Second international conference on the

FUNCTIONAL ARCHITECTURE OF MEMORY

May 21 to 23, 2014

The FAM conference aims at bringing new insights on today's major controversies in recognition memory, and bridging human and animal memory function.

World leading experts on the Medial Temporal Lobe will discuss findings obtained with complementary approaches (behavioral, imaging, functional neuroanatomy and electrophysiology).

Go to **www.rub.de/philosophy/famconference** for preliminary schedule, further description of the event and registration.

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SPEAKERS

John **AGGLETON** (Cardiff, UK)
Verner **BINGMAN** (BGSU, USA)
Rebecca **BURWELL** (Brown University, USA)
Emrah **DUEZEL** (DZNE, Germany)
Madeline **EACOTT** (Durham University, UK)
Alexander **EASTON** (Durham University, UK)
Howard **EICHENBAUM** (Boston Univ., USA)
Ray **KESNER** (Utah, USA)
Stefan **KOEHLER** (Western Ontario Univ., CA)
James **KNIERIM** (Johns Hopkins Univ., USA)
Denise **MANAHAN-VAUGHAN** (RUB, Germany)
Charan **RANGANATH** (UC Davis, USA)
Michael **RUGG** (UT Dallas, USA)
Magdalena **SAUVAGE** (RUB, Germany)
Wendy **SUZUKI** (New York Univ., USA)
Clea **WARBURTON** (Bristol University, UK)
Menno **WITTER** (Trondheim, Norway)
Motoharu **YOSHIDA** (RUB, Germany)

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Local Organizer

Prof. M. Sauvage, Mercator Research Group, Functional Architecture of Memory Unit, Ruhr-University Bochum, Germany.

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Raya Schindler, Alexandra Gerhardt and Corinna Hartling for administrative support

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Functional Architecture of Memory Conference

May 21st – 23rd 2014

General Information

Key Information

1. Way to the conference center (see map page 6)
From the "Ruhr-Universität" U35 subway station go up the stairs and turn right towards the university. Your route takes you directly to the building of the university library (1). Keep left of the library, go down the stairs and continue straight ahead to a second stairway (2). Go down these stairs and go straight until you pass the Audimax (3) and reach the cantine-building. Enter the building and take the elevator down to level 04 (signs). The talks will be held in Room 3 (4) (10 min walk).

2. Internet Access
A Wireless LAN environment is available in the conference center. Please ask the reception desk for access ID.

3. Breakfast/Lunch
Two cafeteria (cash-only) can be found within the conference center: the Mensa (level 02) and the Bistro and Coffee bar (level 01). The Uni Center, close to the U35 station (10 min walk from the venue, see map page 6) also offers fast food alternatives and nice terraces. For a relaxing break, we recommend the Ruhr University *botanical garden* (opening hours: 9:00 – 18:00) across the street from the conference center in the direction of Kemnader See (less than 5 min).

4. 'Students/speakers –only' round table
Each day from 13:00 to 13:50 in room 82 level 04 takes place a students/speakers-only discussion session students/postdocs (no PIs) have the opportunity to get feedback from the speakers of the day. We stronly encourage students to take advantage of this unique oppportunity to ask the questions they never ‚dared' to.

5. Dinner

For participants who registered to the **conference dinner** (Thursday May 22nd), a bus transport is organized from the parking of the Mensa to Burg Blankenstein (www.burgblankenstein.de). Departure: meeting point at the information booth of the conference center at 5:15 p.m. sharp. Return: pick-up at the drop off point (parking of Burg Blankenstein) at 9 p.m. sharp. 3 stops: UNI-center, Park Inn, Bermuda Dereieck). If you miss departure you can either call a taxi: +49 234 333000 or take a public bus (CE31 runs every 30 min from the castle to Bochum main station, a 30 min ride).

No events are organized for Wednesday 21st or Friday 23rd but speakers and participants are encouraged to reconvene for drinks in the Bermuda Triangle in the evening at 21:00. The meeting point is in front of the restaurant Gulum (Kortumstr. 20a, see page 52). Wearing your badges would help finding each other.

Our tips for dinner on those two days:
*The **'country side' choice.*** Direction Kemnader Lake: restaurant Post's Lottental (5 min walk) and restaurant: See Nami (Chinese; 20 min walk) close to the lake. By good weather, we very much recommend the Beach bar (also 20 min walk, see map page 53)
*The **'downtown' alternative***. Many restaurants are available in the Bermuda triangle (take the U35 back to Bochum main station and follow the map on page 52)

Should you need help to go one way or the other, students will be available at the reception booth at 17:15 each day to show you the way.

Map of the University

1. University Library
- Coffeebar

2. Stairs

3. Audi Max

4. Veranstaltungszentrum (VZ)
- Cantine (Mensa)/Bistro

5.Food Court
- American, Italian, Chinese

6. Post Office

7. Restaurant 'Summa Cum Laude' (terrace)

8. Pharmacy

9. Botanical Gardens
- Direction Kemnader See

Functional Architecture of Memory Conference

May 21st – 23rd 2014

Program

Time	Wednesday May 21st	Thursday May 22nd	Friday May 23rd
9:00 – 09:40	***M. Sauvage „Welcome" (9:00-9:10)*** ***Data Blitz Session (9:10-10:20)***	***J.P. Aggleton (Cardiff University)*** Multiple mnemonic systems embedded within the anterior thalamus: Implications for hippocampal function	***C. Ranganath (UC Davis, USA)*** Context-dependent coding of objects in the human hippocampus
09:40 – 10:20	***Data Blitz Session***	***D. Manahan-Vaughan (RUB, Germany)*** Information processing within the olfactory system and interactions with the hippocampus	***E.C. Warburton (University Bristol, UK)*** The 'when' and 'where' of object recognition memory: Mapping the neural circuitry
10:20 – 10:40	Coffee	Coffee	Coffee
10:40 – 11:20	***Data Blitz Session***	***E. Düzel (DZNE, Germany)*** 7Tesla fMRI of the hippocampus and entorhinal cortex: insights into the functional organization of novelty encoding and pattern separation	***M. Sauvage (RUB, Germany)*** Proximodistal functional segregation of CA3: evidence for segregated spatial and non-spatial hippocampal subnetworks
11:20- 12:00	***Data Blitz Session***	***R. P. Kesner (Utah University, USA)*** The role of the hippocampus in supporting pattern completion	***R. Burwell (Brown University, USA)*** Object and context representations in parahippocampal structures
12:00 – 13:00	Lunch/Break	Lunch/Break	Lunch/Break
13:00 – 13:50	Students/Speakers Discussion	Students/Speakers Discussion	Students/Speakers Discussion
14:00 -14:40	***M.D. Rugg (UT Dallas, USA)*** Brain networks supporting successful recollection: does anything change with age?	***H. Eichenbaum (Boston University, USA)*** The hippocampus in space and time	***J. Knierim (John Hopkins University, USA)*** Parallel processing streams through the entorhinal cortex to the hippocampus: Content vs. context
14:40 – 15:20	***V.P. Bingman (Bowling Green State, USA)*** Insights from the avian hippocampus: Evidence for pre-mnemonic, perceptual neglect of environmental features and age-related cognitive decline	***W. Suzuki (NYU, USA)*** Dynamic plasticity in the medial temporal lobe: An update	***M.P. Witter (University Trondheim, Norway)*** Identified entorhinal neurons. A closer look at their connectivity.
15:20 – 15:40	Coffee	Coffee	Coffee
15:40 – 16:20	***S. Köhler (Western University, Canada)*** Familiarity and the human medial temporal lobes	***M. Yoshida (RUB, Germany)*** Shaping hippocampal functions through cholinergic neuromodulation	***A. Easton (Durham, UK)*** What is the role of context in memory, and how is it special?
16:20 – 17:00	Open Discussion "Recollection and familiarity" Mod.: M. Eacott	Open Discussion "Space and time processing" Mod.: H. Eichenbaum	Open Discussion "Parahippocampal function" Mod.

Time	Wednesday May 21st (9:00 to 10:20)
9:00 – 9:10	***M. Sauvage*** **„Welcome“**
9:10- 10:50	***Data Blitz Session*** ***(5 min talk , 2 min questions)***
	M. Pyka (RUB, Germany) Parametric anatomical modeling: A method for modeling the anatomical layout of neurons and their projections
	C. T. Wotjak (MPI Munich, Germany) In vivo imaging of spatial learning in mice
	M. J. Valero-Aracama (RUB, Germany) Environmental enrichment modulates the cellular excitability of hippocampal CA1 pyramidal cells in a housing duration and anatomical location dependent manner
	J. Disterhoft (Northwestern University, USA) Hippocampal CA3 pyramidal neurons show increased excitability in aging
	E. Save (Univ. Marseille, France) Coding of self-motion-based traveled distances in the medial entorhinal cortex
	O. Bein (Hebrew University Jerusalem, Israel) The influence of prior knowledge on encoding processes in the hippocampus
	N. Maingret (Collège de France, France) Selective reinforcement of hippocampo-cortical interactions during sleep potentiates memory consolidation
	M. A. De Souza Silva (Univ. Düsseldorf, Germany) The NK3 receptor agonist senktide facilitates episodic-like memory consolidation in rats
10:20 – 10:40	**Coffee**

Time	Wednesday May 21st (10:20 to 13:50)
10:20 – 10:40	**Coffee**
10:40- 12:00	***Data Blitz Session*** ***(5min talk, 2 min questions)***
	N. Axmacher (UK Bonn, Germany) Memory Consolidation by replay of stimulus-specific neural activity
	L. M. Talamini (UA, Netherlands) Generalization from episodic memories across time: a route for semantic knowledge acquisition
	J. Kizilirmak (OvG University, Germany) Insight learning improves recognition memory for visual stimuli
	A. Ben-Yakov (Weizmann Institut, Israel) Repetition increases online hippocampal activity and decreases offline activity in response to a single event
	R. Tibon (IDC Herzlyia, Israel) Temporal texture of associative encoding modulates recall processes
	C. Sweeney-Reed (UK Magdeburg,Germany) Prestimulus temporal lobe theta power predicts successful human episodic memory formation
	L. Menendez de la Prida (Cajal Institute, Spain) Discoordination of entorhinal theta inputs underlies episodic-like memory deficits in experimental temporal lobe epilepsy
	F. Mormann (University Bonn, Germany) Invariance of single unit responses in the human medial temporal lobe to image transformations in a visual object presentation task
12:00 – 13:00	**Lunch/Break**
13:00 – 13:50	**Students/Speakers Discussion**

Time	Wednesday May 21st
9:00 – 09:40	*M. Sauvage „Welcome" (9:00-9:10)* *Data Blitz Session (9:10-10:20)*
09:40 – 10:20	*Data Blitz Session*
10:20 – 10:40	Coffee
10:40 – 11:20	*Data Blitz Session*
11:20- 12:00	*Data Blitz Session*
12:00 – 13:00	Lunch/Break
13:00 – 13:50	Students/Speakers Discussion
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14:40 – 15:20	*V.P. Bingman (Bowling Green State, USA)* Insights from the avian hippocampus: Evidence for pre-mnemonic, perceptual neglect of environmental features and age-related cognitive decline
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15:20 – 15:40	**Coffee**
15:40 – 16:20	***M. Yoshida (RUB, Germany)*** Shaping hippocampal functions through cholinergic neuromodulation
16:20 – 17:00	**Open Discussion** **"Space and time processing"** **Mod.: H. Eichenbaum**

Time	Friday May 23rd
9:00 – 09:40	***C. Ranganath (UC Davis, USA)*** Context-dependent coding of objects in the human hippocampus
09:40 – 10:20	***E.C. Warburton (University Bristol, UK)*** The 'when' and 'where' of object recognition memory: Mapping the neural circuitry
10:20 – 10:40	**Coffee**
10:40 – 11:20	***M. Sauvage (RUB, Germany)*** Proximodistal functional segregation of CA3: evidence for segregated spatial and non-spatial hippocampal subnetworks
11:20- 12:00	***R. Burwell (Brown University, USA)*** Object and context representations in parahippocampal structures
12:00 – 13:00	**Lunch/Break**
13:00 – 13:50	**Students/Speakers Discussion**
14:00 -14:40	***J. Knierim (John Hopkins University, USA)*** Parallel processing streams through the entorhinal cortex to the hippocampus: Content vs. context
14:40 – 15:20	***M.P. Witter (University Trondheim, Norway)*** Identified entorhinal neurons. A closer look at their connectivity.
15:20 – 15:40	**Coffee**
15:40 – 16:20	***A. Easton (Durham, UK)*** What is the role of context in memory, and how is it special?
16:20 – 17:00	**Open Discussion** **"Parahippocampal function"** **Mod.**

Functional Architecture of Memory Conference

May 21st – 23rd 2014

Data Blitz Session

Parametric Anatomical Modeling: A method for modeling the anatomical layout of neurons and their projections

Martin Pyka, Sen Cheng

Mercator Research Group "Structure of Memory" and Faculty of Psychology, Ruhr University Bochum, Germany

Biological neural networks are likely to be described by a low-dimensional parameter space. The parameters include, for example, the 3d-shape of neuron layers, the neurons' spatial projection patterns, spiking dynamics, neurotransmitter systems, etc. Many studies generate artificial neural networks that match some of the properties of biological networks to study their computational properties. While some parameters, such as the spiking dynamics, are easily modeled, others are not, such as the anatomical layout of neurons and their projections.

We present a new method, called Parametric Anatomical Modeling (PAM), to fill this gap. PAM can be used to derive network connectivities and delays from anatomical data, such as the position and shape of the neuronal layers and the dendritic and axonal projection patterns. Within the PAM framework, several mapping techniques between layers can account for a large variety of connection properties between pre- and post-synaptic neuron layers. PAM is implemented as a Python tool and integrated in the 3d-modeling software Blender.

We demonstrate on a 3d-model of the hippocampus and entorhinal cortex how PAM can help to uncover the relationship between the form and function of the hippocampus. Models created by PAM can also serve as an educational tool to visualize the 3-d connectivity of brain regions. The low-dimensional, but yet biologically plausible, parameter space renders PAM suitable to analyse allometric and evolutionary factors in networks and to model the complexity of real networks with comparatively little effort.

In vivo imaging of spatial learning in mice

Carsten. T. Wotjak

Max Planck Institute of Psychiatry, Dept. Stress Neurobiology and Neurogenetics, Munich, Germany

With the water cross-maze, we established a spatial learning task, which is perfectly suited for experiments in mice and which allows to differentiate between place- vs. response-based navigation strategies. We combined this task with manganese-enhanced MRI (MEMRI) to visualize the brain matrix activated during place learning in vivo. Lesion studies confirmed the causal involvement of the identified structures in spatial navigation.

Environmental enrichment modulates the cellular excitability of hippocampal CA1 pyramidal cells in a housing duration and anatomical location dependent manner

Maria. J. Valero-Aracama

Neural Dynamics Laboratory, Ruhr-Universitat Bochum, Germany

Housing animals in enriched environments (EE) improves their performance in learning and memory (L & M) tasks and reduces their propensity to develop certain disorders such as epilepsy. While an increased cellular excitability in the hippocampus is a likely underpinning of the L & M enhancement, the literature to this respect is scarce and mixed. In the seizure-related research, no mechanism has been proposed to mediate its beneficial effect. However, the slow after hyperpolarization potential (sAHP) could be a good candidate since it is the focus of some anticonvulsant therapies, and indirect evidence indicates that might be modulated by an EE. In this study we show that an EE increases the cellular excitability of CA1 pyramidal cells but only when the housing duration was inferior to 40 days and mainly in the dorso-distal region and the left hippocampus. This effect seems to be mediated by the modulations of the input resistance (IR) and the spike threshold (TH). Additionally we observed a larger sAHP in EE-cells. These results enlighten the complex modulations of an EE in the cellular excitability of CA1 pyramidal cells which are sensitive to the housing duration, anatomical location and could explain the excitability required for L & M enhancements and the inhibition necessary for seizure prevention.

Hippocampal CA3 pyramidal neurons show increased excitability in aging

John Disterhoft, Dina Simkin, M. Matthew Oh

Department of Physiology, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

Learning/memory impairments and cognitive decline in non-pathological aging have been attributed to deficient encoding of information by hippocampal neurons due to maladaptive changes in their functional properties. Little is known about how aging affects the biophysical properties of CA3 pyramidal neurons which play an important role in encoding novel information, pattern completion, and memory retrieval. Thus, we systematically examined the intrinsic firing properties of CA3 pyramidal neurons from young (2-4 months) and aged (28-32 months) rats using whole-cell patch-clamp. Here we demonstrate that aged CA3 pyramidal neurons fire significantly more action potentials (AP) during theta-burst frequency stimulation with narrower AP half-widths and enlarged fast afterhyperpolarization (fAHP). Furthermore, we observed increased expression of Kv4.2/4.3, but not BK, channels in aged CA3 neurons which suggest that increased A-type potassium conductance underlies age-related alterations in biophysical properties of CA3 neurons. These changes in intrinsic properties of CA3 neurons likely contribute to the tendency for increased pattern completion and decreased cognitive flexibility seen in aging animals and humans.

Coding of self-motion-based traveled distances in the medial entorhinal cortex

Etienne Save, Pierre-Yves Jacob, Bruno Poucet, Francesca Sargolini

Laboratoire de Neurosciences Cognitives, Aix-Marseille University, CNRS, Marseille, France

An increasing amount of data points to a role of the medial entorhinal cortex (MEC) in path integration. This is supported by the existence of grid cells whose pattern of activity is thought to reflect a combination of spatial and movement signals. In particular, the regular arrangement of the multiple firing fields suggests that grid cells encode the distances travelled by the animal using self-motion cues. We tested the hypothesis that the MEC is involved in distance encoding by examining the effect of MEC lesions on the ability of rats to travel across specific distances by relying on self-motion cues. Rats with either sham lesions (N=8) or excitotoxic lesions on the dorsal hippocampus (N=8) or the MEC (N=10) were trained to travel across 3 distances, 30, 60 and 90 cm from a starting point on a linear track in the absence of external cues. All groups displayed lower accuracy at higher distances. This effect was exacerbated in the MEC group. In particular MEC-lesioned animals were significantly impaired at the 60cm condition, compared to both controls and hippocampal rats. Moreover, MEC lesioned animals tended to underestimate their traveled distance at both 60cm and 90cm conditions. These results point to a role of the MEC in coding of distances based on self-motion cues.

The influence of prior knowledge on encoding processes in the hippocampus

Oded Bein[1] and Maril, A.[1,2]

Cognitive Science Department, The Hebrew University of Jerusalem, Israel

Recent models suggest that events that are inconsistent with our prior knowledge are encoded via an HPC-medial Pre-Frontal Cortex (mPFC) interaction, while schema-consistent events can be encoded independently of the HPC. The current study examined HPC involvement in memory for items (e.g., CHICKEN) encoded with a related associate (e.g, 'egg', schema items) or with unrelated words (e.g., 'earrings', no-schema items). Results provided direct evidence linking HPC-mPFC functional-connectivity with subsequent memory of no-schema items. Furthermore, a differentiated voxel-by-voxel activity-patterns for remembered versus forgotten items revealed that the HPC is involved in schema-items encoding as well, inconsistently with current frameworks. We conclude that the HPC is involved in subsequent memory of both schema and no-schema events, but by a different mode of operation for each class of stimuli.

Selective reinforcement of hippocampo-cortical interactions during sleep potentiates memory consolidation

Nicolas Maingret

Center for Interdisciplinary Research in Biology, Collège de France, Paris, France.

Hippocampo-cortical interactions during sleep have been proposed to underlie a progressive transfer of information initially encoded in the hippocampus to neocortical areas, including the prefrontal cortex, for long term storage of memory traces. This would occur during coordinated hippocampal ripples (200Hz), cortical delta waves (1-4Hz) and thalamo-cortical sleep spindles (10-15Hz) and associated neuronal reactivations. However, this theoretical framework is mostly supported by correlational evidence. We reasoned that if the coordination of hippocampal ripples and cortical oscillations does play a key role in information transfer for memory consolidation, then experimentally reinforcing their co-occurence during sleep should improve memory performance.

We have developed a novel closed-loop brain stimulation protocol to induce ripple-triggered delta waves followed by spindles (K-complexes) during sleep in rats. Stimulations were delivered during slow wave sleep following weak, time-limited training on an hippocampus-dependent spatial object recognition task. Spatial reference memory was assessed after 24h. Following timed stimulation, test rats performed significantly better than chance, in contrast to control rats in which either no stimulation was applied or stimulation was delayed by a random duration following ripple detection.Our results indicate that enhancing the hippocampo-cortical dialogue potentiated the consolidation of a weak memory trace that would otherwise not have been consolidated. This provides direct evidence that precise correlations between ripples and K-complexes play a causal role in the stabilization of memory traces for long-term storage.

The NK3 receptor agonist senktide facilitates episodic-like memory consolidation in rats

Owen Y. Chao, Joseph P. Huston, Maria A. De Souza Silva

Center for Behavioral Neuroscience, University of Duesseldorf, Germany

Senktide, a potent neurokinin-3 receptor (NK3-R) agonist, has promnestic effects in the adult and aged rodents in several behavioral paradigms and improves scopolamine-induced impairment. It was found to improve episodic-like memory (ELM) in mice when administrated before learning. In the present study we assess the possible effects of senktide on memory consolidation by administering it post-trial (after the learning trial) in adult rats. A standard ELM test, based on the integrated memory for object, place and temporal order which we developed (Kart-Teke et al., 2006) was applied. This test involves two learning trials and one test trial. The delay between the learning and test phase was varied to examine our hypothesis: 1 h, 6 h or 23 h delay without any treatment. The animals exhibited ELM after after 1h, but not 6h or 23h. Then, vehicle or senktide (0.2 mg/kg, s.c.) was applied after the 2nd learning trial and and the test conducted 6h and 23h later. The senktide-treated group now exhibited intact ELM memory in the test 6h later and recovery of some of the ELM components in the test 23h later, unlike the vehicle-treated group. Finally, animals received either vehicle or SR142801, a selective NK3-R antagonist (6 mg/kg, i.p.) 1 min before senktide injection (0.2 mg/kg, s.c.) and were tested 6 h later. The vehicle + senktide group showed intact ELM, while the SR146801 + senktide group did not. The results indicate that senktide facilitates ELM consolidation and its effect is NK3-R dependent.

Memory Consolidation by Replay of Stimulus-Specific Neural Activity

Nikolai Axmacher

Klinik für Epileptologie , Universität Bonn, Germany

Memory consolidation transforms initially labile memory traces into more stable representations. One putative mechanism for consolidation is the reactivation of memory traces after their initial encoding during subsequent sleep or waking state. However, it is still unknown whether consolidation of individual memory contents relies on reactivation of stimulus-specific neural representations in humans. Here, we show in healthy human participants that stimulus-specific activation patterns can indeed be identified by applying multivariate pattern classification analysis (MVPA) to fMRI data, that these patterns reoccur spontaneously during postlearning resting periods and sleep, and that the frequency of reactivation predicts subsequent memory for individual items.

Generalization from episodic memories across time: a route for semantic knowledge acquisition

Lucia M. Talamini

Department of Psychology, University of Amsterdam, Netherlands

The storage of input regularities, at all levels of processing complexity, is a fundamental property of the nervous system. At high levels of complexity, this may involve the extraction of associative regularities between higher order entities such as objects, concepts and environments across events. We propose that such a mechanism provides an important route towards the formation of higher order semantic knowledge. The present study assessed whether subjects were able to extract complex regularities from multiple associative memories and whether they could generalize this regularity knowledge to new items. We used a memory task in which subjects were required to learn face-location associations, but in which certain facial features were predictive of locations. We assessed generalization, as well as memory for arbitrary stimulus components, over a 4-hour post-encoding consolidation period containing wakefulness or sleep. We also assessed the stability of regularity knowledge across a period of several weeks thereafter. We found that subjects were able to detect the regularity structure and generalize it to new items. Interestingly, generalisation performance increased across the 4hr post-learning period. However, no differential effects of cerebral sleep and wake states during this interval were observed. Furthermore, it was found that regularity extraction hampered the storage of arbitrary facial features, resulting in an impoverished memory trace. Finally, across a period of several weeks, memory for the regularity structure appeared very robust whereas memory for arbitrary associations showed steep forgetting. The current findings improve our understanding of how regularities across memories impact memory (trans)formation.

Insight learning improves recognition memory for visual stimuli

Jasmin Kizilirmak, Joana Galvão Gomes da Silva, Stefan Repplinger, Fatma Imamoglu, Alan Richardson-Klavehn

Memory and Consciousness Lab, Department of Neurology, Otto-von-Guericke University Magdeburg, Germany

The solution of a problem suddenly coming into mind accompanied by an aha-experience is referred to as an insight. Besides a cognitive dimension, insights also have an affective dimension, which at least is reflected by the associated “Aha!”-expression. The current study's aim is to elucidate the relevance of insights in learning and memory. We hypothesize a positive memory effect mediated by the affective state of aha-experiences during an image recognition task. To operationalize the phenomenon of insight, the subjects (N=20) were confronted with two-tone pictures – similar to Mooney face images – of animals and machines. They were asked to recognize the motives shown on the pictures within 20 seconds because otherwise a grey-scale solution was presented. Thereby, we obtained information about the occurrence of aha-experiences and the related feeling. After this encoding phase, there was one week of retention interval leading to a second recognition test with subsequent old/new-judgement. Our results show a significantly higher solution rate for old compared to new items (0.61 vs. 0.45, $p<0.001$). Occurrence of an aha-experience and self-generation of the solution independently increased the probability of subsequent recognition. Analysing the effect of generation and aha-experience on affective rating, self-generation and aha-rating led again independently to more positive ratings. Concluding from our behavioural data, the occurrence of an aha-experience solving a problem is enhancing the encoding of unfamiliar stimuli. We suggest the associated positive affective rating as an indicator for dopaminergic activity facilitating plasticity changes of medial temporal lobe structures.

Repetition increases online hippocampal activity and decreases offline activity in response to a single event

Aya Ben-Yakov, Yadin Dudai

Department of Neurobiology, Weizmann Institute of Science, Israel

We recently identified encoding-related hippocampal activity time-locked to the offset of brief realistic episodes (movie clips). By presenting participants with the same clips multiple times we examined the effect of increasing familiarity on the hippocampal response, attempting to separate retrieval from encoding signatures in a single experience. We find that increased familiarity results in a decrease in hippocampal activity at the event offset across the hippocampus. This is coupled with an increase in posterior-hippocampal activity at event onset. Our results reveal a spatiotemporal dissociation between an online familiarity signal and an offline novelty signal in response to the same stimulus.

Temporal texture of associative encoding modulates recall processes

Roni Tibon, Shir Ben-Zvi, Ayelet Peer and Daniel A. Levy

School of Psychology and Unit for Applied Neuroscience, The Interdisciplinary Center, Herzliya, Israel

Binding aspects of an experience that are distributed over time is an important element of episodic memory. In the current study, we examined how the temporal complexity of an experience may govern the processes required for its retrieval. We recorded event-related potentials during episodic cued recall following pair associate learning of concurrently and sequentially presented object-picture pairs. Cued recall success effects over anterior and posterior areas were apparent in several time windows. In anterior locations, these recall success effects were similar for concurrently and sequentially encoded pairs. However, in posterior sites the effect was larger for the retrieval of sequentially encoded pairs. Such posterior modulations have been associated with recollective retrieval processes in which the hippocampus is implicated. We surmise that these differences in retrieval related activations result from the addition of the temporal dimension in the sequential condition, increasing the complexity of the episodic experience at encoding by creating sequences of discontiguous events. The encoding and retrieval of such events seemingly requires greater engagement of hippocampal recollective processes, leading to modulation of the late posterior component.

Prestimulus temporal lobe theta power predicts successful human episodic memory formation

Catherine Sweeney-Reed

[1]Clinic for Neurology and Stereotactic Neurosurgery, Magdeburg, Germany

Episodic memory results from processing of external stimuli through interaction with an internal brain state in continuous flux, such that perceptions, with their contexts, can be subsequently accessed. Poststimulus neural oscillations during successful memory encoding have been the focus of extensive investigation. Interest in prestimulus neural activity, reflecting the internal state of the brain, is growing, however, as it has been shown to impact upon whether memories are successfully formed. Scalp ERPs have been shown to predict memory formation, and medial temporal lobe theta activity preceding stimulus presentation, detected using MEG, has been found to predict successful memory formation, with greater hippocampal and rhinal cortical theta oscillations corresponding with encoding success. We had the opportunity to record electrocortical signals from temporal lobe both medially and laterally from a patient receiving a subdural grid and electrode strips as a part of treatment for pharmacoresistant epilepsy during while the patient viewed a series of photographic scenes. The scenes were subsequently shown again, mixed with new scenes, and the patient judged whether the scene had been previously viewed. The initial scenes were categorized as subsequently remembered or forgotten. Enhanced prestimulus theta power prior to stimulus presentation resulting in successful compared with unsuccessful memory formation, was identified in both the medial and also lateral temporal lobe. Our findings provide further support for a role for enhanced prestimulus theta power in memory formation in the temporal lobe.

Discoordination of entorhinal theta inputs underlies episodic-like memory deficits in experimental temporal lobe epilepsy

Liset Menendez de la Prida

Instituto Cajal, CSIC, Madrid, Spain

Deficits of episodic memory are present during aging and in many neurological conditions including Alzheimer's disease and temporal lobe epilepsy (TLE). However, the basic mechanisms both in health and disease are unknown. Here we discuss our recent data on the neurophysiological correlates of episodic-like memory in normal and TLE rats as tested with the “what-where-when” paradigm (Inostroza, Brotons-Mas et al. JN 33(45), 6 Nov 2013). Using multi-site local field potential recordings and detailed spectral analysis we found that different features of the theta rhythm, i.e. the power and coordination, are differently linked to memory of individual components of episodic-like memory. We present unpublished data to dissect the underlying mechanisms and discuss on rationality of potential rescue strategies.

Invariance of single unit responses in the human medial temporal lobe to image transformations in a visual object presentation task

Florian Mormann

Dept. of Epileptology, University of Bonn, Germany

Neurons in the human medial temporal lobe (MTL) show semantic invariance by responding, e.g., to very different pictures of a given person and even to their written or spoken name. In the present work, we examine the invariance of human MTL single unit responses to stimuli which are modified by different transformations of their characteristic properties (e.g., color, shape, orientation) as well as responsiveness to specific types of transformations across stimuli.

Recording from the MTL of patients undergoing epilepsy monitoring, we selected up to ten response-eliciting stimuli, modified them in 12 different ways (blur, noise, pixelate, charcoal drawing, gray scale, color, negative, and rotation by four different angles), and showed these to the patient. We selected units of interest using a two-way ANOVA (stimulus identity and transformation type) on the spike rate measured during the one second period of stimulus presentation. We then used a generalized χ^2-test to examine regional differences in response behavior.

Recordings from up to now five patients (13 sessions) yielded 284 units in the amygdala, hippocampus, enthorinal cortex, and parahippocampal cortex. The ANOVA selected a subset of 83 units with a significant effect for the factor stimulus identity, and a smaller set of 27 units with an effect for the factor transformation type. Remarkably, the units responding to stimulus identity were evenly distributed over the four regions, while those responding to a specific transformation type were found almost exclusively in the parahippocampal cortex.

Functional Architecture of Memory Conference

May 21st – 23rd 2014

Invited Talks

Brain networks supporting successful recollection: does anything change with age?

Michael D. Rugg

Behavioral and Brain Sciences, UT Dallas, USA

Two fMRI studies contrasting the neural correlates of successful episodic recollection across different age groups will be described. The studies employed different operationalizations of recollection (Remember-Know and associative recognition) and experimental materials (single pictures and words, and word pairs). In both studies, robust recollection effects (enhanced activity for recollected relative to unrecollected items) were evident in the 'core recollection network' , that is, the hippocampus and adjacent regions of the medial temporal lobe, along with medial prefrontal cortex, posterior cingulate/retrosplenial cortex, and left angular gyrus. Strikingly, the magnitudes of these effects were age-invariant in both studies. Hippocampal effects, but not effects elsewhere in the network, correlated significantly across subjects with recollection accuracy independently of age. Successful recollection was also associated with enhanced connectivity between each region of the core recollection network and other cortical regions. Whereas the magnitude of these connectivity increases were age-invariant, their relationship with recollection accuracy was not, in that connectivity strongly co-varied with accuracy in young subjects, but did so to a much lesser degree in middle-aged and older individuals. We conclude that the brain circuitry underlying successful recollection undergoes relatively little reorganization or degradation with healthy aging. Possible reasons for the age-differences in the relationship between connectivity increases and recollection performance will be discussed.

Insights from the avian hippocampus: evidence for pre-mnemonic, perceptual neglect of environmental features and age-related cognitive decline

Verner P. Bingman

Department of Psychology , Bowling Green State University, USA

The advancing understanding of the neural organization of the avian hippocampus, both with respect to its sub-divisional organization and how it is embedded in the broader connectivity scheme of the avian forebrain, potentially enables a perspective on hippocampus and memory that revives an interest in the central importance of space. The maturing of GPS-tracking technology has enabled a revolution in navigation research, including the expanded possibility of studying hippocampal-mediated mechanisms that guide navigation in the field. Using GPS-trackers, three sets of field observations converge on the conclusion that hippocampal lesions lead not only to a cognitive loss of spatial memory/navigation, but more foundationally, a perceptual neglect of distinctive environmental features. Homing pigeons with hippocampal lesions 1) actually fly *straighter* homeward-directed paths from distant, *unfamiliar* release sites (a kind-of pigeon-auto-pilot), 2) routinely ignore conspicuous geographic boundaries and settlements, and 3) respond less to and navigate worse in the presence of conspicuous wind turbines. The data suggest an unforeseen, pre-mnemonic, perceptual neglect of environmental features. In the context of the "Functional Architecture of Memory", it seems the avian hippocampus is not simply involved in the formation of spatial memories (or any kind of memories), but is central to the creation of space itself.

Viewing the avian hippocampus as an architect of space also has implications for age-related decline in cognitive/memory function. Homing pigeons also age and I will discuss some recent data demonstrating substantial decline in spatial working memory in older homing pigeons; a cognitive decline that may be related to degenerative processes in the hippocampus, and speculating further, a perceptually impoverished space.

Familiarity and the human medial temporal lobes

Stefan Köhler

Behavioural and Cognitive Neuroscience, University of Western Ontario, London, Canada

It is well established that recognition of a previously encountered stimulus can succeed in the absence of successful recollection of contextual detail about a specific past encounter, by way of a process known as familiarity assessment. The goal of the present talk is to review recent patient-based and neuroimaging research from my lab that focused on neural mechanisms that support this process in the human medial temporal lobes. Our work has been guided by the hypothesis that computations in extrahippocampal structures, including but not limited to perirhinal cortex (PRc), support item-based familiarity, and that contributions of the hippocampus are not critical. I will address three specific issues. First, I will focus on a potential role of human PRc in the assessment of the cumulative familiarity of concepts shaped over a life-time of experiences, which differs from the assessment of recency that is typically required in experimental tasks of recognition memory. Second, I will ask whether familiarity signals in PRc (based on recent exposure) are category specific, and whether parahippocampal cortex may also carry familiarity signals for some stimulus classes. In the final portion of my talk, I will review some initial findings that address whether familiarity signals in PRc could be characterized as distributed representations.

Multiple mnemonic systems embedded within the anterior thalamus: Implications for hippocampal function

John P. Aggleton

School of Psychology, Cardiff University, UK

The anterior thalamic nuclei are centrally involved in human anterograde amnesia and are also vital for rodent spatial learning. These functions partly reflect their dense interconnections with the hippocampus. The anterior thalamic nuclei comprise three major nuclei (anteromedial, anteroventral, and anterodorsal), each with subtly different patterns of connectivity. Double tracer experiments have shown how, with the exception of the lateral dorsal tegmental nucleus, individual inputs rarely bifurcate to terminate in more than one of the anterior thalamic nuclei, emphasising the need to uncover their separate, but complementary, contributions to learning. The view is supported by those lesion experiments that have tried to target individual anterior thalamic nuclei. Based on the connectivity and electrophysiological properties of the anterior thalamic nuclei, the following functional segregation has been proposed. 1) The anterior medial nucleus is part of a 'feed-forward' system, primarily concerned with conveying integrated hippocampal – diencephalic signals to prefrontal sites that aid cognitive flexibility, executive function, and recency judgements. 2) The anterior ventral 'return loop' system provides, among other things, theta to the hippocampal formation, so optimising synaptic plasticity. 3) The anterior dorsal 'head-direction' system is assumed to support navigation. In addition, the impact of anterior thalamic lesions on spatial learning in rats is assumed to be exacerbated by severe dysfunctions in the retrosplenial cortex. Careful analysis of the inputs from the hippocampus to the anterior thalamic nuclei is consistent with a highly segregated mnemonic system that has the potential to process high resolution information.

Information processing within the olfactory system and interactions with the hippocampus

Denise Manahan-Vaughan

Department of Neurophysiology, Medical Faculty, Ruhr University Bochum, Germany

Much progress has been made in our understanding of the molecular mechanisms that enable odor detection and the transfer of this information to higher olfactory structures. However, little is known about how olfactory sensory information contributes to complex spatial representation encoding by the hippocampus, or whether synaptic plasticity is required for odor learning. Current data has been obtained from *in vitro* studies, where it was shown that the rodent piriform cortex (PC) expresses transient synaptic plasticity following afferent stimulation (Lebel et al, 2001, Cereb Cortex) and that olfactory training alters plasticity induction thresholds (Brosh and Barkai, 2004,Curr Neurovasc Res). This indicates that the PC may indeed process olfactory information through synaptic plasticity. Furthermore, olfactory discrimination learning is associated with an increase in hippocampal excitability, suggesting that preprocessing of olfactory information influences subsequent information storage in the hippocampus. We observed that the learning of olfactospatial configurations drives both hippocampal LTD (André and Manahan-Vaughan, 2013, Hippocampus) and stable place fields (Zhang and Manahan-Vaughan, 2013, Cereb Cortex). We found that whereas frequency-dependent synaptic plasticity does not occur in the ascending pathway to the PC, synaptic plasticity occurs in the PC following stimulation of the ascending pathway from the orbitofrontal cortex (OFC), suggesting that persistent information encoding in the PC may be driven by top-down control that confers information about aspects such as odor categorisation. We propose that olfactospatial information processing in the hippocampus is influenced by preprocessing of olfactory information in the PC that is in turn driven by top-down control.

7Tesla fMRI of the hippocampus and entorhinal cortex: insights into the functional organization of novelty encoding and pattern separation

Emrah Düzel

Institute of Cognitive Neurology and Dementia Research, Otto-von-Guericke Universität Magdeburg, Germany

The ability to form long-term memories for novel events depends on information processing within the hippocampus (HC) and entorhinal cortex (EC). The HC-EC circuitry shows a quantitative segregation of anatomical directionality into different neuronal layers. To utilize this directionality information, we measured encoding activity within HC/EC subregions with 7 Tesla high resolution functional magnetic resonance imaging (fMRI). Multivariate Bayes decoding within HC/EC showed that processing of novel scenes images was most strongly related to engagement of input structures (superficial EC and DG/CA2-3), whereas subsequent memory was more dependent on activation of output regions (deep EC and pyramidal CA1). This suggests that while novelty processing is strongly related to HC-EC input pathways, the memory fate of a novel stimulus depends more on HC-EC output. In a second 7T study we sought to test the hypothesis that the hippocampus can harbor pattern separated representations of scenes. We developed a paradigm that allows testing this hypothesis independently of the novelty of scenes and found that among all hippocampal subfields, only DG representations can distinguish similar scene images.

The role of the hippocampus in supporting pattern completion

Raymond P. Kesner

Department of Psychology, University of Utah, USA

Pattern completion is a process associated with retrieval of information based on the CA3 subregion of the hippocampus which contains recurrent collaterals and proposed to play a major role in CA3 in retrieving originally stored information patterns in the face of partial inputs to the CA3 region. Behavioral data will be presented to support the role of the CA3 subregion of the dorsal hippocampus in engaging pattern competion processes. This includes disruptive effects of pattern completion for visual cues following ibotenic acid lesions of CA3, intracranial injections of naloxone within CA3, and naloxone injections into CA3 to disrupt relapse from cocaine addiction. Also, disruptive effects of dorsal CA3 lesions on cued recall requiring pattern completion based on object-place and place- object arbitrary associations as well as disruptive effects of dorsal dentate gyrus lesions or dentate gyrus neurogenesis on remote memory based on CA3 mediated pattern completion. Overall there is excellent behavioral evidence for a role of the dorsal CA3 in subserving a pattern completion process.

The hippocampus in space and time

Howard Eichenbaum

Center for Memory and Brain, Boston University, USA

The hippocampus is essential to episodic memory, which is characterized by our ability to recall the spatial and temporal organization of past experiences. An understanding of how the hippocampus supports episodic memory would benefit by using an animal model to identify neural coding mechanisms for the spatial and temporal organization of memories within the hippocampus. Here I will present evidence that neural networks in hippocampus develop an organized, hierarchical representation of features of events within and across spatial contexts. Furthermore, I will describe recent evidence that hippocampal "time cells" encode specific moments in the course of temporally extended experiences and time cell ensembles encode specific memories and predict memory accuracy. These findings reveal neural mechanisms for spatial and temporal organization of memories and support an emerging view that the hippocampus supports episodic memory by creating a scaffold for the organization of events within their spatial and temporal context.

Dynamic plasticity in the medial temporal lobe: An update

Wendy Suzuki

Center for Neural Science, New York University, USA

A major goal of our lab is to understand the neural basis of episodic memory, or memory for the events of our lives. Our strategy has been to subdivide episodic memory into its component parts and we have focused on two major aspects of episodic memory: 1) the ability to form new associations on-line (i.e., new associative learning) and 2) memory for temporal order (i.e., what come first, second or third). In this talk, I will describe our latest findings addressing these two components of episodic memory. Our previous studies showed that about 18% of recorded hippocampal cells signals new associative learning. In a new study, we report an even larger proportion of the recorded hippocampal neurons are engaged in new associative learning and further show that individual hippocampal cells can participate in highly flexible ways in new learning during different time points of the trial. In other studies, we showed a strong timing signal in the hippocampus as subjects perform a temporal order memory test. In the second update that I will describe, we examined whether timing signals in the hippocampus were present in other tasks that do not explicitly require memory for temporal order. We not only found strong timing signals during an object-place associative learning task, but many hippocampal cells signaled the conjunction of timing during the delay with other context-rich task information. These findings, taken together illustrate the wide range and striking flexibility of hippocampal cell responses during memory-demanding tasks.

Shaping hippocampal functions through cholinergic neuro-modulation

Motoharu Yoshida

Neural Dynamics Laboratory, Ruhr-Universität Bochum, Germany

The cholinergic projections to the hippocampus play a crucial role in modulating the memory capability of the hippocampus. Blockades of the cholinergic modulation disrupt memory encoding both in humans and animals, and deficits in the cholinergic system underlie Alzheimer's disease. In addition, the cholinergic system has been proposed to play a key role in the transition of hippocampal functional stages between memory encoding and consolidation. However, the mechanisms through which hippocampal functions are altered by the cholinergic modulation are not fully understood.

We investigated cholinergic cellular modulations and its role in the hippocampus using in vitro electrophysiological recordings and computational simulations. First, I will present that cholinergic activation supports persistent firing in hippocampal CA1 and CA3 pyramidal cells. Persistent firing is a repetitive neural spiking, which lasts for more than 30 sec after being triggered by a brief stimulation. This persistent firing was supported by the calcium-activated nonselective cationic (CAN) current, and may allow information retention during encoding. Second, I will present that the CAN current may support more robust in vivo-like persistent firing compared to the classical network based mechanism using computational simulations. This suggests that the CAN current activation is crucial in supporting persistent firing in vivo. Third, I introduce a possible mechanism as to how the cholinergic system supports the transition between encoding and consolidation stages. These observations points to an important role of the cholinergic modulation of the CAN current in supporting mnemonic functions of the hippocampus.

Context-dependent coding of objects in the human hippocampus

Charan Ranganath

Dynamic Memory Lab, UC Davis, USA

The hippocampus is known to play an important role in memory, but current theories of human memory differ in how they conceptualize this role. One fundamental question concerns whether the hippocampus represents specific items or objects in memory or whether it assigns context-dependent representations to objects. I will present results from studies that addressed this question by using multivariate analyses of functional magnetic resonance imaging (fMRI) data. These studies reveal that the hippocampus encodes objects in a highly context-specific manner, such that the same object is represented quite distinctly if the context is not preserved, whereas different objects are assigned similar representations if they are associated with a similar temporal contexts. Activity patterns in neocortical brain regions, in contrast, are more consistent with coding of specific attributes of an event either separately, or in an additive manner. The results are consistent with models proposing that that the hippocampus in binds object and context information, which in turn could explain its specific role in episodic memory.

The 'when' and 'where' of object recognition memory: Mapping the neural circuitry

E.Clea Warburton

School of Physiology and Pharmacology University of Bristol, UK

Recognition memory, our ability to distinguish between novel and familiar objects or places, is central to our ability to recall day-to-day events, or plan future behaviours. Recognition memory judgements can be made using different types of information, and the type of information utilised determines the involvement of distinct brain structures. Lesion studies have implicated a neural circuit involving the the perirhinal cortex, hippocampus and medial prefrontal cortex in object-in-place memory and temporal order memory, however there are both direct and indirect anatomical connections between these regions and traditional disconnection techniques cannot differentiate between their contributions. Here we describe studies in which we explored 1) the cellular mechanisms within the neural circuit which underlie the formation of different forms of recognition memory and 2) used a novel pharmacogenetic technique to selectively inactivate a direct hippocampal-prefrontal cortex connection and thus investigate the contribution of this projection to recognition memory function . The pharmacogenetic technique involves using an EIAV neuron-specific lentiviral vector, expressing lac-z, pseudotyped with a hybrid rabies envelope protein that enhances retrograde transport. Injection of the virus into the medial prefrontal cortex of male Lister Hooded rats resulted in expression of the lac-z protein in a subset of hippocampal cells that project directly to the medial prefrontal cortex Infusion of a 'prodrug' Daun02 into the hippocampus, via chronically implanted bilateral cannulae, selectively inactivated the hippocampal-medial prefrontal cortex projection. Rats were then tested on a battery of object recognition memory tests, which depend on the subjects spontaneous preference for novel objects (object recognition), objects presented earlier in a sequence (temporal order memory) or objects in novel spatial configurations (object in place memory). Intracerebral administration of selective glutamatergic antagonists demonstrated that both AMPA and NMDA receptor neurotransmission is critical for the formation of recognition memories within the hippocampal-cortical neural circuit. Importantly selective inactivation of a direct intermediate HPC/subicular-mPFC projection impaired temporal order recognition memory but not object-in-place

recognition memory. These results suggest that during recognition memory, a subset of direct projections from the HPC to mPFC are critical for the formation of a memory representation involving the temporal, but not the spatial information required for the judgement of prior occurrence.

Proximodistal functional segregation of CA3: evidence for segregated spatial and non-spatial hippocampal subnetworks

Magdalena Sauvage

Mercator Research Group, Ruhr-Universität Bochum, Germany

A well-accepted model of episodic memory is that spatial and non-spatial information are processed by segregated cortical pathways and ultimately associated within the hippocampus. The projections of these cortical areas are topographically organized along the proximodistal axis of the hippocampus. In addition, proximal CA3 (close to the dentate gyrus; DG) receives principally inputs from the exposed blade of DG and sends projections preferentially to distal CA1 (close to the subiculum). In contrast, the enclosed blade of the DG projects principally to distal CA3, which in turn projects mainly to proximal CA1 (both close to CA2). Based on these data and recent functional studies focusing on CA1 and the DG, we have recently suggested the existence of segregated hippocampal subnetworks dedicated either to the processing of spatial information or that of non-spatial information, that would be recruited when only one dimension of a representation is salient.(Nakamura et al, Journal of Neuroscience, 2013). Here, we bring evidence of a preferential recruitment of proximal CA3 and distal CA1 during non-spatial memory by combing a delayed non-matching to sample odor recognition memory task and high-resolution molecular imaging based on the detection of the immediate-early gene Arc used as a marker of neuronal activation. Conversely, we report a stronger involvement of distal CA3 over proximal CA3 during a (new) spatial version of the latter task. Finally, similar results were obtained using a spontaneous object recognition memory task in which the temporal (e.g. non-spatial) dimension of episodic memory can be dissociated from the spatial one. These results bring further support to the existence of segregated spatial and nonspatial hippocampal subnetworks possibly recruited for unidimensional representations, and are complementary to the well-accepted concept of associations of spatial and non-spatial information within the hippocampus in the case of multidimensional representations.

Object and context representations in parahippocampal structures

Rebecca Burwell

Department of Cognitive, Linguistic & Psychological Sciences, Brown University, Providence, USA

Environmental contexts are not simply places, but include stimulus items, objects, and features that characterize the local space. A general assumption is that the hippocampus is necessary to configure these stimulus items with place to represent contexts. We have proposed that representations of environmental contexts are formed upstream of the hippocampus in the postrhinal cortex. I will discuss evidence that the postrhinal/parahippocampal cortex (1) combines spatial information from the retrosplenial cortex with object information from the perirhinal cortex to represent the spatial layout of stimulus items in the local environment, (2) monitors the current context for changes in spatial layout, and (3) updates the representation of the current context with identified changes. The representation is made available to other brain areas for the binding of events with context to form episodes that are located in time, for guiding context-relevant behavior, and for recognizing objects in scenes and contexts.

Parallel processing streams through the entorhinal cortex to the hippocampus: Content vs. context

James Knierim

The Solomon H. Snyder Department of NeuroscienceJohn Hopkins University, Baltimore, USA

Unlike the grid cells of MEC and place cells of the hippocampus, LEC neurons do not show strong spatial selectivity during foraging in empty, open fields. However, when discrete objects are present in the field, a number of LEC cells fire at the location of the objects. When the objects are moved, a small fraction of LEC cells continue to fire at the former location of the objects. In the presence of objects, a small number of LEC neurons also display place-specific firing at locations away from the objects. In double cue rotation experiments, in which a local reference frame is rotated relative to a global reference frame, population analyses reveal a weak but reliable spatial signal dominated by the local cues. Thus, the LEC can convey both spatial and nonspatial signals to the hippocampus, suggesting a role in representing information about individual items in the external environment, including their location or remembered location. In contrast to the global context information provided by the MEC, the LEC may provide the hippocampus information about the specific content of an experience.

Identified entorhinal neurons. A closer look at their connectivity.

Menno P. Witter

Norwegian University for Science and Technology NTNU, Trondheim, Norway

Decades of multidisciplinary research identified the entorhinal cortex as a key component of the set of brain structures that are required for conscious memory. Yet, descriptions of the perplexing variety of entorhinal functions are generally based on a deceivingly simple wiring diagram. Superficial layers of entorhinal cortex are the main source of cortical input into the hippocampal formation and the main cortical output from the hippocampal formation is mediated by way of deep entorhinal layers. The intrinsic entorhinal network links deep hippocampal output layers to superficial input layers.

Principal neurons in different layers show strikingly different basic electrophysiological properties. In contrast, principal neurons in a particular layer of the entorhinal 'twin structures' called lateral and medial entorhinal cortex, are essentially indifferent with the exception of those in layer II. Our data further show a striking uniqueness of intralaminar layer II connectivity. Stellate cells in layer II of the medial entorhinal cortex show little to no monosynaptic excitatory connections, but exhibit polysynaptic connectivity mediated by fast-spiking interneurons. In contrast, LEC layer II fan cells, considered comparable to MEC stellate cells, show direct excitatory connections, although with a low probability.

In order to fully understand the strikingly different functions of the two entorhinal siblings, interneurons need to be integrated in the networks. We identified interneuron morphological subclasses and are in the process of assigning their molecular and physiological identities and specific connectivity. Another relevant explanatory factor is the major input difference between the lateral and medial entorhinal cortices and the different ways these inputs interact with local networks.

Although our understanding of the complex entorhinal connectome is still incomplete, we are closer to a level that allows comprehending normal functions. Knowledge of entorhinal neuronal properties and their specific connections has further been instrumental to study initial disease related pathological processes in for example Alzheimer's disease.

What is the role of context in memory, and how is it special?

Alexander Easton

Department of Psychology, Durham University, UK

We have argued in recent years that episodic memory can be defined in animals and humans as the memory for what happened, where it happened and on which occasion it happened. Whilst occasions can sometimes be differentiated by temporal cues, often they can be differentiated by non-temporal cues – such as context. Our studies have shown that memory for what happened where and in which context behave differently to memories for what happened where and when (defined by recency) in both animals and humans. In both cases, memory involving context appears to more closely resemble episodic memory. To understand how this relates to neuronal representations of context, we need to be clear about the role context plays in memory. We present evidence in humans that object recognition tasks are performed differently when different cues are available to the participant. The presence of an object in a given location on a given background context influences the degree of recollection in the task, more so than would be expected by merely providing additional cues for recall. In addition, we present evidence from rats that different types of context can be used to allow rats to spontaneously identify their memory for different (highly similar) episodes. We will discuss how these approaches might allow us to better understand the mechanisms by which neuronal representations of context can influence memory.

Functional Architecture of Memory Conference

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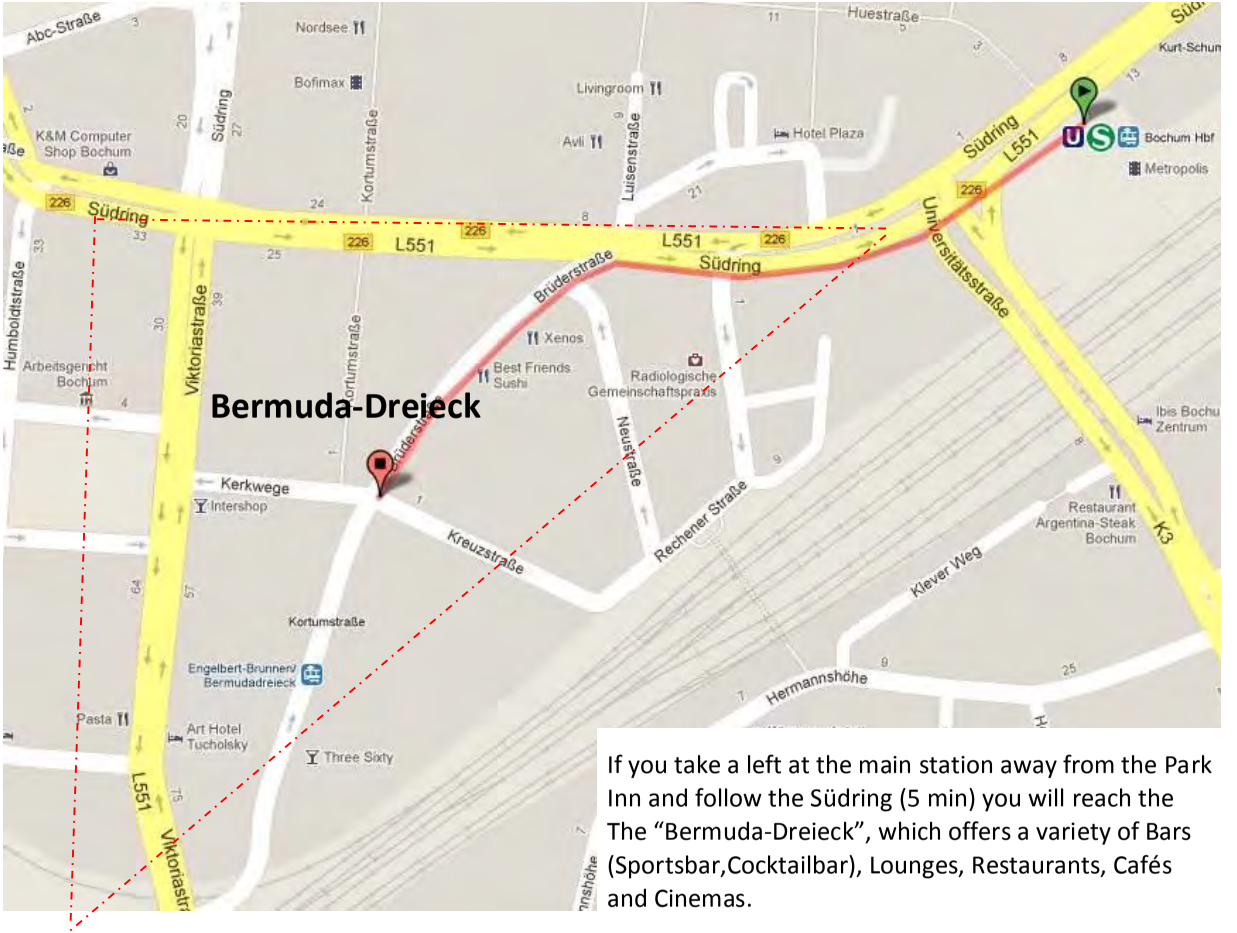
Recreational Info



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Kemnader-See

The “Kemnader See” (15 min) offers a nice recreational landscape, furthermore there is the “Strand-Deck”, a beach bar, as well as the swimmingpool (“Freizeitbad Heveney”)

Sightseeing

To reach the sightseeing goals you need a price class B ticket (24h Ticket 11,30 €)

Haus Kemnade
Terrace and restaurant (Tue-Sun 14:00 – 23:00)
Take the bus (CE31 runs every 30 min) from Bochum main station to „Haus Kemnade (25 min)
http://hauskemnade.de

Burg Blankenstein
Beer garden and restaurant (Mo-Fr from 18:00-open)
Take the bus (CE31 runs every 30 min) from Bochum main station to castle „Burg Blankenstein" (30 min)
http://www.burgblankenstein.de/

Hattingen Oldtown
Take the tram 308 (direction „Hattingen Mitte S-Bahnhof" every 15 min) from Bochum main station (30 min) to the historical Hattingen Oldtown where you will find several shops and restaurants.
http://www.international.hattingen.de/

Local Cab Company
If you would like to call a cab you can call one under 0049- 234-333000

Functional Architecture of Memory Conference

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