Mammals sense light with three ocular photoreceptors: rods, cones, and intrinsically photosensitive retinal ganglion cells (ipRGCs). Rods and cones resolve details in the visual scene and are tuned to wavelength. Conversely, ipRGCs integrate light over time and space, primarily to support 'non-image' vision. The mechanisms of integration by ipRGCs are enigmatic, particularly since these cells use a phototransduction motif that allows invertebrates like Drosophila to parse light with exceptional temporal resolution.

Here, we provide electrophysiological evidence for a single mechanism that allows murine ipRGCs to integrate light over time as well as wavelength. In essence, light distributes the visual pigment, melanopsin, across three states. Two states are silent while one is signalling. Interconversion from signalling to silent states maintains pigment availability for continuous signalling during illumination, thermal stability of the signalling state permits temporal summation over minutes, and spectral separation of the silent states promotes uniformity of activation across visible wavelengths. By enabling a broader tuning of ipRGCs in both chromatic and temporal domains, melanopsin tristability produces signal integration for development, physiology, and behavior.