Report From the VSIA Taskforce on Standards for Reporting Optical Aberrations of the Eye

Larry N. Thibos, PhD; Raymond A. Applegate, OD, PhD; James T. Schwiegerling, PhD; Robert Webb, PhD; VSIA Standards Taskforce Members

INTRODUCTION

In response to a perceived need in the vision community, an OSA taskforce was formed at VSIA-99 and charged with developing consensus recommendations on definitions, conventions, and standards for reporting of optical aberrations of human eyes. An interim progress report was presented at OSA-99 annual meeting in Santa Clara in Sept., 99. At VSIA-2000, progress reports were given by taskforce subcommittees on (1) reference axes, (2) describing functions, and (3) model eyes.

BACKGROUND

The recent resurgence of activity in visual optics research and related clinical disciplines (eg, refractive surgery, ophthalmic lens design, ametropia diagnosis) demands that the vision community establish common metrics, terminology, and other reporting standards for the specification of optical imperfections of eyes. Currently there exists a plethora of methods for analyzing and representing the aberration structure of the eye but no agreement exists within the vision community on a common, universal method for reporting results. In theory the various methods currently in use by different groups of investigators all describe the same fundamental quantity and therefore it should be possible to reliably convert results from one representational scheme to another. However, the practical implementation of these conversion methods is computationally challenging, is subject to error, and

reliable computer software is not widely available. All of these problems support the need for a working group to establish standards for reporting aberration data and to specify test procedures for evaluating the accuracy of data collection and data analysis methods.

VSIA-99 REPORT

Following a call for participation (Thibos LN, Applegate RA, Howland HC, Williams DR, Artal P, Navarro R, Campbell MC, Greivenkamp JE, Schwiegerling JT, Burns SA, Atchison DA, Smith G, Sarver EJ, and others. A VSIA-sponsored effort to develop methods and standards for the comparison of the wavefront aberration structure of the eye between devices and laboratories. In Vision Science and Its Applications. Washington, D.C.: Optical Society of America; 1999;236-239), approximately 20 people met at VSIA-99 to discuss the proposal to form a taskforce that would recommend standards for reporting optical aberrations of eyes. The group agreed to form three working parties that would take responsibility for developing consensus recommendations on definitions, conventions and standards for the following three topics: reference axes, describing functions, and model eyes.

It was decided that the strategy for Phase I of this project will be to concentrate on articulating definitions, conventions, and standards for items which are not empirical in nature. For example, several schemes for enumerating the Zernike polynomials have been proposed in the literature. Selecting one to be the standard is a matter of choice, not empirical investigation, and therefore is included in the charge to the taskforce. On the other hand, issues such as the maximum number of Zernike orders needed to describe ocular aberrations adequately is an empirical question which will be avoided for the present, although the taskforce may wish to formulate recommendations on such issues at a later time. The target date for completion of Phase I was the VSIA-2000 meeting in February, 2000.

CURRENT AND FUTURE ACTIVITIES

Steve Burns from Schepens Research Institute of Boston, MA agreed to organize a WEB site to facilitate the dissemination of draft recommendations to, and the retrieval of comments from, the vision community. The URL for that facility is: <http://color.eri.harvard.edu/handbook/>. This temporary location is meant to facilitate informal discussion between the community and the taskforce members. When the taskforce recommendations become available, they will be posted on the OSA OpticsNet website for comment by members of the vision science community. (Draft recommendations are now available at the following URL: <http://www.osa.org/Homes/vision/resources/intro.htm>.) Following an appropriate time for comment and debate, the standards will be formalized and posted on OpticsNet for wider dissemination to the greater optics community.

Phase II of the taskforce's activities will be devoted to implementation of specific projects that will be compliant with the standards established in Phase I. Some suggestions for these Phase II projects follow.

Reference Axes Subcommittee

–Develop a shareware library of software tools needed to convert data from one ocular reference axis to another (eg, convert a wavefront aberration for the corneal surface measured by topography along the instrument's optical axis into a wavefront aberration specified in the eye's exit pupil plane along the eye's fixation axis.)

–Generate test datasets for evaluating software tools

Describing Functions Subcommittee

–Develop a shareware library of software tools for generating, manipulating, evaluating, etc. the recommended describing functions for wavefront aberrations and pupil apodizing functions.

–Develop additional software tools for converting results between describing functions (eg, converting Taylor polynomials to Zernike polynomials, or converting single-index Zernikes to double-index Zernikes, etc.)

–Generate test datasets for evaluating software tools

Model Eyes Subcommittee

–Build a physical model eye that can be used to calibrate experimental apparatus for measuring the aberrations of eyes

–Circulate the physical model to all interested parties for evaluation, with results to be presented for discussion at a future VSIA meeting.

Taskforce Chair: Larry Thibos
<thibos@indiana.edu>
Subcommittee Chairs:
Reference Axes: Ray Applegate
<Applegate@uthscsa.edu>
Describing Functions: Jim Schwiegerling
<jschwieg@u.arizona.edu>
Model Eyes: Rob Webb
<webb@helix.mgh.harvard.edu>