prioritize the encoding of dynamic task rules over the stable environmental representation maintained by the hippocampus.

Active single-cell memory

Motoharu Yoshida

Research Group Yoshida, Leibniz Institute for Neurobiology, Magdeburg, Germany.
German Center for Neurodegenerative Diseases (DZNE), Magdeburg, Germany,

The prevailing view holds that neurons operate primarily as input-output units, becoming active only when they receive sufficiently strong synaptic inputs from other neurons. On the other hand, *in vitro* experiments have long indicated that neurons can maintain their activity through intrinsic cellular mechanisms under certain neuromodulatory conditions, thereby acting as memory elements. However, whether individual neurons act as memory elements and support cognition *in vivo* remains unclear. In my talk, I will first present the cellular and molecular mechanisms of active single-cell memory—*intrinsic persistent firing*—in hippocampal and entorhinal neurons, as evidenced by *in vitro* electrophysiological recordings. I will then discuss the role of intrinsic persistent firing in the maintenance of hippocampal and entorhinal spatial representations, and its contribution to spatial working memory performance in behaving mice. These findings redefine neurons as active contributors to information retention, beyond their traditional role as passive input-output units and potentially reshaping our understanding of neural computation.

Medial septal circuits in exploratory locomotion: cellular correlates of brain state changes

Stefan Remy

Research Group Remy, Leibniz Institute for Neurobiology (LIN), Magdeburg, Germany

Transitions between rest, locomotion, sleep, and other behaviors are accompanied by distinct neuronal activity patterns, or brain states, that can be observed in network dynamics. The medial septum and diagonal band of Broca (MSDB) are key regulators of hippocampal and cortical activity and are thought to play an important role in shaping such state transitions. However, the functional contribution of specific MSDB cell types and the integration of locomotion-related input by individual hippocampal and MSDB neurons remains incompletely understood.

Using single-cell RNA sequencing, we characterized the cellular heterogeneity of the MSDB and identified novel genetic subclusters and transcriptional gradients that provide new molecular access points for circuit dissection. We further identified a glutamatergic projection from the MSDB to the ventral tegmental area (VTA) that is critically involved in exploratory locomotion.

Combining circuit-specific manipulation with machine-learning-based behavioral analysis, we show that activation of this pathway selectively promotes exploratory behaviors such as sniffing, whisking, and rearing. In addition, the circuit directly targets distinct VTA neuron populations, including dopaminergic neurons.

These findings link molecularly defined MSDB cell types to behavioral state transitions and brain-state dynamics, providing new insight into how basal forebrain circuits organize behavior.



Invited Talks

Day 3

Development and lesion-induced plasticity in the primate medial temporal lobe

Pierre Lavenex

Institute of Psychology, University of Lausanne, Switzerland

The hippocampal formation, often considered as one functional unit, is the central component of a large brain network essential for the processing of spatial and episodic memories. Yet, it is now well established that different hippocampal structures and circuits contribute to different types of information processing. In the first part of my talk, I will discuss the differential postnatal maturation of distinct hippocampal regions and layers and putative functional circuits from a global perspective that takes into consideration the work of many other researchers who have contributed to our current understanding of various hippocampal functions. Both neuroanatomical and molecular data suggest that the differential maturation of distinct hippocampal circuits underlie the emergence and maturation of different hippocampus-dependent memory processes, ultimately leading to the emergence of episodic memory concomitant with the maturation of all hippocampal circuits.

In the second part of my talk, I will discuss experimental studies on the plasticity of medial temporal lobe structures following restricted hippocampal lesions. I will show that populations of immature neurons found in the entorhinal and perirhinal cortices are differentially affected by hippocampal lesion occurring shortly after birth or in adulthood. In neonate-lesioned monkeys, the number of immature neurons in the entorhinal and perirhinal cortices was generally higher than in controls. The number of mature neurons was also higher in layer III of area Er of neonate-lesioned monkeys, but no differences were found in layer II of area 36. In adult-lesioned monkeys, the number of immature neurons in the entorhinal cortex was lower than in controls but did not differ from controls in the perirhinal cortex. The number of mature neurons in layer III of area Er did not differ from controls, but the number of small, mature neurons in layer II of area 36 was lower than in controls. In sum, hippocampal lesions impacted populations of mature and immature neurons in discrete regions and layers of the entorhinal and perirhinal cortices, which are interconnected with the amygdala and provide major cortical inputs to the hippocampus. These structural changes may contribute to some functional recovery following hippocampal injury in an age-dependent manner.

Sleep-dependent memory formation in the developing brain

Marion Inostroza

University of Tübingen, Germany

Early life is characterized by remarkable learning capacities, yet memories formed during infancy often appear inaccessible later in life, a phenomenon commonly referred to as infantile amnesia. Increasing evidence from rodent research suggests that these early experiences are not simply forgotten but can persist in latent forms and influence learning and behavior in adulthood. Understanding how such memories are formed and stabilized during early development remains a central challenge in memory research.

I will present findings from studies in rats investigating how sleep supports memory formation during infancy. The developing brain differs substantially from the adult brain in both neural organization and sleep architecture. In particular, early life is characterized by a high proportion of REM sleep and immature coordination between hippocampal and cortical networks. These developmental features raise the possibility that the mechanisms supporting sleep-dependent memory consolidation during infancy differ from those described in adults.

Using behavioral paradigms assessing spatial and schema-like memory together with electrophysiological recordings, our work examines how hippocampal and medial prefrontal networks interact with sleep dynamics across development. The findings suggest that infancy represents a distinct state of the memory system, in which sleep plays a critical role in shaping how early experiences are processed and stored over the long term.



Neurobiological mechanisms underlying the developmental emergence of episodic memory

Paul Frankland

The Hospital for Sick Children (“SickKids”), Toronto, Canada
University of Toronto, Canada

Memories for events (i.e., episodic memories) formed in early development differ from those in adulthood in at least two regards. First, these memories tend to be less precise (i.e., infantile generalization). Second, they tend to be rapidly forgotten (i.e., infantile amnesia). My talk will focus on the neurobiological mechanisms that account for these different operating characteristics of episodic memory in the developing brain. With respect to infantile generalization, our studies have shown that maturation of inhibitory hippocampal microcircuits is necessary for the formation of adult-like, precise memories for events. With respect to infantile amnesia, our studies have revealed that developmentally-regulated myelination of prefrontal cortical circuits is necessary for the formation of adult-like, enduring event memories. Similar to developing sensory systems—where cortical circuit refinement occurs during defined windows of heightened brain plasticity known as critical periods—our work suggests that similar refinement of hippocampal and prefrontal cortical circuits underlies the emergence of adult-like episodic memory function.



Are medial temporal lobe subregions "specialized" for particular classes of visual stimuli?

Rosanna Olsen

Rotman Research Institute, Baycrest, Toronto, Canada
University of Toronto, Canada

A long-standing question in cognitive neuroscience concerns whether medial temporal lobe (MTL) subregions are specialized for processing particular classes of visual stimuli. Influential accounts have proposed category-selective roles for MTL structures—for example, that perirhinal cortex supports object representations whereas parahippocampal cortex preferentially processes scenes and spatial contexts. However, alternative frameworks suggest that functional organization within the MTL may instead reflect differences in representational or integrative demands rather than strict stimulus categories.

In this talk, I will review evidence bearing on this debate. First, I will present findings from an fMRI study examining associative inference, a form of memory that requires integrating information across overlapping episodes. Although several MTL subregions exhibited scene sensitivity in an independent functional localizer, these same regions were recruited during encoding to support associative inference even when episodes were linked by faces. These findings suggest that regions often characterized as scene-selective may contribute more generally to integrating disparate elements of experience.

I will then present recent work from my laboratory examining visual discrimination performance in individuals with mild cognitive impairment. Behavioral, structural, and functional measures indicate that perceptual discrimination deficits emerge early along the continuum from healthy aging to cognitive impairment and relate to interactions between perirhinal cortex integrity and anterior temporal network functional connectivity.

Together, these findings challenge strictly category-based interpretations of MTL function and instead support a view in which MTL subregions contribute to distinct representational computations that are recruited flexibly depending on task demands.

Role of adult-born dentate neurons in successful cognitive aging

Nora Abrous

University of Bordeaux, INSERM, Magendie, Neurogenesis and Pathophysiology Group, France

Aging is accompanied by a decline in memory but these alterations are extremely variable between subjects: some individuals preserve cognitive abilities (Resilient, Res), whereas others show a clear substantial cognitive decline incapacitating in everyday life (Vulnerable, Vul). These inter-individual differences have also been described in rodents especially in tasks measuring spatial memory abilities. We believe that understanding the processes underlying such individual differences is a key step to predict, prevent or slow age-related cognitive disorders.

Spatial memory processes depend upon the hippocampus and more particularly upon the creation of new neurons in the dentate gyrus. Aging is associated with an exhaustion of the pool of new neurons and their delayed maturation. However, it remains unknown if aging influences the integration and role of adult-born hippocampal neurons (ABNs) generated early in adult life and whether this is influenced by the cognitive status of the individuals. We will show that long-lived ABNs support successful cognitive aging by preserving their synaptic inputs onto the proximal segments of their dendrites, and that these proximal synaptic sites also demonstrate a maintenance of their mitochondrial homeostasis. Furthermore, by-passing the reduced inputs of ABNs in vulnerable rats through direct optogenetic stimulation successfully improved their memory abilities. Overall, our data indicate not only the rate of neurogenesis but also the that the maintenance of long-lived ABNs integration within the neuronal network is essential for successful cognitive aging, highlighting their potential as a therapeutic target for restoring cognitive functions in old age.

Medial temporal lobe network changes in aging and early Alzheimer's disease

Anne Maass

German Center for Neurodegenerative Diseases (DZNE), Magdeburg, Germany
Otto von Guericke University Magdeburg, Germany

The medial temporal lobe (MTL) is among the earliest brain regions affected by aging and Alzheimer's disease, including the early accumulation of neurofibrillary tau tangles in the superficial layers of the entorhinal cortex. Facilitated by amyloid-related hyperactivity, tau is thought to propagate along functional pathways to the neocortex, with the posteromedial cortex (retrosplenial cortex, precuneus) among the earliest affected regions. Functional MRI studies in older adults at risk for Alzheimer's disease often report increased hippocampal activity or connectivity, and it remains debated whether this reflects pathological hyperexcitability or compensatory network responses. To investigate how aging and early Alzheimer's pathology affect connectivity within the MTL and between the MTL and posteromedial regions, longitudinal multimodal imaging studies including Alzheimer's biomarkers are essential.

In this talk, I will first present longitudinal 3T functional MRI findings from the Prevent-AD cohort examining how MTL connectivity changes over time in cognitively normal older adults at increased risk for Alzheimer's disease. These analyses reveal differential trajectories along the hippocampal long axis, with aging and Alzheimer's-related processes associated with distinct changes in connectivity of the anterior versus posterior hippocampus with the posteromedial cortex. In healthy aging, functional connectivity strength between the posterior hippocampus and the precuneus, as well as within the posteromedial cortex, decreased and was associated with poorer longitudinal episodic memory performance. In contrast, increased connectivity between the anterior hippocampus and the superior precuneus was related to higher baseline Alzheimer's disease pathology. Associations between hippocampal connectivity and episodic memory were further moderated by APOE4 genotype, suggesting that genetic risk shapes the relationship between network organization and memory performance. To probe local circuit alterations within the MTL in relation to tau pathology, I will then present ultra-high-field 7T fMRI data in cognitively normal older adults that map layer-specific intrinsic functional connectivity within the MTL circuit. Specifically, we examine how layer- and subfield-specific connectivity relates to MTL tau burden and whether these associations are moderated by APOE4 genotype or astroglial reactivity.

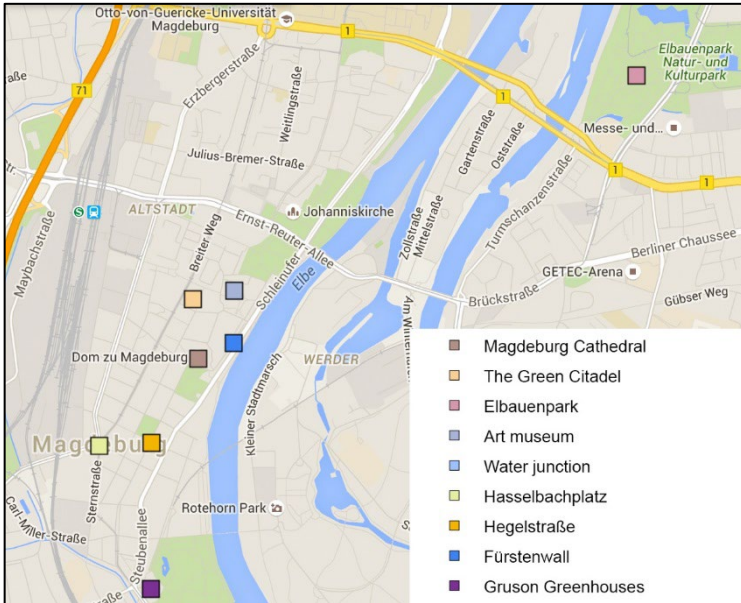


Together, our studies suggest that aging and Alzheimer's pathology are associated with specific alterations in functional connectivity within MTL subregions and between the MTL and posteromedial cortical regions supporting episodic memory. Early alterations may reflect a complex interplay between hyperactivity, tau propagation along memory networks, and potentially compensatory connectivity changes that transiently support memory function in the face of emerging pathology.



Recreational Information

Sightseeing



The water junction cannot be reached via public transport.
 Taxi Magdeburg: +49 391 737373



The Green Citadel of Magdeburg

One of Magdeburg's most eye-catching attractions for visitors is also one of the last architectural masterpieces designed by the artist Friedensreich Hundertwasser. The Hundertwasser Building is located among a mixture of Baroque facades and examples of modern design.

Magdeburg Cathedral

Magdeburg Cathedral is the first Gothic-style cathedral to be constructed on German soil, one of the largest church buildings in Germany and the most famous attraction in Magdeburg, the capital city of the federal state of Saxony-Anhalt.



Art Museum in the Monastery of Our Lady

The Art Museum in the Monastery of Our Lady is the most important venue for contemporary art and sculpture in the German Land of Saxony-Anhalt and is one of the most popular tourist attractions in the region.



Fürstenwall

The Fürstenwall area dates back to the Middle Ages and contains city fortifications facing the river Elbe and the two preserved fortified towers. Built in 1725, this was the first public promenade in Germany. The adjacent Möllenvogteigarten is the oldest preserved garden design in the city of Magdeburg.

Hegelstraße

The Hegelstraße street begins at the Cathedral and runs in a southerly direction. The popular boulevard was built between 1880 and 1920, during the Gründerzeit era, and is lined with magnificent representative buildings.



Hasselbachplatz

At Hasselbachplatz, which is named after a former major of Magdeburg (1809-1882), you can marvel at the city's most magnificent Gründerzeit-style facades. This district is home to many pubs, bars and restaurants and is well worth a visit, especially in the evening.





Gruson Greenhouses

The Gruson Greenhouses are a traditional botanical garden featuring the exotic collection of plants. The facility preserves and continues the botanical legacy of Magdeburg's industrialist and plant collector Hermann Gruson (1821-1895).

The Elbauenpark including Millennium Tower

With its unique Millennium Tower, the world's tallest wooden construction of its kind, the Elbauenpark is well worth a visit 365 days a year. The Millennium tower is hosting interactive exhibitions of 6000 years of evolution of science and technology while the park itself offers themed gardens, a butterfly house, a deer enclosure and a climbing park.



Waterway Junction



The water-saving lock Rothensee and the longest canal bridge in Europe (918 m) which spans the river Elbe, the double ship lift Hohenwarthe and the connecting canals are all part of a gigantic building project to connect the waterways of Hanover, Magdeburg and Berlin.



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