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**PRESS RELEASE**
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## LIGHT THERAPY TO RESTORE HEARING AND SIGHT

- **Technology enables rodents to hear light**
- **Light-sensitive switch controls action of drugs**

Light therapy is a promising new technique that could improve the quality of cochlear implants for deaf people. The technology, pioneered by a team of scientists in Germany delivers a stimulus to the auditory nerve inside the inner ear, the cochlea. There is some evidence from studies in rodents that light can be heard.

Optogenetics is a combination of genetics, optics, and virology which uses light to turn brain cell groups on and off. **Professor Tobias Moser** at the University Medical Center Göttingen in Germany leads an international research group to develop the optical stimulation of the inner ear.

The electrical cochlear implants enable speech comprehension in more than 450,000 hearing-impaired people around the world. However, the unfocused spread of electrical stimulation from each electrode limits how well a person can hear - and this is a major drawback. The more accurately in space the nerve is stimulated, the better the sound. "We have been looking for a way to improve the transmission of frequency and intensity of the sounds to the auditory nerve. Optogenetics seemed to offer a possible solution," he said today (2 July) at FENS 2016 in Copenhagen.

How can light activate hearing? The researchers modified cells in the inner ear of rodents (usually mice, but also rats and gerbils) with harmless viruses to make them respond to light. The genes produce light-sensitive ion channels on the membranes of the auditory nerves and when LED light is directed onto these neurons and their activity was recorded, they found that rodents reacted to the light similarly as to sound. Rodents with ion channels that endowed neurons with greater light-sensitivity required a reduced amount of light to stimulate hearing. Spatially-confined optical stimulation achieved better frequency coding than the electrical cochlear implant currently available.

Professor Moser explained, "Think of the cochlea as a spiral staircase where each step is like a key on the piano which turns on its neurons that are housed in the stair well. We are very good at discriminating tone frequencies, because the travelling wave is sharply tuned, so for soft tones only one key is pressed. In the cochlear implant, the spread of current from each electrode contact is so massive that it activates many steps – the keys - at a time. By delivering the optical stimulus more accurately in space we hope to be able to activate individual keys nearly as well as in acoustic hearing. "

Approximately five percent of the world's population suffer from impaired hearing which can lead to social isolation, depression and a reduced capacity to work. Although this technology is some years away from clinical trials in people, researchers could work towards a gene therapy that enables the auditory nerves to respond to LED light embedded in a cochlear implant.

Much more research needs to be carried out before clinical trials in people begin. "Optogenetic stimulation of the cochlea restored hearing in deaf mice. Our research strongly suggests that optical cochlear implants could be developed. The study demonstrates a strategy for optogenetic stimulation of the auditory pathway in rodents and lays the groundwork for future applications of cochlear optogenetics in auditory research and devices to help deaf people hear again," said Professor Moser."

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As well as optogenetic stimulation, scientists are also now exploring a more subtle approach to apply and activate drugs with light. **Dr Martin Sumser** from Ludwig-Maxilimilians University in Munich is particularly interested in a technique called photopharmacology which could help restore vision in people with diseases of the retina, such as macular degeneration and retinitis pigmentosa. These conditions are difficult to treat with drugs or implants and millions of people face the prospect of going blind.

Light is ideally suited as a potential treatment because it can be delivered very precisely onto diseased cells and tissues without causing any harm. Photopharmacology aims at overcoming the problems of existing treatments by incorporating a light-sensitive switch into the molecular structure of drugs. These switching units allow light to be used as an external control of the action of the drug.

Blindness is frequently caused by the loss of the intrinsically light-sensitive photoreceptor cells in the eye. However, some other cell types in the retina remain intact and still function but do not respond to light. Targeting these remaining cells using photopharmacology means that it is now possible to endow them with a light sensitivity.

"The trick now is to alter drugs in such a way that they change their activity when they are illuminated with light," explained Dr Sumser. "We call this approach photopharmacology. Here we use chemically-synthesised drug compounds which are introduced into cells and activated by light in a highly controlled way."

Research in genetically-blind mice has already shown that after the treatment they were able to distinguish between light and dark. "It remains to be seen to what extent photopharmacology can restore sight," said Dr Sumser.

Although the principles of photopharmacology and optogenetics are the same, the main difference with photopharmacology is that it is not necessary to use a virus as a carrier of the therapeutic gene. This is one of the major advantages when compared to approaches using gene therapy, which cannot easily be reversed.

With the development of LEDs the local delivery of light is nowadays technically feasible and affordable, and harmless to the body. In case of unforeseen problems with the light therapy, the dosage of the drug can be easily adjusted or changed for a newer version of the light-switchable drug.

Considering other diseases such as cancer or diabetes, treatments are often accompanied by undesired side effects. To overcome these problems, one has to either change or stop the treatment. Dr Sumser is hopeful that photopharmacology could one day be developed into an effective therapy which can be controlled with a high level of precision, acting only on the cells which are affected by the disease.

"Imagine how good it would be for people with diabetes not to have to inject themselves each day," he speculated.

"In the laboratory we successfully applied this photopharmacological approach to control cell division in a light-dependent fashion thereby inducing cellular death in cultured cancer cells and similarly, to pancreatic cells to stimulate insulin release."

The most advanced research in photopharmacology, however, is vision restoration. Working with a team of ophthalmologists in Seattle, USA, Dr Sumser is confident that clinical trials could start within the next two to three years.

**Further reading**

**END**

**Abstract Reference** Moser: Optogenetic stimulation of the auditory pathway
Sumser: Photopharmacological approaches to fighting cancer and diabetes

**Workshop W02**

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**NOTES TO EDITORS**

**The 10th FENS Forum of Neuroscience**, the largest basic neuroscience meeting in Europe, organised by FENS and hosted by the Danish Society for Neuroscience will attract an estimated 6,000 international delegates. FENS mission is to advance research and education in neuroscience within and outside Europe, to facilitate interaction and coordination between its members. FENS represents 43 national and single discipline neuroscience societies with about 24,000 member scientists from 33 European countries. http://www.fens.org/

**Further Reading**

Restoring Light Sensitivity in Blind Retinae using Photochromic AMPA Receptor Agonist. Laprell L, Sumser MP *ACS Chemical Neuroscience* October 23 2015 7, 15-20