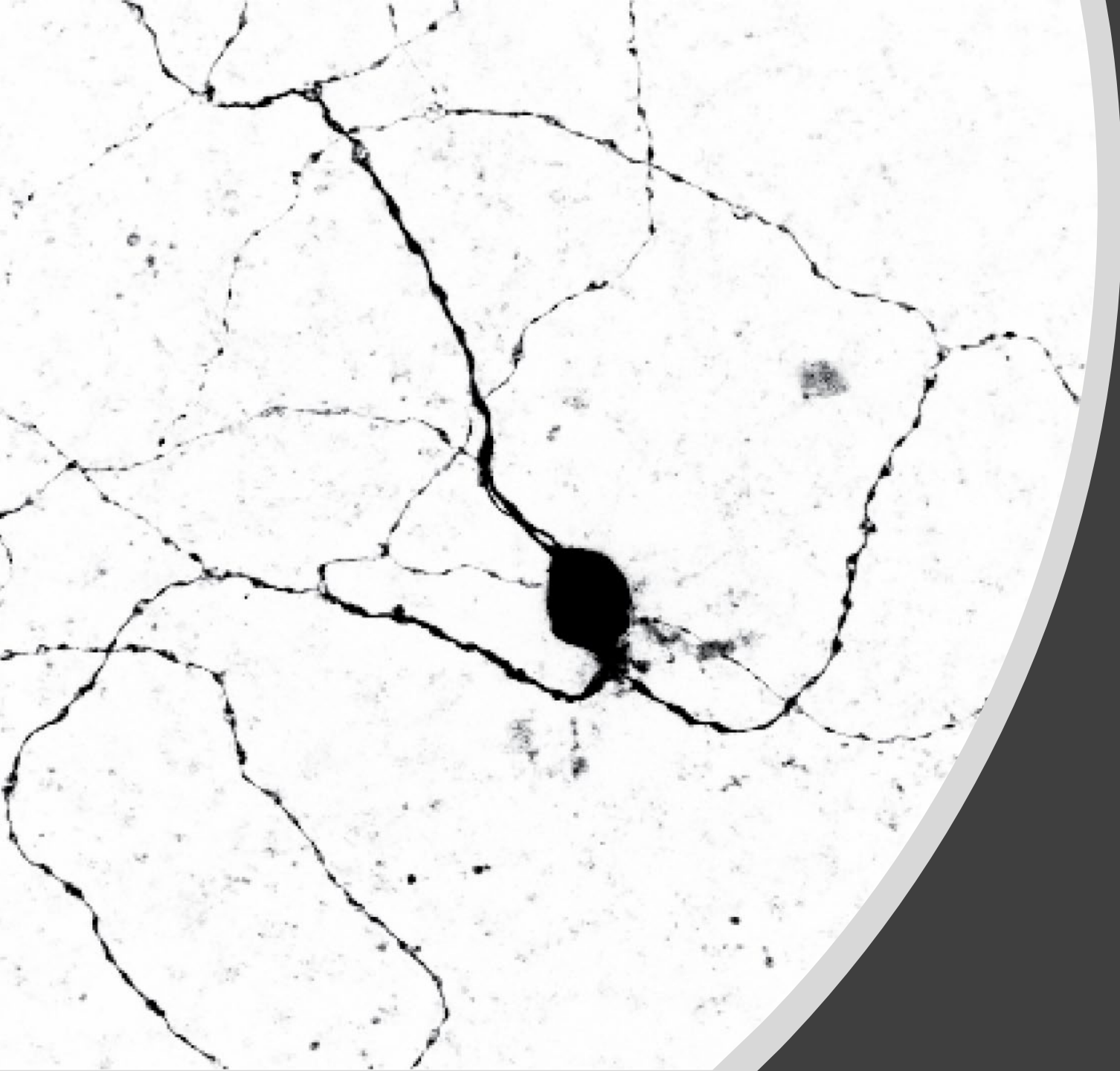




Influence of light on sleep and health

Tiffany M. Schmidt

Department of Neurobiology

Northwestern University

*No Conflicts to Disclose

Light impacts everything (and most impacts are subconscious)

Image Forming Vision

Perception of the
Visual Scene



Light impacts everything (and most impacts are subconscious)

Image Forming Vision
Perception of the
Visual Scene



Non-Image Forming Impacts of Light

Sleep/Circadian Photoentrainment



Light impacts everything (and most impacts are subconscious)

Image Forming Vision
Perception of the
Visual Scene



Non-Image Forming Impacts of Light

Sleep/Circadian Photoentrainment



Alertness



Light impacts everything (and most impacts are subconscious)

Image Forming Vision
Perception of the
Visual Scene



Non-Image Forming Impacts of Light

Sleep/Circadian Photoentrainment



Alertness



Learning



Light impacts everything (and most impacts are subconscious)

Image Forming Vision
Perception of the
Visual Scene



Non-Image Forming Impacts of Light

Sleep/Circadian Photoentrainment



Alertness



Learning



Mood/Mental Health



Light impacts everything (and most impacts are subconscious)

Image Forming Vision
Perception of the
Visual Scene



Non-Image Forming Impacts of Light

Sleep/Circadian Photoentrainment



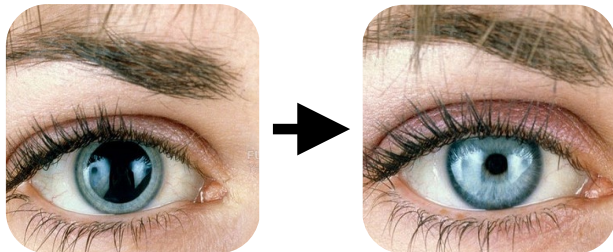
Alertness



Learning



Pupillary Light Reflex



Mood/Mental Health



Light at the wrong
time of day has
major impacts on
sleep and mental
and physical health



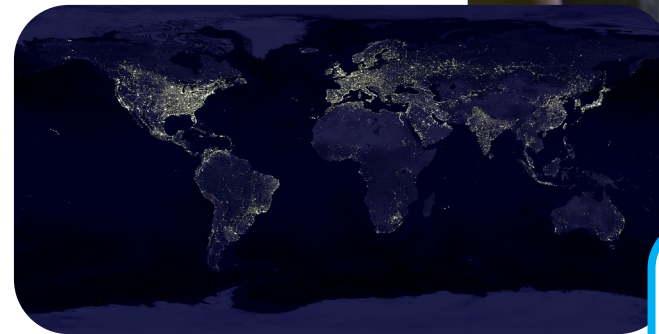
The lighting environment has evolved, and so have our schedules

“Then”

Now



Expensive and/or
labor intensive
Relatively dim
Red shifted



Light at Night



Tablets and Screens

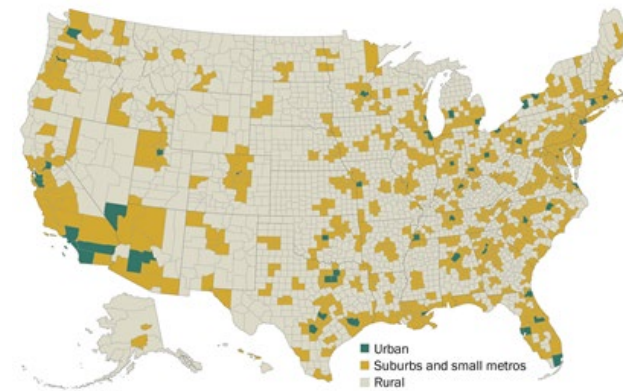
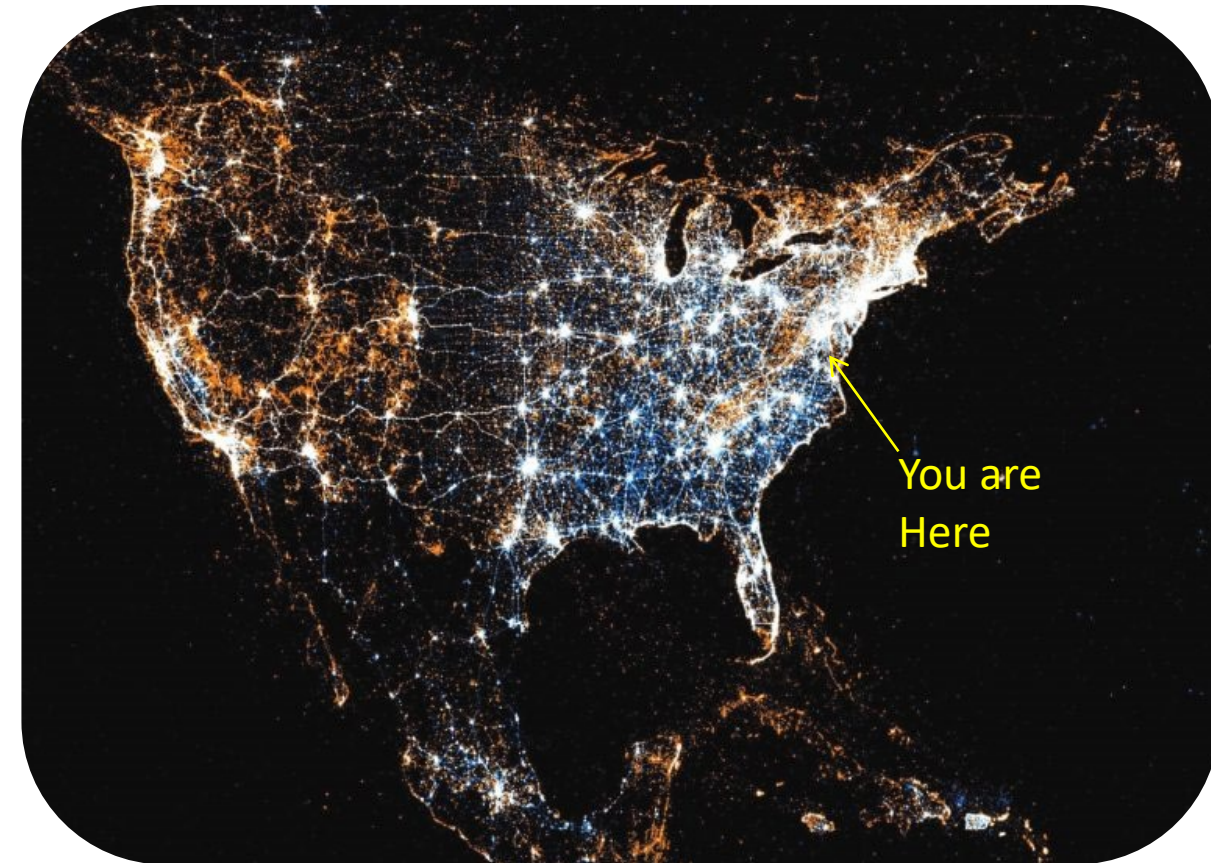
Relatively cheap
Ubiquitous
Bright
Often blue shifted

Shift Work
(~25% of population)

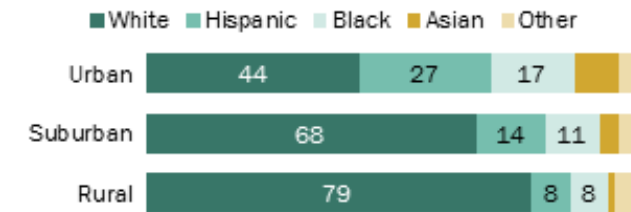


Getty Images
Lawson et al., 2021,
CDC NIOSH Science Blog

Racial and socioeconomic disparities in exposure to light at night and health outcomes



Source: Pew Research Center analysis of National Center for Health Statistics Urban-Rural Classification Scheme for Counties.
"What Unites and Divides Urban, Suburban and Rural Communities"
PEW RESEARCH CENTER



Note: Racial groups include only non-Hispanics. Hispanics are of any race. Asians include Pacific Islanders. County categories based on the National Center for Health Statistics Urban-Rural Classification Scheme for Counties.

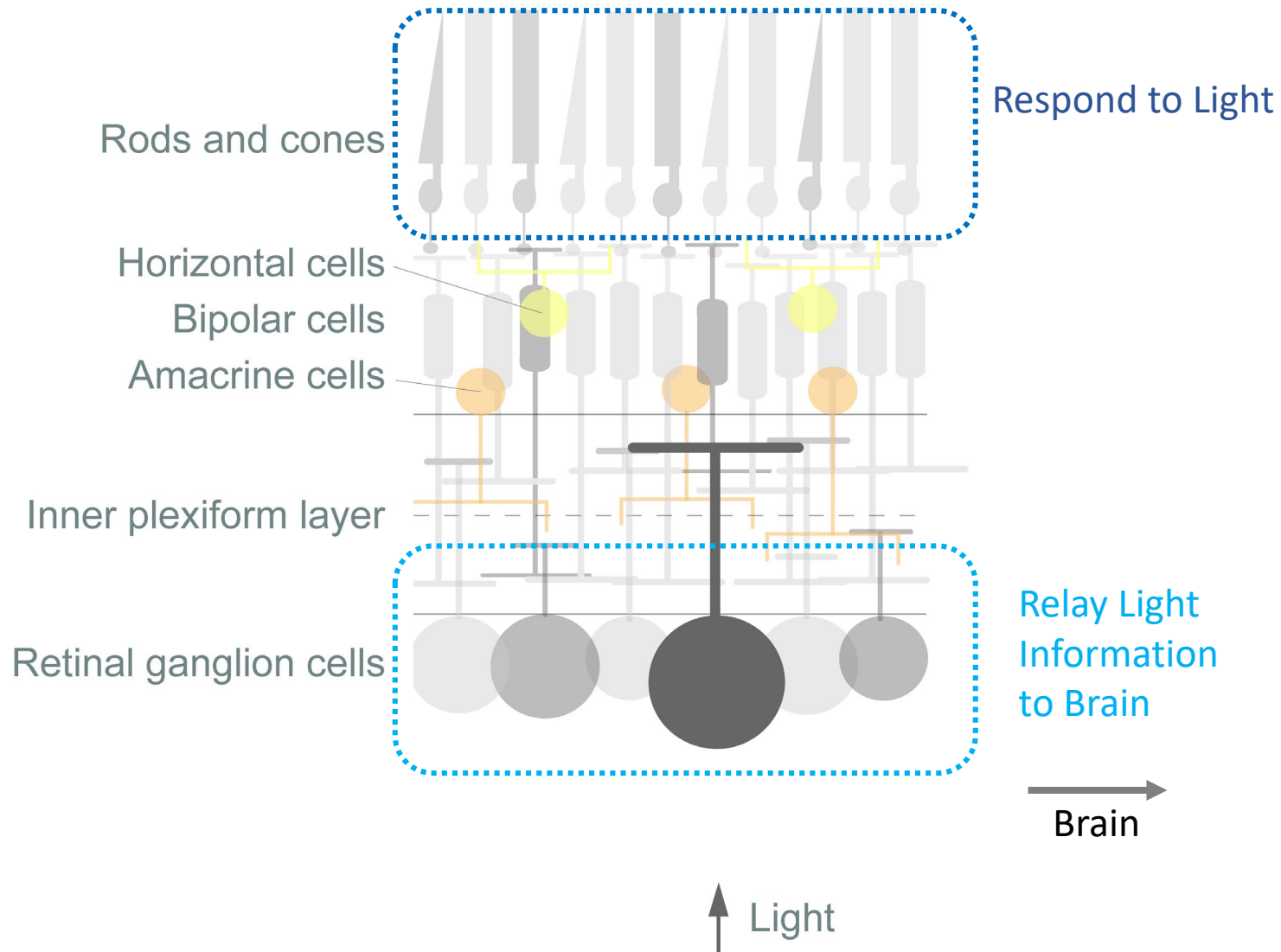
Source: Pew Research Center analysis of 2012-2016 American Community Survey data.

"What Unites and Divides Urban, Suburban and Rural Communities"

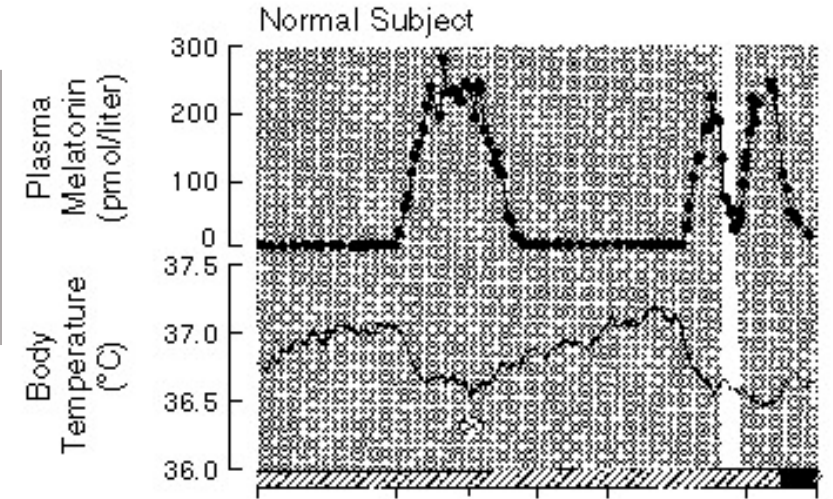
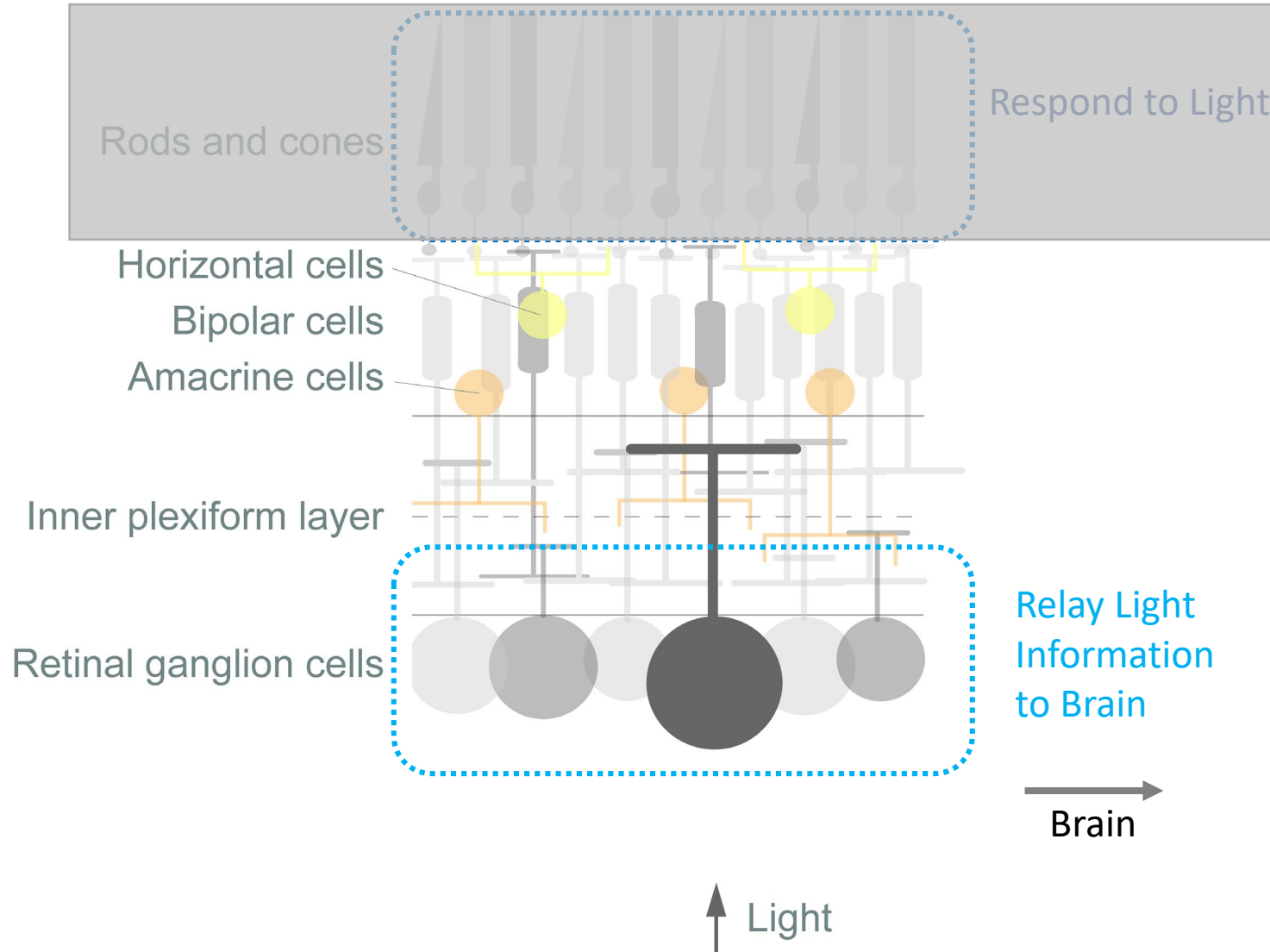
PEW RESEARCH CENTER

- Low SES individuals are more likely to be shift workers
- Hispanic and Black individuals are more likely to be shift workers
- Shift work associated with myriad sleep and health issues.

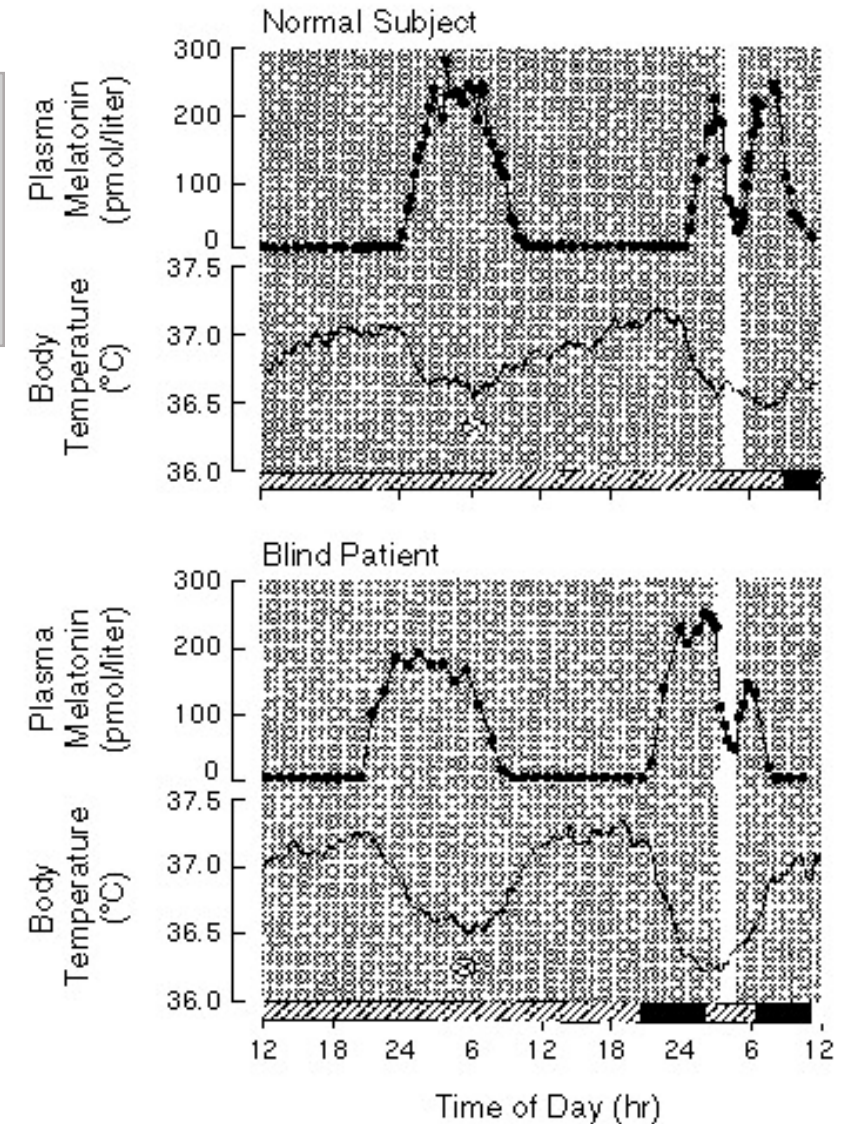
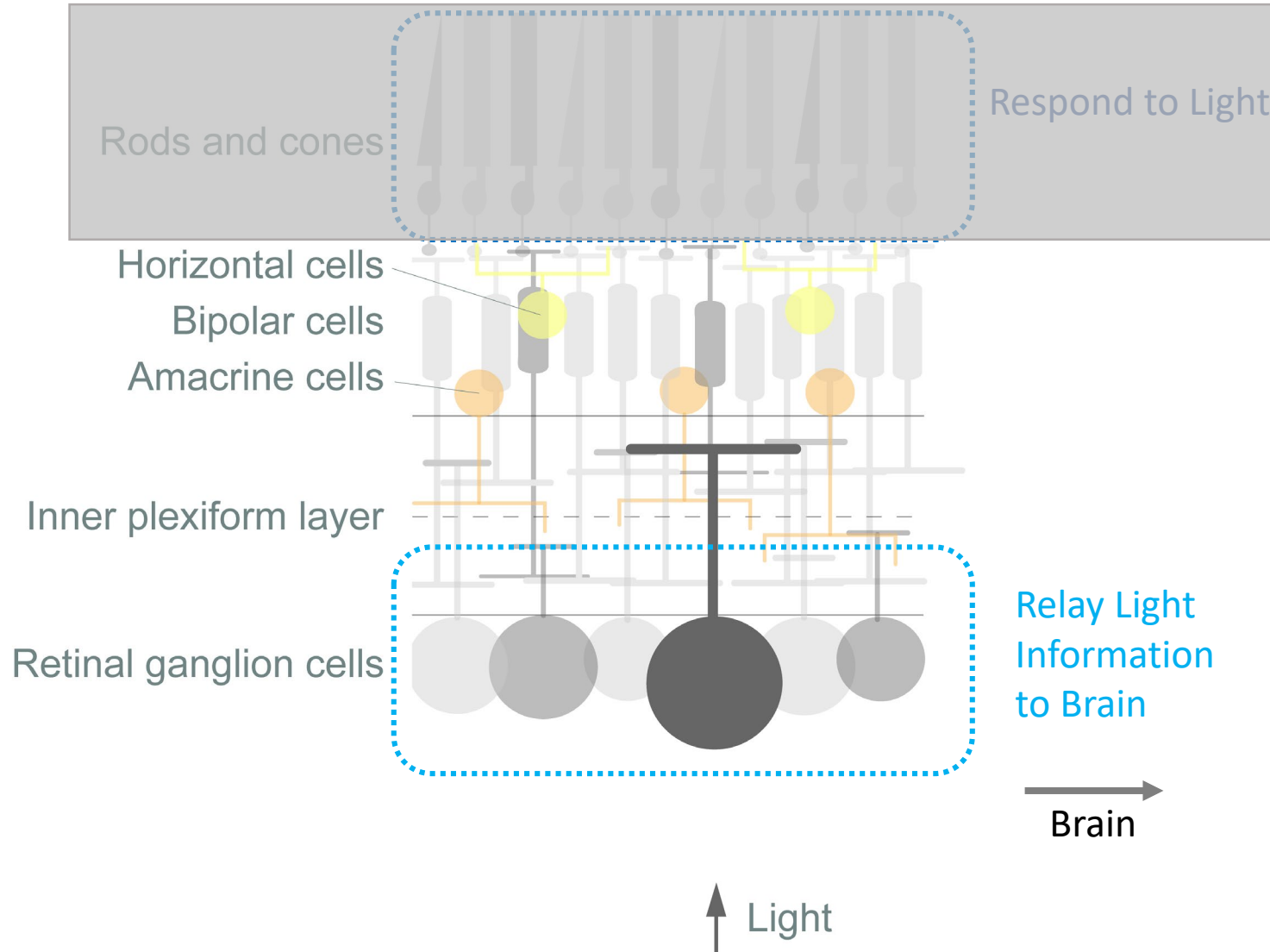
A framework for the first steps in light detection



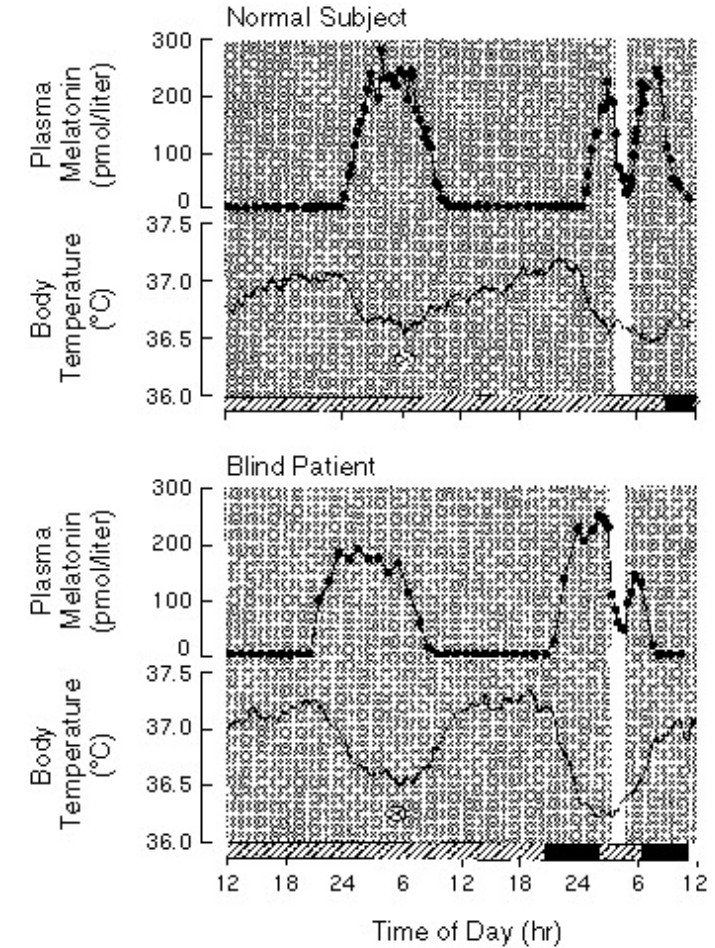
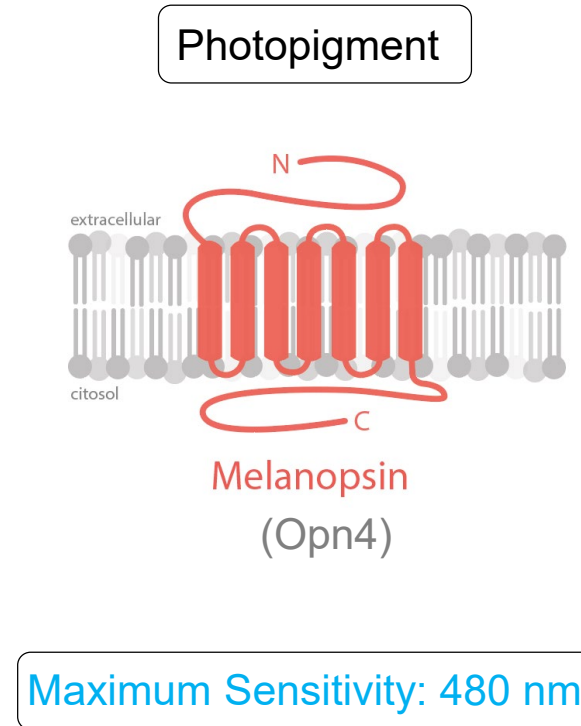
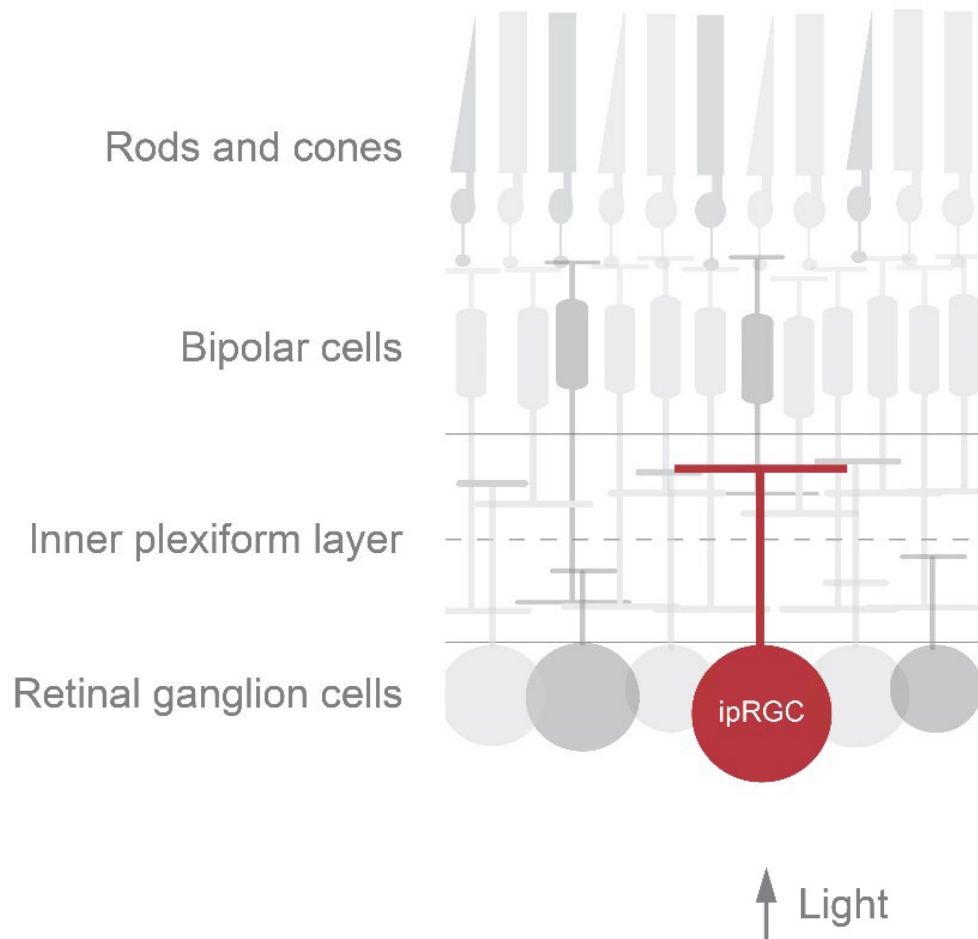
Patients lacking rod and cone photoreceptors retain non-image forming functions



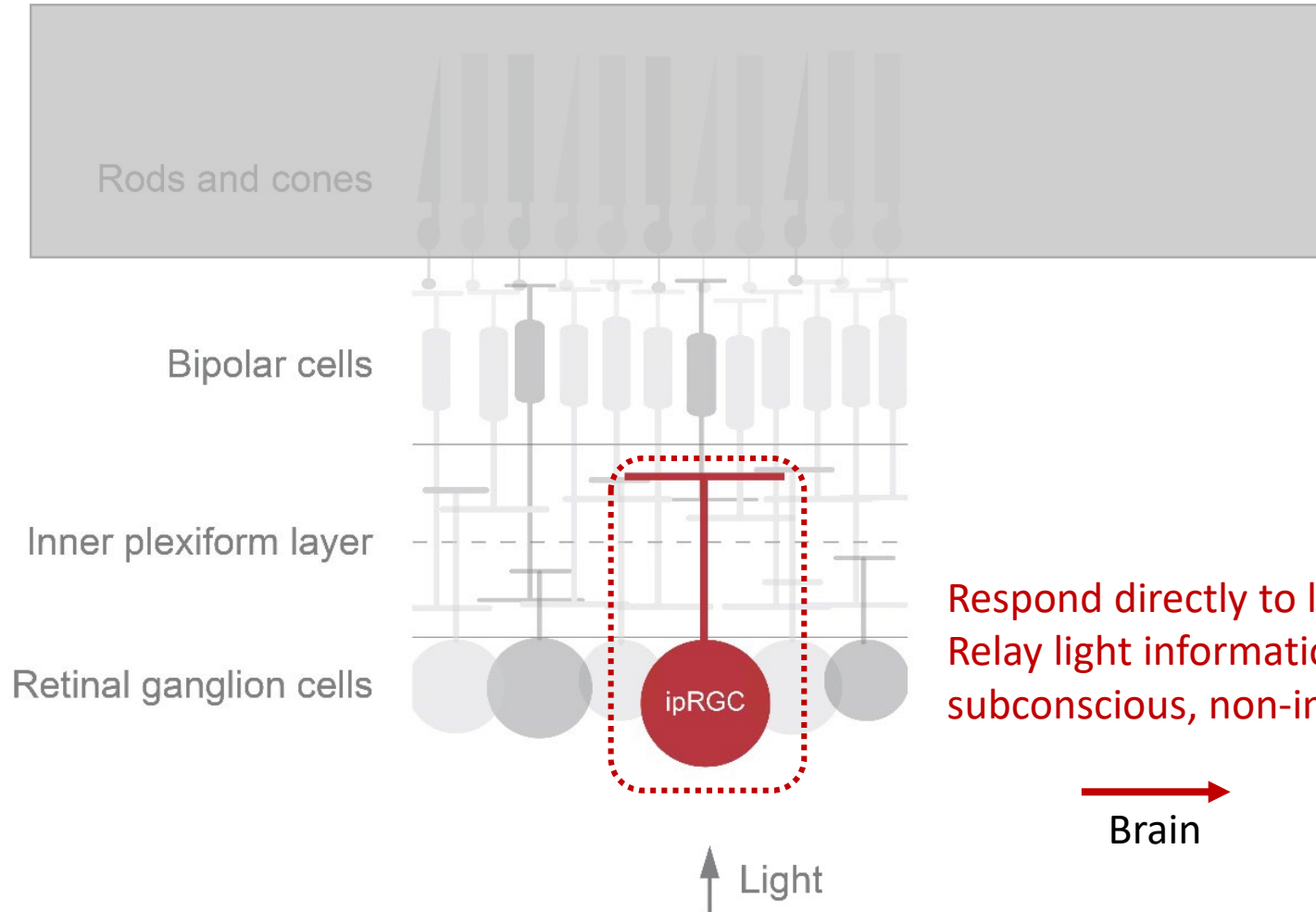
Patients lacking rod and cone photoreceptors retain non-image forming functions



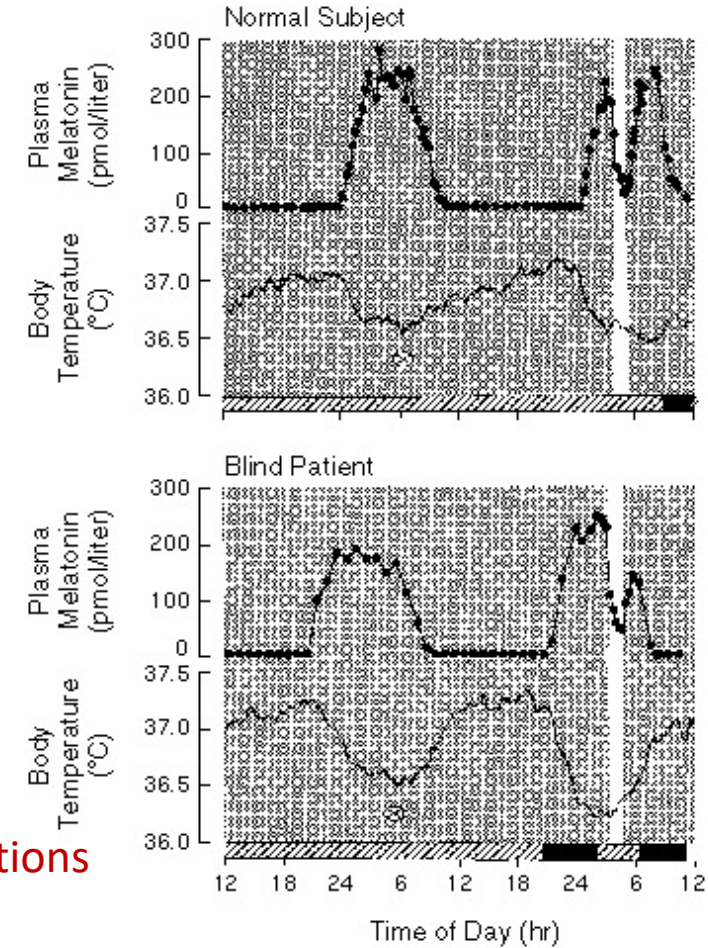
Intrinsically photosensitive retinal ganglion cells (ipRGCs)



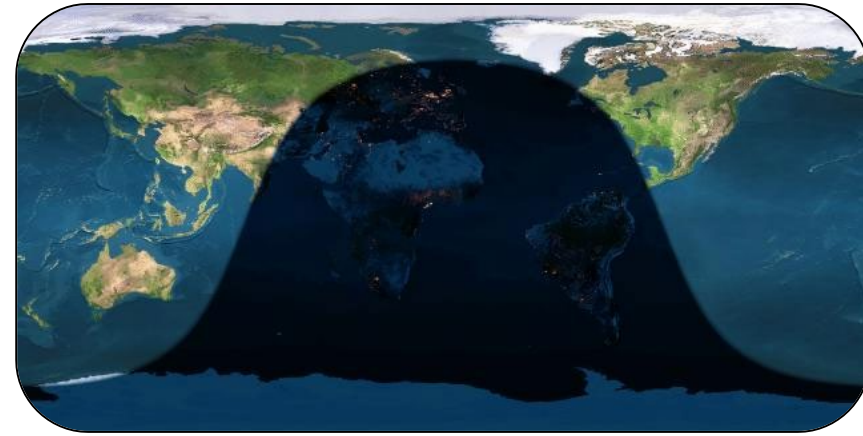
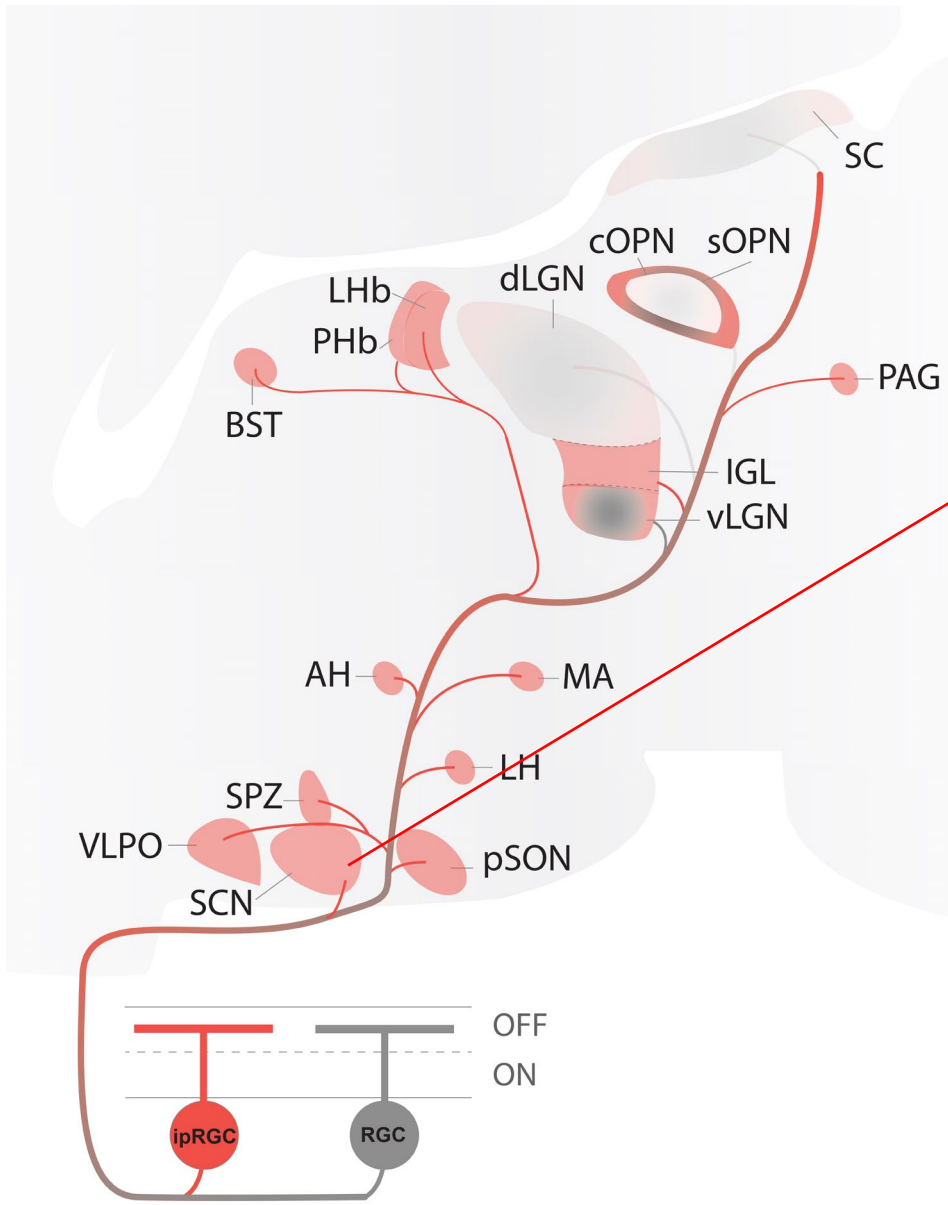
Intrinsically photosensitive retinal ganglion cells (ipRGCs)



Respond directly to light
Relay light information to brain for
subconscious, non-image forming functions

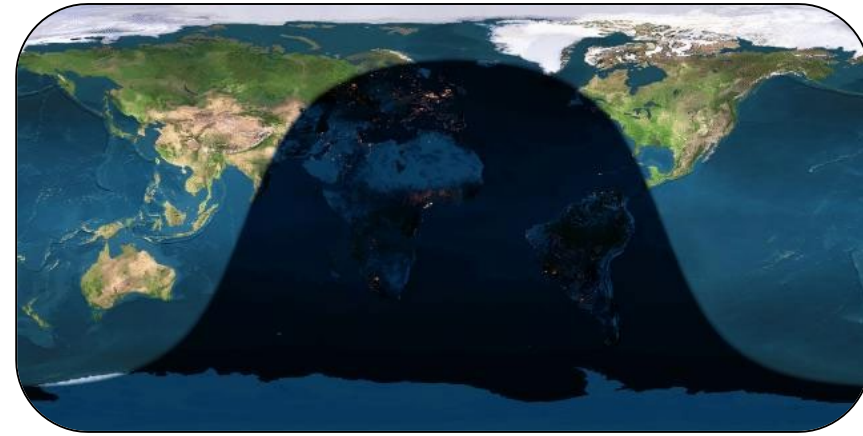
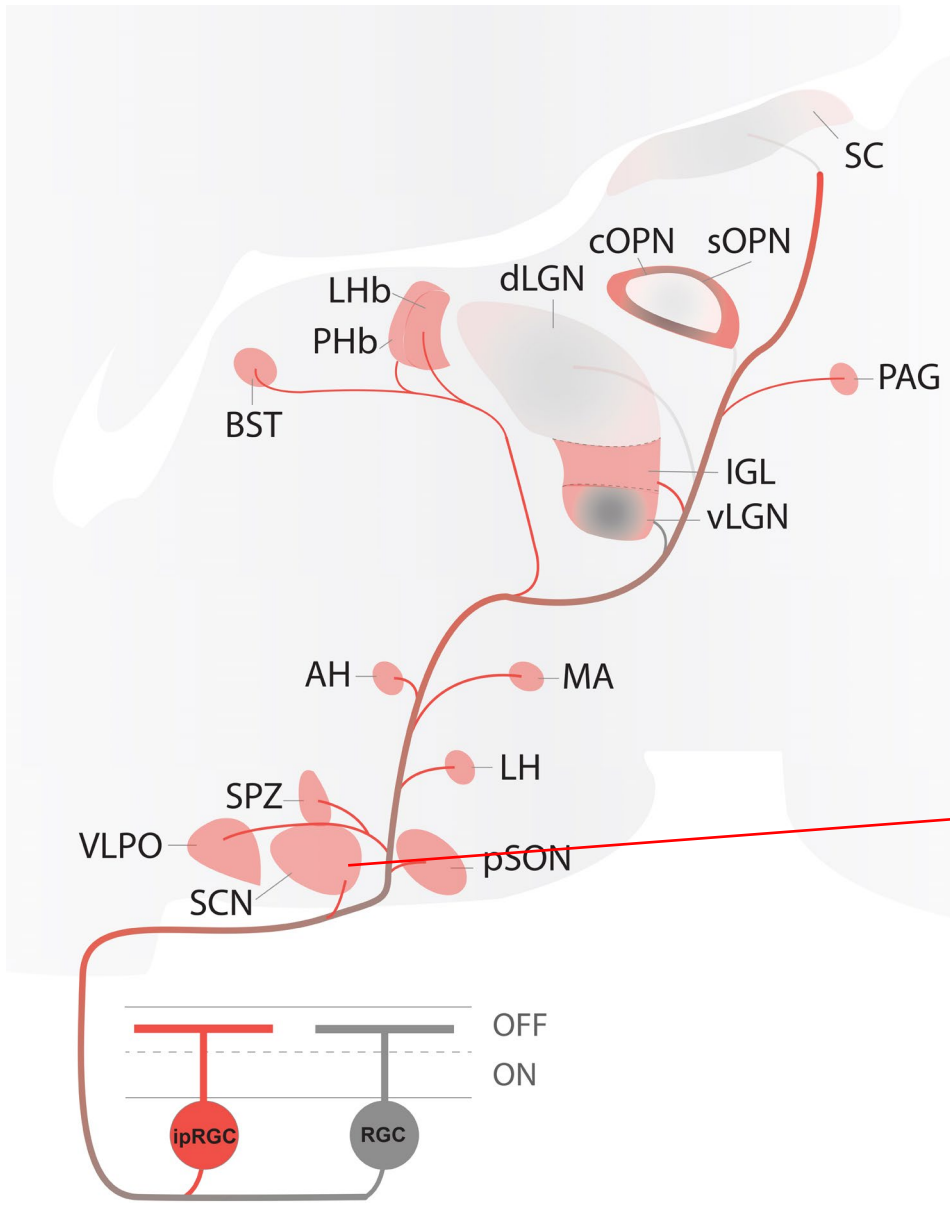


ipRGCs are required for non-image forming functions

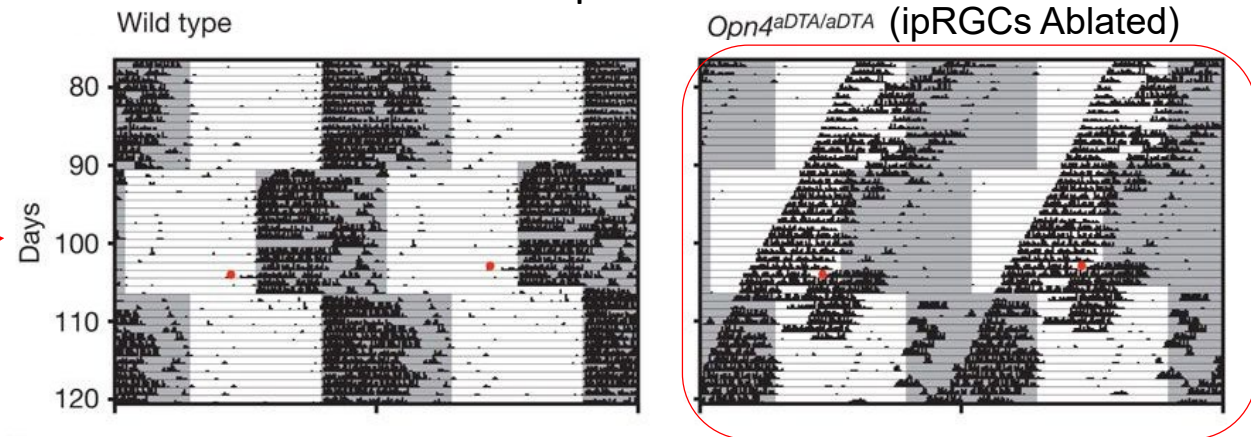


Güler et al., 2008
Hatori et al., 2008
Chew et al., 2017
...and many others

ipRGCs are required for non-image forming functions

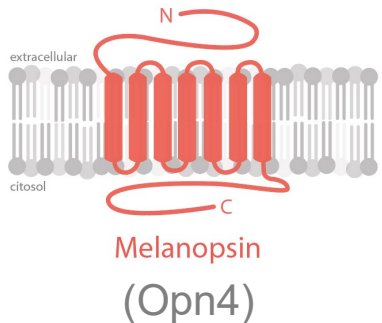
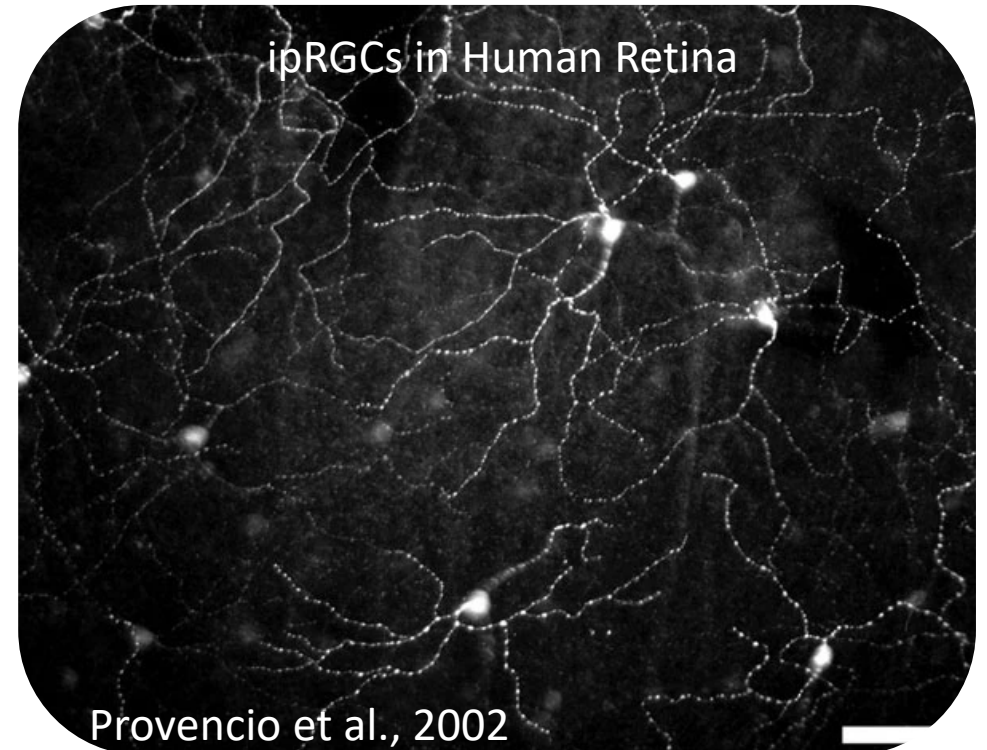
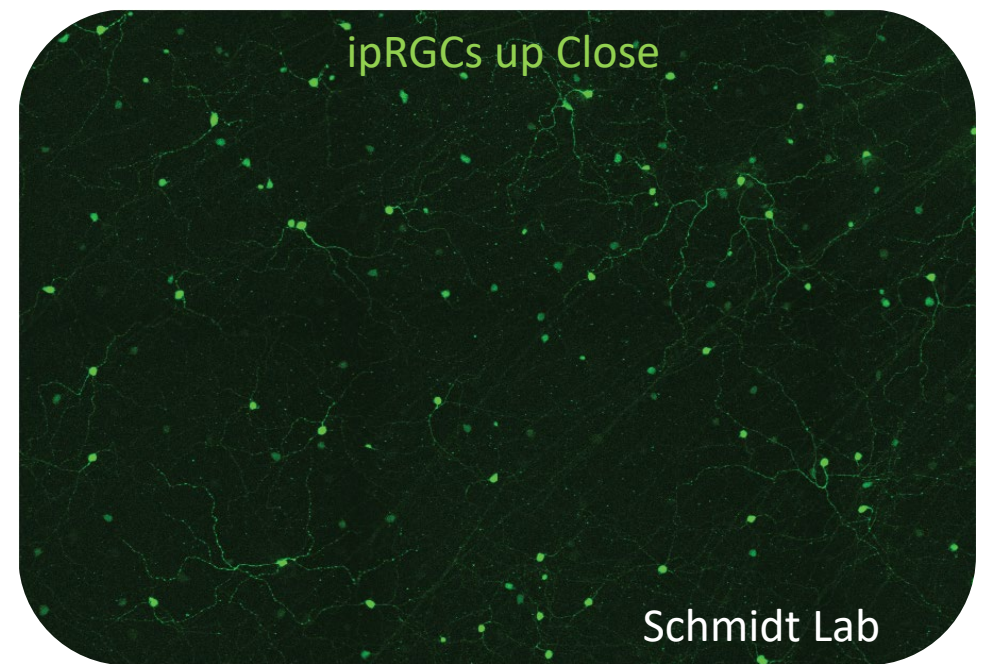
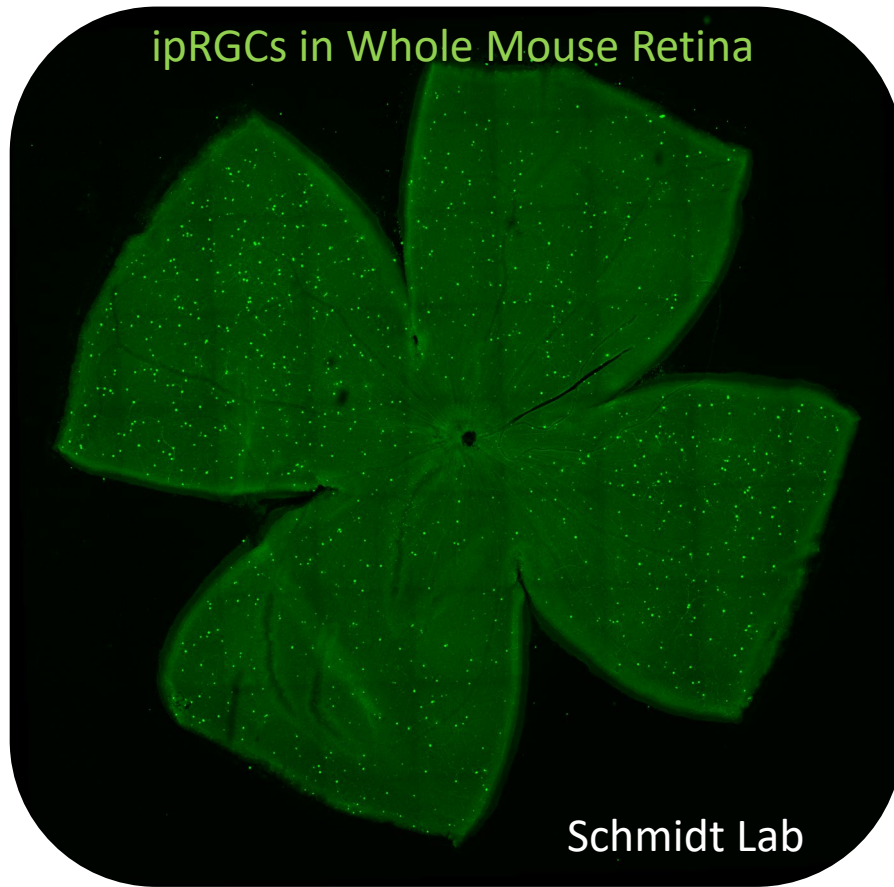


Circadian photoentrainment of activity and sleep are lost when ipRGCs are ablated



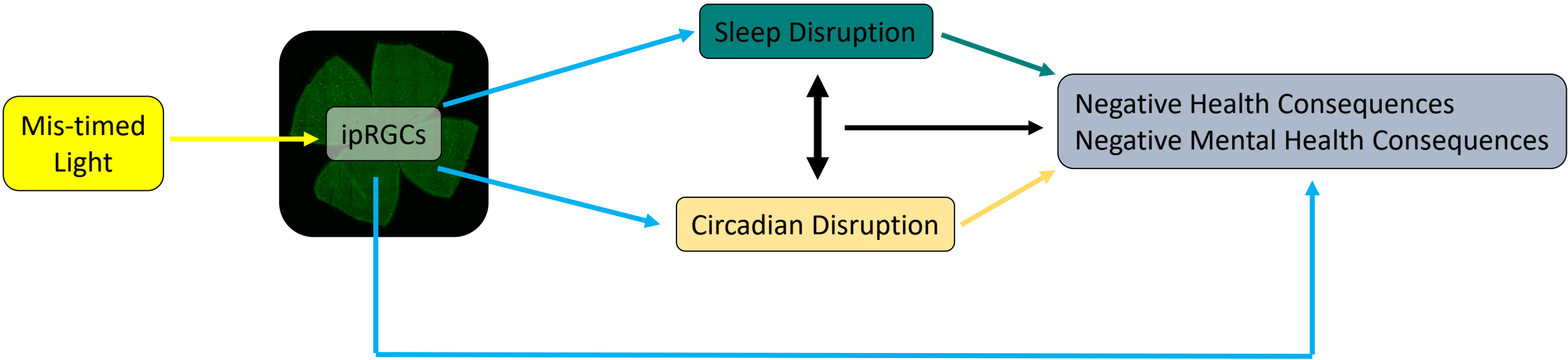
Güler et al., 2008
Hatori et al., 2008
Altimus et al., 2008
...and many others

ipRGCs are well conserved between mice and humans and are genetically tractable

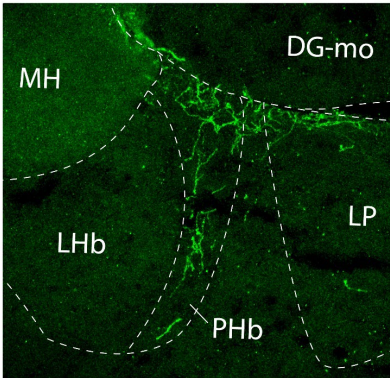


Genetic marker means we can assess cellular function, circuits, and behavior with mouse genetics and viral techniques

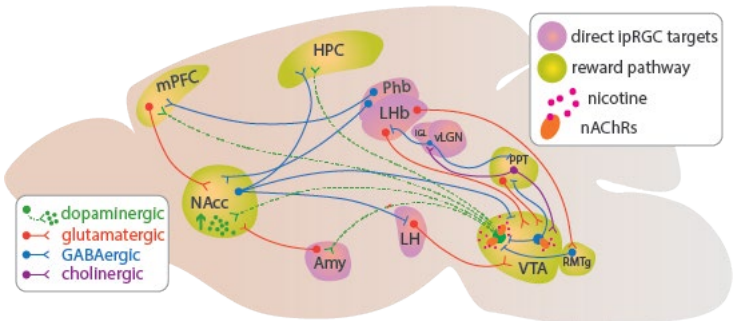
A key, approachable problem: Light's direct and indirect impacts are routed through ipRGCs in ways we still don't understand



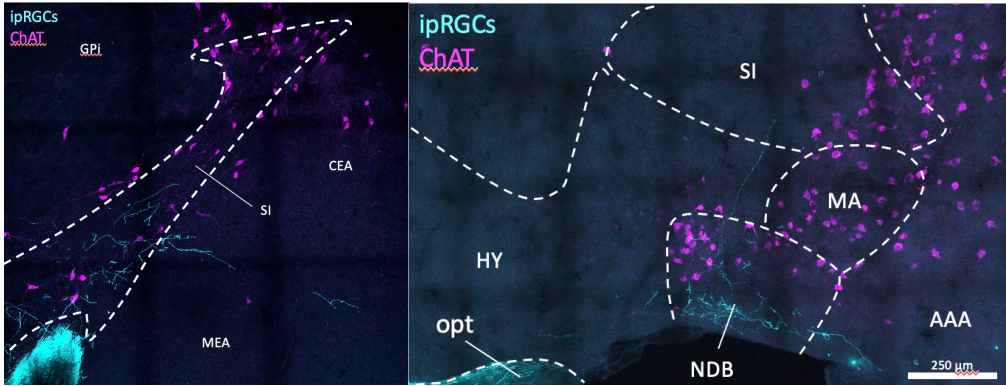
PHb
Mood, Visual Threat Anticipation



Modulation of Addiction
and Reward Pathways

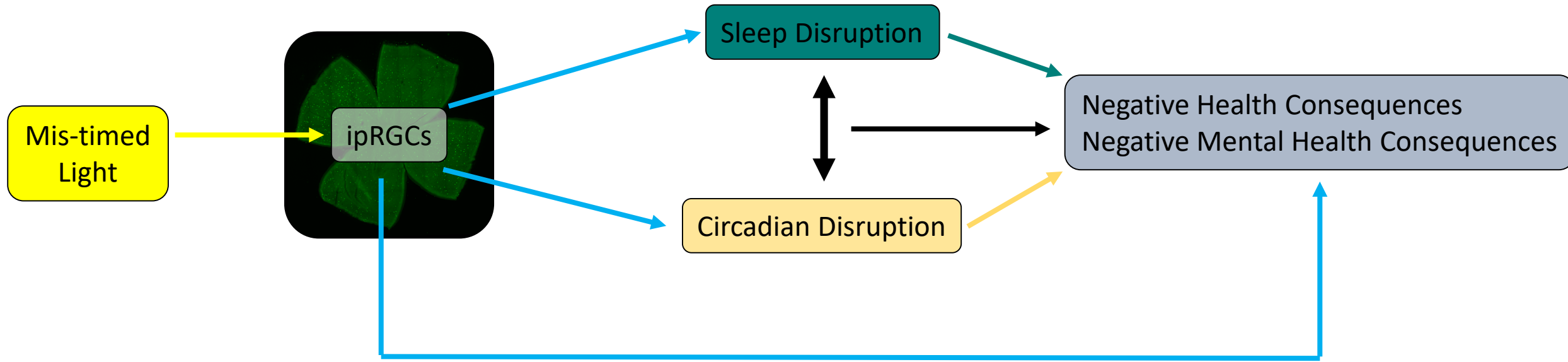


Basal Forebrain
Attention, Addiction, Aggression, and more



Images courtesy of
Dr. Marcos Aranda,
Dr. Heather Mahoney,
and Jake Bhoi

A key, approachable problem: Light's direct and indirect impacts are routed through ipRGCs in ways we still don't understand



ipRGCs are a critical node in understanding sleep and circadian disruption. Understanding their function can help us better address health issues and health disparities related to aberrant light exposure and sleep and circadian dysfunction

- What is the extent of light modulation of brain function and behavior?
- Where (and how) in the brain does this happen?
- Is this altered in patients with mental health disorders or neurodegenerative diseases?
- Do chronic mental health conditions or neurodegenerative disorders impact ipRGC function?
- How is the sleep and quality of life differentially impacted in patients with retinal and eye diseases?
- How can we optimize ipRGC function for full health benefits? Can we use this to reduce health disparities?