Encoding Visual Information in Retinal Ganglion Cells with Prosthetic Stimulation.
Freeman, DK, Rizzo, JF, Fried, SI. (2011).

Retinal prostheses aim to restore functional vision to those blinded by outer retinal diseases using electric stimulation of surviving retinal neurons. The ability to replicate the spatiotemporal pattern of ganglion cell spike trains present under normal viewing conditions is presumably an important factor for restoring high-quality vision. In order to replicate such activity with a retinal prosthesis, it is important to consider both how visual information is encoded in ganglion cell spike trains, and how retinal neurons respond to electric stimulation. The goal of the current review is to bring together these two concepts in order to guide the development of more effective stimulation strategies. We review the experiments to date that have studied how retinal neurons respond to electric stimulation and discuss these findings in the context of known retinal signaling strategies. The results from such in vitro studies reveal the advantages and disadvantages of activating the ganglion cell directly with the electric stimulus (direct activation) as compared to activation of neurons that are presynaptic to the ganglion cell (indirect activation). While direct activation allows high temporal but low spatial resolution, indirect activation yields improved spatial resolution but poor temporal resolution. Finally, we use knowledge gained from in vitro experiments to infer the patterns of elicited activity in ongoing human trials, providing insights into some of the factors limiting the quality of prosthetic vision.