Neurofunctional Techniques

Lesson 14

13, 18 November 2024

Paper presentations

Calendar

- M 30 Sept: Course introduction
- W 2 Oct: Functional imaging
- F 4 Oct: Statistics (Cesca)
- M 7 Oct: Functional imaging
- W 9 Oct: Biophysics of diffusion
- F 11 Oct: Statistics (Cesca)
- M 14 Oct: Functional imaging
- W 16 Oct: General introduction to the papers for the presentations
- F 18 Oct: Statistics (Cesca)
- M 21 Oct: Modeling in neuroscience
- W 23 Oct: Molecular approaches in neuroscience
- F 25 Oct: Statistics (Cesca)
- F 25 Oct: Laboratory (14:00- 18:00)
- M 28 Oct: Practical exercises on the first part of the course
- W 30 Oct: Genome editing in neuroscience (Dr. Jaudon)
- M 4 Nov: Optogenetics
- W 6 Nov: Papers assignment to the groups; introductions to the specific papers
- T 12 Nov: X-genetics + Practical exercises on the second part of the course
- W 13 Nov: Introductions to the specific papers
- M 18 Nov: Introductions to the specific papers

- 9, 10, 11 Dic: Paper presentation 15:00-19:00)
- Tue 17 Dic: Test (14:00 - 16:00 Room 3A, Building H2bis)

Structure of the exam

1. **Paper presentation in small groups (5 students 1 hour) Maximum score 20 (+1):**

   a) **Presentation (30 min)**
   - **What was known**
   - **What is the gap**
   - **What are the main findings**
   - **Are the techniques appropriate**
   - **What are the broader implications**

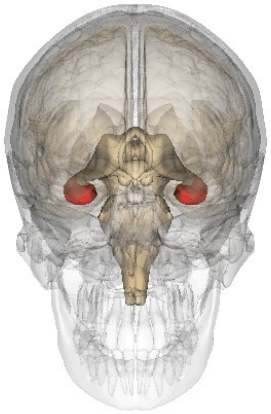
   b) **Questioning on individual figures and techniques used (30 min)**
   (9, 10, 11 December)

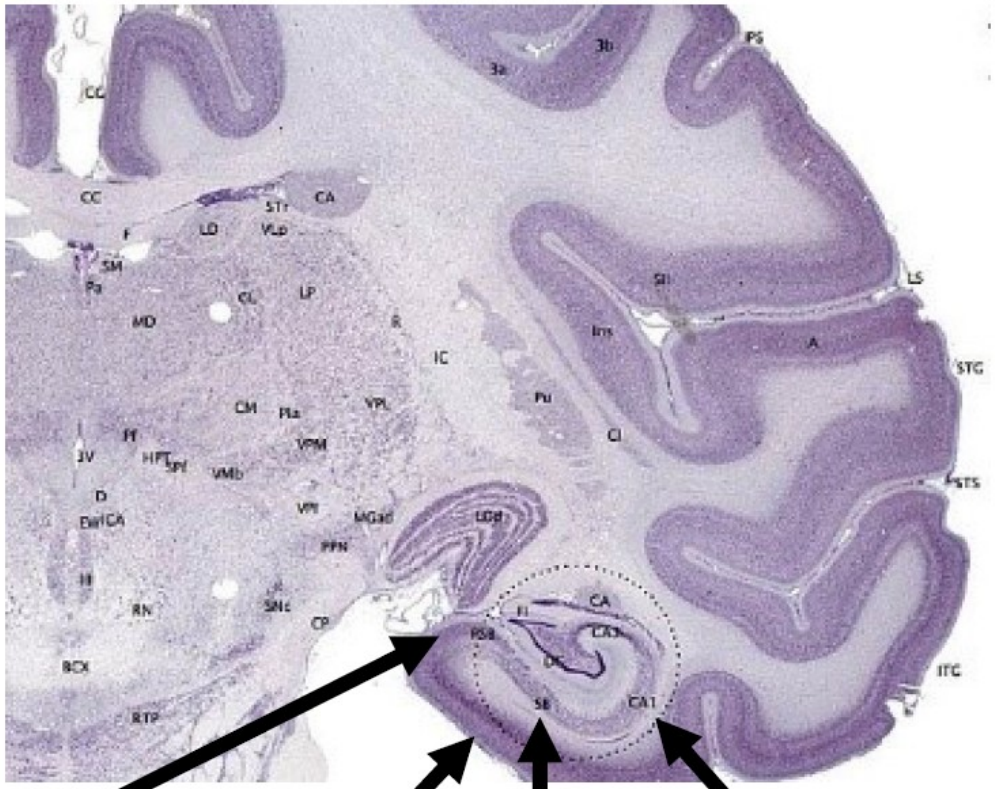
2. **Questionnaire on the Moodle platform. 10 multiple choice questions (also on statistics). Each question has only one correct answer, and each correct answer is awarded 1 point. Maximum score: 10.**
   (17 December Room 3A Building H2bis
   First turn: 14:00 - 15:00
   Second turn: 15:00 - 16:00

Monday 9.12.24	Tuesday 10.12.24	Wednesday 11.12.24	Thursday 12.12.24
Hall 2A-Bld D (14:00-16:00)	**Hall exCla-Bld C1 (16:00-18:00)**	**Hall F-Bld C1 (14:00-16:00)**	**Hall exCla-Bld C1 (16:00-18:00)**
Hall exCla-Bld C1 (16:00-18:00)		**Hall exCla-Bld C1 (16:00-18:00)**	
Group 3 - Paper 1	**Group 6 - Paper 1**	**Group 7 - Paper 1**	**Group 5 - Paper 1**
Mayia My	Rossella Di Pompeo	Cristina Baio	Sofia Mosconi
Giuseppina Russo	Elena Lunardon	Fabiana Cusimano	Maria Sole Faeti
Diomira Elettra Lenti	Beatrice Buso	Angela Marchiano	Valeria clai
Saadet Alkan	AnnaMaria Benetti	Rimoun Kaldas	Alessandra guida
Matteo Theodule	Tobia De Rosso		Maryamsadat Seyedi
Group 2 - Paper 2	**Group 8 - Paper 2**	**Group 4 - Paper 2**	**Group 10**
Martina Merga	Francesca Ronchi	GAMAL AHMED MAHMOUD ABDELAZIM	Corinna Perone
Irene Giovani	Zahra Lashkari	MOHAMED AL SIYABI	Davide Pontiggia
Carlotta Tiranzoni	Lorenzo sieni	Amanuel Bekaffa	Marianna Cis
Nosiba Yaseen	Silvia Cassani	Emmanuel	Sara Abbasigharaei
Jiulija Vodenik	Virginia Camporesi	Yabets Woldegiorgis	Delaram Forouzeh
Group 1 - Paper 3		**Group 9 - Paper 3**	
Canonero Marida		Teo Zakula	
Di Filippo Dalila		Danilo Zanghì	
Nicchiotti Francesca		Diana Dall'Olio	
Pau Alessandra		Noemi Valero	
Russo Martina		Gulnur Asci	
		azziza haddad	

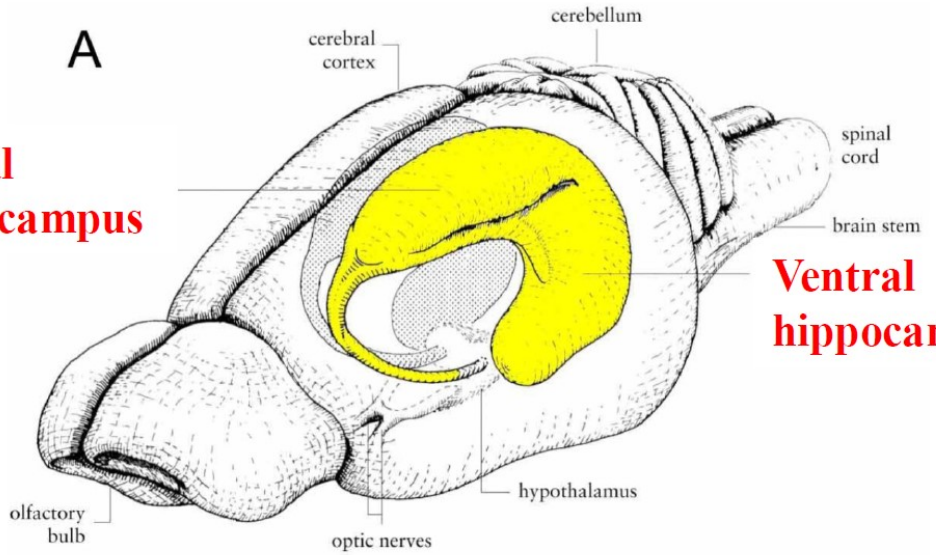
Hippocampus & entorhinal cortex anatomy

Hippocampus in primates

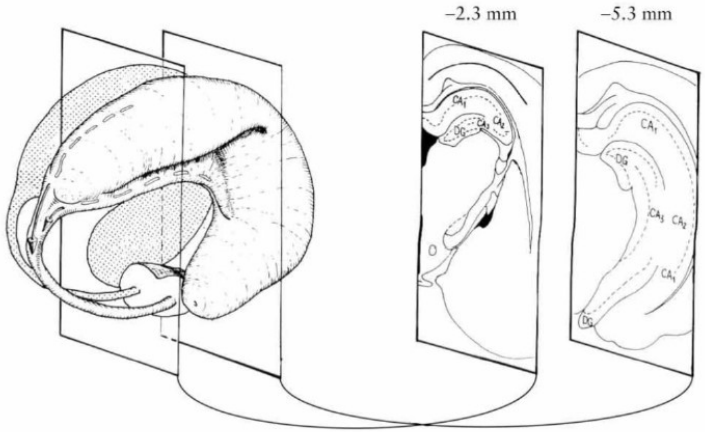




Hippocampus in rodents



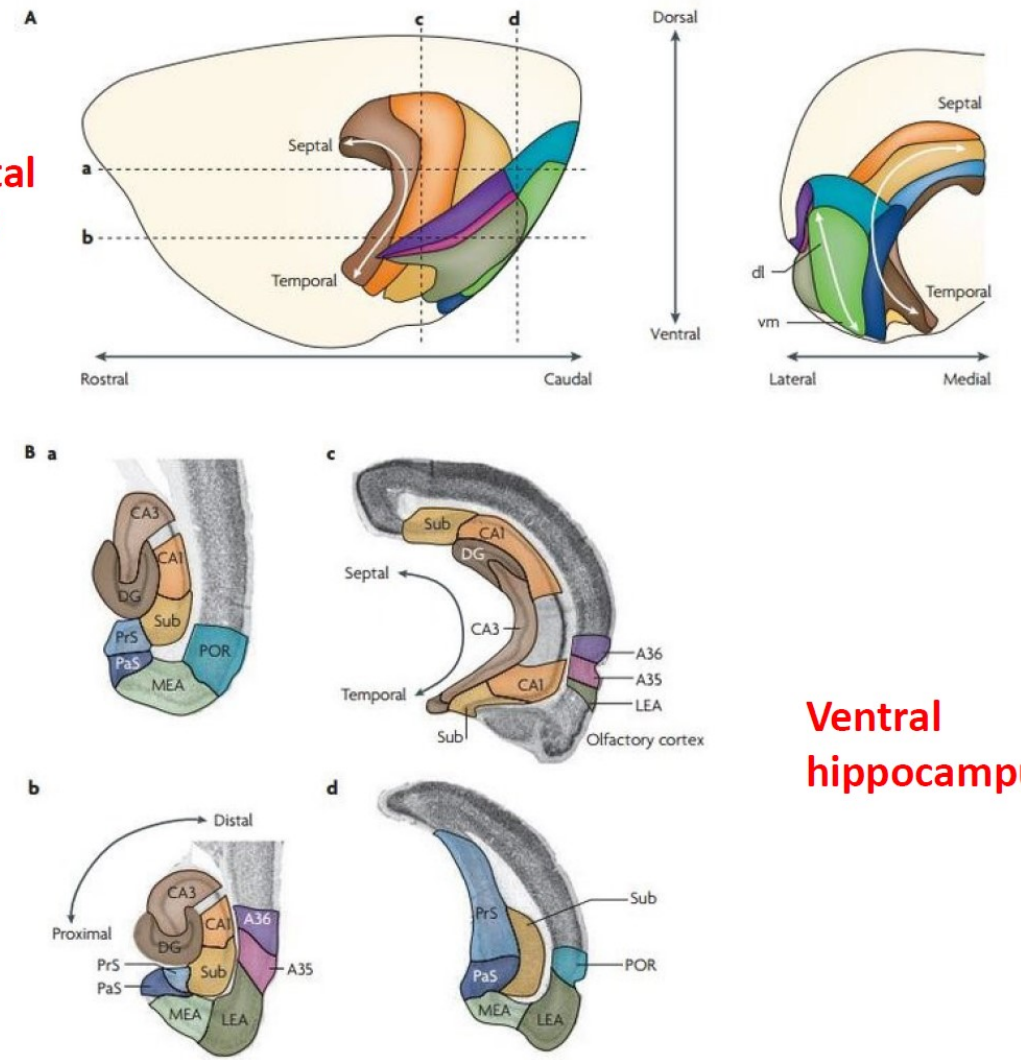
Coronal sections



Hippocampus in rodents

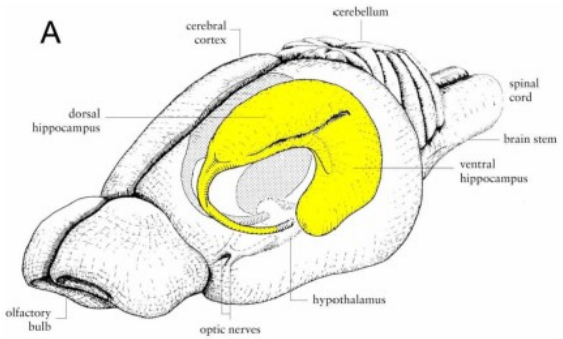
Coronal sections

Horizontal sections



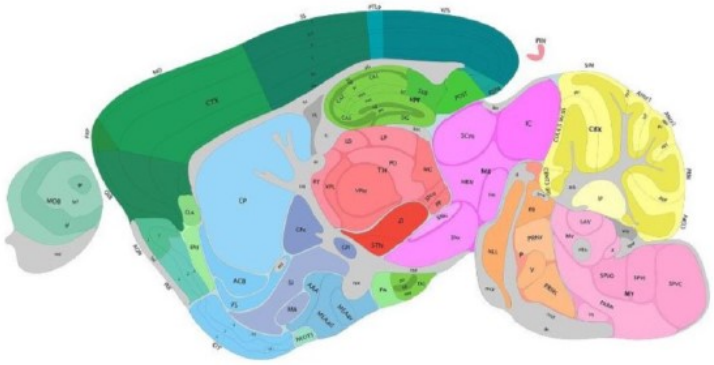
Ventral hippocampus

Hippocampus in rodents - sagittal sections

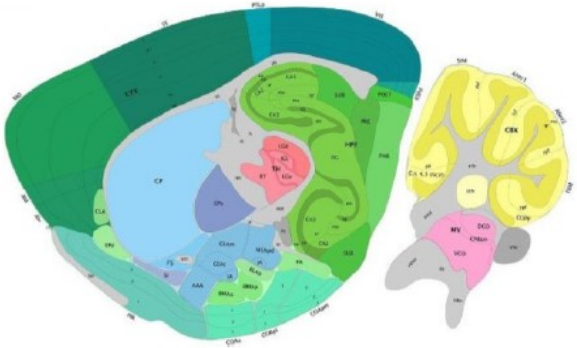


Sagittal section through the midline: no hippocampus

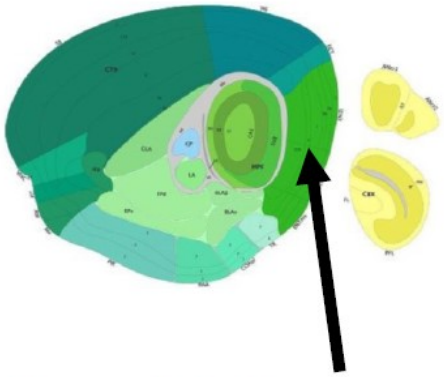
Sagittal section immediately to the right/left of the middle line: dorsal hippocampus + dorsal subiculum



More lateral sagittal section: Dorsal and ventral hippocampus



Very lateral sagittal section: Lateral view of the ventral hippocampus

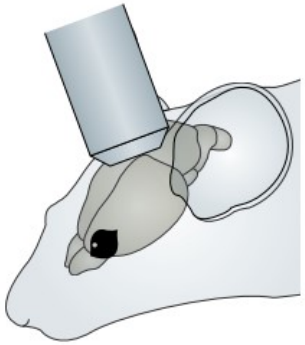


Medial entorhinal cortex

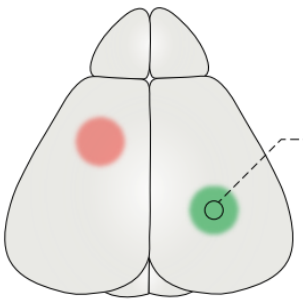
In vivo Ca^{2+} imaging in freely moving mice

In vivo experimental setup configurations for different levels of functional imaging, from macroscopic to subcellular level analyses

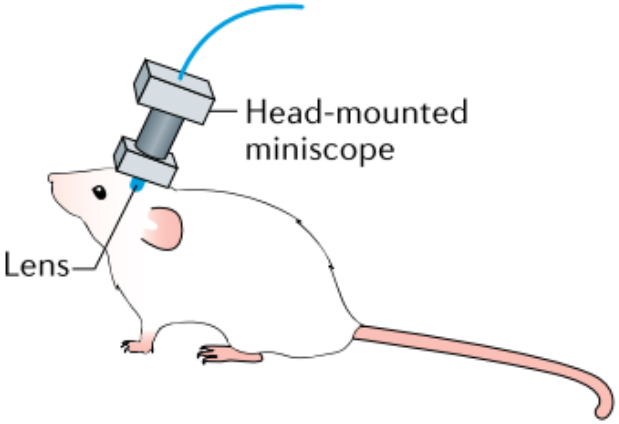
Fiber photometry
in freely moving animals
Macroscopic - mesoscopic



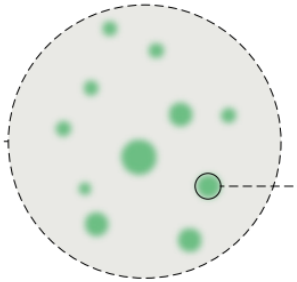
Dorsal surface of cortex



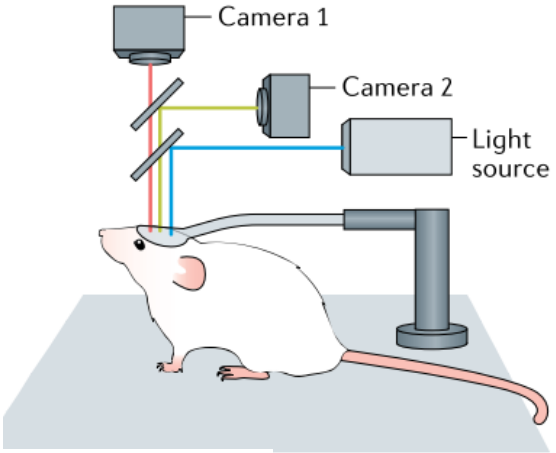
Miniscope
in freely moving animals
Circuit - cellular



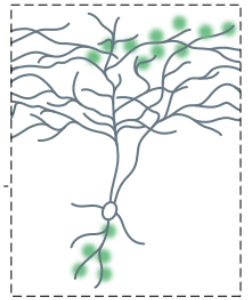
Cellular resolution



2-foton microscopy
in head-fixed animals
Cellular - subcellular



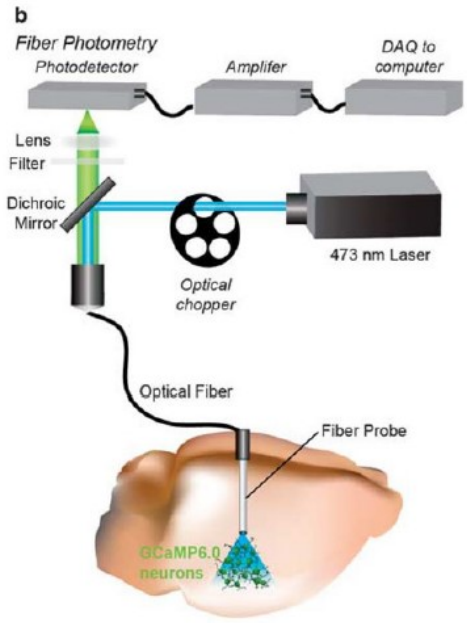
Subcellular resolution

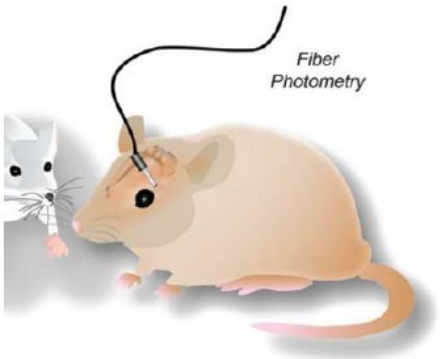


Fiber photometry

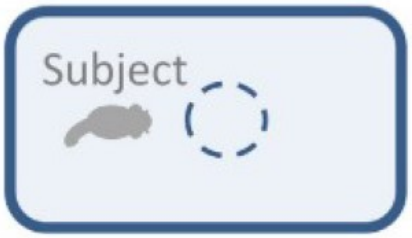
in freely moving animals

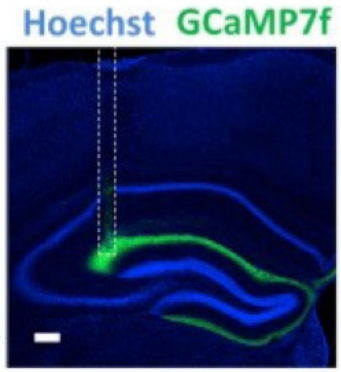
Macroscopic - mesoscopic





Fiber photometry
in freely moving animals
Macroscopic - mesoscopic





Neuron

A direct lateral entorhinal cortex to hippocampal CA2 circuit conveys social information required for social memory

Highlights

- Lateral entorhinal cortex (LEC) inputs to hippocampal CA2 underlie social memory
- Medial entorhinal cortex (MEC) CA2 input is weak and not involved in social memory
- Social memory requires the direct but not indirect LEC inputs to CA2
- LEC CA2 inputs are selectively activated by social over non-social exploration

Authors

Jeffrey Lopez-Rojas, Christopher A. de Solis, Felix Leroy, Eric R. Kandel, Steven A. Siegelbaum

Correspondence

jl5545@columbia.edu (J.L.-R.), sas8@columbia.edu (S.A.S.)

In brief

Although the CA2 hippocampal region is essential for social memory and detection of social novelty, the inputs that provide social information to CA2 are unknown. We found that social memory depends on the direct inputs CA2 receives from the lateral entorhinal cortex. As this input is activated similarly by novel and familiar individuals, CA2 itself may compute novelty.

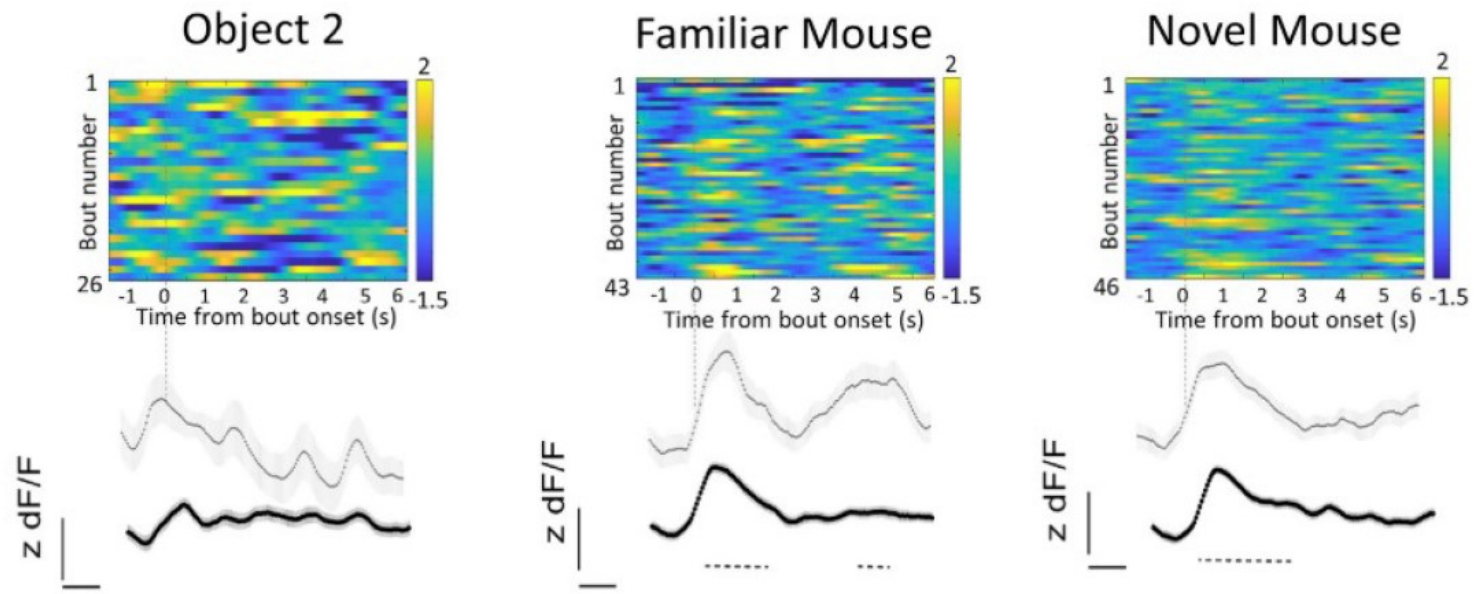
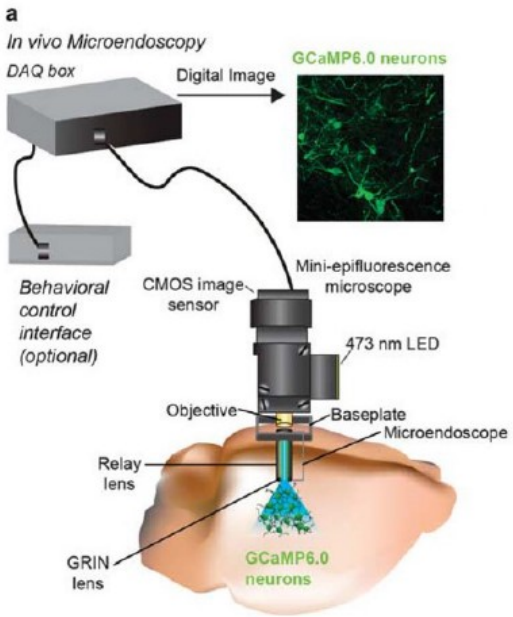


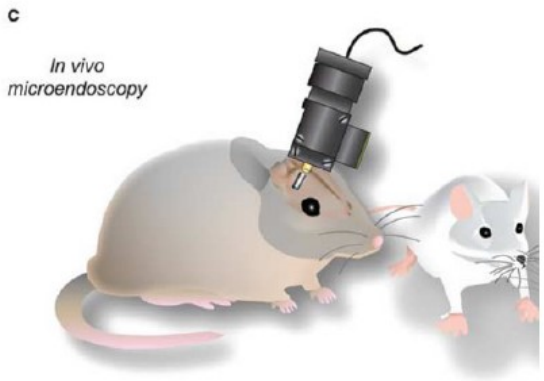
Figure 6

Miniscope = miniature microscope

in freely moving animals

Circuit - cellular



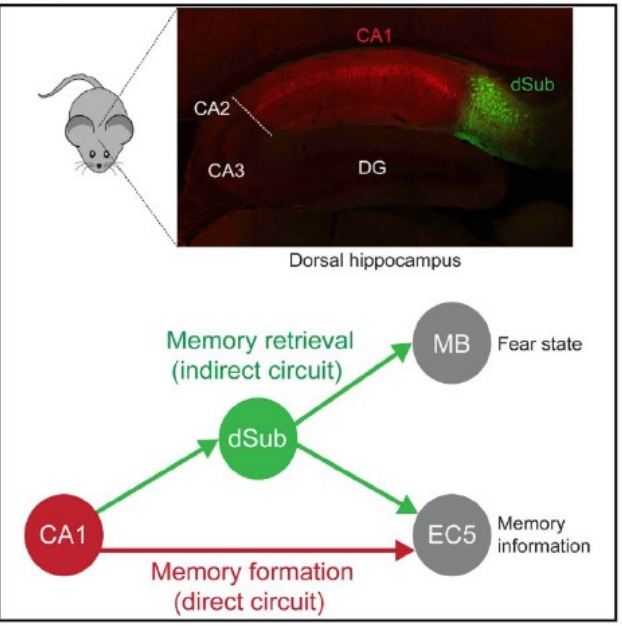


Article

Cell

Distinct Neural Circuits for the Formation and Retrieval of Episodic Memories

Graphical Abstract



Authors

Dheeraj S. Roy, Takashi Kitamura, Teruhiro Okuyama, ..., Yuichi Obata, Atsushi Yoshiki, Susumu Tonegawa

Correspondence

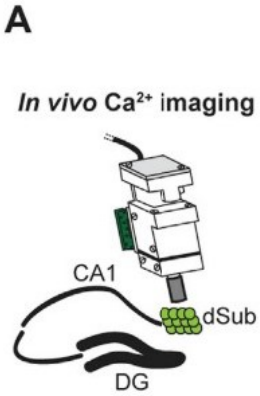
tonegawa@mit.edu

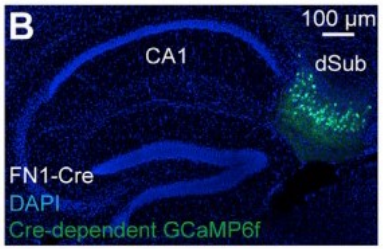
In Brief

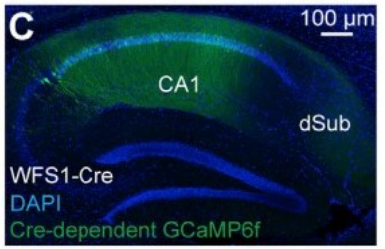
Episodic memories are formed and retrieved through distinct hippocampal pathways.

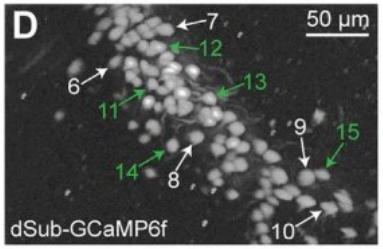
Miniscope in freely moving animals Circuit - cellular

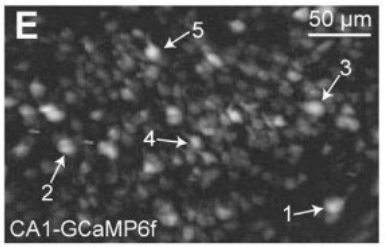
Figure 6





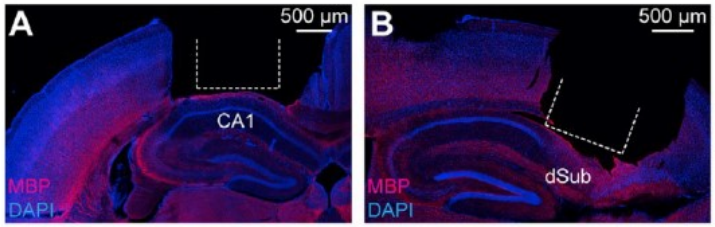


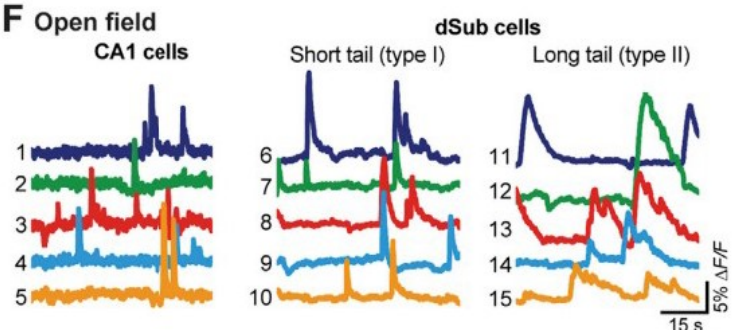




Possibility to image up to 1000 neurons

Figure S6



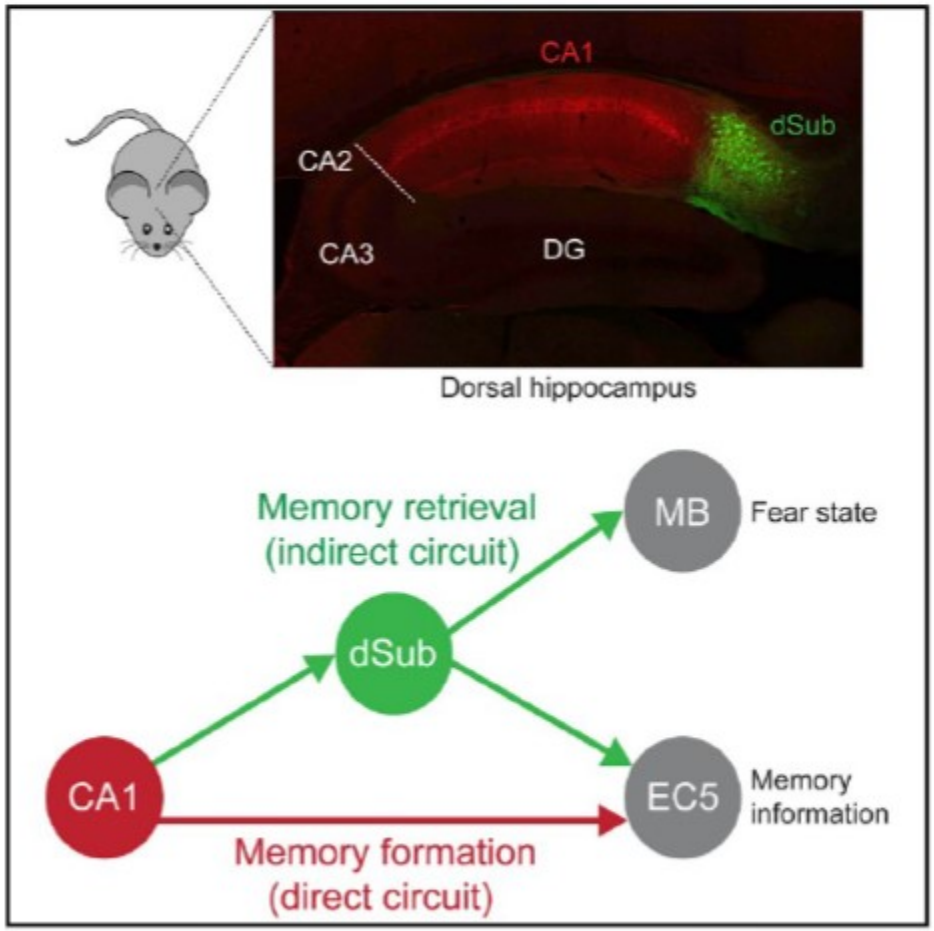


Behavioral tests

Cell

Distinct Neural Circuits for the Formation and Retrieval of Episodic Memories

Graphical Abstract



Authors

Dheeraj S. Roy, Takashi Kitamura, Teruhiro Okuyama, ..., Yuichi Obata, Atsushi Yoshiki, Susumu Tonegawa

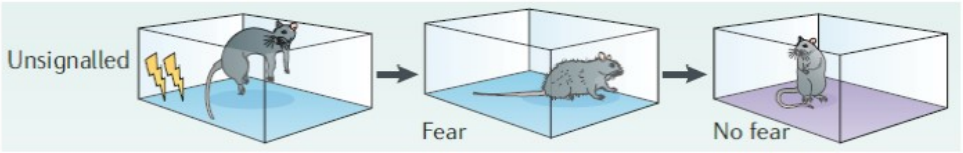
Correspondence

tonegawa@mit.edu

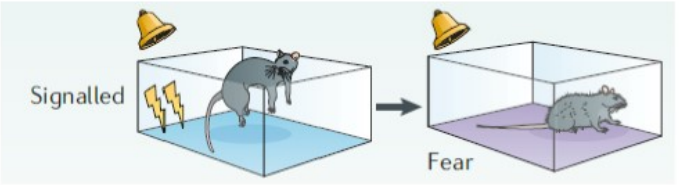
In Brief

Episodic memories are formed and retrieved through distinct hippocampal pathways.

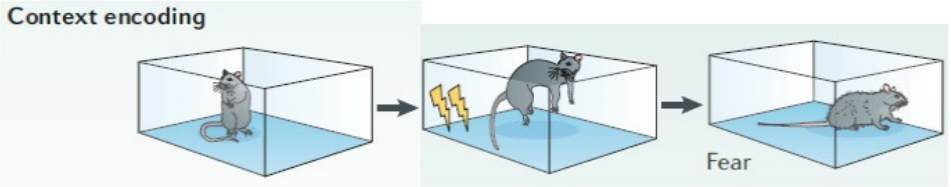
1. **Contextual fear conditioning (CFC)**



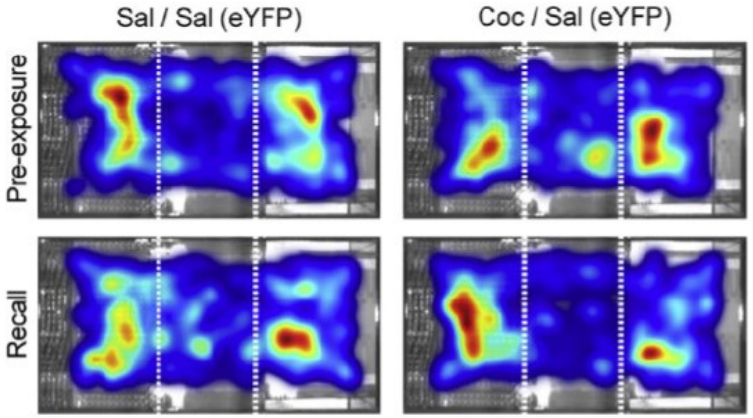
2. **Trace fear conditioning (TFC)**
3. **Delay fear conditioning (DFC)**



4. **Memory updating**



5. **Conditioned place preference (CPP)**



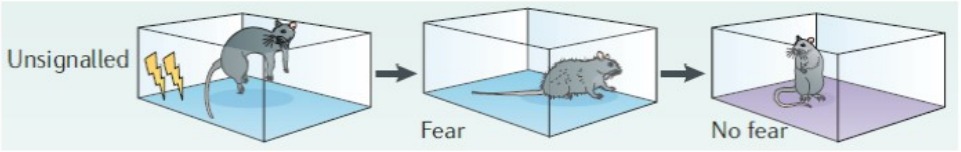
NEUROSCIENCE

A shift in the mechanisms controlling hippocampal engram formation during brain maturation

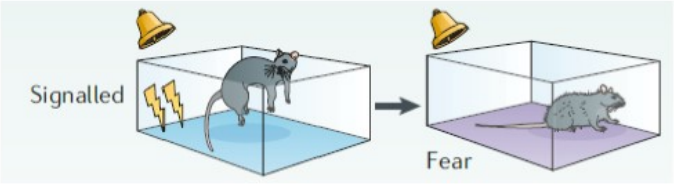
Adam I. Ramsaran[1,2], Ying Wang[1,3], Ali Golbabaei[1,4], Stepan Aleshin[5], Mitchell L. de Snoo[1,4], Bi-ru Amy Yeung[1,3], Asim J. Rashid[1], Ankit Awasthi[1], Jocelyn Lau[1,3], Lina M. Tran[1,3,6], Sangyoon Y. Ko[1,3], Andrin Abegg[1,7]†, Lana Chunan Duan[1,4], Cory McKenzie[1,2], Julia Gallucci[1]‡, Moriam Ahmed[1], Rahul Kaushik[5,8], Alexander Dityatev[5,8,9], Sheena A. Josselyn[1,2,3,4,10], Paul W. Frankland[1,2,3,4,11]*

The ability to form precise, episodic memories develops with age, with young children only able to form gist-like memories that lack precision. The cellular and molecular events in the developing hippocampus that underlie the emergence of precise, episodic-like memory are unclear. In mice, the absence of a competitive neuronal engram allocation process in the immature hippocampus precluded the formation of sparse engrams and precise memories until the fourth postnatal week, when inhibitory circuits in the hippocampus mature. This age-dependent shift in precision of episodic-like memories involved the functional maturation of parvalbumin-expressing interneurons in subfield CA1 through assembly of extracellular perineuronal nets, which is necessary and sufficient for the onset of competitive neuronal allocation, sparse engram formation, and memory precision.

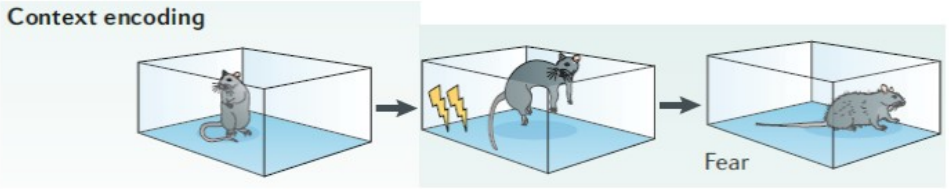
1. **Contextual fear conditioning (CFC)**



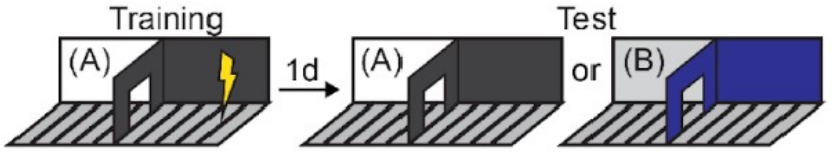
2. **Delay fear conditioning (DFC)**



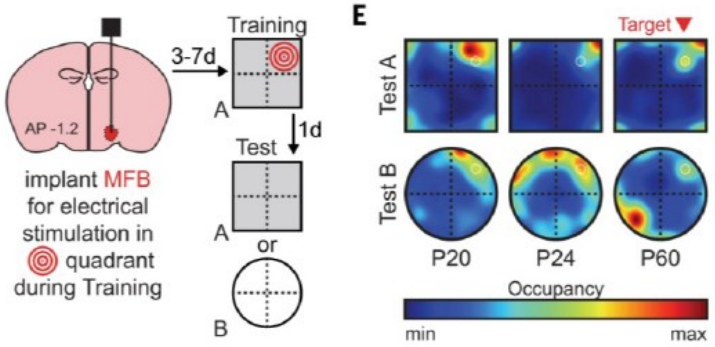
3. **Memory updating**



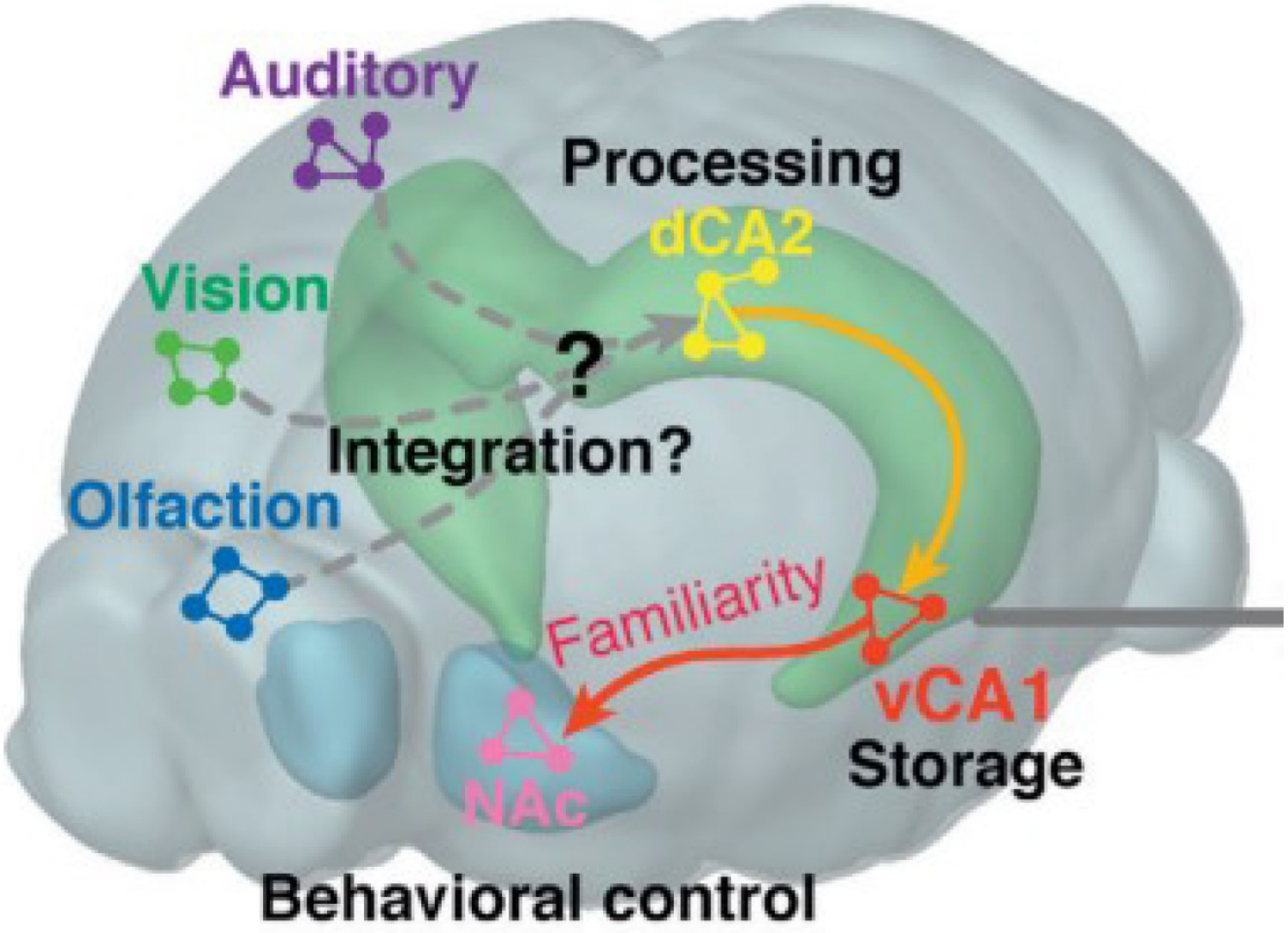
4. **Inhibitory avoidance (IA)**



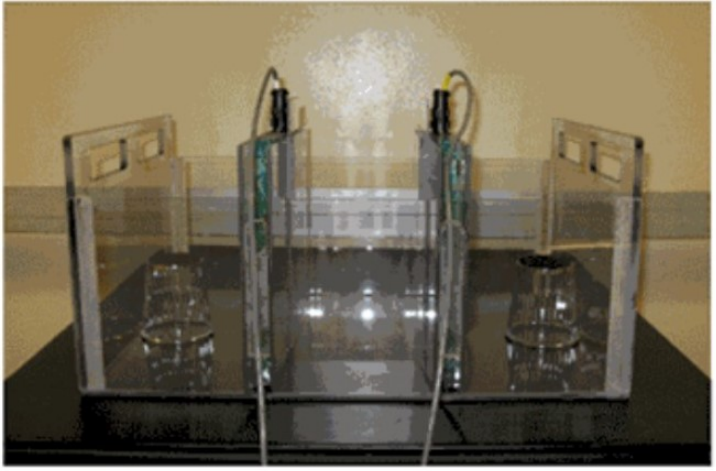
5. **Spatial foraging Task (Conditioned place preference)**

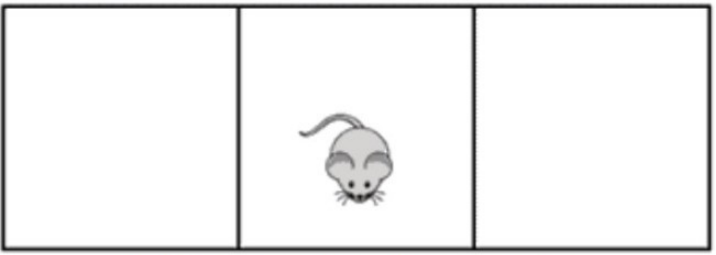


Social memory

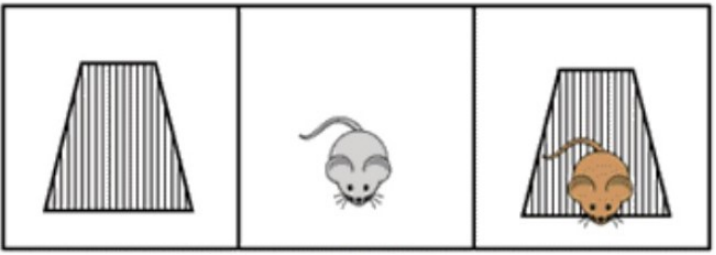

Auditory
Processing
dCA2
Vision
?
Integration?
Olfaction
Familiarity
vCA1
Storage
NAc
Behavioral control

3-Chamber Sociability and Social Novelty Test

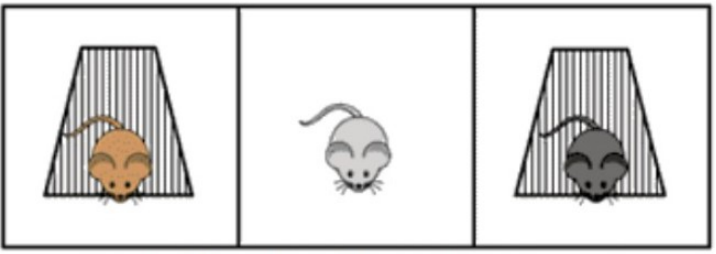




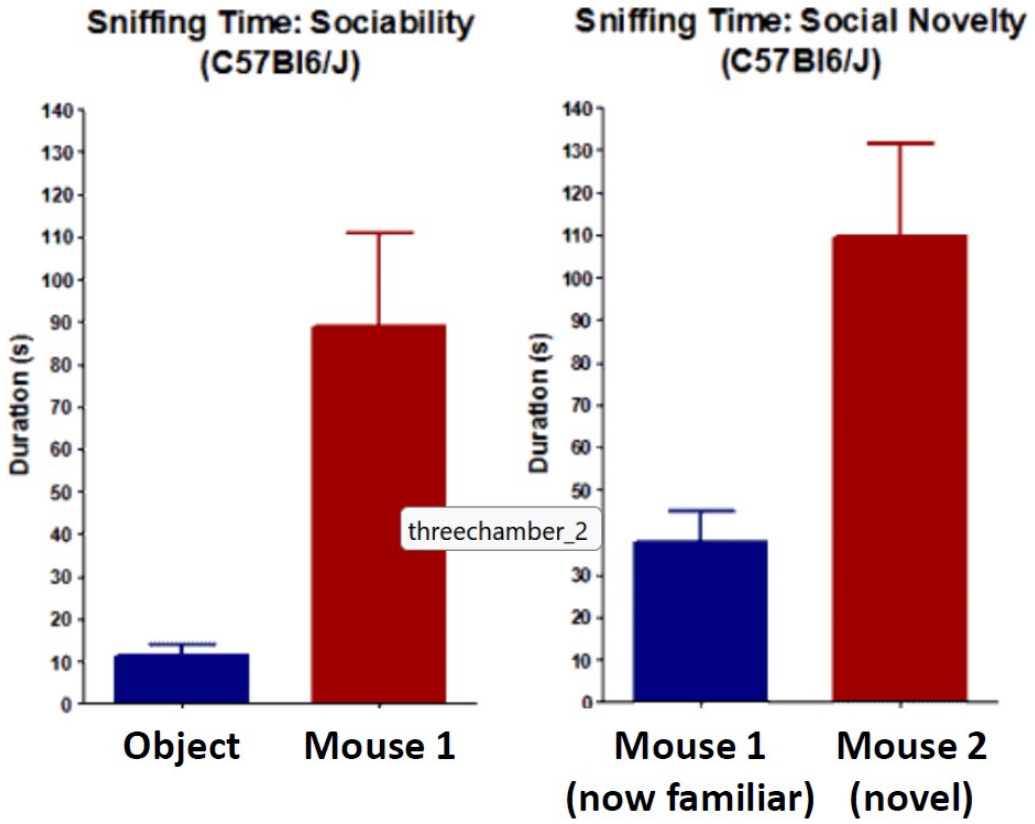
Habituation: Empty Apparatus



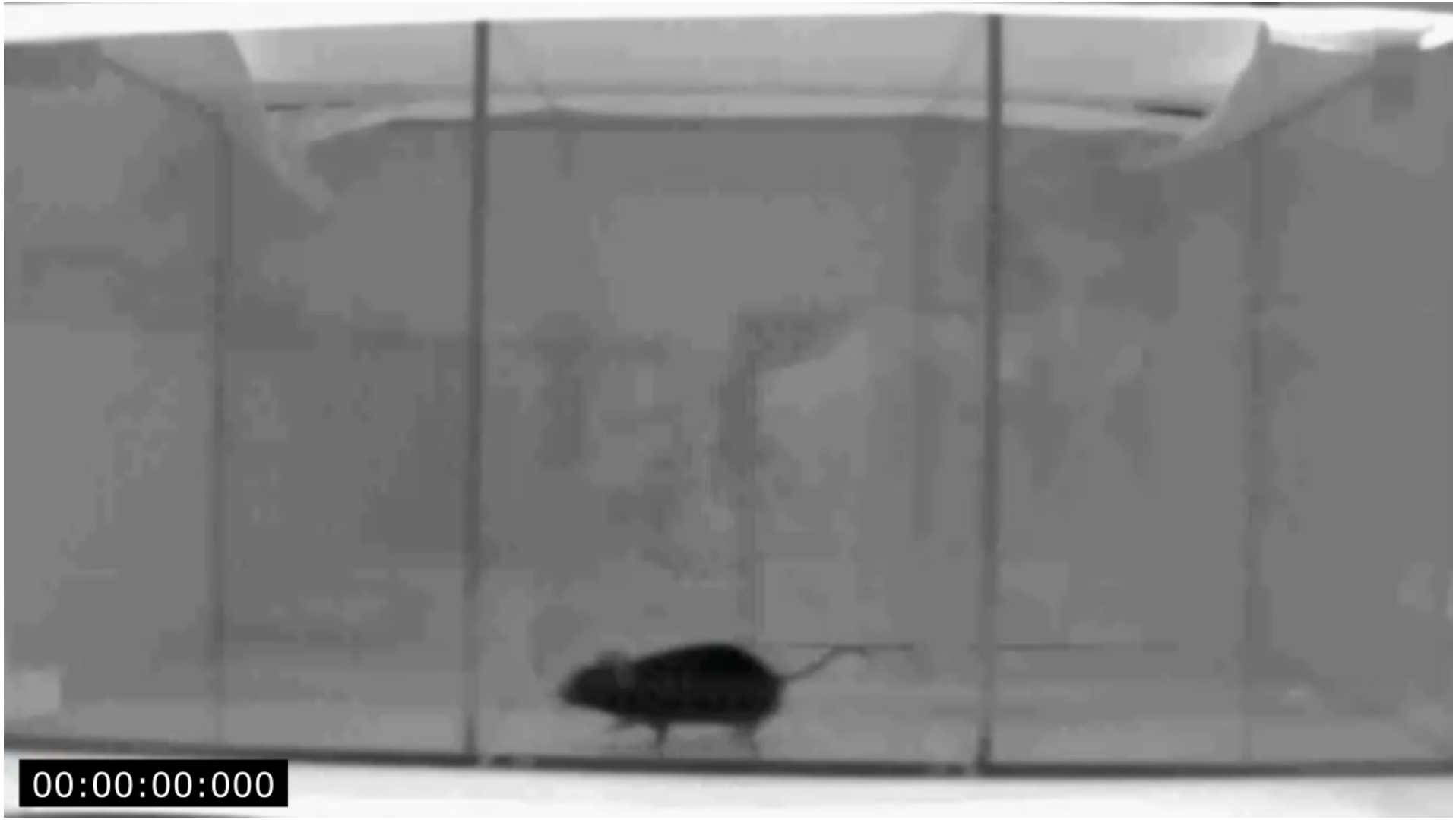
Sociability: Novel Object; Mouse 1



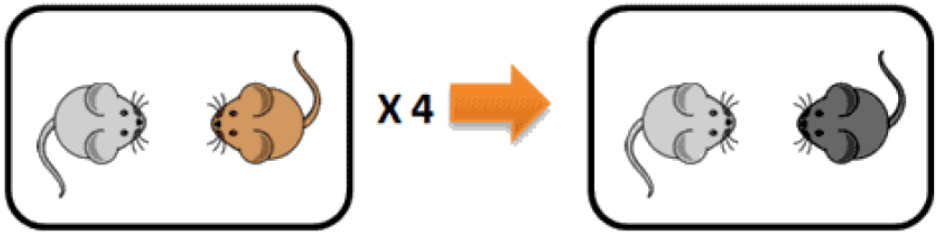
Social Novelty: Mouse 1; Mouse 2



3-Chamber Sociability and Social Novelty Test



5-Trial Social Memory Test



Trial 1-4:
Intruder 1

Trial 5:
Intruder 2