Conditioning the brain immune system through physical activity

Staying physically active is one of the most beneficial things that a person can do for maintaining whole-body health. It is well understood that physical activity is important for building muscle, improving cardiovascular health, and boosting metabolism. We have discovered that, in addition to these positive effects, physical activity is also critical for maintaining a healthy immune system in the brain.

The immune system is made up of a network of cells and tissues that function together to defend the body against foreign invaders (usually bacteria and viruses), as well as to eliminate diseased or dying cells. Within the brain, it is the non-neuronal glial cells that perform the immune duties. When glial cells come in contact with harmful substances, they become functionally activated, which allows them to carry out their immune functions. Glial activation is an essential step in defending against foreign invaders and damaging particles and returning the brain to its balanced homeostatic state.

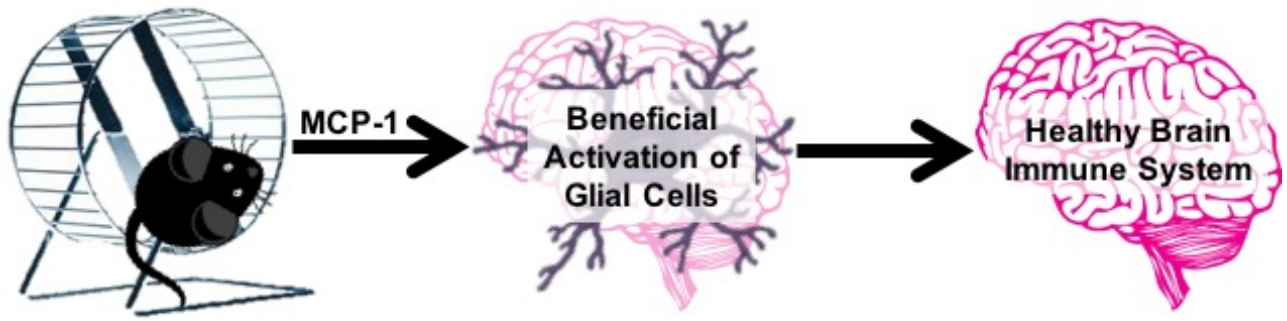

Fig. 1. MCP-1 mediates the beneficial effects of physical activity on the brain immune system

In this study, we used two groups of mice to investigate the brain immune response to physical activity: one group was housed without access to an exercise wheel (sedentary group), but the other group had access to an exercise wheel, which they could voluntarily use (physically active group). We found that the brains of the physically active mice exhibited much more activated glial cells, as well as higher amounts of both beneficial and harmful immune signaling molecules, termed cytokines, compared to the brains of the sedentary mice. We propose that the physically active mice demonstrated the indicators of a healthy and primed immune system that is ready to fight foreign pathogens and infection, as opposed to a possibly suppressed immune system

present in the sedentary mice.

Additionally, we investigated the role of one key cytokine, monocyte chemoattractant protein (MCP)-1, in mediating brain immune responses to physical activity. Two additional groups of mice lacking MCP-1 were used for these studies: one group was housed without access to an exercise wheel (MCP-1 knockout sedentary group), and the other group had access to an exercise wheel (MCP-1 knockout physically active group). In contrast to their wild-type counterpart mice, which had the MCP-1 cytokine present, the MCP-1 knockout mice showed almost no activation of glial cells, regardless of whether they were in the physically active or sedentary group. MCP-1 knockout mice also displayed a very different pattern of brain cytokine expression when compared to the wild-type mice. Most notably, the MCP-1 knockout physically active group of mice had very high levels of the pro-inflammatory and notoriously damaging cytokine, called interferon gamma. These data indicate that for physical activity to produce beneficial effects in the brain, MCP-1 must be present to mediate these effects.

Remarkably, although all four groups of mice displayed differences in markers of immune cell activity and cytokine expression in the brain, similar changes were not observed in the periphery, as levels of serum cytokines in each of these four mice groups did not differ from one another.

Our data indicate that brain immune responses to physical activity can be independent from the reaction of the peripheral immune system to physical activity, and that these responses are at least partially dependent on MCP-1. This study illustrates that physical activity can support brain health by boosting the beneficial activity of the brain immune system.

Lindsay Joy Spielman *and* ***Andis Klegeris***
Department of Biology, University of British Columbia Okanagan Campus, Canada

Publication

The effects of voluntary wheel running on neuroinflammatory status: Role of monocyte chemoattractant protein-1.
Spielman LJ, Estaki M, Ghosh S, Gibson DL, Klegeris A
Mol Cell Neurosci. 2017 Mar