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# P5.60 Encoding vs retrieval of episodic memory in rats: different theta oscillatory signatures in hippocampo-cortical networks according to individual episodic memory profile

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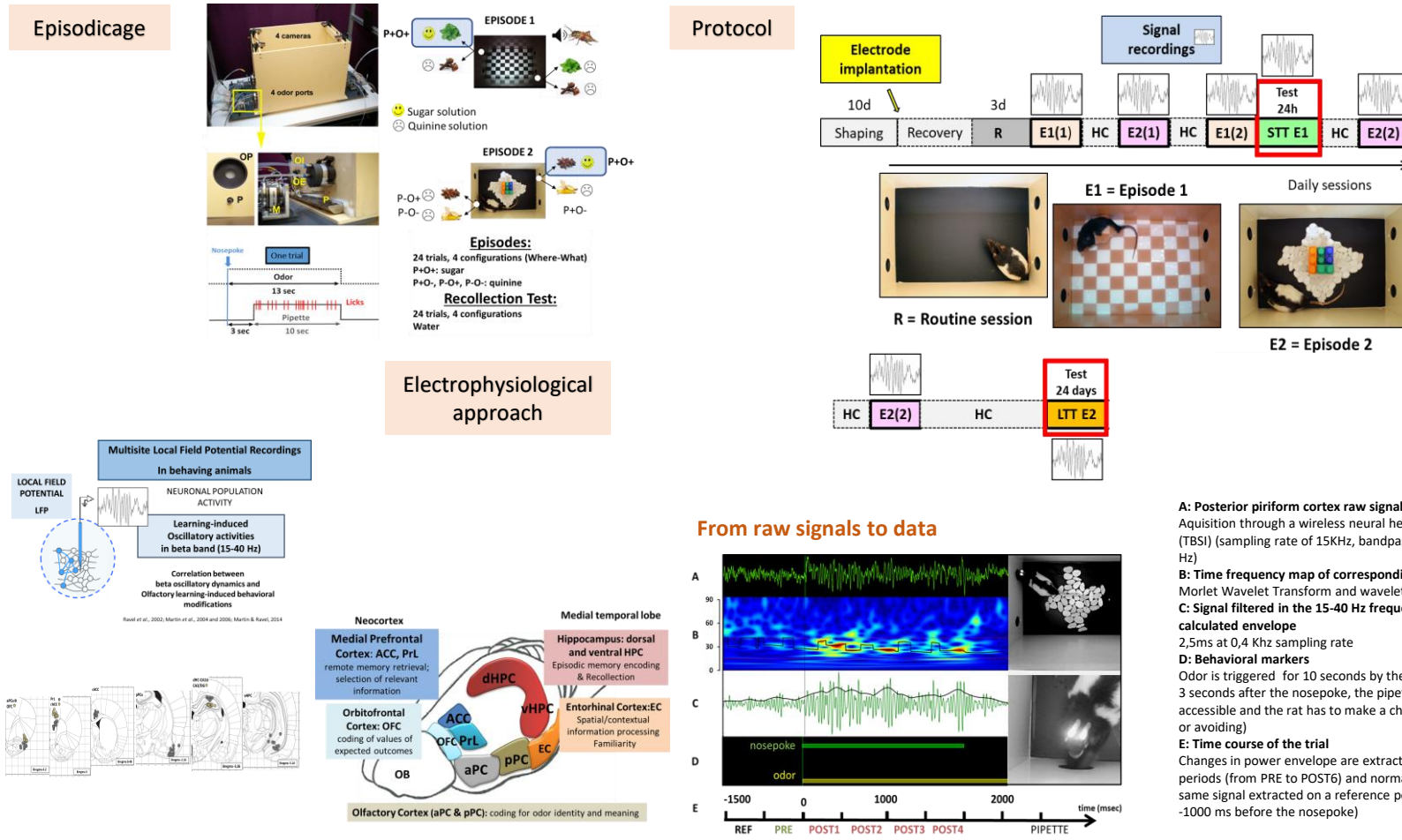


## Scientific Background:

Episodic memory, our capacity to recollect personal life episodes, has been initially defined in Humans in terms of the information it contains. Pioneering studies on food-caching birds have demonstrated that animals are also able to form such complex memories. We developed an original behavioral paradigm to study this complex form of memory in rats (Veyrac & al, *J Neuroscience*, 2015). With this paradigm, we brought evidence for individual episodic memory profiles similar to what has been observed in Humans.

In the present project,

- We explored further **how does individual episodic memory evolve across time and successive experience** of episodes built on the same model.
- We took advantage of individual memory profiles to further **understand neural circuits supporting successful episodic recollection**.
- We focus our exploration **on odor-induced theta oscillatory activity between 4 and 12 Hz** in the network in the different experimental situations.

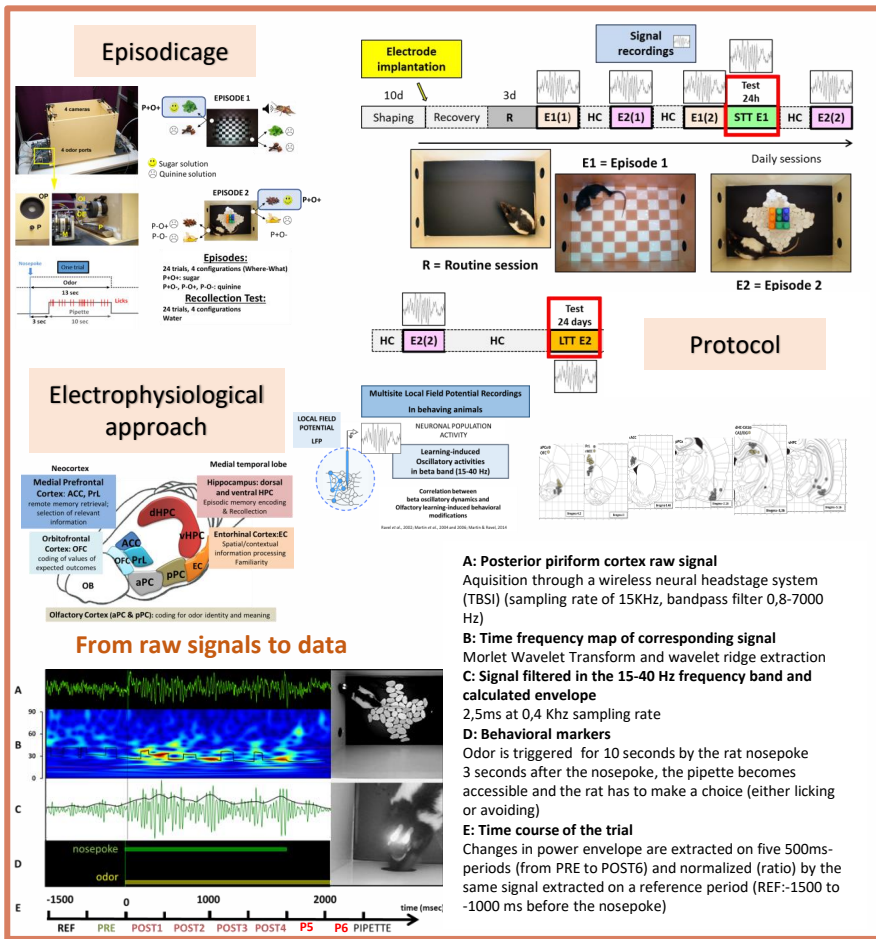


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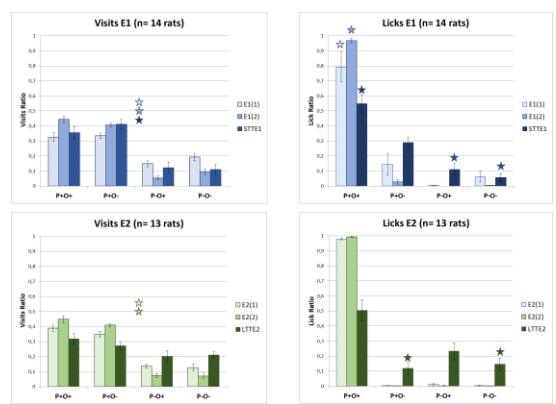
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## Episodic memory performance:



STTE1 Short term episodic retrieval (24h)

LTT E2 long term episodic retrieval (24d)

## Odor-induced theta power variations in the network

**Working Hypothesis:**  
Is the network involved in episodic retrieval different for recent and remote memory? Could we detect any difference between rats able to retrieve the entire odor-place-context representation (WWW) compared to those who failed (OTHERS)?

**Analysis Strategy:**  
We focused the analysis on **odor-induced change in power** since the odor is the last piece of information the animal had before making his decision to lick or not. We present the results obtained in the theta band (4-12Hz) since this band has been reported to support memory processes in large scale network communication. The analysis was first restricted to correct retrieval trials (Correct rejection CR/ Hit) To analyse theta power variations in each situation (E1(1 & 2), STTE1; E2(1 & 2), LTT E2) we took into account 3 factors (memory profile: WWW/OTHERS; Configuration: CR/Hit and the 6 time bins before the access to the pipette).

|                                |
|--------------------------------|
| no power variation             |
| time effect                    |
| time*configuration effect      |
| selective time*profile effect  |
| different time* profile effect |
| time*profile*configuration     |

|     |       |         |  |
|-----|-------|---------|--|
|     | E1(1) |         |  |
|     | OFC   |         |  |
| aPC | PrL   | dCA1    |  |
| pPC | rACC  | dCA3-DG |  |
|     | cACC  | vHPC    |  |

|     |       |         |  |
|-----|-------|---------|--|
|     | E1(2) |         |  |
|     | OFC   |         |  |
| aPC | PrL   | dCA1    |  |
| pPC | rACC  | dCA3-DG |  |
|     | cACC  | vHPC    |  |

|     |       |         |  |
|-----|-------|---------|--|
|     | STTE1 |         |  |
|     | OFC   |         |  |
| aPC | PrL   | dCA1    |  |
| pPC | rACC  | dCA3-DG |  |
|     | cACC  | vHPC    |  |

|     |       |         |  |
|-----|-------|---------|--|
|     | E2(1) |         |  |
|     | OFC   |         |  |
| aPC | PrL   | dCA1    |  |
| pPC | rACC  | dCA3-DG |  |
|     | cACC  | vHPC    |  |

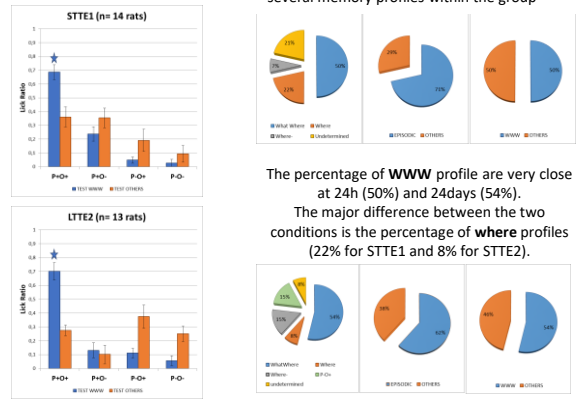
  

|     |       |         |  |
|-----|-------|---------|--|
|     | E2(2) |         |  |
|     | OFC   |         |  |
| aPC | PrL   | dCA1    |  |
| pPC | rACC  | dCA3-DG |  |
|     | cACC  | vHPC    |  |

|     |        |         |  |
|-----|--------|---------|--|
|     | LTT E2 |         |  |
|     | OFC    |         |  |
| aPC | PrL    | dCA1    |  |
| pPC | rACC   | dCA3-DG |  |
|     | cACC   | vHPC    |  |

In both test situations, the analysis reveals several memory profiles within the group



**Encoding: E1(1&2), E2(1&2)**  
No behavioral difference but a real evolution of the network across the successive presentations

**E1(1): the very first episode:**  
**WWW rats only:** OFC, dCA3, vHPC for CR only dCA1 for HIT only  
**E2(1):**  
**WWW rats only:** OFC, aPC, dCA1, pPC  
**All:** PrL and rACC

**Recent Episodic network: E1 STTE1**  
Odor-induced changes during encoding and retrieval are very close except for dCA3.  
Different response to Hit/CR for PrL and dCA1 in WWW only

**Remote Episodic network: E2 LTT E2**  
**WWW only:** aPC, PrL, rACC, dCA1, dCA3  
**All rats:** pPC & OFC

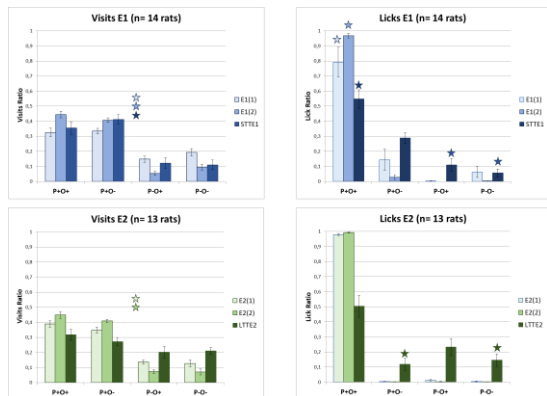
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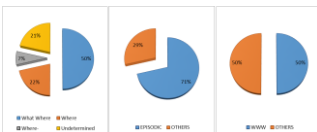
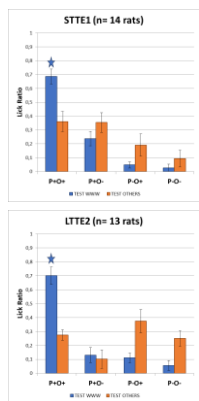
## Episodic memory performance:



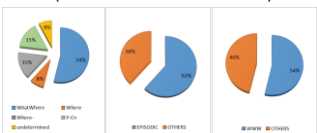
STTE1 Short term episodic retrieval (24h)

LTTE2 long term episodic retrieval (24d)

In both test situations, the analysis reveals several memory profiles within the group



The percentage of WWW profile are very close at 24h (50%) and 24days (54%). The major difference between the two conditions is the percentage of **where** profiles (22% for STTE1 and 8% for LTTE2).



## Odor-induced theta power variations in the network

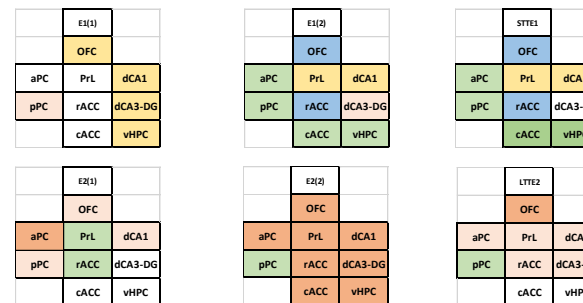
### Working Hypothesis:

Is the network involved in episodic retrieval different for recent and remote memory? Could we detect any difference between rats able to retrieve the entire odor-place-context representation (WWW) compared to those who failed (OTHERS)?

### Analysis Strategy:

We focused the analysis on **odor-induced change in power** since the odor is the last piece of information the animal had before making his decision to lick or not. We present the results obtained in the theta band (4-12Hz) since this band has been reported to support memory processes in large scale network communication. The analysis was first restricted to correct retrieval trials (Correct rejection CR/ Hit) To analyse theta power variations in each situation (E1(1 & 2), STTE1; E2(1 & 2), LTTE2) we took into account 3 factors (memory profile: WWW/OTHERS; Configuration: CR/Hit and the 6 time bins before the access to the pipette).

|                               |
|-------------------------------|
| no power variation            |
| time effect                   |
| time*configuration effect     |
| selective time*profile effect |
| different time*profile effect |
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### Encoding: E1(1&2), E2(1&2)

No behavioral difference but a real evolution of the network across the successive presentations

### E1(1): the very first episode:

**WWW rats:** OFC, dCA3, vHPC for CR only  
dCA1 for HIT only

### E2(1):

**WWW rats:** OFC, aPC, dCA1, pPC  
**All:** PrL and rACC

### Recent Episodic network : E1 STTE1

Odor-induced changes during encoding and retrieval are very close except for dCA3.

Different response to Hit/CR for PrL and dCA1 in WWW only

### Remote Episodic network : E2 LTTE2

**WWW only:** aPC, PrL, rACC, dCA1, dCA3

**All rats:** pPC & OFC

## Conclusions:

Taking advantage of the episodic paradigm developed in our team (Veyrac et al, 2015) We explored further **how does individual episodic memory evolve across time and successive experience** of episodes built on the same model.

## The take home message:

- Even in the absence of any behavioral difference during the encoding of the episodes, **odor-induced changes in theta band in the hippocampus and the Orbitofrontal Cortex are predictive of a complete episodic memory retrieval (recent and remote)**
- **The activity of the network evolves across the encoding of the two episodes**
- **Recent memory retrieval: odor-induced theta variation in PrL and dCA1 are selective of a successful episodic retrieval**
- **Remote memory retrieval: the WWW network is larger: dCA1, dCA3-DG, PrL, rACC & aPC.**
- **The hippocampus is still engaged in the network for remote episodic memory.**