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Interaction between olfaction and food intake: first evidence for a role of astroglial plasticity in the olfactory bulb

Virginie Dumas-Meyer, Gaëlle Champel-Potokar, Anne Dufourcq, Marielle Levillain, Catherine Papillon, Patrice Congar, Isabelle Denis.
virginie.dumas-meyer@jouy.inra.fr

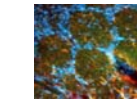
Context

Olfaction participates in the elaboration of the hedonic value of foods and plays an important role in food choice and the regulation of food intake. Reciprocally, the detection of food odors is influenced by the metabolic state (hunger/satiety), thereby contributing 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, the glutamatergic synapses between olfactory sensory neurons (OSN) and mitral cells are regulated by peri-glomerular 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 central nervous (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 olfactory responses.



This hypothesis is based on:

- The existence of an astroglial plasticity within glutamatergic synapses in other brain structures involved in adaptive behaviour
- The presence of abundant astrocyte networks in the OB
- The presence of NPY-Y1 receptor on the astrocytes of the OB glomeruli

GFAP/NPY-Y1 receptor/Hoechst labelling

Objectives

To test the hypothesis that astrocytes of the OB glomeruli are involved in the metabolic sensing of the olfactory system, we have compared the expansion of the astroglial processes within the glomeruli in fed or fasted rats.

Methods

Models

Fed rats/ Fasted rats (17h, 24h or 48h)

5 week old Wistar rats

Fasting states

olfactory food seeking behavior, body weight loss, glycemia and leptinemia.

Astroglial deployment within the OB glomeruli

Immunohistochemical - quantification of the GFAP area.

Quantification of the expression of the Y1 receptor of NPY

Western Blotting

Results

Fasting status of the rats

Body weight loss (n=12)

Glycemia (n=6)

Leptinemia (n=12)

Olfactory food seeking behavior (n=6)

Astroglial deployment within the OB glomeruli

Fed

24h of fasting

48h of fasting

GFAP/Hoechst labelling

Dorsal olfactory glomeruli (n=80-100 glomeruli/section, n=4 rats/condition)

Ventral olfactory glomeruli (n=80-100 glomeruli/section, n=4 rats/condition)

Fasting reduced the GFAP labelling area within the dorsal glomeruli

Expression of the NPY-Y1 receptor

NPY: Major orexigenic peptide involved in food intake regulation

Fasting increases the expression of the NPY-Y₁R, which is mainly located on the astrocytes, in the OB.

Conclusions

Our results strongly suggested that the deployment of astroglial processes within the OB glomeruli varies according to the metabolic status of the rats. This morphological plasticity may be influenced by peptides involved in food intake regulation such as NPY, and may participate to the adaptation of olfactory sensitivity to food intake.

Perspectives

We aim to explore the underlying mechanisms by evaluating the impact of the hormones involved in food intake regulation on the neurone-astrocyte cross-talk in the glomeruli.

