

Mice, Attention and the Superior Colliculi

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Original version of this paper is available on: <http://psychologon.cz/component/content/article/14-psycholog-online/314-mysi-pozornost-a-colliculi-superiores>

This article presents a commentary on a report claiming that the neurobiological origin of attention deficit disorder has been discovered. It compares the report with the original article, on which it is based, and informs the reader on the fundamental issues of ADD and ADHD. The neurobiological origin of the disorder has not been found, but, despite that, the research findings may have a considerable impact on its discovery in the future.

Lisa Winter, a contributor to the website IFL Science, which popularises science and, on a regular basis, presents new findings from various scientific fields to the general public, published an article with an ambitious title “Neurobiological Origin of Attention Deficit Disorder Discovered” (Winter, 2014) in April.

The article appeared in reaction to a study of the University of Strasbourg which examined reactions of transgenic mice. I must agree with the author on several points she mentions. Attention deficit disorder (ADD) and attention deficit hyperactivity disorder (ADHD) belong among the most contentious topics of contemporary psychology. Both of the disorders are frequently discussed by professionals as well as lay public. One of the main reasons for these discussions is the fact that the current scientific research has yet to discover the exact origin of the two disorders. Moreover, there exist a large number of various hypotheses among experts concerning not only their origin but also

their proper treatment. The discovery of the origin of ADD would lead to a unification of research and to new possibilities of treatment and diagnosis not only of ADD, but also ADHD, for both disorders share a lot of common signs and symptoms. Such a breakthrough seemed incredible to me. That is why I decided to consult the source – the original article.

The title itself decreased my hopes: “Defective response inhibition and collicular noradrenaline enrichment in mice with duplicated retinotopic map in the superior colliculus”. What does the article deal with? Scientists in Strasbourg managed to create a unique breed of mice in which they multiplied the number of axons of retinal ganglion cells (a special type of neurons located in the eye) associated with the superior colliculi (an upper pair of “bumps” in the tectum, a part of the midbrain, which are involved in the systems of optic tracts (Čihák, 1997)). In this way, they produced hyperstimulation of the superior colliculi without influencing other parts of the brain. They used this modification to verify one of the theories, which claims that it is hyperstimulation of this part of the brain that causes some of the ADD/ADHD symptoms, particularly impulsiveness and easy distraction of attention.

Three kinds of mice were involved in the experiments: wild mice, heterozygous mice (whose genetic modification is weaker) and homozygous mice (whose modification is very strong). These mice were used in a large number of experiments, which explored their sensorimotor functions and behaviour associated with the superior colliculi – spacial orientation, memory and inhibition of reactions. In a large majority of the experiments, all the mice had the same results irrespective of their kind. The most important difference was discovered in a series of experiments examining anxiety and inhibition of reactions. All the kinds of mice manifested the same level of anxiety. Knock-out mice, unlike wild ones, were more prone to examine hostile environments. This finding may be linked to one of the key features of impulsiveness, a reduced level of reaction inhibition. On the basis of this finding, the authors of the study made use of the Go/No-Go testing. This testing is used for studying attention, inhibition of reactions, learning and memory even in humans. It involves simple tasks, including the identification of the correct condition “Go” and the incorrect

one “No-Go”. The mice ran around in two tunnels of different colours. The “Go” tunnel had a reward in the form of food at its end, while there was no reward at the end of the “No-Go” tunnel. All the kinds of mice reached similar results under “Go” conditions. Under “No-Go” conditions, homozygous mice (with the strongest modification) diverged considerably from the other two groups. Their reaction to the “No-Go” condition was almost identical to their reaction to the “Go” condition – as if they could not stop using the wrong condition. These results further supported the theory of inadequate inhibition of reactions.

Inhibition of reactions could have been caused by abnormal levels of some neurotransmitters in the brain. To exclude this possibility, the scientists examined levels of dopamine, adrenaline and serotonin in five different brain structures. They did not find any differences between groups of these neurotransmitters. They discovered, however, that homozygous mice had a considerably higher amount of noradrenaline (a neurotransmitter whose excess causes psychomotor restlessness) in the superior colliculi.

Having considered the article, can I thus, together with Lisa Winter, celebrate a huge scientific breakthrough? The authors of the study themselves are cautious in the evaluation of the importance of their work. It is undoubtedly a unique study, the first one to examine changes in the behaviour and molecular structure of this kind of knock-out mice. It also shows the relation between hyperstimulation of the superior colliculi and one form of impulsiveness (defective inhibition of reactions). In addition to that, it points to an increased amount of noradrenaline in this part of the brain. These two findings are in accordance with some of the symptoms present in patients with ADHD. Moreover, they support two hypotheses related to the possible causes of ADHD – hyperstimulation of the superior colliculi leading to impulsiveness and decrease in attention and a malfunction of the regulation of noradrenaline. Nevertheless, the origin of ADD/ADHD has not been discovered conclusively. On the other hand, the study suggests a new model for the examination of the ADHD pathology and, in this way, it may contribute to a better understanding of the disorder in the future as well as to the final discovery of its origin.

Translated by Lucie Seibertová

Sources

- 1 Čihák, R. (1997): Anatomie III. Grada: Praha
- 2 Mathis, Ch., Savier, E., Bott, J-B., Clesse, D., Bevins N., Sage-Ciocca, D., ... & Michael Reber (2014). Defective response inhibition and collicular noradrenaline enrichment in mice with duplicated retinotopic map in the superior colliculus. Brain Structure and Function. Doi: 10.1007/s00429-014-0745-5
- 3 Winter, L., (2014). Neurobiological Origin of Attention Deficit Disorder Discovered. Dostupné z <http://www.iflscience.com/brain/neurobiological-origin-attention-deficit-disorder-discovered#mg4JjfYm3wStEAM2.99>

Source of picture

- <http://www.neviditelnycert.cz/blog/pel-mel/1277-inteligentni-potkan.html>