Complementarity of Vision Electrophysiology and Psychophysical Tests

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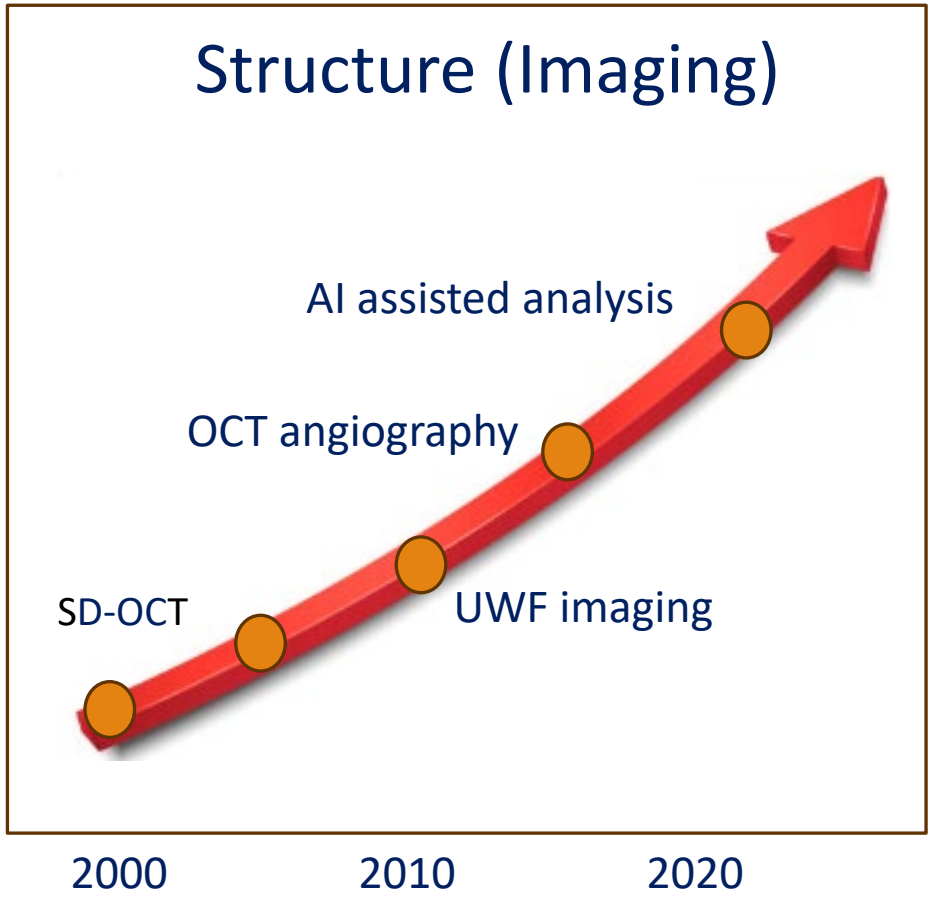
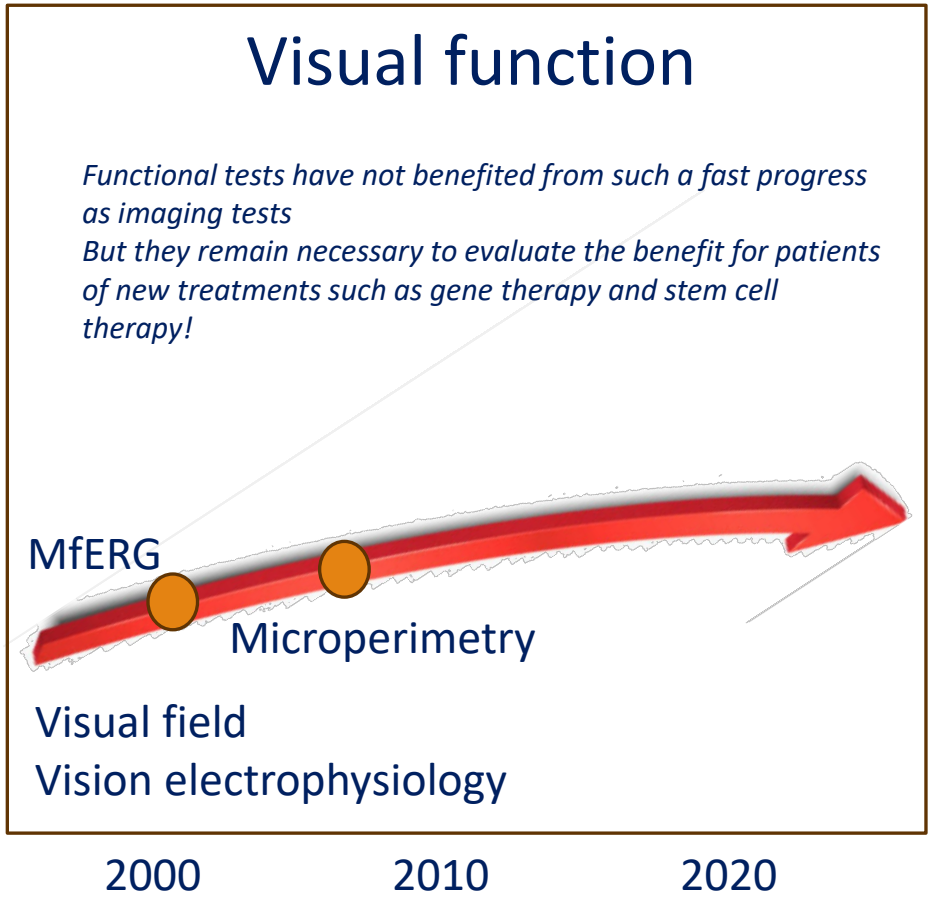
Disclosures

Lille chamber of commerce and Opera

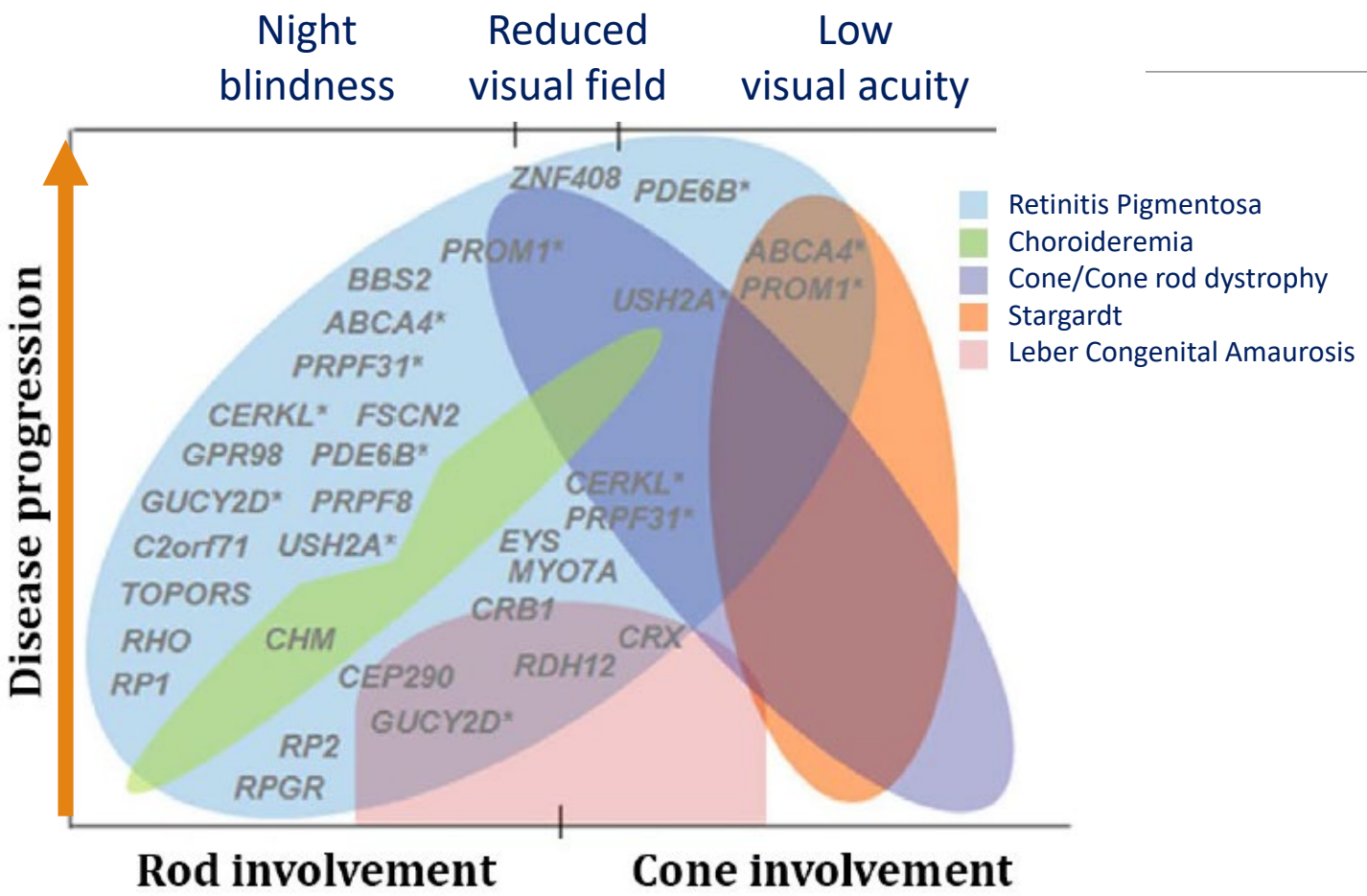
Context: inherited retinal diseases (IRD)

Progression of diagnosis technology in the ophthalmology clinics





Context: inherited retinal diseases (IRD)



Source: BRAVO-GIL & al, 2017

More than 280 different genes involved
Inhomogeneous group of diseases

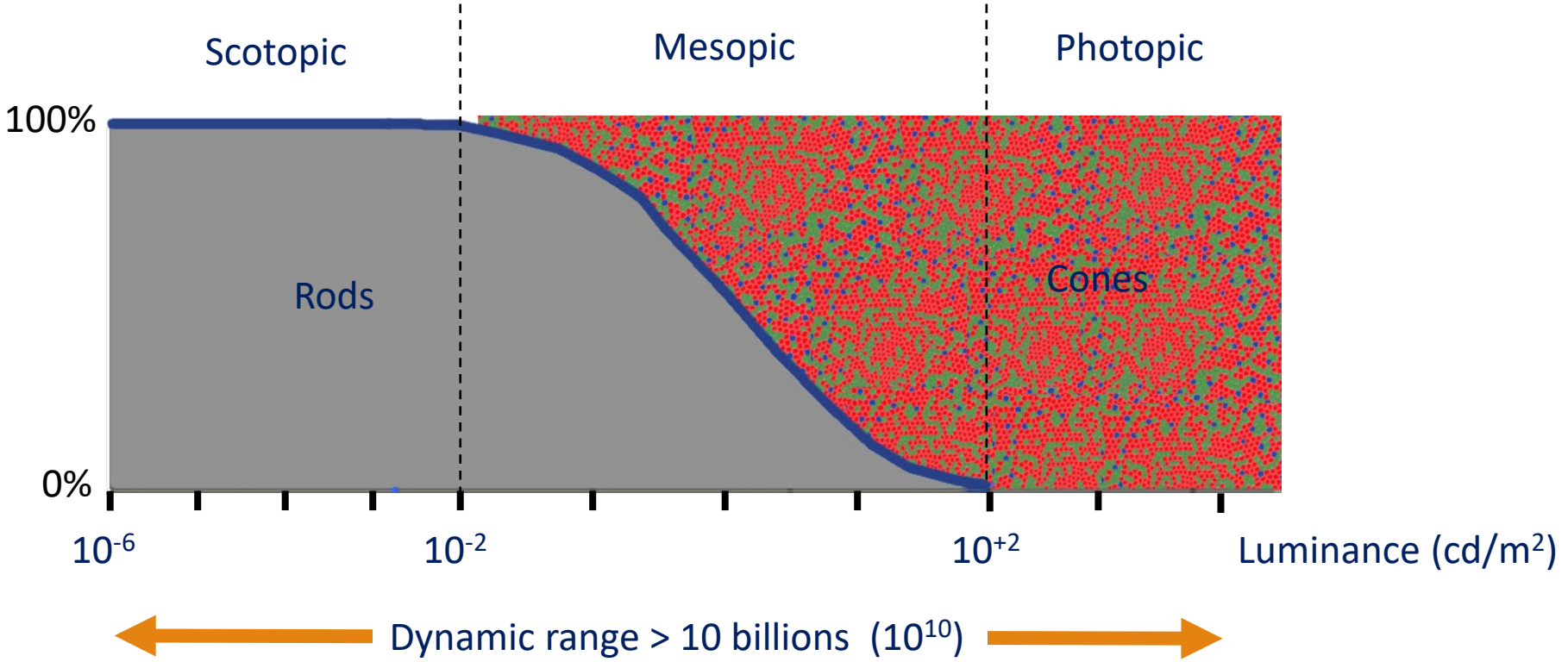
Early stage of IRDs involves frequently one class of photoreceptors:

- Rods
- L-M Cones
- S-cones

Rods and cones

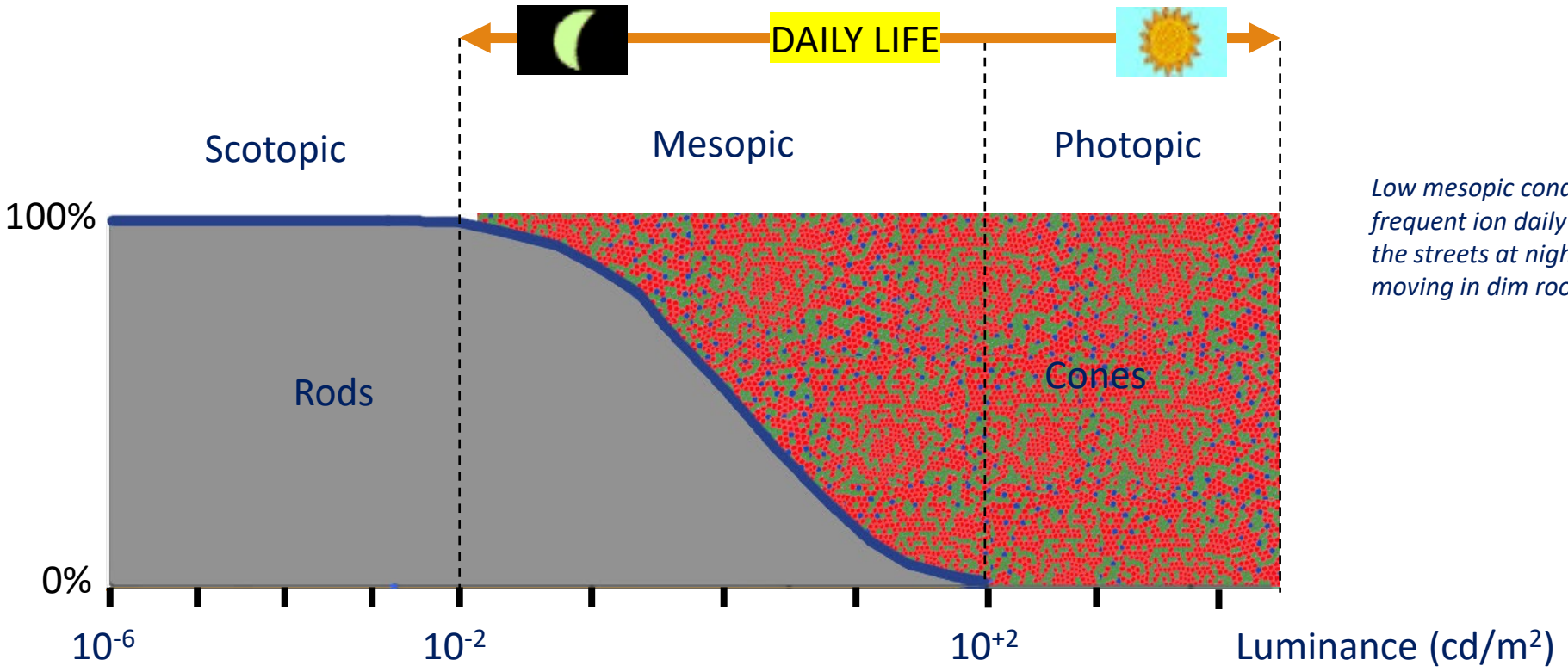
Physiological properties of photoreceptors

Take advantage of physiological properties to detect a specific class of photoreceptors
Example: rods and L-M cones



Rods and cones

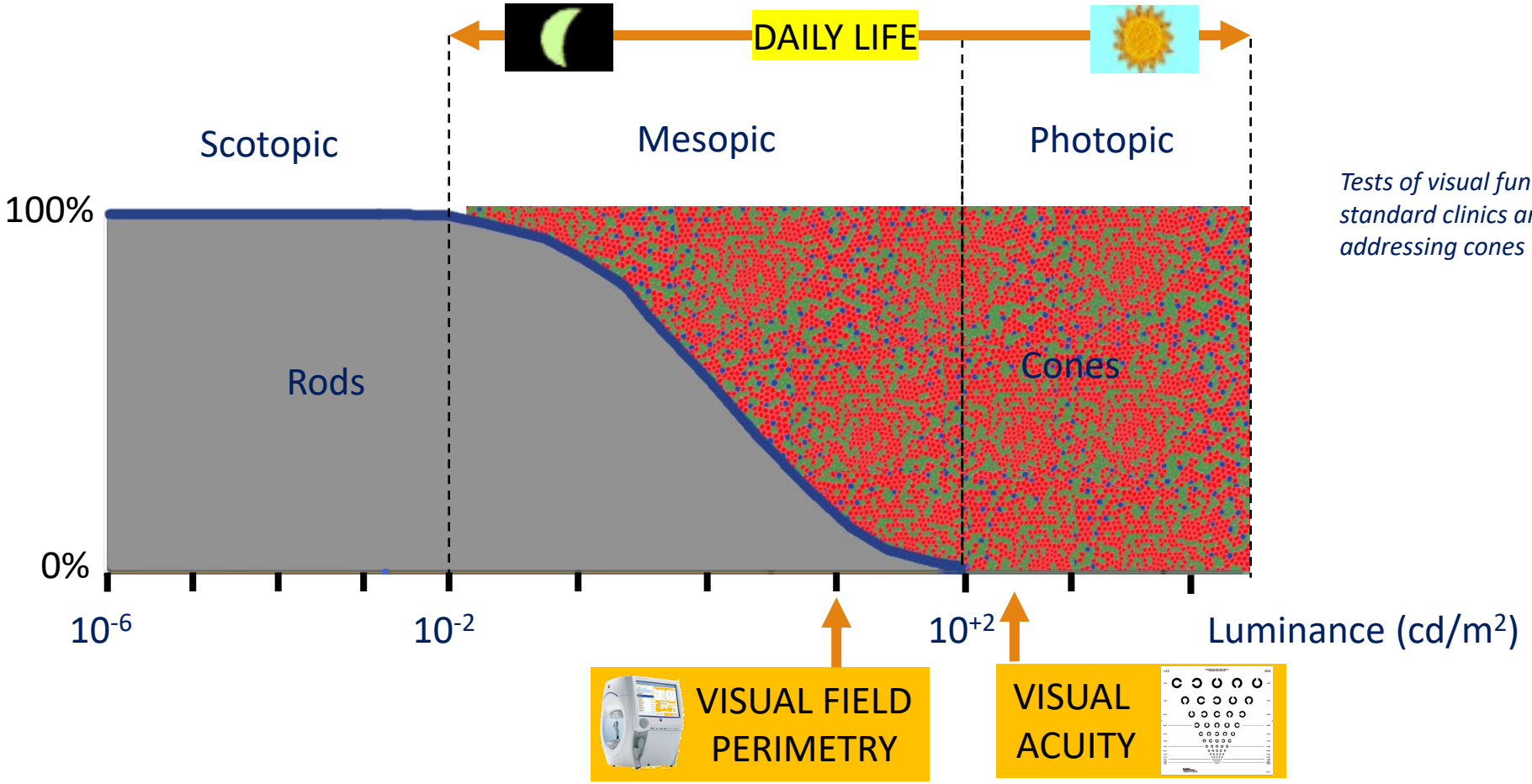
Daily life



Low mesopic conditions are very frequent ion daily life: walking in the streets at night, driving at night, moving in dim room etc

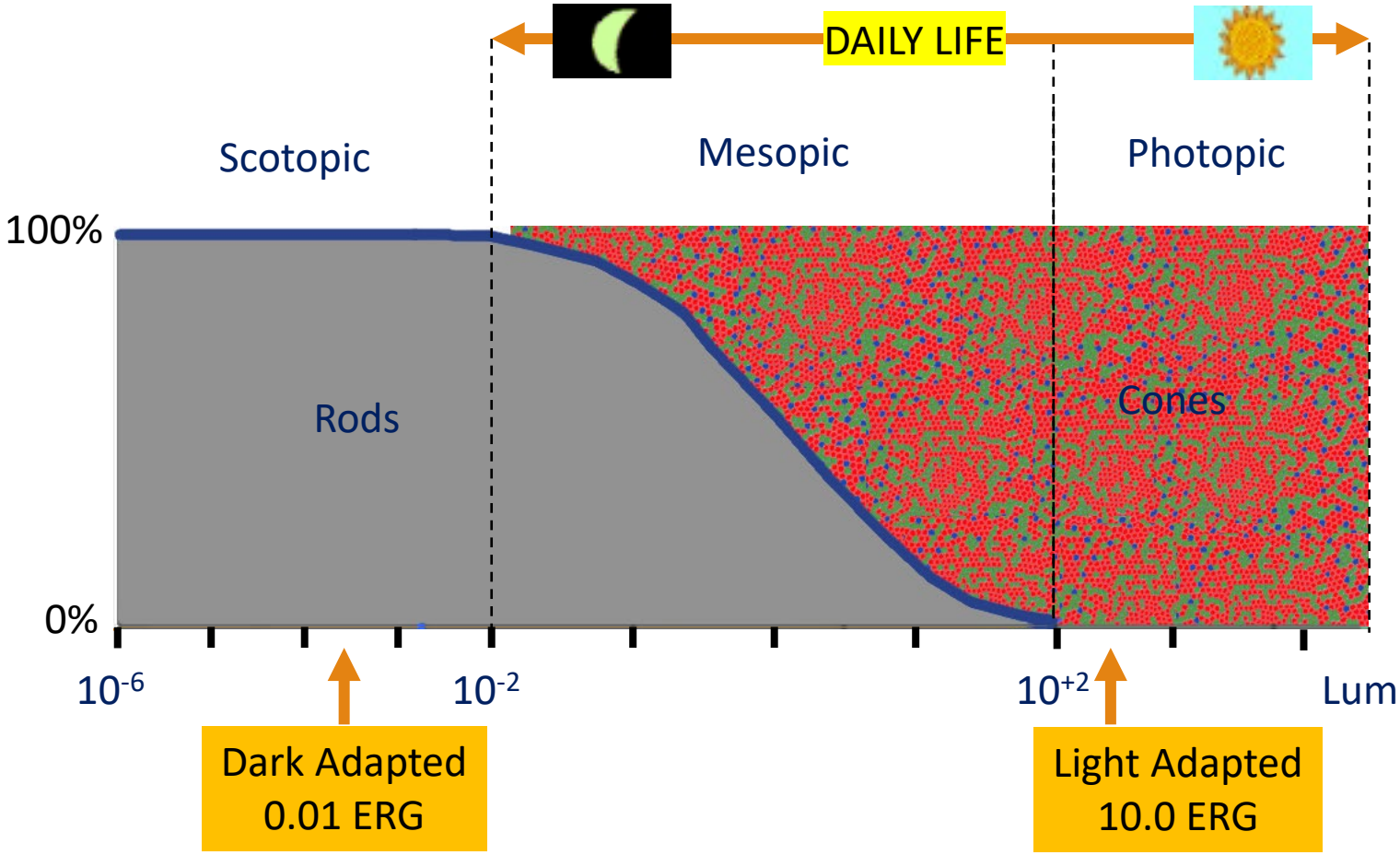
Rods and cones

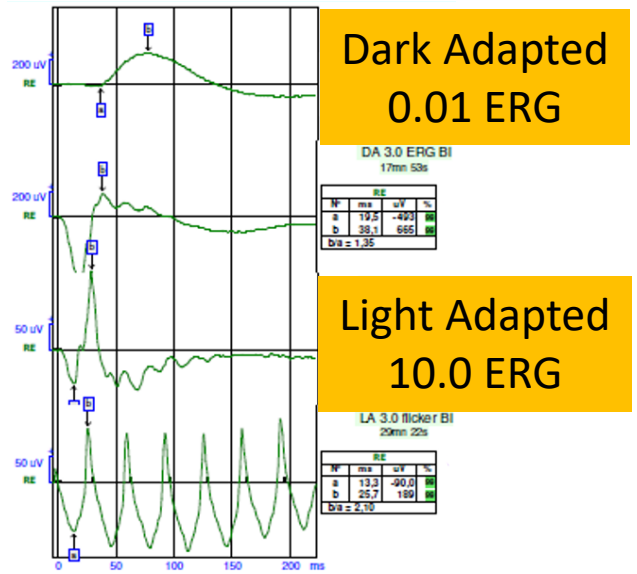
Standard equipments for testing visual functions



Tests of visual functions available in standard clinics are essentially addressing cones

Rods and cones
Flash Electroretinography

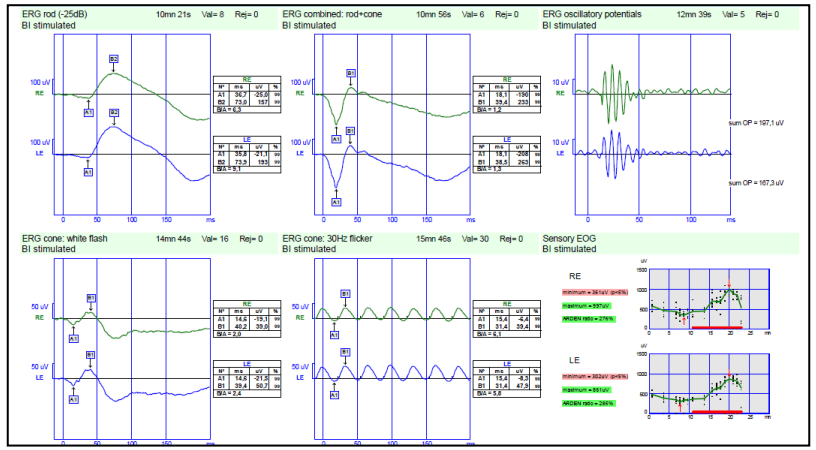


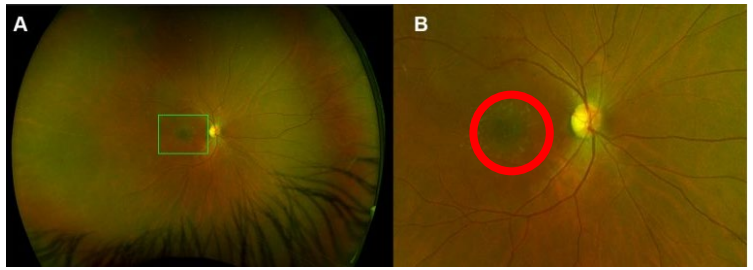


Limits of flash electroretinography

Cannot detect local alterations (early stage of disease)

Stargardt : flash ERG





Need to alter at least 30% of number of photoreceptors to have a significant change of flash ERG

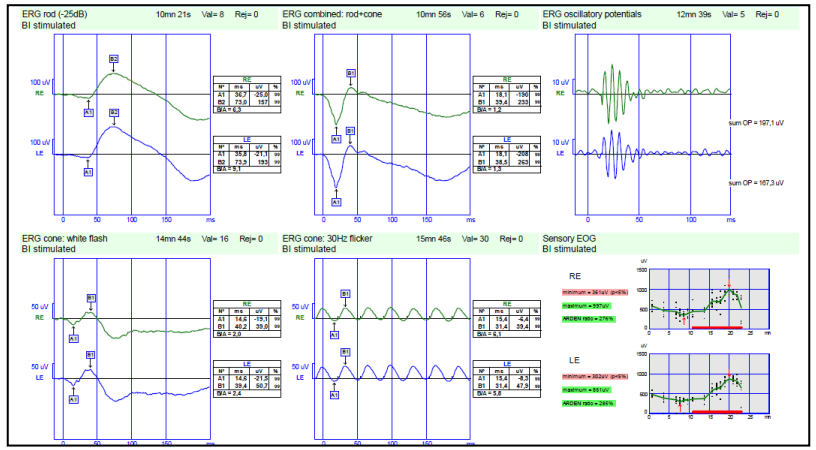
Macula = only 11% of cones and 5% of rods

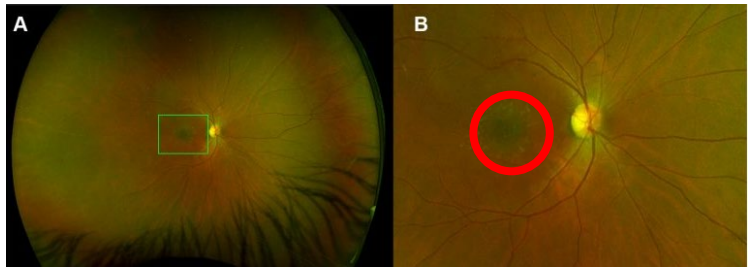
Vision electrophysiology requires well trained technicians to obtain reliable results

Limits of flash electroretinography

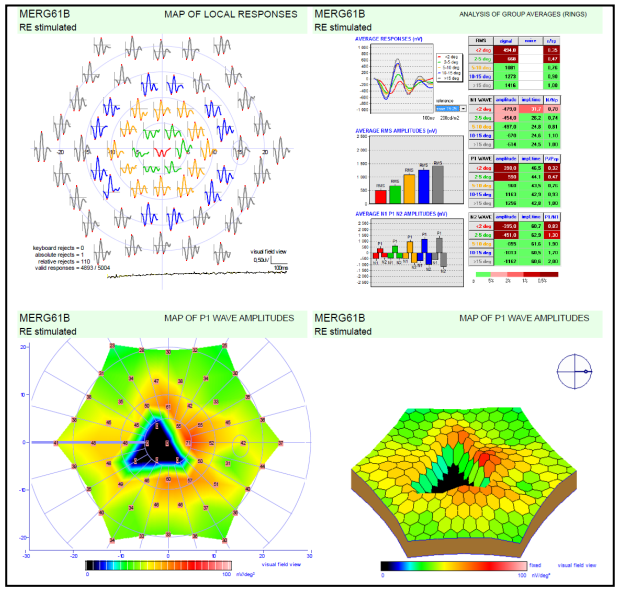
Multifocal ERG

Stargardt : flash ERG





Central deficit in MfERG

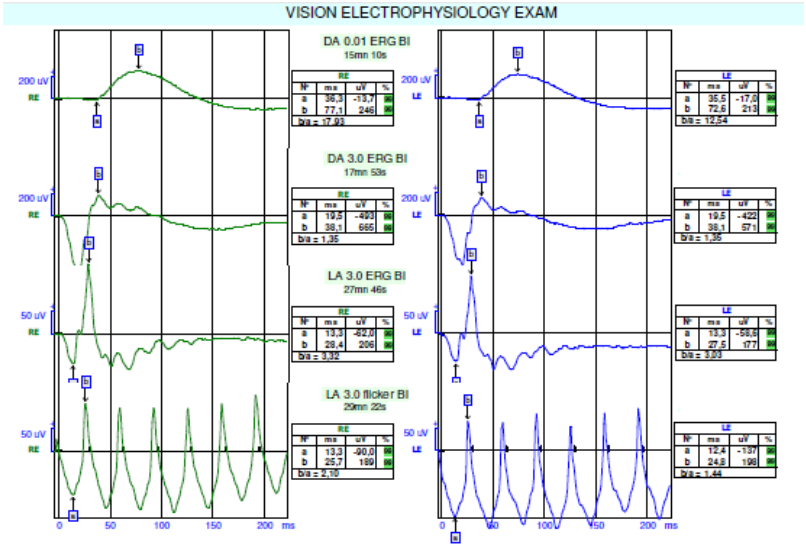


- Only photopic (cones)
- Only central retina

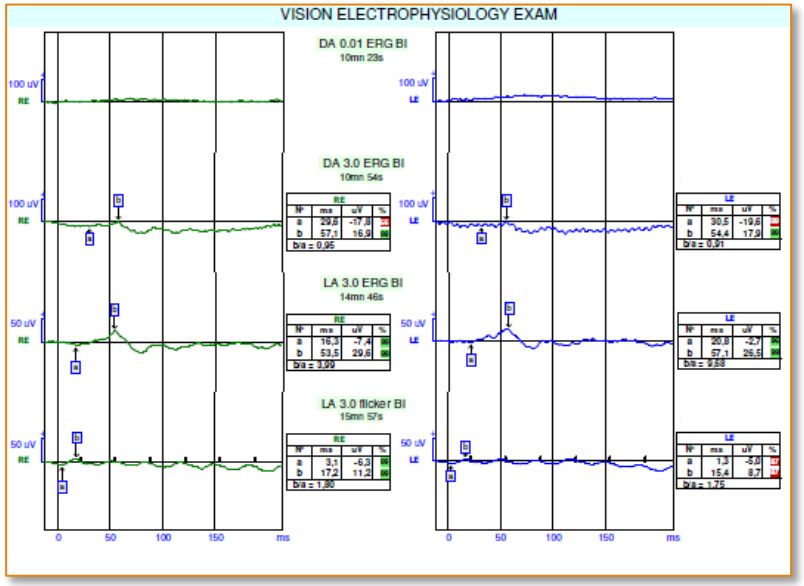
Limits of flash electroretinography

Low sensitivity (advanced stage of disease)

Normal



Retinitis pigmentosa

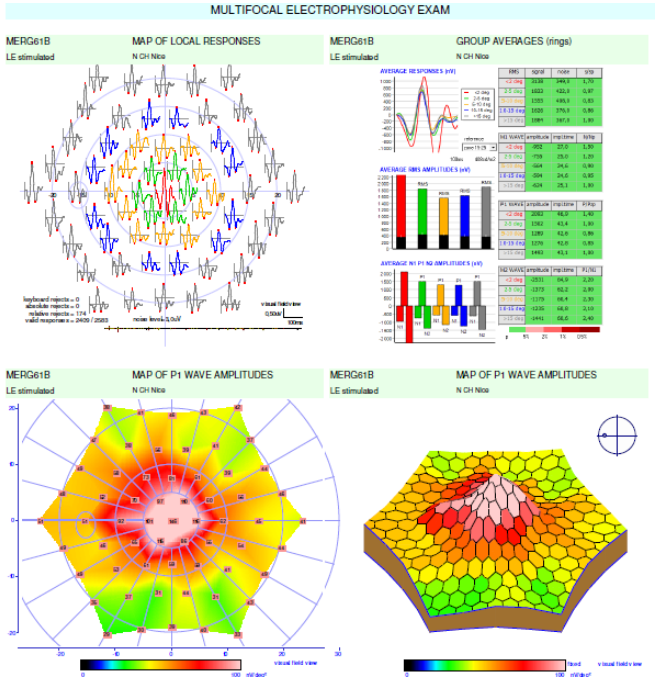


Retinitis pigmentosa (advanced stage)

ERG is
“extinguished”

Multifocal ERG

Normal



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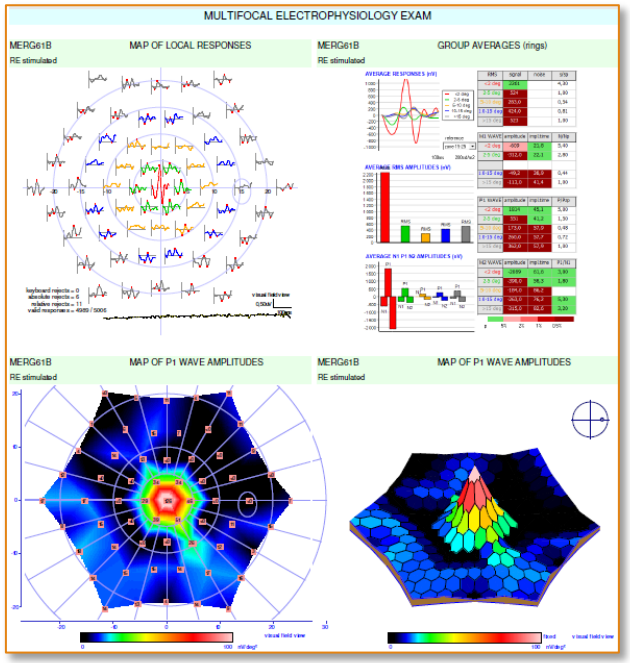


Retinitis pigmentosa (advanced stage)

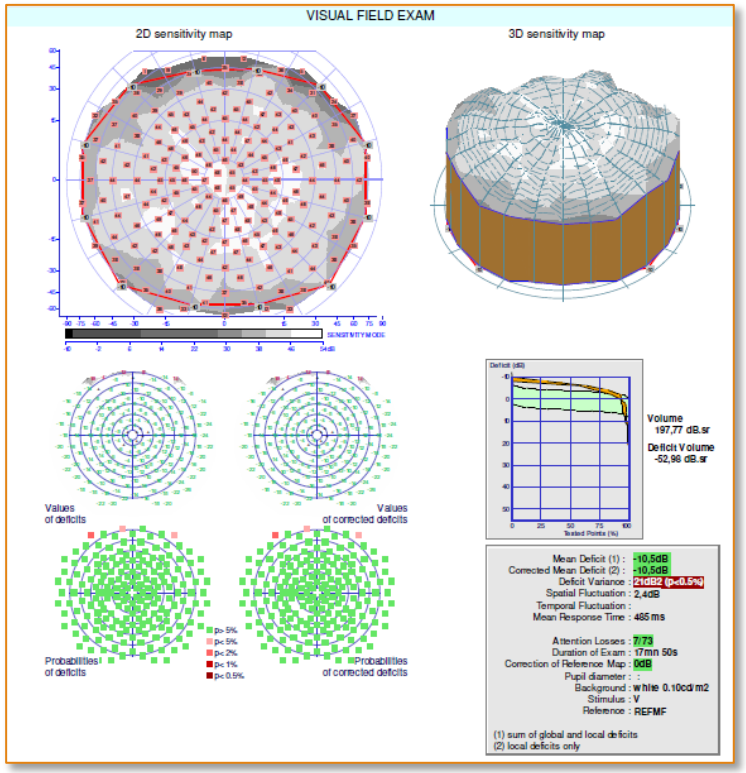
Not recordable response

Visual field

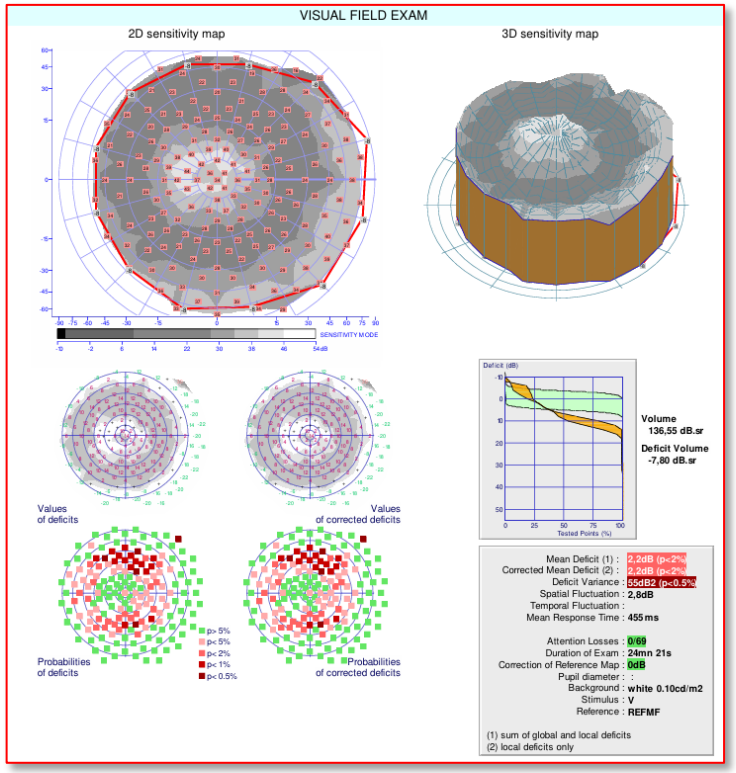
White stimulation (size V) – Low mesopic background (0.1 cd/m2)

Psychophysical tests are much more sensitive than electrophysiology to detect remaining visual functions
Using non standard test parameters (low mesopic level, large stimulus size)

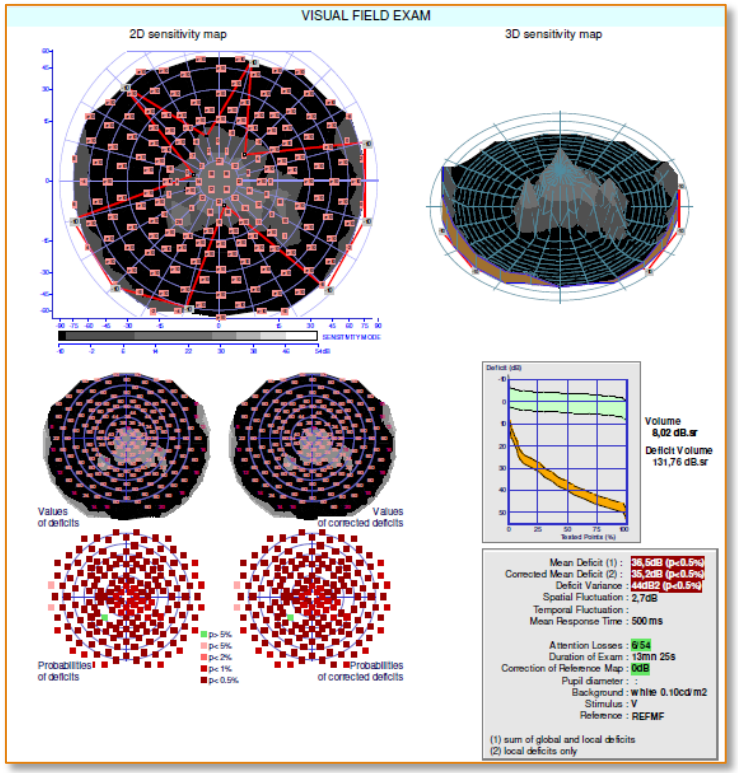
Normal



Retinitis pigmentosa

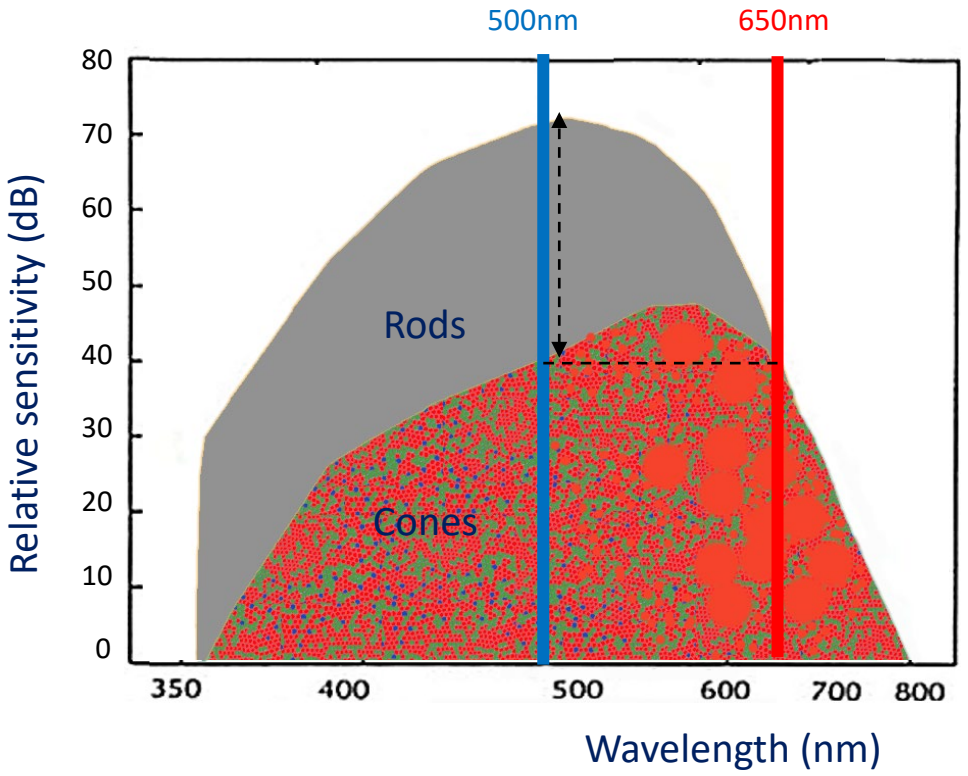


Retinitis pigmentosa (advanced stage)



Evaluation of the contribution of rods and cones

Dark adapted chromatic perimetry



Compare sensitivity thresholds for 500 and 650 nm

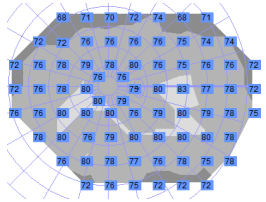
If difference > 23 dB : rods
If difference < 3 dB : cones

Sensitivity (dB)	Relative luminance
3	1/2
10	1/10
20	1/100
30	1/1000

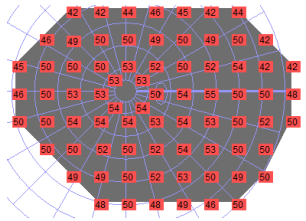
Evaluation of the contribution of rods and cones

Dark adapted chromatic perimetry

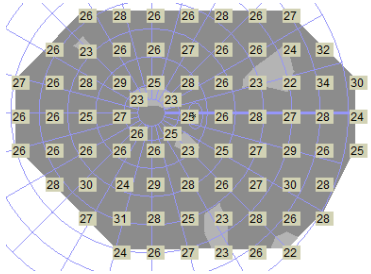
Normal



500nm

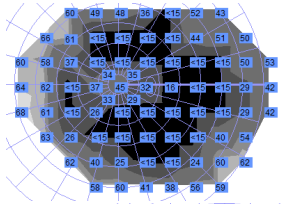


650nm

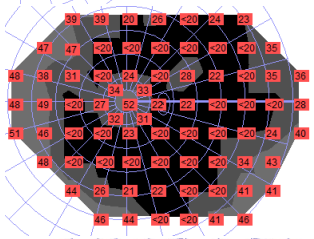


difference

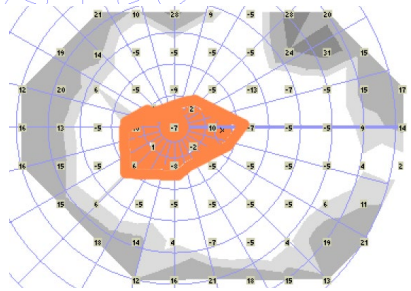
Retinitis pigmentosa



500nm



650nm



difference

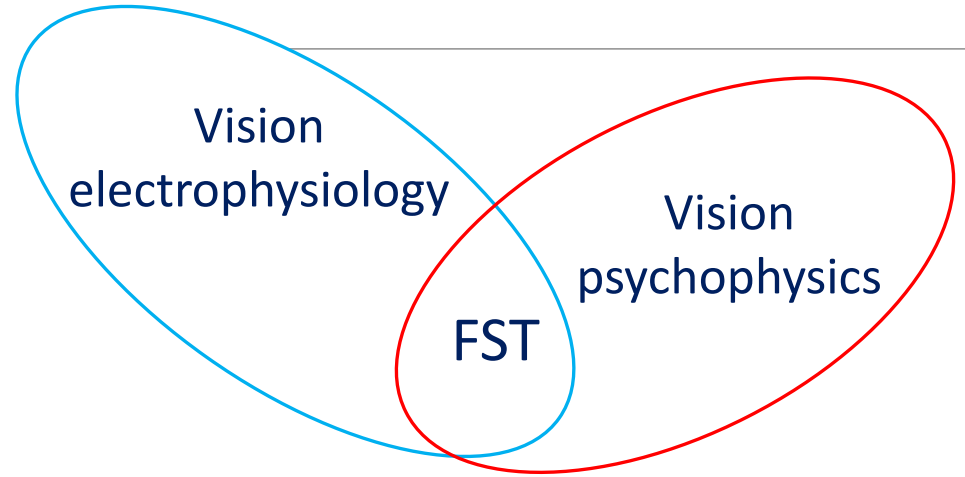
Compare sensitivity thresholds for 500 and 650 nm

- Difference > 20 dB : rod mediation
- Difference < 3 dB : cone mediation

Orange area = cones only
White area = no detected response from cones and rods
Gray area = rods and cones responses

A similar approach can be used to obtain
- a specific response of cones (red stimulation over a dim blue background)
- a specific response of S-cones (blue stimulation over an amber background)

Full Field Stimulus Threshold (FST)



Full-field (ganzfeld) flash

Threshold of sensitivity to light

Doc Ophthalmol
https://doi.org/10.1007/s10633-023-09962-7

ISCEV STANDARDS

ISCEV and IPS guideline for the full-field stimulus test (FST)

J. K. Jolly · J. R. Grigg · A. M. McKendrick · K. Fujinami · A. V. Cideciyan · D. A. Thompson · C. Matsumoto · R. Asaoka · C. Johnson · M. W. Dul · P. H. Artes · A. G. Robson

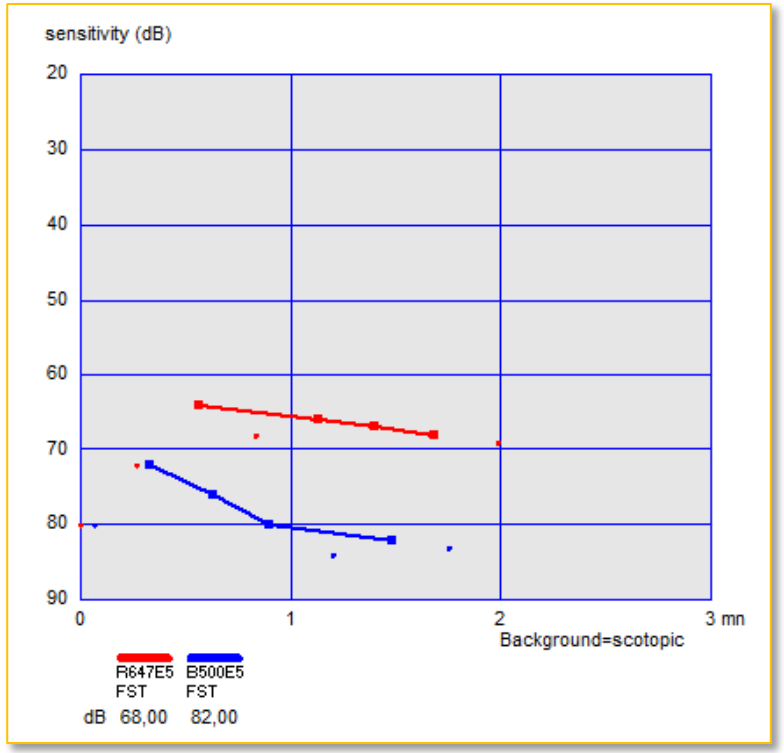
For patients who cannot perform a reliable visual field (unstable fixation, low cooperation)

Full Field Stimulus Threshold (FST)

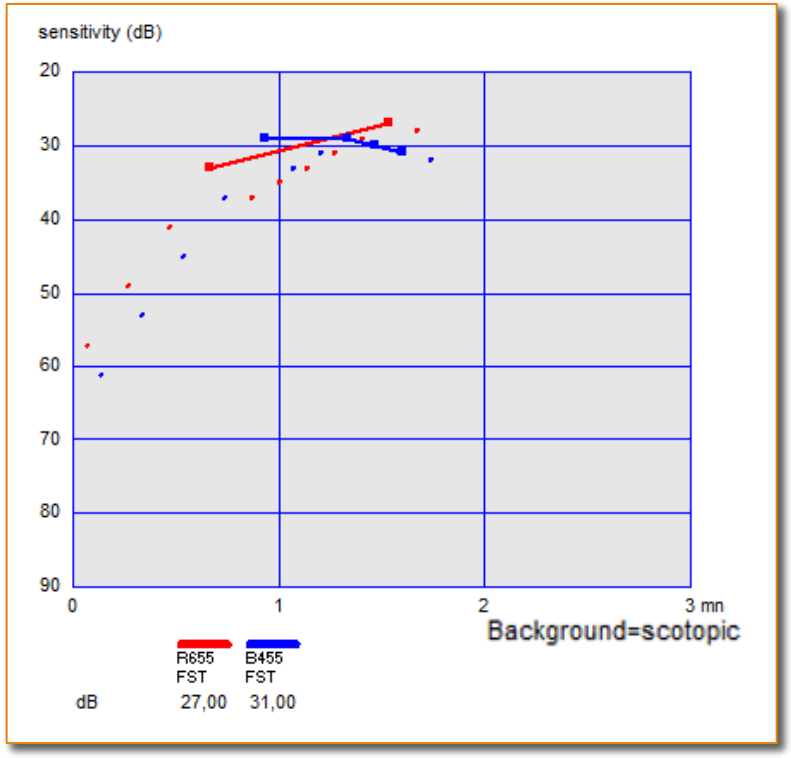
After dark adaptation
with blue and red stimulation

Difference between blue and red threshold gives an estimate of the contribution of rods and cones.
IN the RP example, there is no difference meaning that there are no significant rod responses.

Normal



Retinitis pigmentosa (advanced stage)



Full Field Stimulus Threshold (FST)

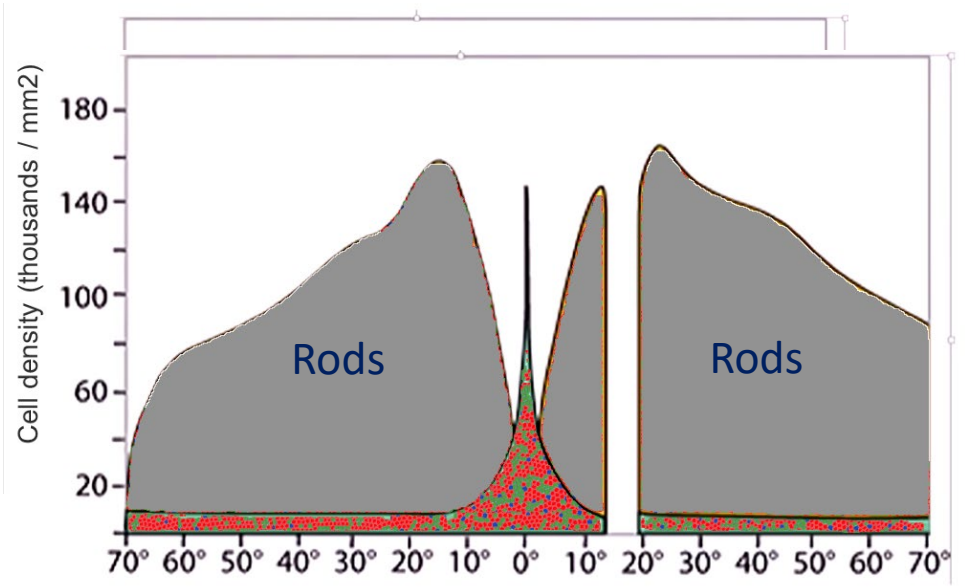
Advantages and limits

FST advantages:

- Can be used on patients with poor fixation
- Provides a single number!
- Even more sensitive than visual field due to spatial integration properties of rods

FST limits:

- Detects the area of best sensitivity
- Where is change occurring?



Distribution of rods and cones over the retina

For gene therapy or stem cell therapy,
it is important to evaluate evolution at the site of treatment
and for the different classes of photoceptors
The change(s) may not occur at the are of best sensitivity of the retina

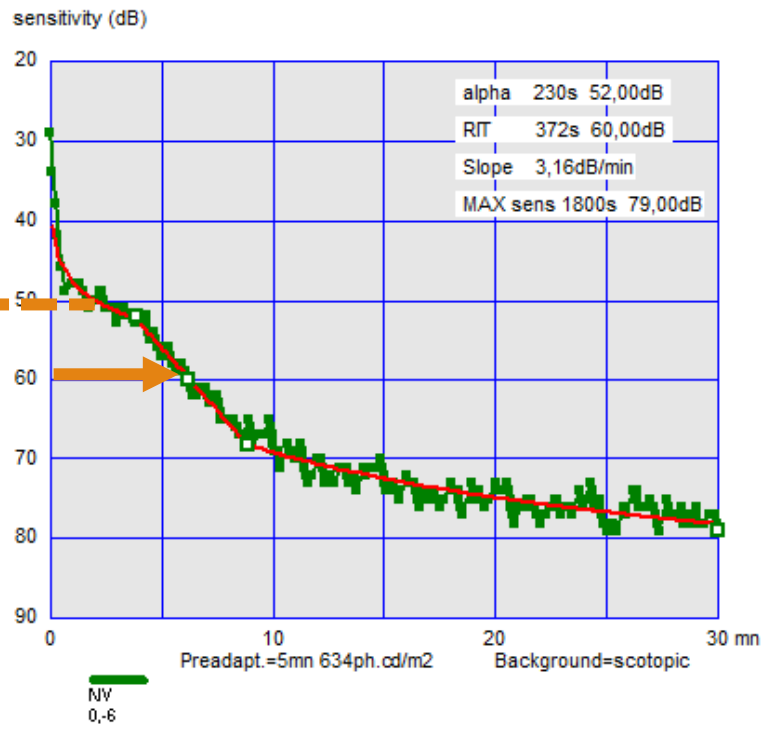
Analysis of kinetics of the visual cycle

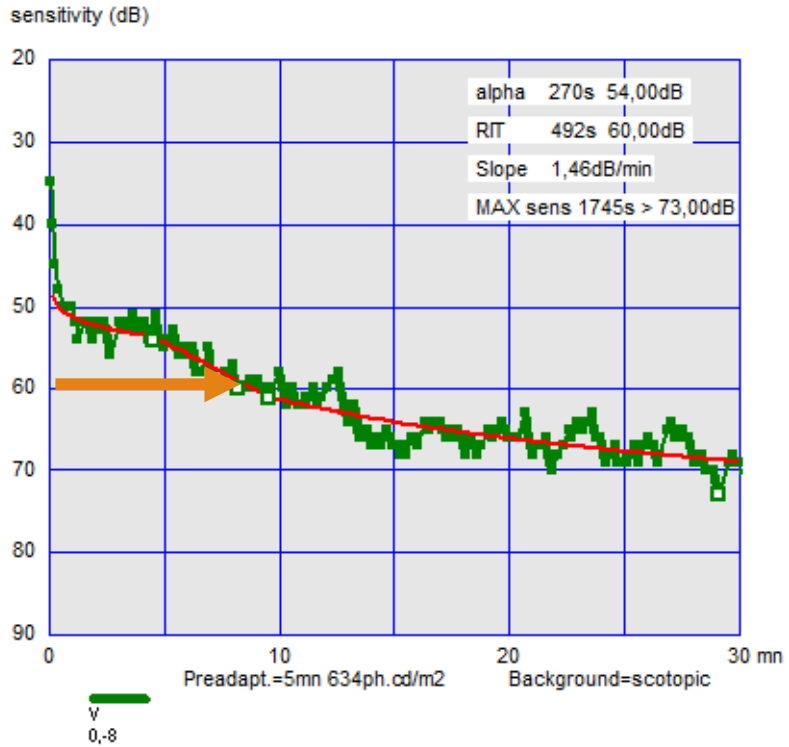
Recovery of light sensitivity after bleaching

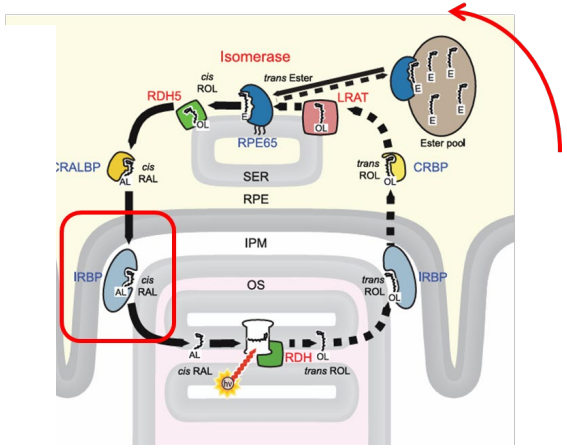
Delayed responses after bleaching are indication of alterations of the visual cycle

Cone plateau

Rod intercept time (RIT)







Source: Lamb & Pugh, 2006

Summary

The evaluation of IRDs requires several test which are need as a consequence of their heterogeneity
Vision electrophysiology remains very important as it provides important information for diagnosis: Inner/outer responses, ON/OFF responses, etc..

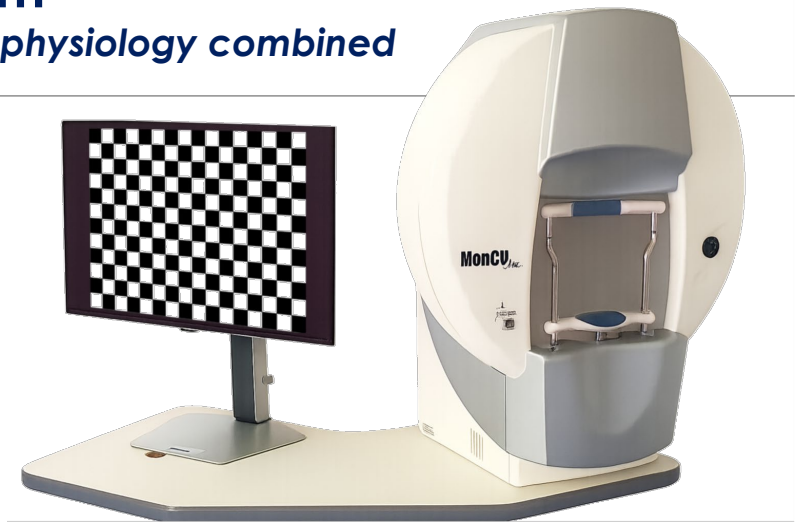
	Specific photoreceptor responses	Local responses	Kinetic of visual cascade	Inner/outer retina ON/OFF
Flash ERG	YES	NO	NO	YES
Multifocal ERG	NO	YES (cone)	NO	YES (cone)
Dark adapted perimetry	YES	YES	NO	NO
FST	YES	NO	NO	NO
Dark adaptometry	YES	YES (limited locations)	YES	NO

A multimodal visual function testing solution

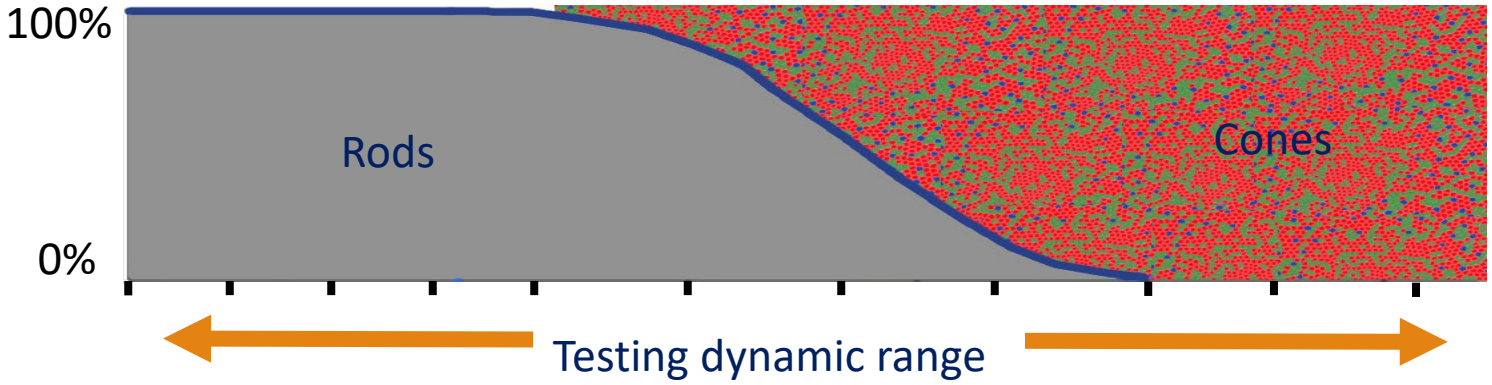
MonCvONE-CR++ system

Vision psychophysics and electrophysiology combined

The future of visual function evaluation in inherited retinal diseases



- Standard perimetry
- Ganzfeld flash ERG
- Pattern ERG and VEP
- Scotopic chromatic perimetry
- FST
- Dark adaptometry
- Pupillometry



A testing range that covers the entire dynamic range of luminance
The device can also generate color background and stimulations for tests specific of L-M cones and S-cones.

Take home message

- Standard ophthalmic equipment is not adequate for the evaluation and follow-up of visual functions in Inherited Retinal Diseases

- Inherited Retinal Diseases are inhomogeneous group of diseases
  ➔ Need for several different visual function tests including electrophysiology and psychophysical tests

Thank you !!!

APPRECIATION

Jacques Charlier

感谢您出席“中华医学会第二十九次眼科学术大会(CCOS2025)”，并作精彩学术演讲，
为大会成功举办做出了重要贡献，特此纪念。

For the Participation and Outstanding Contribution to the 29th Congress of Chinese Ophthalmological Society.

2025年9月4 - 7日 中国 · 杭州

September 4 - 7, 2025 Hangzhou, China

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