

# Straylight literature overview for C-Quant. March 2006

## INTRODUCTIONS

This and other documents are prepared by TJTP van den Berg and coworkers for users of the C-Quant by Oculus GmbH.

Dr van den Berg will be pleased to answer questions on these documents, or any other queries you may have with respect to retinal straylight and its measurement.

A first introduction into the phenomenon of straylight at the human retina can be found in the accompanying document "Introduction to retinal straylight"

An introduction into the psychophysical approach to assess retinal straylight with the C-Quant can be found in a further document "Compensation Comparison"

An extensive scientific paper on the C-Quant basics appeared in February 2006 in IOVS, another is in press in the Journal of Biomedical Optics, and others are submitted or in preparation. In short the principles have been published as Van den Berg TJTP, Coppens JE, Franssen L. New Approach for Retinal Straylight Assessment: Compensation Comparison. Invest Ophthalmol Vis Sci. 2005 ;46 :ARVO Eabstract 4315

## BACKGROUND SUMMARY and LITERATURE REFERENCES

Originally, the insight in retinal straylight developed from studies on the phenomenon of glare. It was found that disability glare could fully be understood on the basis of the optical phenomenon of straylight at the retina, quantified by means of the psychophysically measurable value  $L_{eq}/E_{bl}$ .<sup>1,2</sup> Consequently, the CIE (Commission International d'Eclairage) has *defined* disability glare as retinal straylight. This is precisely what the C-Quant Straylight Meter assesses.<sup>3</sup> The Straylight Meter is the only device that assesses retinal straylight. On the other hand more than a dozen so called glare testers have been defined. These instruments do not assess straylight nor disability glare, but a more or less loosely related score.<sup>4,5</sup> The chairman of the CIE committee on disability glare TC1-18 Dr Vos together with Dr van den Berg developed a Standard Glare Observer,<sup>6</sup> accepted as CIE standard. Today it is realized however that retinal straylight constitutes a visual handicap of a much more general nature than glare alone. Patient complaints may include problems of "hazy vision", contrast and color loss, difficulty with against-the light face recognition, halos around bright lights, etc.

Straylight measurement as it is done in the C-Quant is based on a flickering annular source of straylight. This flickering annulus causes a perceptible straylight flicker in the center. In the first realization of straylight measurement, the psychophysical approach of *direct compensation* was used. This implied silencing of this flicker phenomenon in the center by giving counterphase light. The first publication was in 1986.<sup>7</sup> Since then many studies on retinal straylight appeared using this approach, such as on normal population aging effects,<sup>8</sup> on the use of red(yellow) glasses,<sup>9</sup> on

diaphany of the ocular wall,<sup>10,11</sup> on the effects of ocular pigmentation differences,<sup>12</sup> on populations with different kinds of cataracts,<sup>13</sup> etc.

A small instrument was made to accommodate fellow researchers, described in publications in 1991 and 1992.<sup>3,14,15</sup> Publications appeared using these instruments notably by Elliott and coworkers on a variety of subjects,<sup>16-22</sup> by others on refractive surgery,<sup>23-26</sup> and more recently on driver licensing questions.<sup>27-29</sup> etc.

In 2003 a new psychophysical approach was defined, called *Compensation Comparison*, now implemented in the C-Quant. The essential difference was that this new approach is suitable for random subjects and for routine clinical use. The previous approach had shown to be too difficult for routine use. Moreover, the new approach enabled control over the reliability of the assessment. It was no longer possible to influence the measurement outcome, and quality control factors could be defined. A large study took place in 2003-2004. More than 2400 subjects were measured in 5 centers in Europe (Amsterdam, Barcelona, Tübingen, Salzburg and Antwerp). So a reference database is already established, showing this approach to work very well. The measurement values closely correspond to the earlier comparative studies, so that the full set of data accumulated over the past 15 years can serve as reference. An important finding in the European study was that straylight increase occurs frequently in the population, but can not be detected by a visual acuity or other measurement. The amount of increase is often considerable. If one realizes that glare hindrance is already a problem for young eyes, it is clear that a straylight increase by a factor of 4 constitutes a serious handicap. Yet such increase was often found. In terms of the “straylight parameter” *s*: its value should be limited to  $\log(s) < 1.45$ . Papers are under way, but for now please refer to the accompanying documents or to [www.glare.be](http://www.glare.be) for the EU study.

Other studies not mentioned above include: effects of straylight on the PERG,<sup>30</sup> ocular lubricants and straylight,<sup>31</sup> mathematics and modeling of the straylight function,<sup>32-34</sup> corneal disease and straylight,<sup>35</sup> in vitro study on light scattering of the human eye lens and straylight,<sup>36-39</sup> cataract straylight modeling<sup>40</sup>, wavelength dependence of straylight,<sup>41</sup> the ciliary corona,<sup>42</sup> etc.

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