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Interaction between olfaction and food intake: metabolic state drives changes in the astroglial deployment within the olfactory bulb glomeruli in rats

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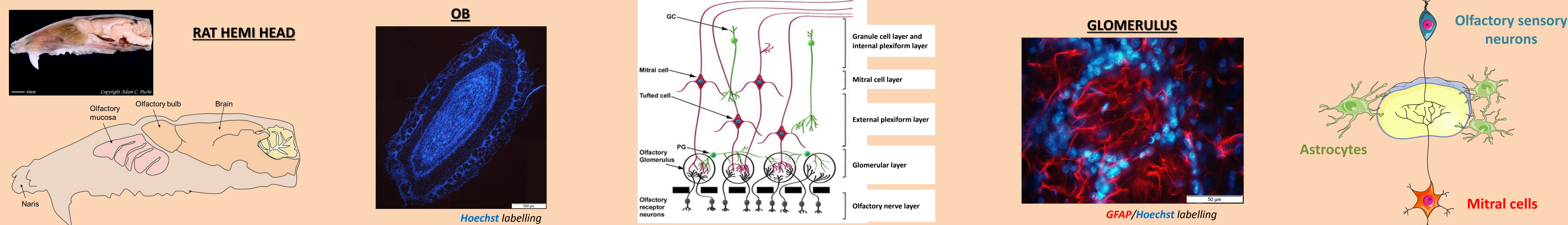
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Context

Olfaction participates in the elaboration of the hedonic value of foods, food choice and the regulation of food intake. Reciprocally, the detection of food odors is influenced by metabolic state and thereby contributes to the initiation and termination of eating behavior. Fasting increases olfactory performances, notably by increasing neuronal activation in the olfactory bulb (OB) (Prud'homme et al, 2009), the first integration site of olfactory signals towards the central nervous system. Within the OB glomeruli, glutamatergic synapses between olfactory sensory neurons and mitral cells are regulated by periglomerular neurons and astrocytes.



Hypothesis

Astrocytes are now fully recognized as synaptic partners (Halassa & Haydon 2010) and are thought to generate some kind of "metaplasticity" in the brain (Min et al, 2012) as well as in the OB glomerular region (Roux et al, 2011).

The neuron-astrocyte cross-talk in the glomeruli, albeit poorly known, may be a central player in the metabolic regulation of the olfactory responses.

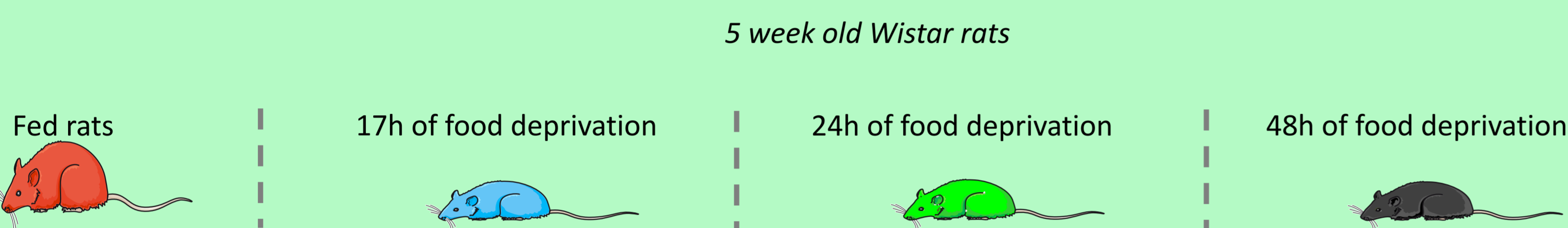
Objectives

To test the hypothesis that glomerular astrocytes are involved in the metabolic sensing of the olfactory system, we have compared the expansion of the astroglial processes (Immunohistochemical – Quantification of the GFAP area) within the glomeruli in:

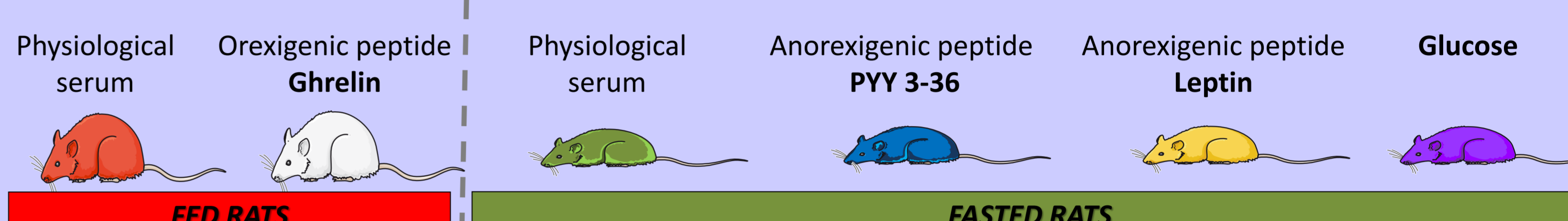
- fed or fasted rats
- Fed and fasted rats injected with different anorexigenic and orexigenic peptides

Models

Fed rats and fasted rats (17h, 24h or 48h of food deprivation):

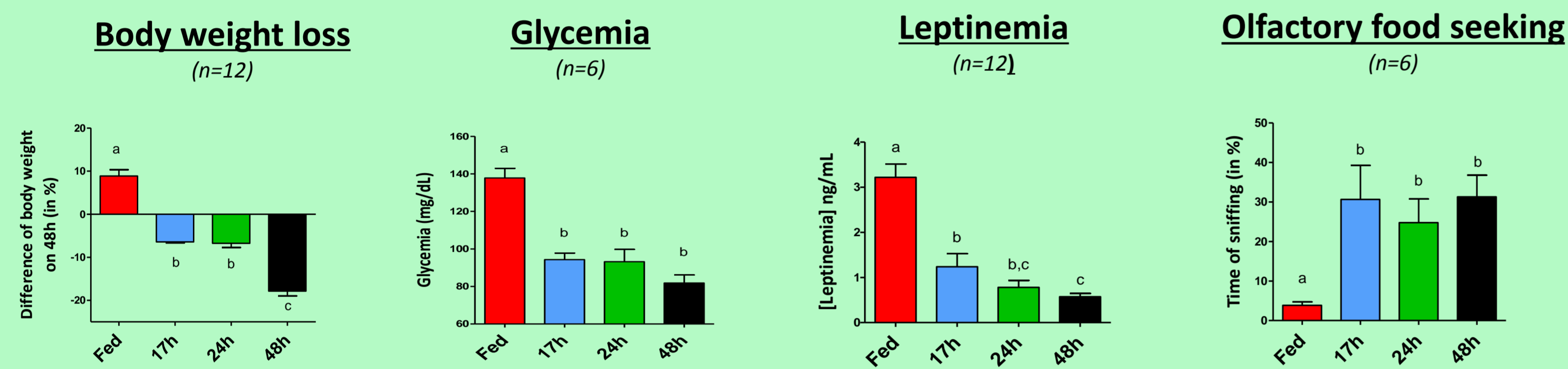


Fed rats and fasted rats (17h of food deprivation) with intra-peritoneal administration of:

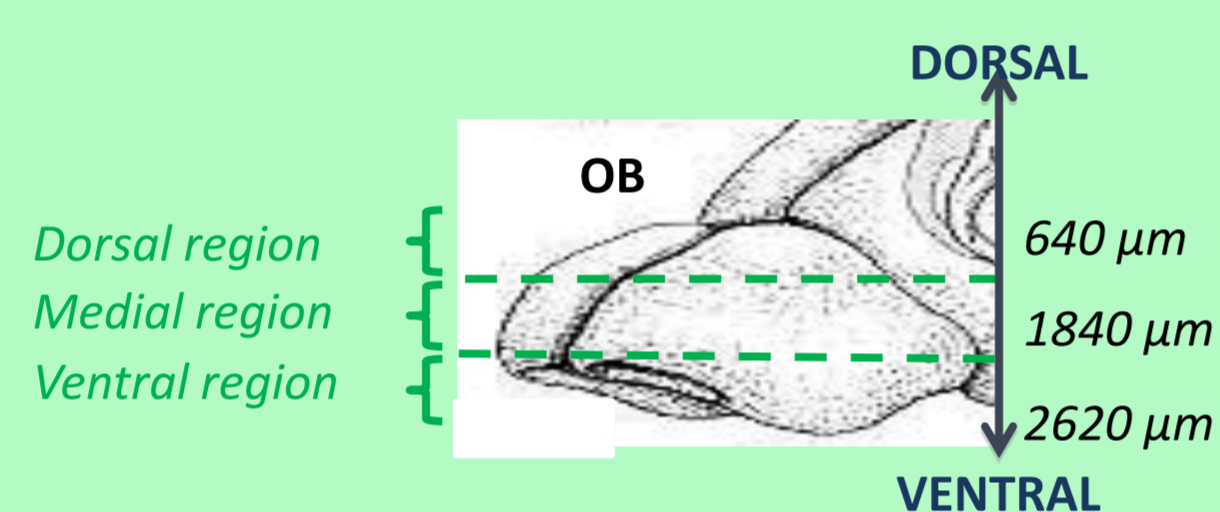


Results

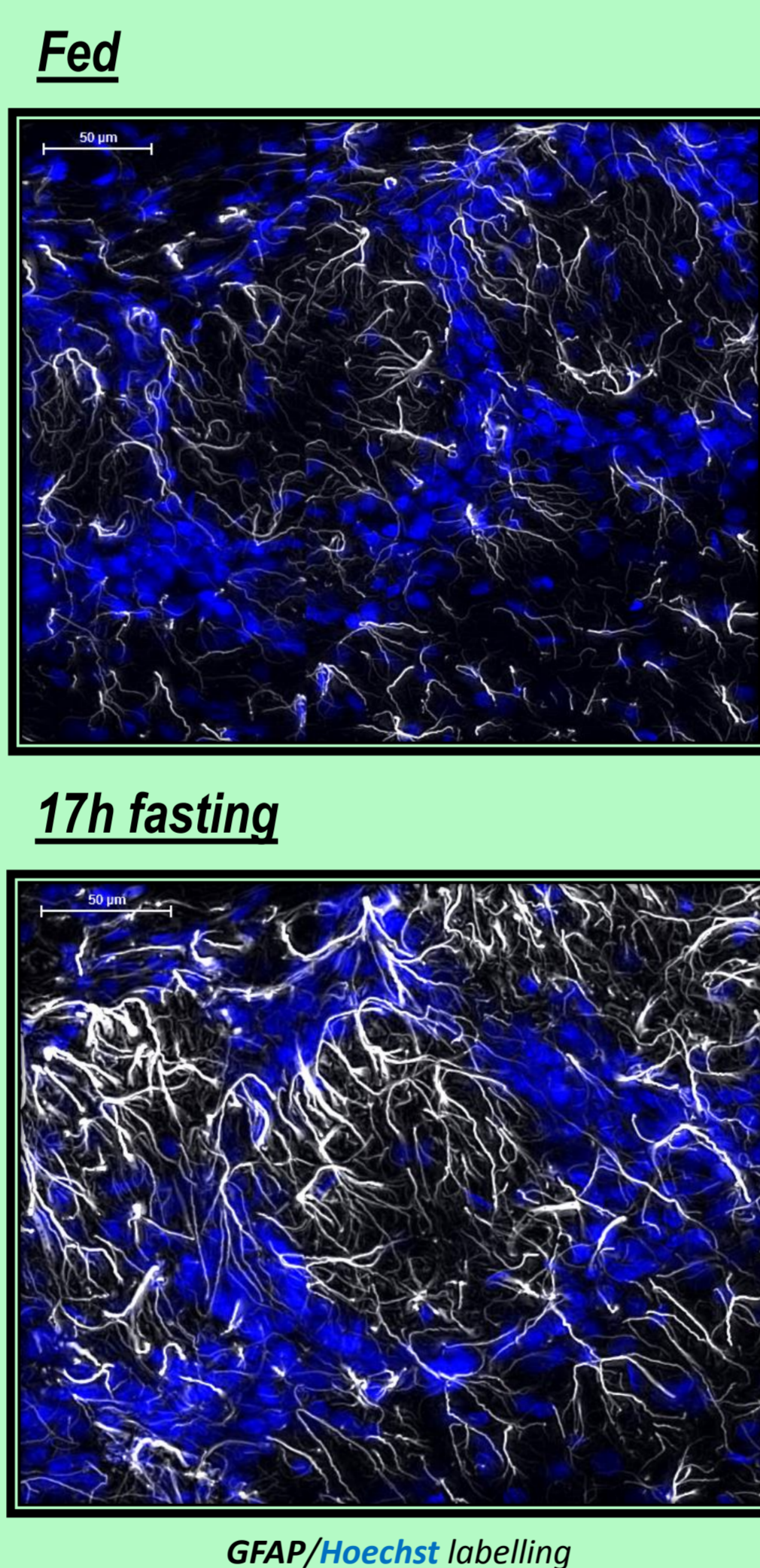
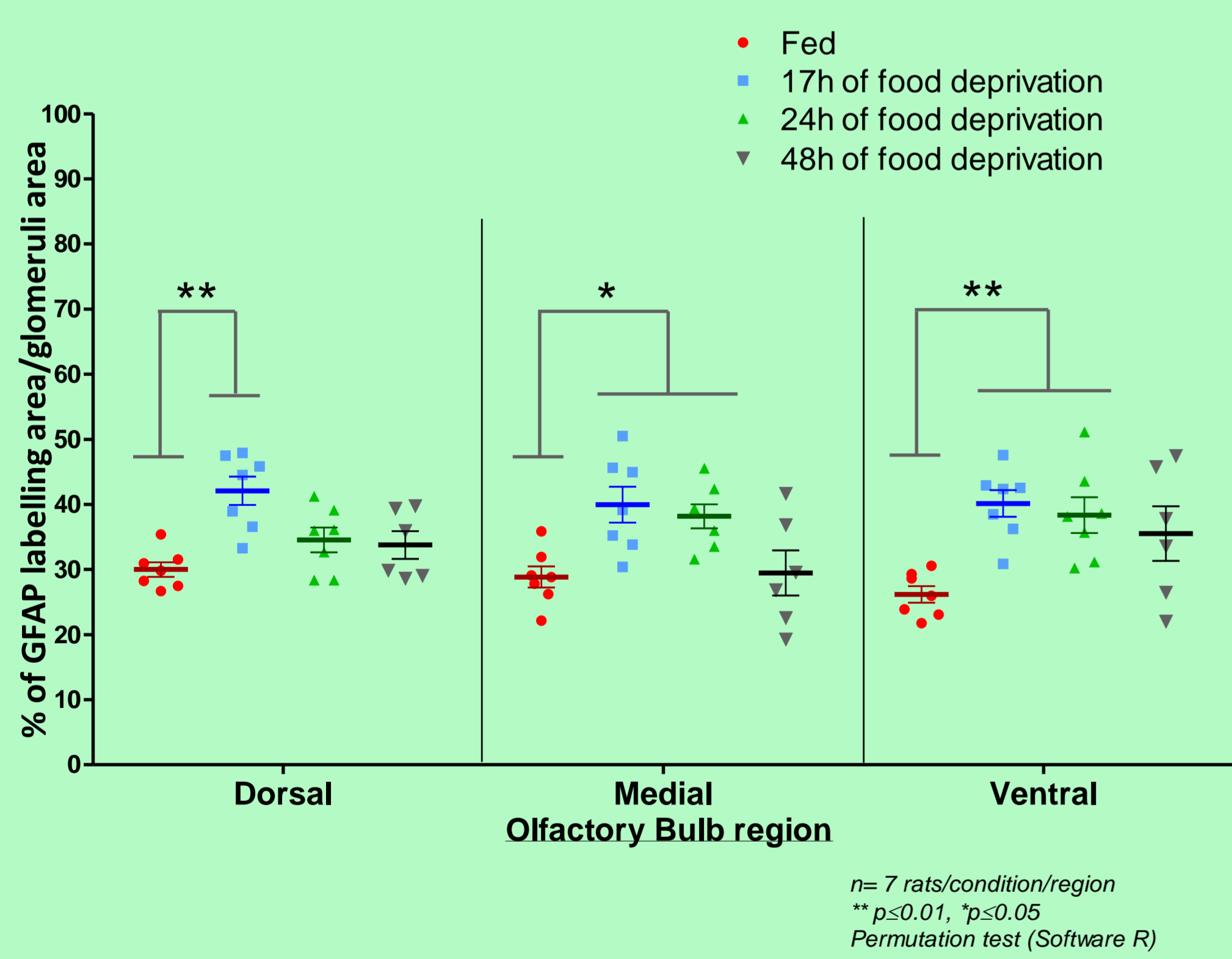
Fasting status of the rats



Astroglial deployment within the OB glomeruli



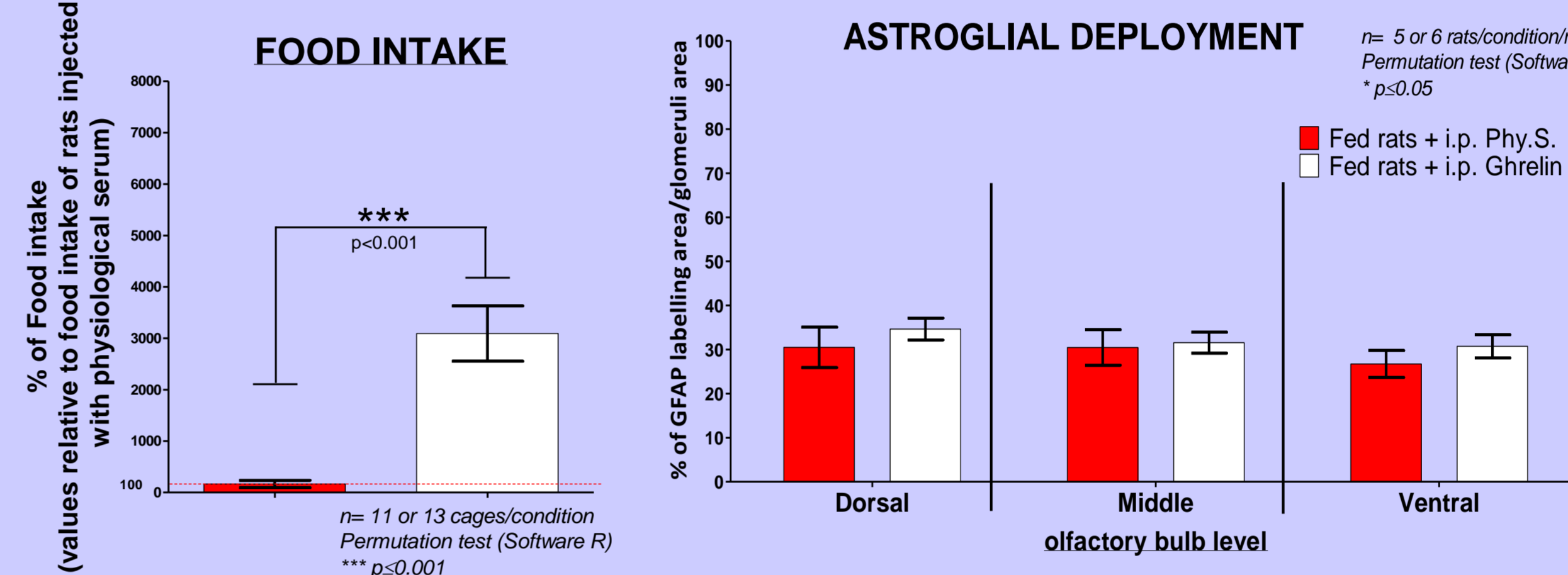
Quantification of GFAP labelling area/glomerulus:
4 sections/OB region/rat (≈ 200 glomeruli/region/rat)
n= 7 rats/condition



Overnight (17h) food deprivation results in an increase in the astroglial deployment within glomeruli in all OB regions.

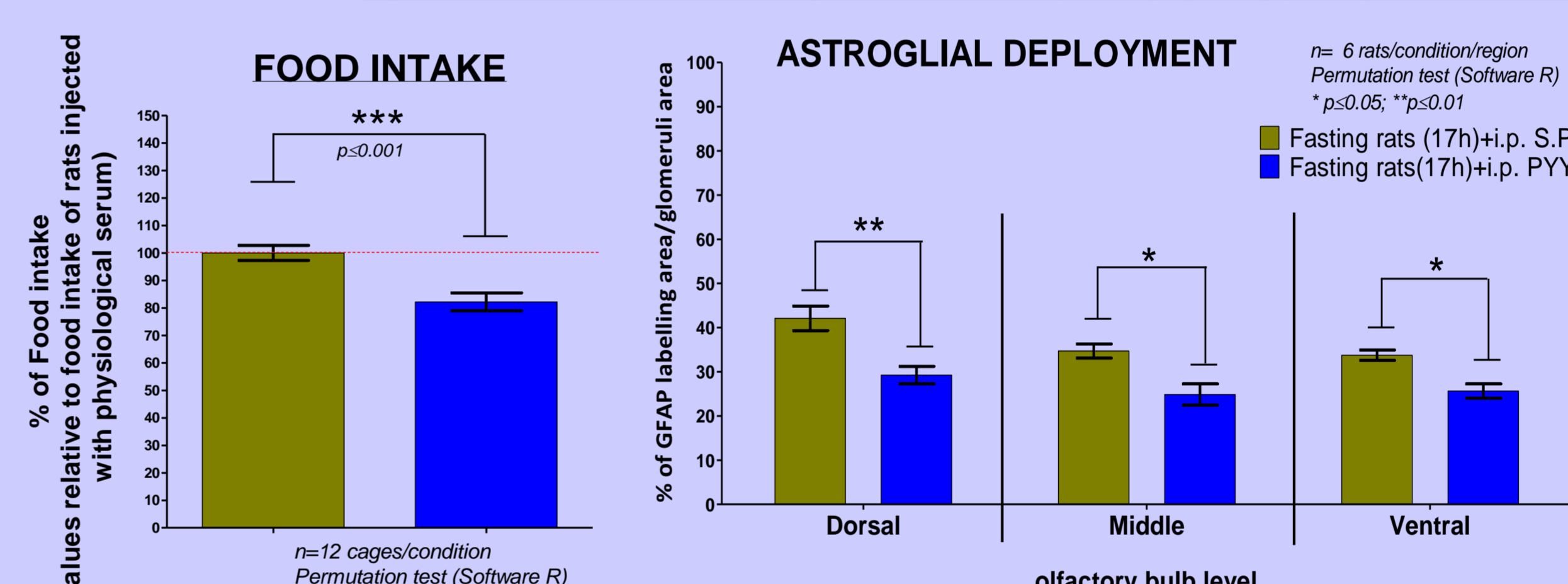
This increased deployment is also observed after 24h fasting in the medial and ventral OB regions but not after 48h fasting.

i.p. administration of GHRELIN (40μg/kg) in fed rats



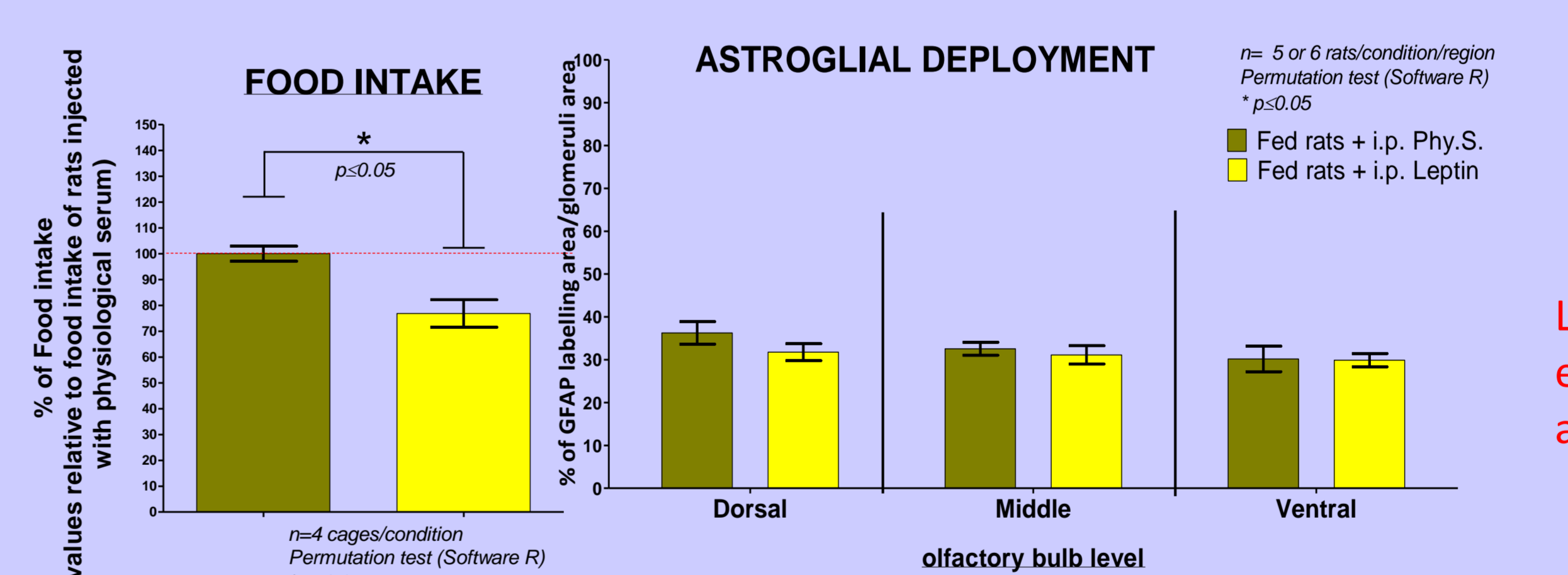
Ghrelin doesn't mimic the effect of fasting on astroglial deployment

i.p. administration of PYY 3-36 (100μg/kg) in fasted rats (17h)



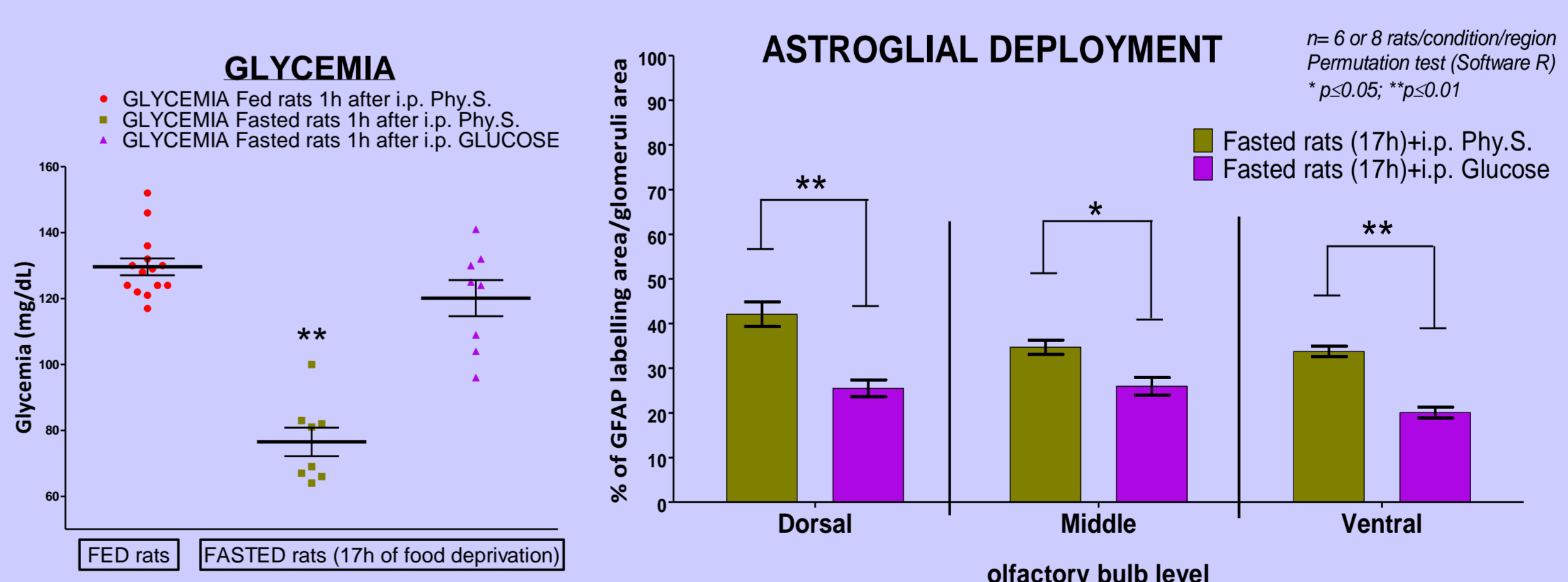
PYY 3-36 reverses the astroglial deployment induced by fasting

i.p. administration of LEPTIN (25μg/kg) in fasted rats (17h)



Leptin doesn't mimic the effect of satiety on astroglial deployment

i.p. administration of GLUCOSE (2g/kg) in fasted rats (17h)



Glucose reverses the astroglial deployment induced by fasting

Conclusion

Our results show that the deployment of astroglial processes within the OB glomeruli varies according to the metabolic status of the rats and is influenced by peptides involved in food intake regulation, such as PYY 3-36, and/or by changes in glycemia. This morphological plasticity may participate in the adaptation of olfactory sensitivity to food intake, by regulating the first step of odor signal integration in the CNS.

Perspectives

We are now seeking for the functional consequences of this astroglial plasticity on the olfactory signal and the underlying mechanisms.

