



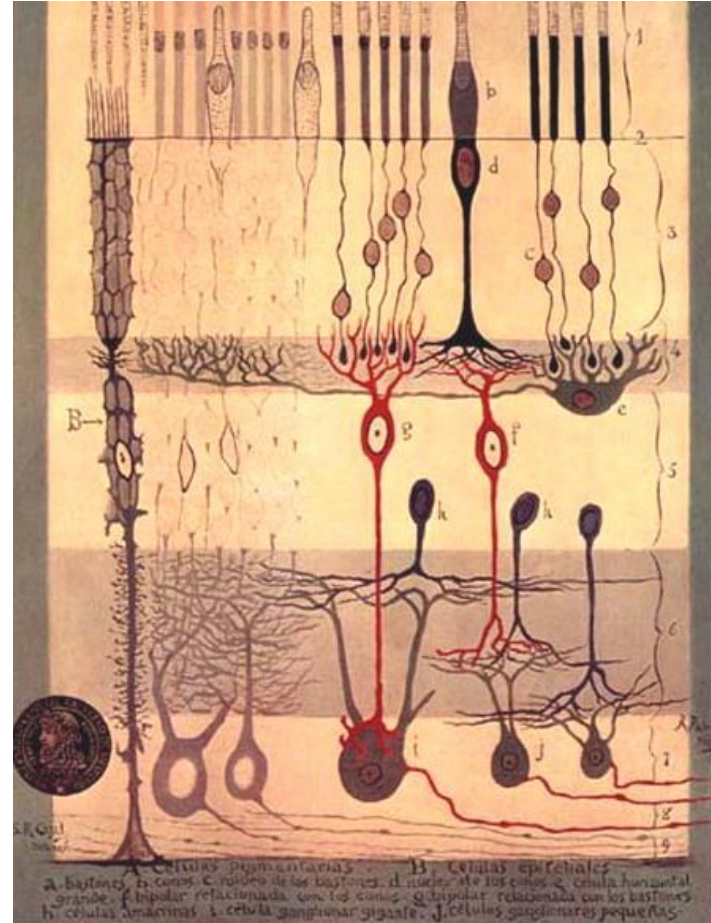
Pupillometry

and ipRGCs

3 pathways of vision

For more than 100 years,
the model of vision was based on
2 types of photoreceptors:

- rods
- cones



Cajal ~1880

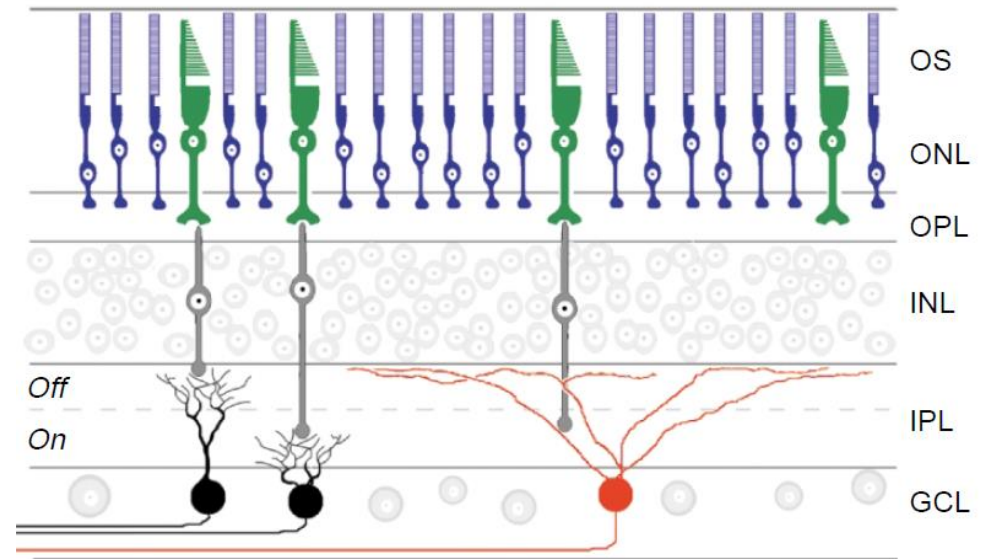
3rd pathway of vision

Recent evidence for a 3rd type of pathway :

- Visual responses found in rodents without rods and cones (Bonaventure & al, 1961)
 - Discovery of melanopsin, a novel photo pigment (Provencio & al, 1998)
 - Pigment present in some rodent ganglion cells (Berson & al, 2002)
 - Pigment present in some primate ganglion cells (Dacey & al, 2005)
- ➔ Intrinsically photosensitive retinal ganglion cells (ipRGCs)

3 pathways of vision

- Cones: green
- Rods: blue
- ipRGCs: red



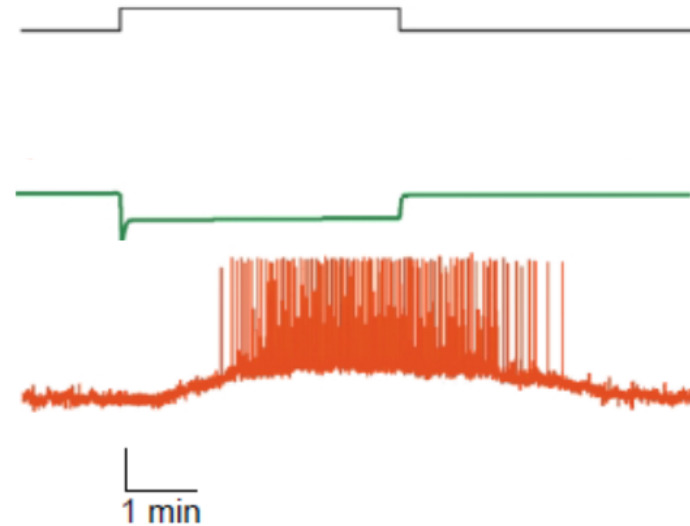
Cones and rods connect to bipolar cells

ipRGCs connect directly to the brain

Berson, 2003

3 pathways of vision

- Light stimulus
- Response from cones
- Response from ipRGCs



Cones and rods generate a fast hyperpolarization

ipRGCs generate very delayed action potentials

Adapted from Berson, 2003

3 pathways of vision

	Rods	Cones	ipRGCs
Light response	Fast hyperpolarization	Fast hyperpolarization	Slow depolarization
Photo pigment	Rhodopsin	Cone opsin	Melanopsin
Action potential	No	No	Yes
Receptive field	Very small	Very small	Very large

3 pathways of vision

nature

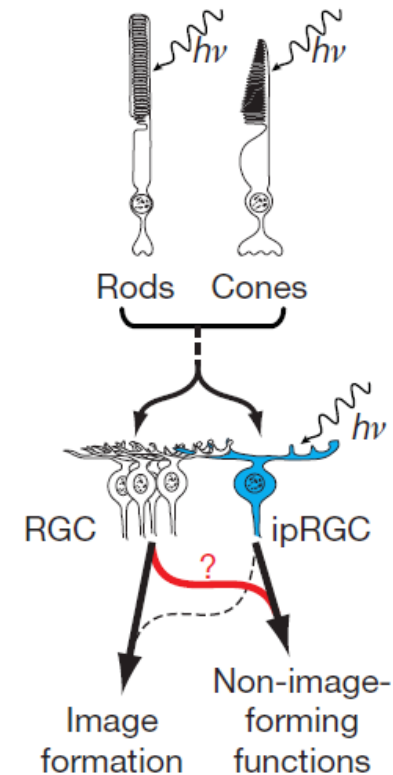
Vol 453 | 1 May 2008 | doi:10.1038/nature06829

LETTERS

Melanopsin cells are the principal conduits for rod-cone input to non-image-forming vision

Ali D. Güler^{1*}, Jennifer L. Ecker^{1*}, Gurprit S. Lall^{2*}, Shafiqul Haq³, Cara M. Altimus¹, Hsi-Wen Liao³, Alun R. Barnard², Hugh Cahill³, Tudor C. Badea⁴, Haiqing Zhao¹, Mark W. Hankins⁵, David M. Berson⁶, Robert J. Lucas², King-Wai Yau³ & Samer Hattar¹

ipRGCs not only respond directly to light but also receive input from rods and cones

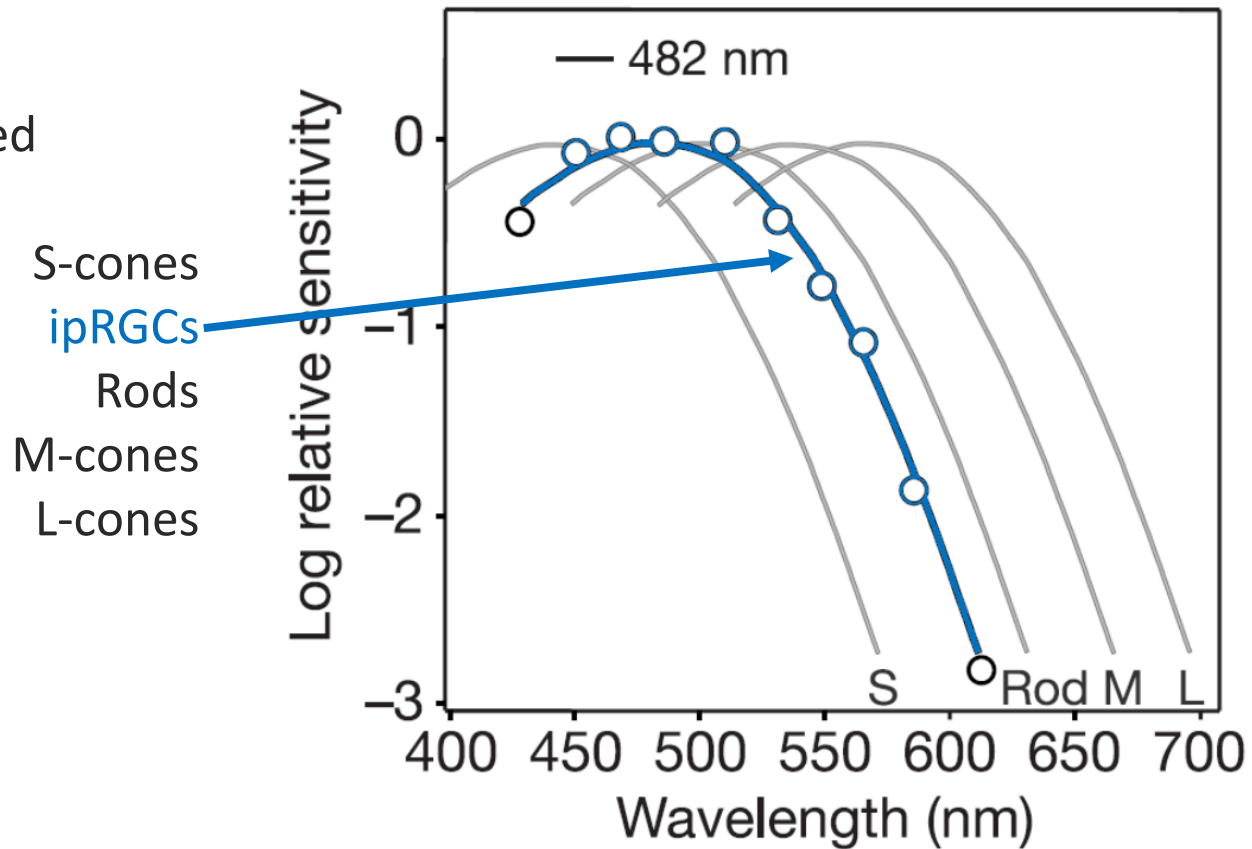


3 pathways of vision

	Rods	Cones	ipRGCs
Number	120 million	7 million	3000
Sensitivity	high	medium	low
Time response	slow	fast	Very slow
Spectral response	lower for red light	lower for blue light	Maximum for blue ~482 nm
Saturation	low	high	?
Recovery time	long	short	?

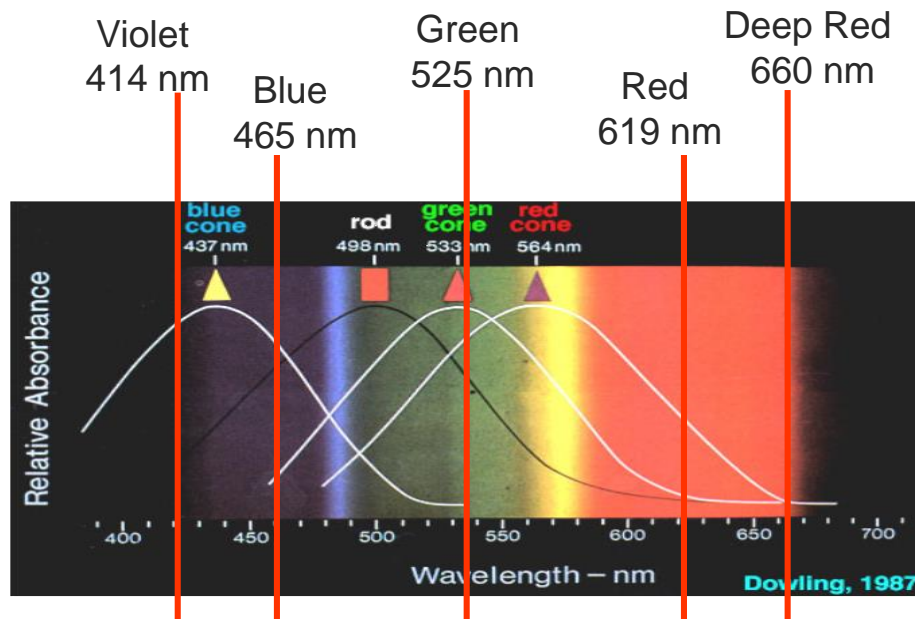
3 pathways of vision

Responsivity scaled
to best fit

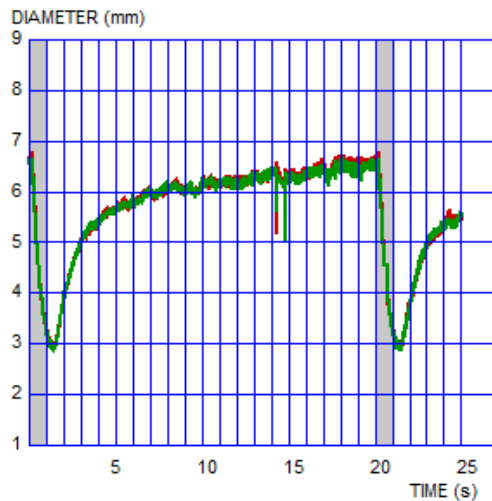


MonColor stimulator

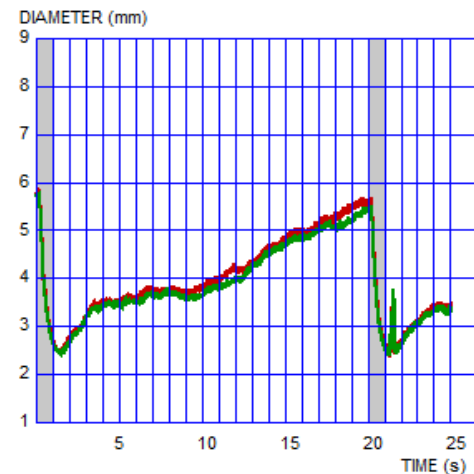
- ultra bright LEDs with 5 wavelengths for background and for flash stimulus



- post illumination pupil response (PIPR)



- response to red (619nm)



- response to blue (465nm)

- PIPR > 20 seconds to recover baseline after 1 second stimulation with blue stimulus ONLY
- PIPR is intrinsic to melanopsin-containing ipRGCs ([Gamlin et al., 2007](#)).

Clinical applications

- follow-up of patients with retinal dystrophies

Graefes Arch Clin Exp Ophthalmol
DOI 10.1007/s00417-011-1809-3

RETINAL DISORDERS

The characterization of functional disturbances in Chinese patients with Bietti's crystalline dystrophy at different fundus stages

Dan Ning Liu · Yong Liu · Xiao Hong Meng · Zheng Qin Yin

Ophthalmic
Research

Ophthalmic Res 2012;47:113–121
DOI: [10.1159/000330049](https://doi.org/10.1159/000330049)

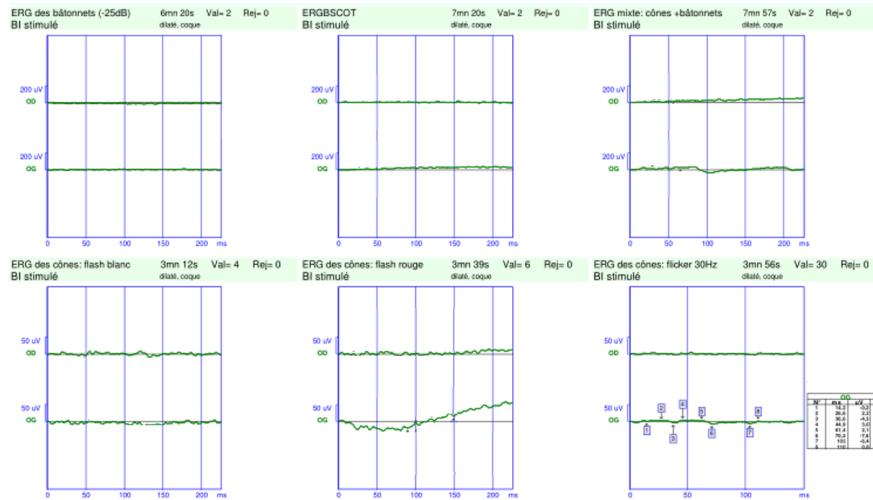
Transient Pupillary Light Reflex in Relation to Fundus Autofluorescence and Dark-Adapted Perimetry in Typical Retinitis Pigmentosa

Yong Liu Dan Ning Liu Xiao Hong Meng Zheng Qin Yin

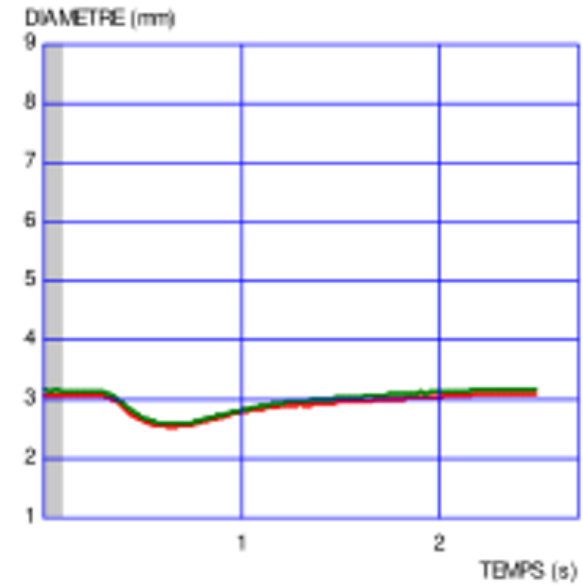
Southwest Hospital/Southwest Eye Hospital, Third Military Medical University, Chongqing, China

Clinical applications

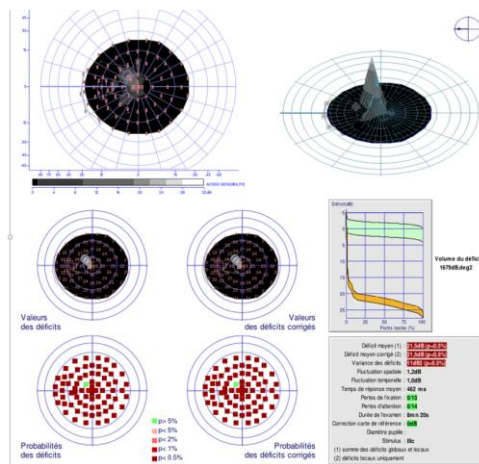
- follow-up of patients with extinguished ERG (RP)



Flat ERG except small response with 30Hz flicker



Pupillary response to white flashes



Visual field with central island of vision

Clinical applications

- glaucoma

Visual Neurophysiology

Intrinsically Photosensitive (Melanopsin) Retinal Ganglion Cell Function in Glaucoma

Beatrix Feigl,^{1,2} Dietmar Mattes,³ Ravi Thomas,² and Andrew J. Zele¹

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Int Ophthalmol
DOI 10.1007/s10792-014-9920-1

ORIGINAL PAPER

Evaluation of pupillary response to light in patients with glaucoma: a study using computerized pupillometry

Alessio Martucci · Massimo Cesareo ·
Domenico Napoli · Roberto Pietro Sorge ·
Federico Ricci · Raffaele Mancino · Carlo Nucci

Clinical applications

- sleep disorders and glaucoma

— ACTA OPHTHALMOLOGICA SCANDINAVICA 2000 —

High prevalence of sleep-disordered breathing in patients with primary open-angle glaucoma

S. Hakki Onen¹, Frédéric Mouriaux², Lotfi Berramdane²,
Jean-Claude Dascotte², Jean-François Kulik³
and Jean-François Rouland²

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Clinical applications

- seasonal disorders

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Contents lists available at [ScienceDirect](#)

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

The post illumination pupil response is reduced in seasonal affective disorder

Kathryn Roecklein^{a,*}, Patricia Wong^a, Natalie Ernecoff^a, Megan Miller^a, Shannon Donofry^a, Marissa Kamarck^a, W. Michael Wood-Vasey^b, Peter Franzen^c