



available at [www.sciencedirect.com](http://www.sciencedirect.com)



journal homepage: [www.elsevier.com/locate/psyneuen](http://www.elsevier.com/locate/psyneuen)



## Stress response and humoral immune system alterations related to chronic hypergravity in mice

Nathan Guéguinou<sup>a</sup>, Mickaël Bojados<sup>b</sup>, Marc Jamon<sup>b</sup>,  
Hanane Derradji<sup>c</sup>, Sarah Baatout<sup>c,d</sup>, Eric Tschirhart<sup>e</sup>,  
Jean-Pol Fripiat<sup>a</sup>, Christine Legrand-Frossi<sup>a,\*</sup>

<sup>a</sup> Nancy-University, Henri Poincaré University, Development and Immunogenetics team, JE 2537, 9 Avenue de la forêt de Haye, F-54500 Vandoeuvre-lès-Nancy, France

<sup>b</sup> INSERM UMR-910, Functional Genomics, Pathology and Behavior, Faculty of Medicine of La Timone, F-13010 Marseille, France

<sup>c</sup> Molecular & Cellular Biology, Institute for Environment, Health & Safety, SCK.CEN, Boeretang 200, B-2400 Mol, Belgium

<sup>d</sup> Faculty of Bioengineering Sciences, Gent University, Coupure Links, B-9000 Gent, Belgium

<sup>e</sup> Université du Luxembourg, Campus Limpertsberg, Faculté des Sciences, Techniques et de la Communication, Life Sciences Research Unit – Inflammation, 162a, avenue de la Faiencerie L-1511 Luxembourg, Luxembourg

Received 28 January 2011; received in revised form 12 May 2011; accepted 28 May 2011

### KEYWORDS

Mice;  
Hypergravity;  
Anxiety Behavior;  
Stress;  
Corticosterone;  
Immunoglobulins;  
Humoral immunity;  
Cytokines

**Abstract** Spaceflights are known to induce stress and immune dysregulation. Centrifugation, as hindlimb unloading, is a good ground based-model to simulate altered gravity which occurs during space missions. The aim of this study was to investigate the consequences of a long-term exposure to different levels of hypergravity on the stress response and the humoral immunity in a mouse model. For this purpose, adult C57Bl/6J male mice were subjected for 21 days either to control conditions or to 2G or 3G acceleration gravity forces. Corticosterone level and anxiety behavior revealed a stress response which was associated with a decrease of body weight, after 21-day of centrifugation at 3G but not at 2G. Spleen lymphocyte lipopolysaccharide (LPS) responsiveness was diminished by 40% in the 2G group only, whereas a decrease was noted when cells were stimulated with concanavalin A for both 2G and 3G groups (about 25% and 20%, respectively) compared to controls. Pro-inflammatory chemokines (MCP-1 and IP-10) and Th1 cytokines (IFN $\gamma$  and IL2) were slightly decreased in the 2G group and strongly decreased in the 3G mouse group. Regarding Th2 cytokines (IL4, IL5) no further significant modification was observed, whereas the immunosuppressive cytokine IL10 was slightly increased in the 3G mice. Finally, serum IgG concentration was twice higher whereas IgA concentration was slightly increased (about 30%) and IgM were unchanged in 2G mice compared to controls. No difference was observed in the 3G group with these isotypes. Consequently, functional immune dysregulations and stress responses were dependent of the gravity level.

© 2011 Elsevier Ltd. All rights reserved.

\* Corresponding author at: 9 avenue de la forêt de Haye, Bâtiment AB, 2<sup>e</sup> étage, F-54500 Vandoeuvre-lès-Nancy, France.  
Tel.: +33 03 83 68 37 25; fax: +33 03 83 68 37 22.

E-mail address: [christine.legrand-frossi@scbiol.uhp-nancy.fr](mailto:christine.legrand-frossi@scbiol.uhp-nancy.fr) (C. Legrand-Frossi).