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Wullen Mathilde, Jean-Marie Billard, Thomas Freret, Valentine Bouet

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# Short and long-term cognitive impairment in mice exposed to hypergravity depends on sex

Wullen M, Billard J-M, Freret T and Bouet V

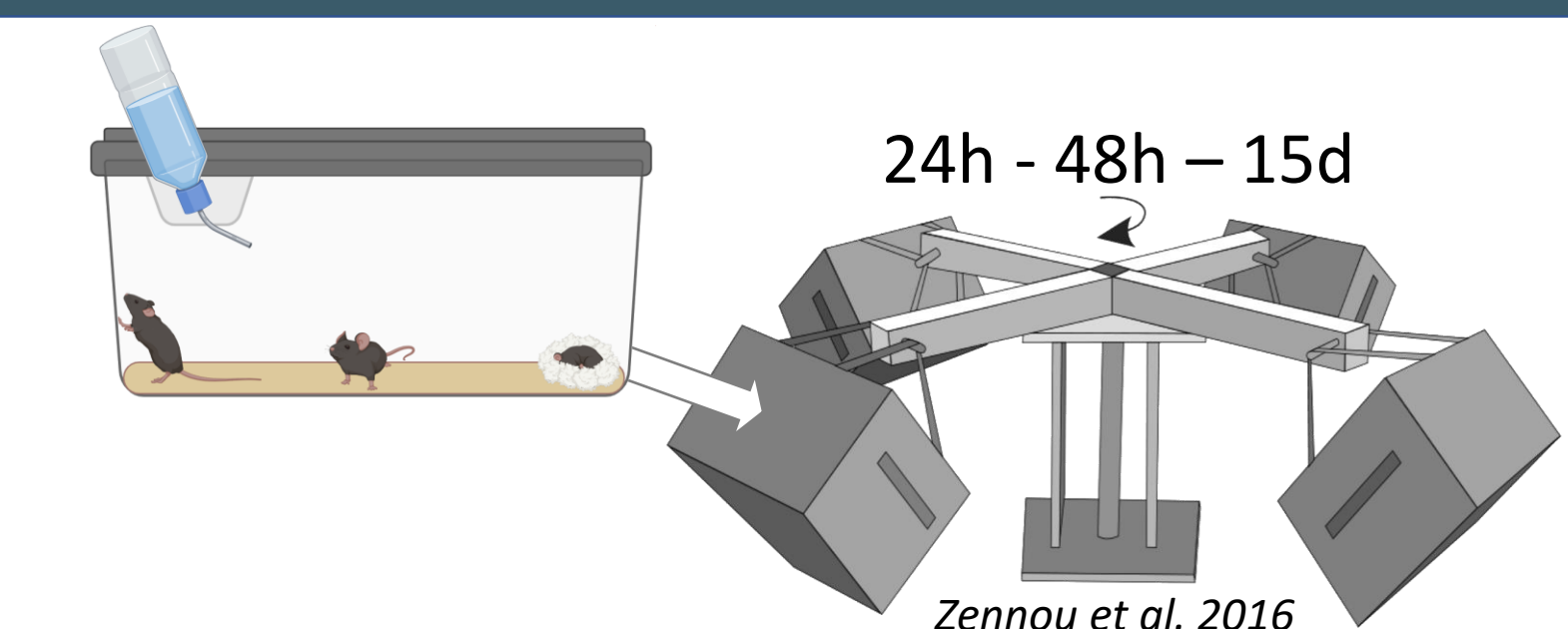
Normandie Univ, UNICAEN, INSERM, COMETE, 14000 Caen, France  
Corresponding author : mathilde.wullen@unicaen.fr

## Introduction

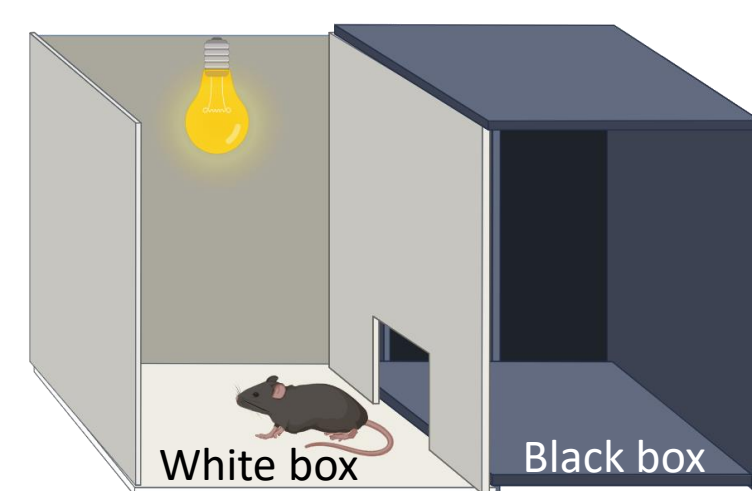
Human missions to Mars will expose astronauts to repeated gravitational fluctuations during flight affecting the vestibular system. Given the numerous connections between the vestibular system and the hippocampus (Hitier, et al. 2014), gravity changes are expected to alter cognition and crew performance increasing the risk of the mission (Clément, et al. 2013). The objective of this study was to characterize cognitive changes induced by short- and long-term 2G hypergravity exposure in mice.

## Materials and methods

Adult male and female C57BL/6JRj mice were exposed to **24 hours, 48 hours, or 15 days** exposure to **2G hypergravity (HG)** in a centrifuge. Immediately after, they were tested for cognitive performances through a battery of behavioral tests (anxiety, short and long term memory, and sociability).



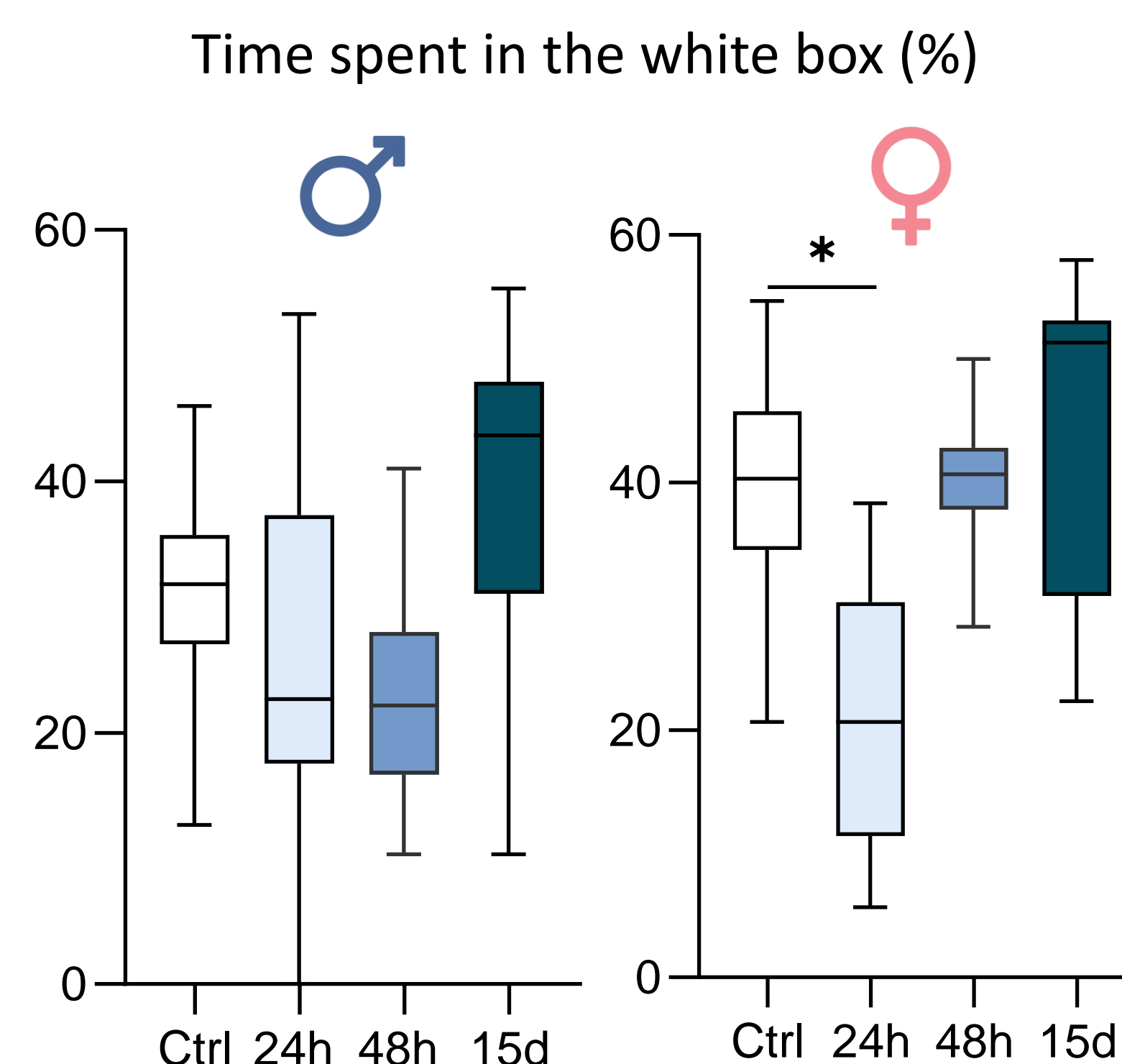
## Anxiety - Black & white test box



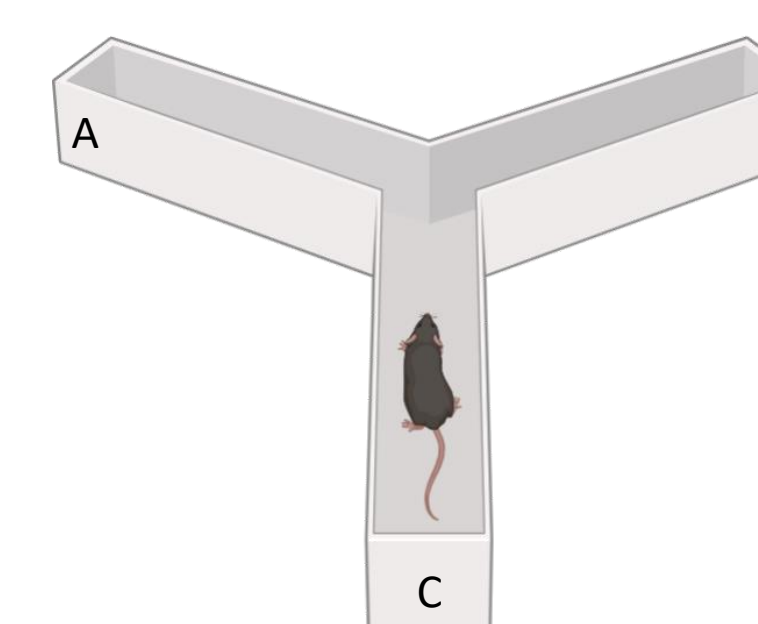
- Test duration : 5min

HG did not affect anxiety-like behavior in males (whatever the exposure duration). Contrarily, 24h of HG increased anxiety in females.

One way ANOVA, \* : p<0.05 ; Mean+/-SEM ; Kruskal-wallis test, \* : p<0.05 and \*\* : p<0.01; Median with interquartile range, n=10 per group.



## Short term memory - Spontaneous alternation in a Y maze

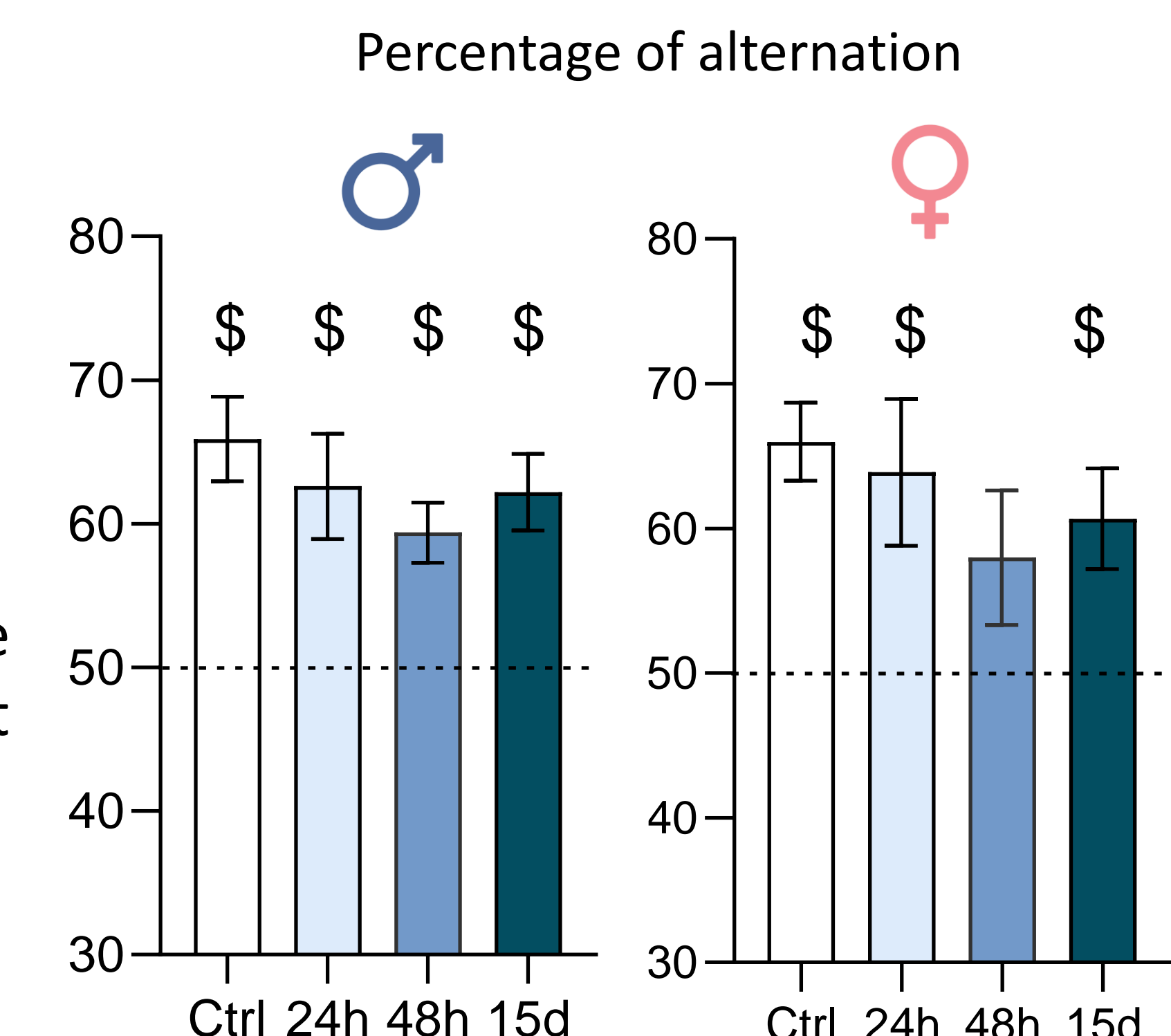


- Test duration : 5min
- Percentage of alternation  

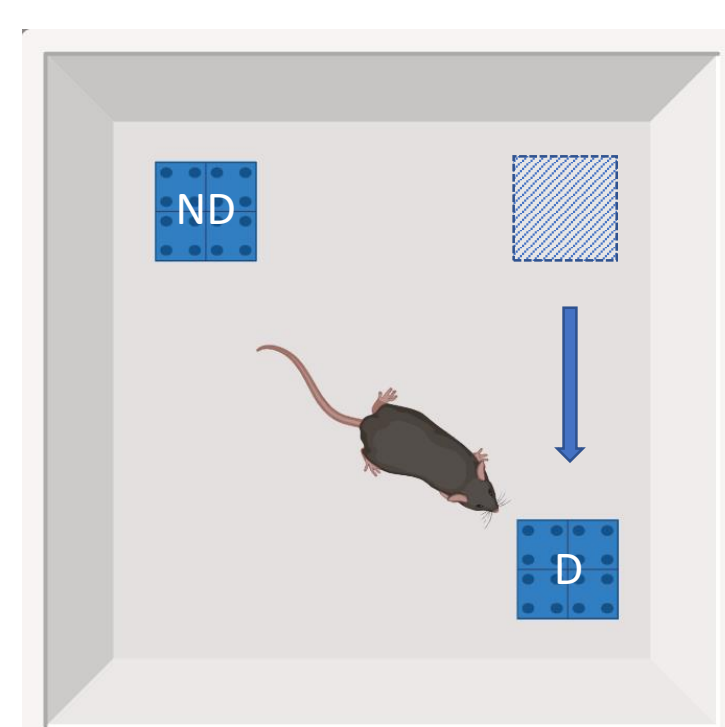
$$= \frac{\text{Number of alternation}}{\text{Total number of entries} - 2} \times 100$$

HG did not affect short term memory in males (whatever the exposure duration). Contrarily, 48h of HG impaired short term memory in females.

One way ANOVA, One-sample t-test ≠ 50% , \$ : p<0.05 ; Mean+/-SEM, n=10 per group.



## Long term memory – Object location memory test

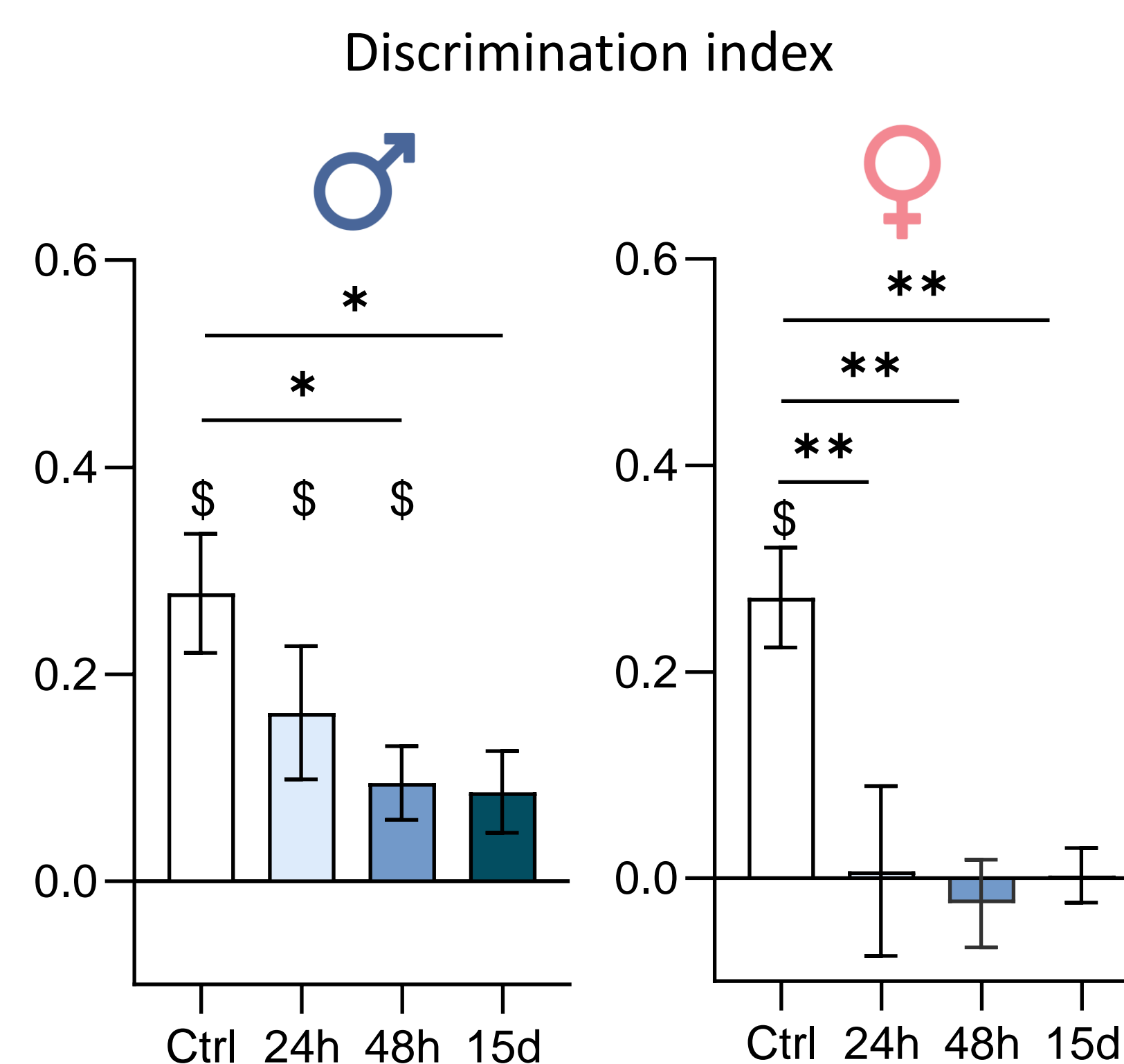


- Test duration : Twice 10min
- Criterion : 20sec of exploration
- % Exploration time  

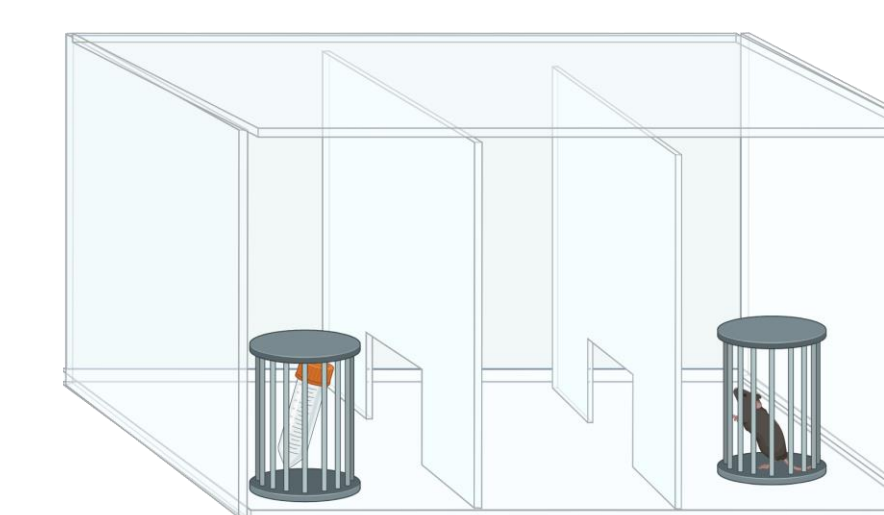
$$= \frac{\text{Displaced} - \text{Non displaced}}{\text{Displaced} + \text{Non displaced}} \times 100$$

Exposure to HG impairs long-term spatial memory in both sexes. However, the deterioration occurs after 48h of HG in males and after 24h in females.

One way ANOVA, \* : p<0,05 and \*\* : p<0.01 ; One sample t-test >0, \$ : p<0.05 Mean+/-SEM, n=10 per group.



## Sociability – Sociability test

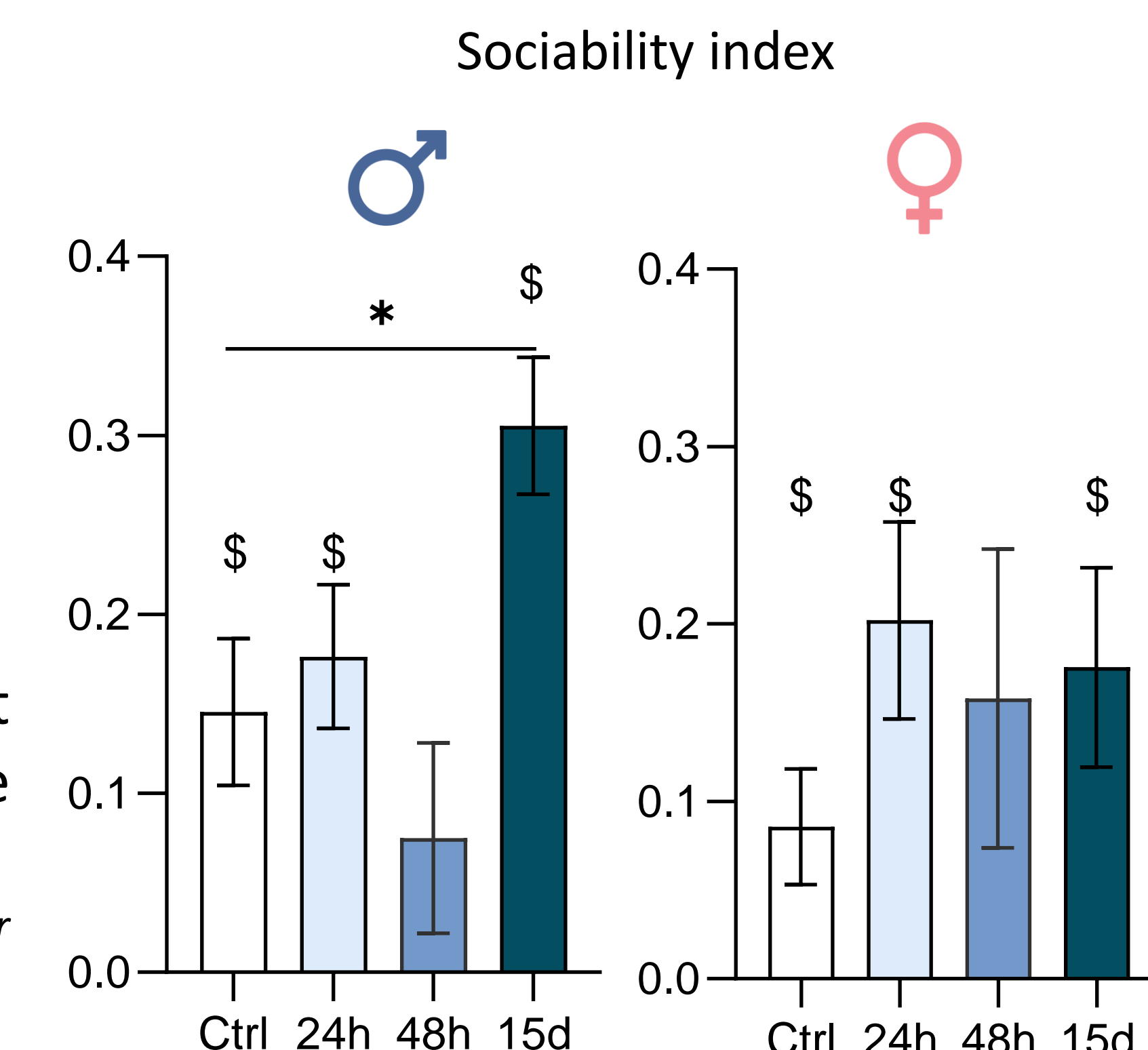


- Test duration : 10min
- Sociability index  

$$= \frac{\text{Time mice} - \text{Time object}}{\text{Time mice} + \text{Time object}} \times 100$$

Sociability was impaired after 48h of HG in both sexes, but improved in males after 15d of HG compared with the control group.

One way ANOVA, \* : p<0.05, One sample t-test >0, \$ : p<0.05, Mean+/-SEM, n=10 per group.



Our data supplest that the increased stimulation of the vestibular system alters cognitive functions related to hippocampus but also anxiety and sociability. Furthermore, the data suggest that females are more affected than males. Further studies will assess functioning and plasticity of the hippocampus.

Centrifuge video right here →

