

## The ever-more surprising brain

Richard Béliveau

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*A burst of new research studies from scientists around the globe are revealing that the brain is ever more fascinating in its structure and function.*

The **brain** is certainly the most complex organ in the human body, comprised of hundreds of billions of cells (neurons) which, collectively, coordinate both the maintenance of vital basic functions (respiration, heartbeat, digestion, sexual drive) as well as more advanced functions such as thought, language, consciousness and memory.

This complexity is illustrated by recent research studies which have shown the brain is even more complex than was previously thought and that the cerebral cortex of humans can be subdivided into no less than 180 distinct regions, each possessing different anatomical and functional characteristics<sup>1</sup>. In light of this complexity, understanding brain function unquestionably represents one of the biggest challenges facing modern science.

Traditionally, the brain has been considered like a “separate” organ, somewhat as if it functioned in an autonomous manner without any interaction with the rest of the body. We now know that this is absolutely not the case and that the health of the brain directly influences that of the body (a healthy mind in a healthy body, according to the ancient Romans).

It was recently shown, in spectacular fashion using a new method of neuron tracing, that multiple regions of the brain involved in movement, cognition and emotions are directly linked to the adrenal glands (responsible for the production of stress hormones), which could explain why these negative emotions are often associated with diverse physical diseases<sup>2</sup>.

### MUST WORK ONE’S BRAIN

In other words, there certainly exists an anatomical link between the brain and the body and our mental states can actually influence our physical well-being, thus establishing a molecular basis for psychosomatic diseases. These results also suggest a pathway that might explain the effectiveness of approaches such as yoga, Pilates or tai-chi, which are centred on body posture in stress management.

This relation between the body and the mind also works in the opposite direction, such that the general health of the body exerts a positive impact on the mind. The best example is undoubtedly physical activity: many studies have clearly shown that regular physical activity has several positive effects on brain function and could even counteract the deterioration of the cognitive facilities that often accompanies aging.



### BENEFICIAL PROTEINS

A recent study allows us to better understand this phenomenon<sup>3</sup>. A team of American and German scientists observed that exercise provoked the release of certain proteins from the muscles, notably an enzyme called cathepsin B. The more active that the animals were, the greater that blood levels of cathepsin B were elevated and the authors showed that this increase stimulated the formation of new neurons and of synaptic connections within the hippocampus (the seat of memory). This suggests that the cathepsin B secreted by the active muscles could play an important role in the positive effects of exercise on cognitive functions, particularly memory.

To verify whether these observations were applicable to humans, the researchers recruited sedentary university students and separated them into two groups, half remaining inactive whereas the others were submitted to rigorous physical training several times each week. After four months of this, the researchers observed increased levels of cathepsin B in the blood of active students and measurable improvements in their physical form, whereas the inactive students showed no changes.

Even more interesting, they observed a direct link between this increase in cathepsin B and the improvements in memory: the greater the increase in the level of this protein, the better were the results of memory tests (reproduction of a complex geometric figure learned earlier). Regular physical activity is thus a good way of maintaining shape, both physical and mental!

- (1) Glasser MF et al. A multi-modal parcellation of human cerebral cortex. *Nature* 2016;536:171-178.
- (2) Dum RP et al. Motor, cognitive and affective areas of the cerebral cortex influence the adrenal medulla. *Proc. Natl. Acad. Sci. USA* 2016;113(35):9922-9927.
- (3) Moon HY et al. Running-induced systemic cathepsin B secretion is associated with memory function. *Cell Metab.* 2016;24:332-340.