FST test on the Vision Monitor

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Introduction

The FST test was initially developed at the SCHEIE Eye Hospital of Philadelphia to evaluate the efficiency and safety of treatments of hereditary diseases of the retina. (ROMAN & al, 2005).

The FST test is used, in combination with other exams in a number of clinical studies:

- in congenital Leber amaurosis (JACOBSON & al, 2009)
- in retinitis pigmentosa (MESSIAS & al, 2013)
- in Stargardt (COLLISON & al, 2014)
- in blue cone monochromatism (LUO & al, 2015)
- in choroideremia (DIMOPOULOS & al, 2017)
- …

Today, it is part of the recommendations for the evaluation of patients with congenital Leber amaurosis type 2 treated with Voretigene Neparvovec (Luxturna).

Principles of the FST test

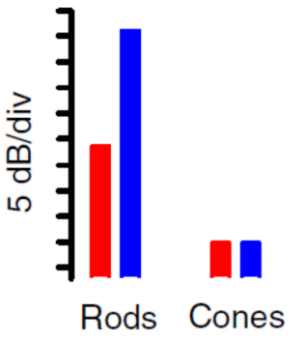
The FST test consists in a measurement, after dark adaptation, of the perception threshold of white or chromatic ganzfeld flash stimulations.

The white test allows a quantification of light sensitivity that can be compared to normal value to determine a loss of sensitivity given in decibels (dB).

The chromatic tests (blue 500nm and red 650nm) indicate whether cones or rods or both types of photoreceptors are involved in light perception (ROMAN & al, 2007).

- rods are more sensitive to blue than to red stimuli
- cones have the same sensibility for red and blue stimuli

A significant difference between the thresholds obtained with blue and red stimuli demonstrates the implication of rods.



Realization of the FST test on the Vision Monitor

The FST test is available on the MonCvONE-CR systems manufactured by Metrovision. It is part of the dark adaptometry program of the Vision Monitor.

The tests are full field (“ganzfeld”) flashes presented every 3 seconds. The patient's task is simply to squeeze the press button every time he/she perceives light. The measurement strategy is the staircase type 8-4-2-1 (increase of the luminance in steps of 8 dB until a response is obtained then decrease in steps of 4 dB until the responses are stopped then further increase in steps of 2 dB and finally decrease in steps of 1 dB). Periodically, a test of patient reliability is performed by testing the response while no stimulation is generated.

Several test procedures are proposed:

Test name	Description	Color(s)	Dynamic range (dB)
FST-W-NV	White - normal	White	36-111
FST-B-NV	Blue - normal	Blue 500 nm (20 nm)	53-128
FST-R-NV	Red - normal	Red 647nm (20 nm)	58-133
FST-W-LV	White – low vision	White	0-48
FST-B-LV	Blue – low vision	Blue 455nm	1-61
FST-R-LV	Red – low vision	Red 655nm	0-58
FST-MULT	Combination of previous tests	Multiples	0-111

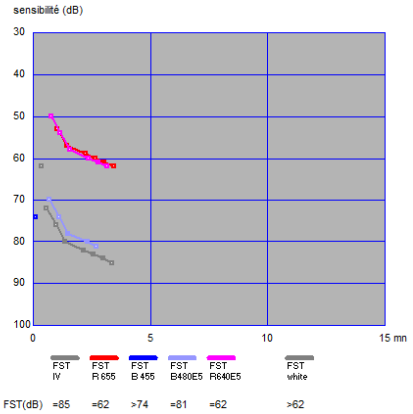
The measurements are expressed in decibels (dB) referenced to 318 photopic cd/m^2 (0 dB).
Note in the right column of the previous table the dynamic range of each test.
Thus, a dynamic range of 0-111 indicates that the luminance of the stimulus can vary from 318 cd/m^2 (0 dB) down to 2,54 x10^{-9} cd/m^2 (111 dB).
There are two tests for each color (« white », red and blue): the first at low luminance levels, for subjects near normal and the second at high luminance levels for very low visions.
The FST-MULT test is a combination of all the tests: it realizes sequentially the presentation of these different tests, which saves significant time.

Result from a normal subject obtained with test FST-MULT

After 20 minutes of dark adaptation, the actual examination lasted 3 minutes.

The threshold measurements obtained are:
- 85 dB with white flashes (gray curve)
- 62 dB with red flashes (red curve)
- 81 dB with blue flashes (blue curve)

The difference of 19 dB between the thresholds with the red and blue flashes is characteristic of the implication of the rod system.



Advantages and limits of the FST test

The FST test presents a number of advantages:

1- it is a fast exam: 3 minutes after the dark adaptation
2- it can be realized on subjects with poor visual acuity and / or reduced visual field
3- it does not require fixation (subjects with nystagmus)
4- it can still provide responses when the ERG is extinguished

The FST test presents limits:

1- it is a psychophysical test that require the cooperation of the subject who must press a response button whenever the stimulus is perceived. For subjects who do not cooperate, it is possible to use a more "objective" test such as chromatic pupillometry
2- the FST test does not perform a global analysis of the retina. It provides a measurement that corresponds to the most sensitive point of the retina. It is not a global evaluation that would involve the entire retina as does the ERG global flash response.
3- the FST test does not provide any spatial information. It provides a measurement that corresponds to the most sensitive point of the retina. It does not provide any information about its location or its extent. Such a study could only be obtained with the dark adapted chromatic perimetry test.
4- the FST does not provide information about the velocity of dark adaption after light bleaching which might be an early indicator of an alteration of the rod system.

Conclusion

The FST test is a useful complement of a set of other tests available on the MonCvONE-CR:

- light adapted perimetry (static or kinetic)
- dark adapted chromatic perimetry (static or kinetic)
- dark adaptometry (mono-point, multipoint, multi-colors)
- chromatic pupillometry
- electro-retinography with the ISCEV standard
- electro-oculography with the ISCEV standard

References

- COLLISON F.T. & al. Psychophysical Measurement of rod and cone thresholds in Stargardt Disease with Full-Field Stimuli. Retina. 2014, 34, 9, 1888-1895.
- DIMOPOULOS I.S. & al. The natural history of full-field stimulus threshold decline in choroideremia. Retina. 2018, 38, 9, 1731-1742.
- JACOBSON S.G. & al Defining the residual vision in Leber congenital amaurosis caused by RPE65 mutations. IOVS. 2009, 50, 2368-2375.
- LUO X. & al Blue cone monochromacy: Visual function and efficacy outcome measures for clinical trials. Plos One 2015, 10,4.
- MESSIAS K. & al Psychophysically determined full-field stimulus thresholds (FST) in retinitis pigmentosa: relationships with electroretinography and visual field outcomes. Doc. Ophthalmol. 2013, 127, 123-129.

- ROMAN A. & al. Quantifying rod photoreceptor-mediated vision in retinal degenerations: dark-adapted thresholds as outcome measures. Exper. Eye Research. 2005,80, 259–272.
- ROMAN A. & al. Full-field stimulus testing (FST) to quantify visual perception in severely blind candidates for treatment trials. Physiol. Meas. 2007, 51-56.

MonCvONE-CR is registered in Europe (CE1639) and in USA (3008058195)
It is designed and manufactured under a quality insurance system ISO13485-2016.