Neuronal circuit-based medicine

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Dysfunction of the visual system, leading to visual handicap or blindness, is critical in humans. Blindness has a drastic effect on day-to-day life but, unfortunately, sight-restoring therapy for the visually impaired and blind is still a major unmet medical need. To find ways to repair visual dysfunction, Botond Roska and his co-workers investigate the retina, thalamus and cortex at the level of cell types and circuits. The knowledge they are acquiring has already improved our understanding of disease mechanisms and opened paths to potential treatments. Roska's research group has illustrated how cell types in the visual system interact in local and long-range circuits and extract features from the visual scene. Combining this knowledge with human genetics and molecular techniques, they have provided insights into the mechanisms of cell type-specific genetic diseases. Bringing their knowledge of visual circuits together with technologies such as optogenetics, they have designed novel therapies for restoring vision in genetic forms of blindness. The essence of these optogenetic therapies is to deliver genetically encoded light sensors to strategically important retinal cell types in the blind retina. Once there, non-photoreceptor cells are converted into photosensors or the photosensitivity of native photoreceptors compromised by disease is restored. These artificial photoreceptors then drive vision. Botond Roska's work illustrates how insights into the organization of the cell types and circuits of the nervous system, when combined with cellular engineering, could be used to design new therapies to fight blindness.

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