Controlling movements with light

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German researchers at the Ruhr-Universitaet have succeeded in controlling the activity of certain nerve cells using light, thus influencing the movements of mice. By changing special receptors in nerve cells of the cerebellum such that they can be activated and deactivated by light, the researchers have shown that the signaling pathways, which are activated by the receptors play a crucial role in controlling movement.

Unlike conventional methods, with the so-called optogenetics, the researchers are able to target one cell type. "We are now going to use this method to find out exactly what goes wrong in the nerve cells in movement disorders such as ataxias", said Prof. Dr. Stefan Herlitze (RUB Department for Biology and Biotechnology). The results are reported in the Journal of Biological Chemistry.

The Bochum team examined a specific signalling pathway that is controlled by a so-called G-protein-coupled receptor. This pathway is important for the modulation of activity in complex neuronal networks. Disturbances of the function can, for example, have an effect on emotional and motor behaviours. "We know that the activity pattern of the Purkinje cells in the cerebellum is crucial for the coordination of movements", Herlitze explained. "It is unclear, however, what contribution is made by the individual receptors." In conventional studies, researchers use drugs that inhibit or stimulate specific proteins in nerve cells to investigate the contribution of these proteins to the activity of the cells. However, Herlitze's team was interested in a protein (G-protein-coupled receptor) which occurs in various cell types. Had the researchers administered a drug, they would not only have deactivated

the receptor in the Purkinje cells, but in all cell types in which it occurs. The drug method therefore makes it impossible to observe the contribution of the receptor in the Purkinje cells in isolation.

Optogenetics: replacing drugs with light

To avoid this problem, Herlitze's team replaced the drugs with proteins that are activated by light. Using genetic methods, the researchers integrated rhodopsin, the light-sensitive protein of the eye, into the Purkinje cells of mice. They also implanted a laser probe in the cerebellum, with which they illuminated the rhodopsin. The light-activated rhodopsin then activated the G-protein-coupled receptor in the Purkinje cells, while the same receptors in other cell types remained inactive. The RUB Department of General Zoology and Neurobiology has been instrumental in establishing this method worldwide.

Investigated receptor is crucial for movement control

The researchers found that activation of the G-protein-coupled receptor changed the activity pattern of the Purkinje cells. Herlitze's team had to expose the rhodopsin to light for several seconds to achieve these effects. A twenty to thirty percent reduction in cell activity was sufficient to induce visible motor deficits in the behaviour of the mice, such as impaired balance or coordination problems. "We were able to demonstrate for the first time that the modulation of a specific G-protein-coupled receptor in the Purkinje cells is of crucial importance for the control and coordination of movement", summed up Herlitze.

More information: Gutierrez, D.V., Mark, M.D., Masseck, O., Maejima, T., Kuckelsberg, D., Hyde, R.A., Krause, M., Kruse, W., Herlitze, S. Optogenetic control of motor coordination by Gi/o protein-coupled vertebrate rhodopsin in cerebellar Purkinje cells. J. Biol. Chem.,

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