

Data Blitz Sessions Overview

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

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

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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

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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

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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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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

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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

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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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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 drift 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

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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 posteromedial 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

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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

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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.

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.