



**HAL**  
open science

## **Long-term impact of a semi-naturalistic living environment on rodent cognitive abilities**

N Ravel, M Berrakmouch, A Bublex, O Tschirhart, Z Miot, M Etcheberry, M  
Thévenet, B Messaoudi, B Paulignan, D Gervasoni, et al.

### ► **To cite this version:**

N Ravel, M Berrakmouch, A Bublex, O Tschirhart, Z Miot, et al.. Long-term impact of a semi-naturalistic living environment on rodent cognitive abilities. NeuroFrance 2023, May 2023, Lyon, France. <hal-05532740>

**HAL Id: hal-05532740**

**<https://hal.science/hal-05532740v1>**

Submitted on 2 Mar 2026

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY 4.0 - Attribution - International License

# Long-term impact of a semi-naturalistic living environment on rodent cognitive abilities

N. Ravel, M. Berrakmouch, A. Bublex, O. Tschirhart, Z. Miot, M. Etcheberry, M. Thévenet, B. Messaoudi, B. Paulignan, D. Gervasoni, K. Julliard, P. Litaudon

Lyon Neuroscience Research Center, CNRS UMR 5292, Lyon 1 University, INSERM U1028, Bron, France

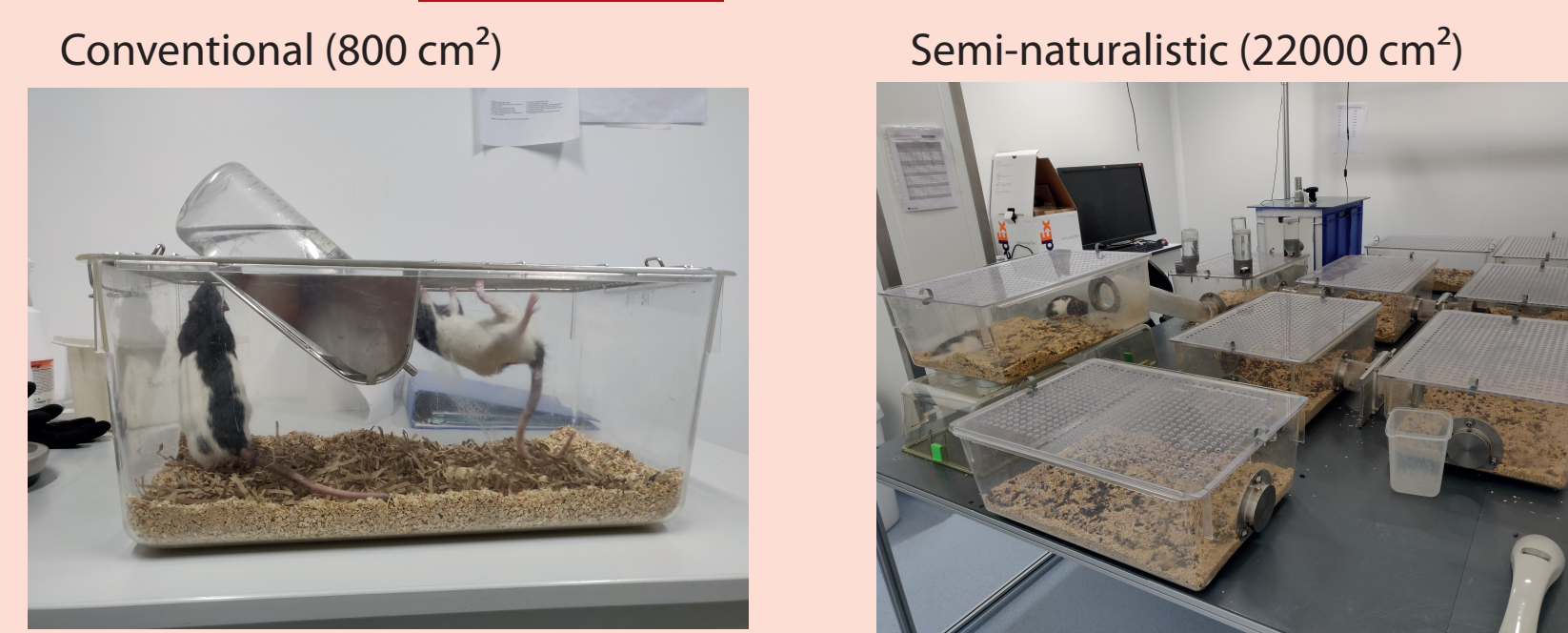
## Introduction

The physical and social environment has been known for a long time to influence brain function. Yet, preclinical neuroscience studies are almost exclusively done in rodents raised in standard laboratory conditions with impoverished environment, limited social interactions, unlimited food access, and reduced living space. This sedentary lifestyle induces metabolism disorders often associated with cognitive deficits. The need for a more naturalistic approach has emerged in the field of cognitive neuroscience but requires a housing environment that allows animals to express most of their behavioral repertoire. According to this novel perspective, rather than trying to reduce inter-individual variability by standardizing housing conditions, it is essential to identify and understand the source of this individual variation and how it affects experimental outcomes.

As a first step toward this goal, we developed a new complex living environment composed of many interconnected modules in 3 dimensions. Our study aims at evaluating the impact of such a housing environment on cognitive performance through different behavioral tasks. The study was first performed on a group of males and then replicated on females.

## Methods

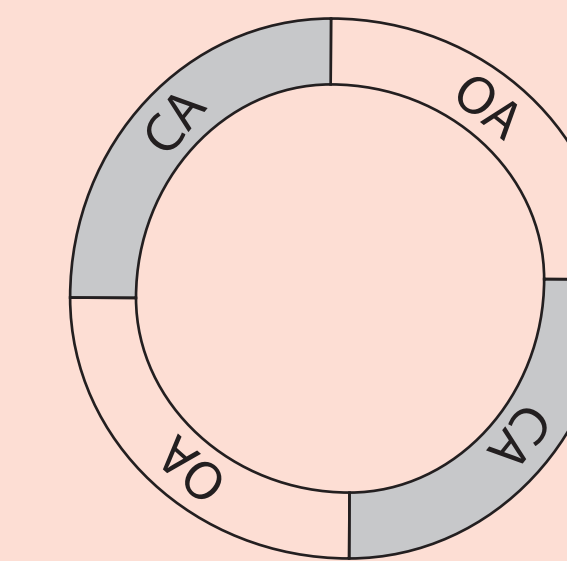
### Housing



At their arrival, Long-Evans rats (4 weeks old) were assigned randomly to two experimental groups of 10 animals: the «conventional» group (C) and the «semi-naturalistic» group (SN). One month after arrival, rats were implanted with RFID microchips to allow their identification throughout the experimental protocol. Long-Evans rats were housed either by two in standard cages or by ten in the semi-naturalistic environment. The latter is made up of 10 compartments connected by tunnels which are important zones of social interactions like social dominance. An opaque shelters is added to provide a nest-like environment for the animals. Both male and female rats were used in two separated experiments.

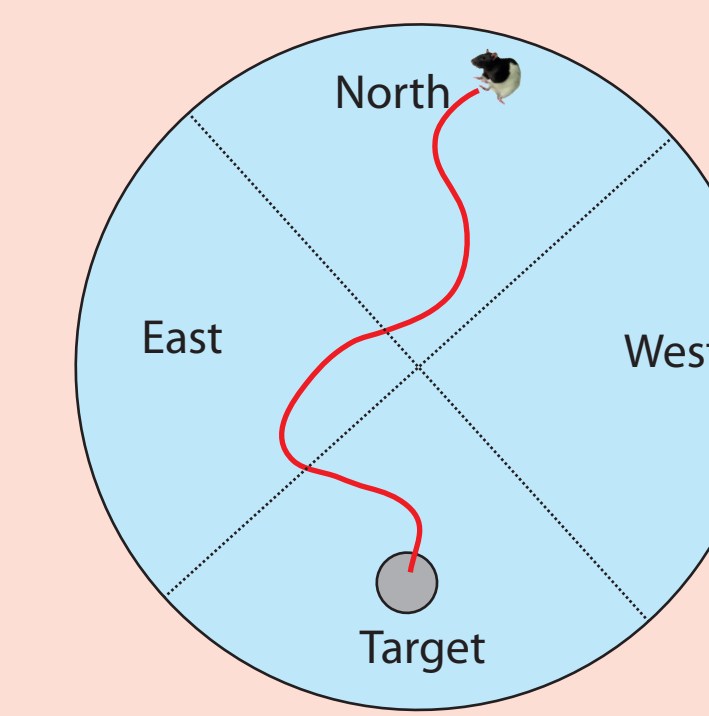
### Behavioral tasks

Anxiety evaluation (Elevated Zero-Maze) (male/female)



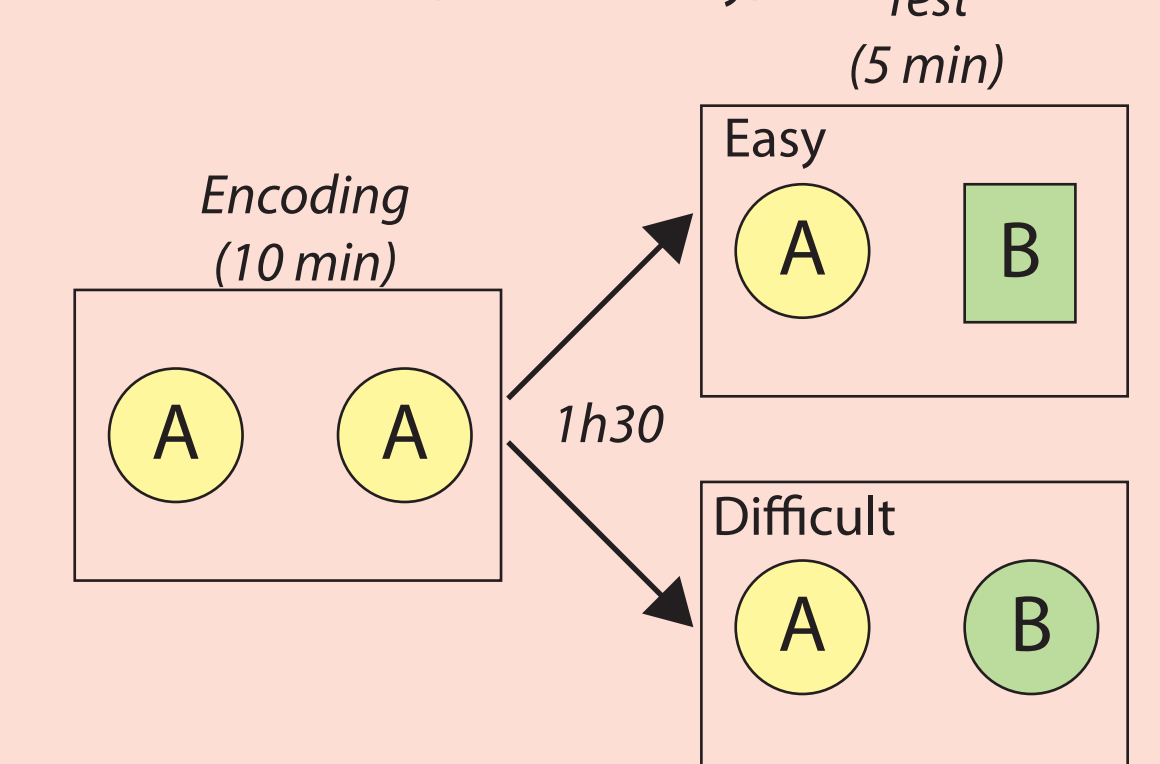
Rats were introduced in the zero maze where they moved freely for 5 minutes. Time spent by the rats into the closed areas (CA) was measured.

Spatial navigation (Morris water-maze) (male/female)



After a period of habituation, the rats undergo 4 days of training with only 1 session per day. A probe test is performed on the 5th day. This sequence is repeated the following week.

Novel Object Recognition test (female only)



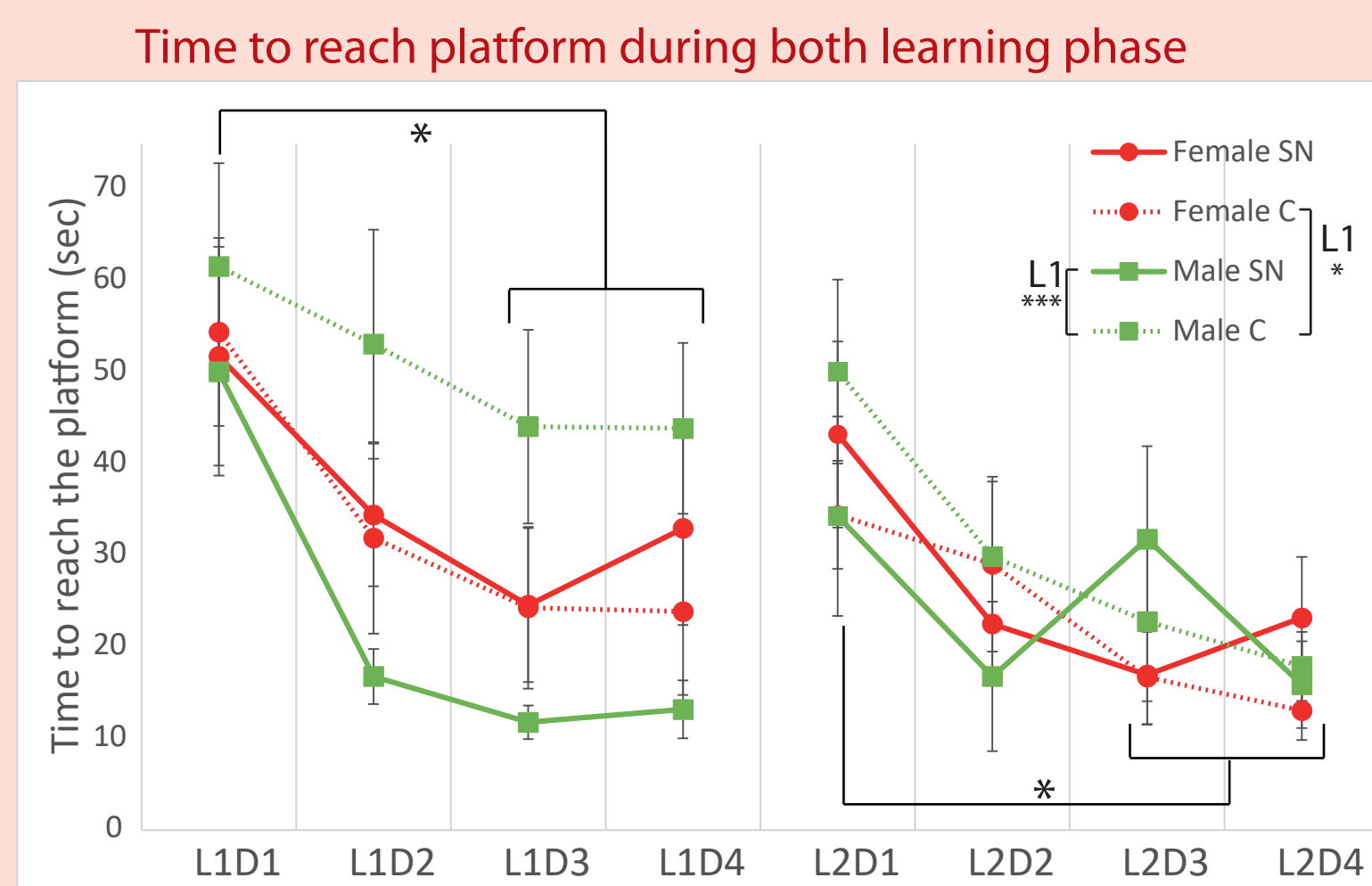
This test is based on the natural tendency for a rat to explore more a novel object than a known one. It tests both the memory of a previously explored object and the discrimination of a novel object from it. Two versions of this test have been performed: an easy and a difficult one with different or similar objects respectively.

### Data analysis

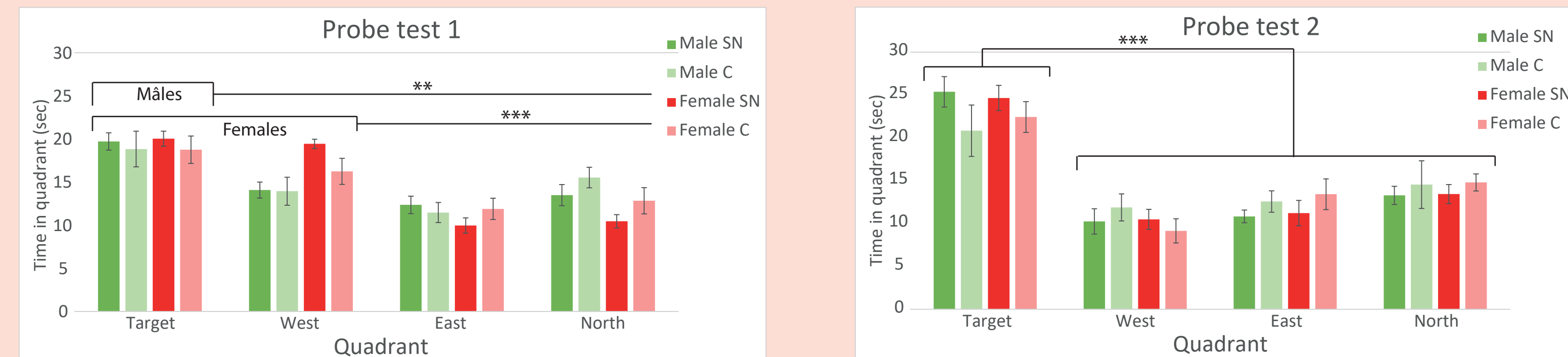
For all experiments, rat trajectories were extracted using DeepLabCut software (<http://www.mackenziemathislab.org/deeplabcut-home>; Mathis et al., Nat. Neurosci., 2018, 21:1281–1289). From trajectories, exploration time around object, time in different zero-maze arms, and time spent in each water-maze quadrant were extracted using A2V\_ANA software (Marc Thévenet).

## Results

### Spatial navigation test (Morris water-maze)



### Time spent in each water-maze quadrant during both probe tests

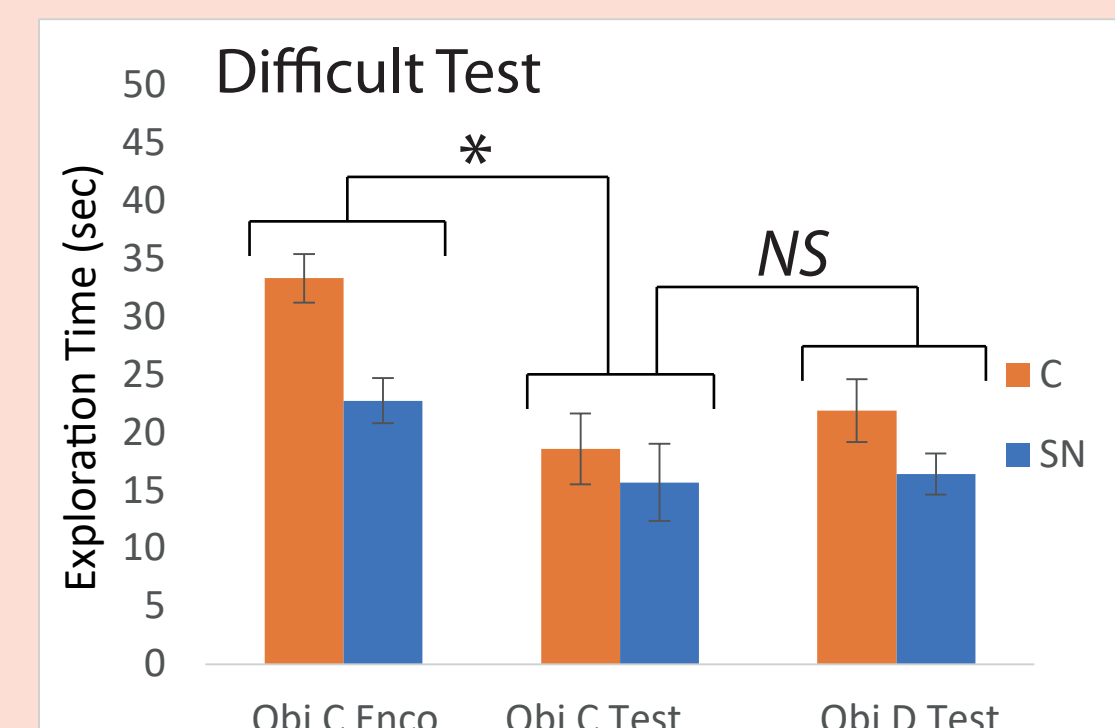
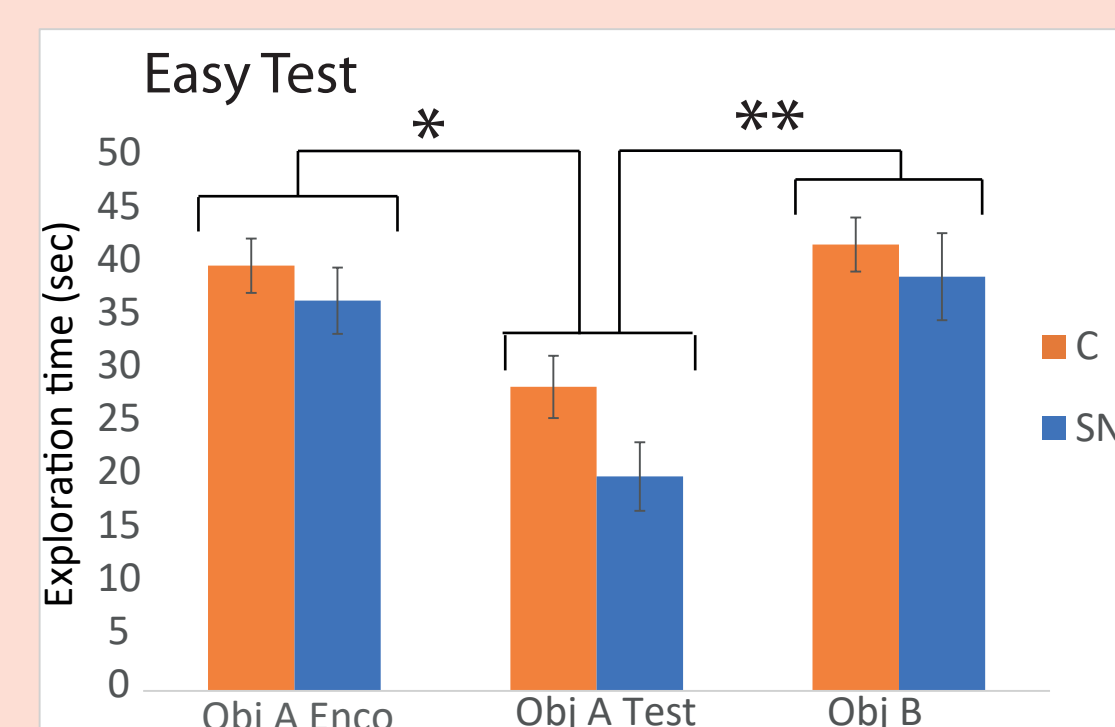


We chose a difficult version of the Morris water-maze test since the rats performed only one trial per day during the learning phase. During the first learning phase (L1), we observed a clear difference between the two groups of males, with most «SN» males finding the submerged platform by the second trial. We did not observe this difference in the females, but the «C» females performed better than the «C» male rats. No difference was observed (group or sex) during the second learning phase. In both probe tests, target quadrant was more explored than others even if in first probe test, female memory was slightly less accurate.

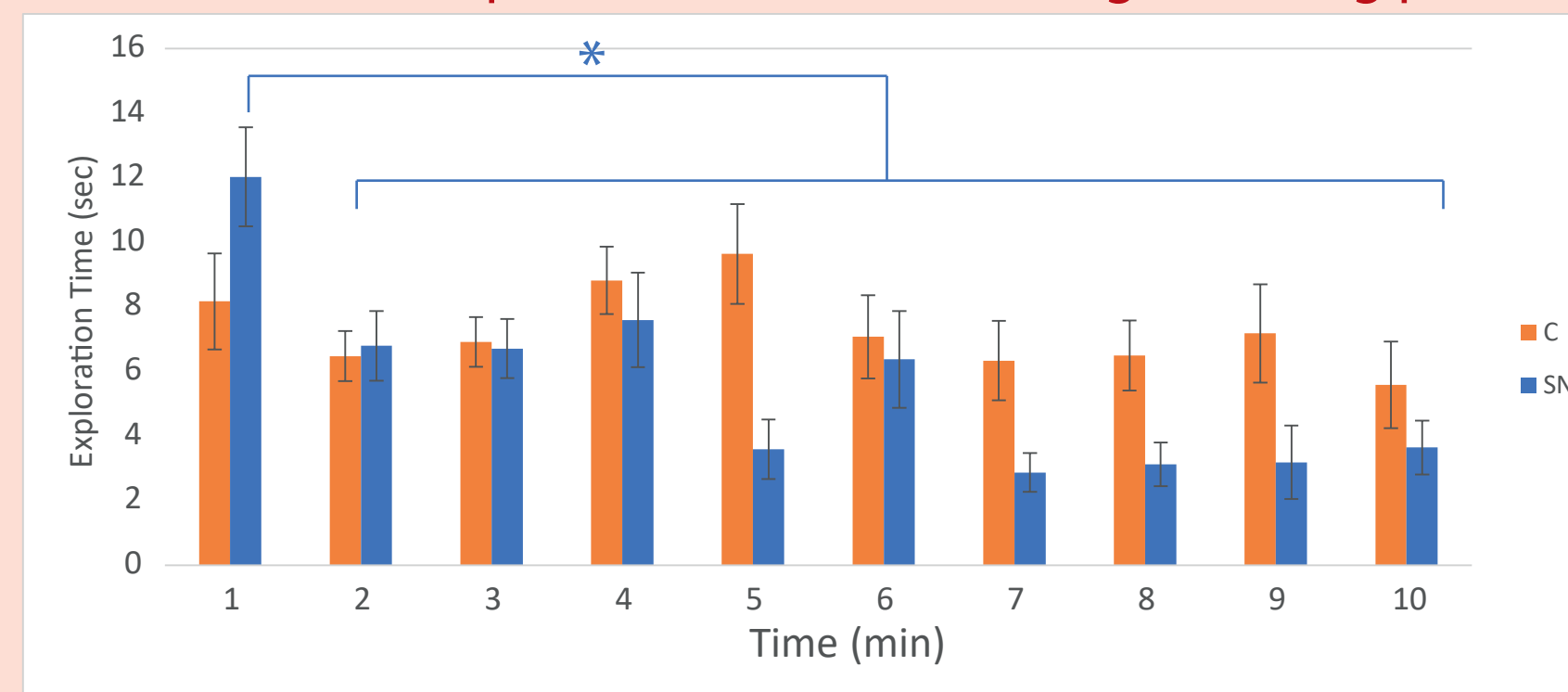
## Conclusion

The present study is a first step towards a more naturalistic approach of rodent cognitive neurosciences. These first data showed that housing environment influences cognitive performances of rats particularly in spatial navigation. Although the results of the object recognition tests are less conclusive, they show that rats raised in a semi-natural housing, trained to a more complex environment, could use different and more efficient strategies to encode the different elements. The data presented here are the results of group analyses. The daily observation of the animals in naturalistic housing condition, clearly highlights a great variability of individual behaviors that we have not yet taken into account in the analyses. The final aim of our project is to go further by deciphering the impact of individual behavioral, physiological and social history on individual cognitive performances and underlying brain processes.

### Novel Object Recognition test

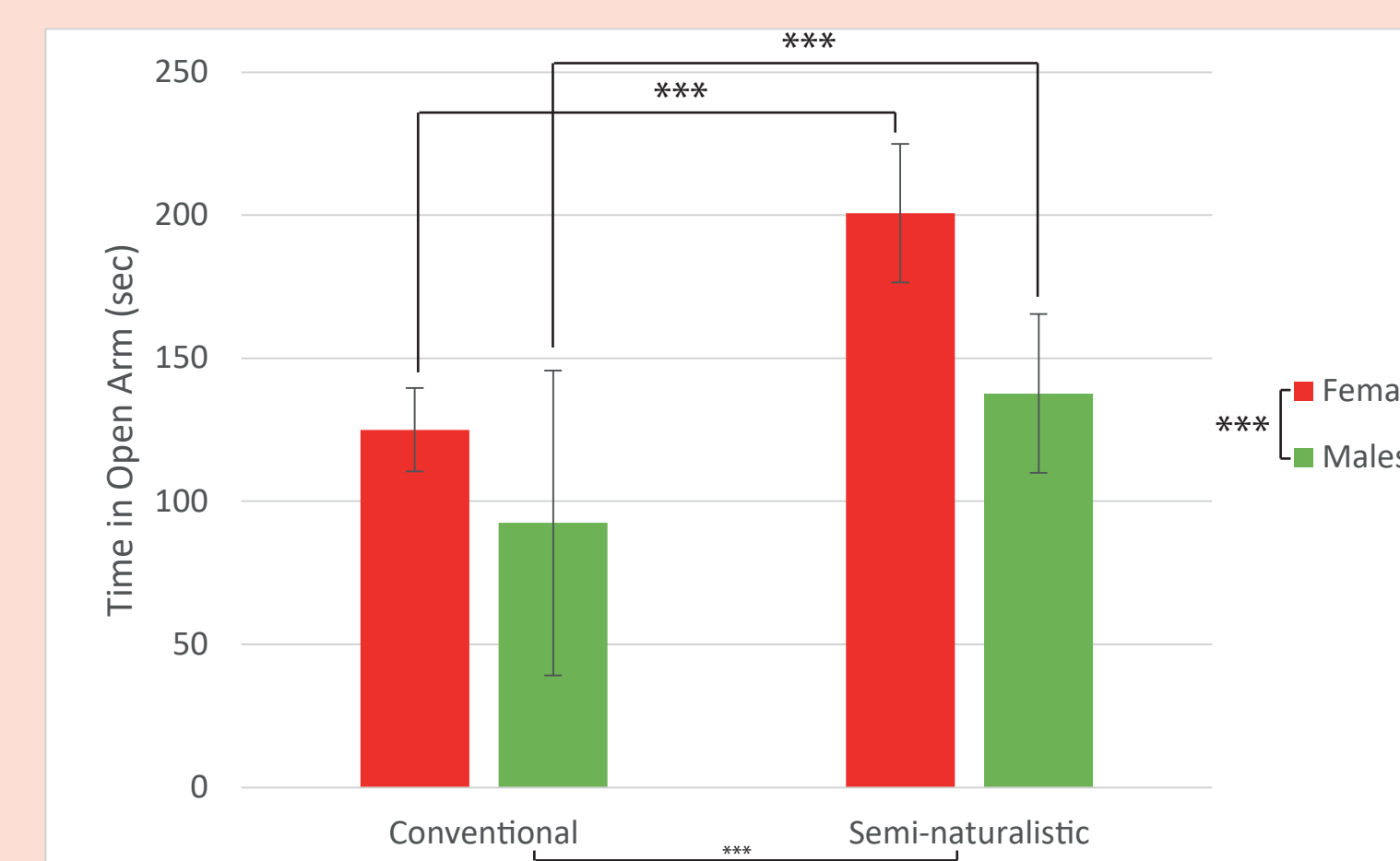


### Evolution of exploration over time during encoding phase



Both group (C and SN) of female rats succeeded in the easy version of the test. They decreased their exploration of the familiar object (Object A) during test phase indicating that this object was recognized. They showed a larger exploration of the new object indicating that the two objects were discriminated. The main difference between the two groups was the exploration strategy. Indeed, «SN» rats decreased their exploration after the first minute during the encoding phase whereas «C» rats exhibited a constant exploration during the tens minutes. By contrast, if both groups of rats recognized the familiar object (Object C) during the difficult version of the task, they failed to discriminate the new object (Object D).

### Anxiety evaluation (Elevated Zero Maze)



The level of anxiety was assessed in the elevated zero maze by measuring the total time spent in the open arm. We observed both a housing effect, with semi-naturalistic rats spending more time in the open arm than conventional rats, and a gender effect, with females expressing a lower level of anxiety than males.