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Antistigmatic accommodation*

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Introduction

Antistigmatic components of accommodation (accommodation that is orthogonal to stigmatic accommodation in symmetric dioptric power space) are rarely mentioned in classic texts[1-5] (if mentioned at all). The impression is given that the process of accommodation is purely spherical and it would seem that clinical optometrists also consider accommodation to be a spherical process. However, it is improbable that a human accommodative system would be capable of undergoing accommodation that is purely spherical. Various studies conducted by members of the Optometric Science Research Group have shown that the accommodative process includes an antistigmatic component[6, 7]. This pilot study will present evidence suggesting that antistigmatic accommodation occurs under various conditions of induced accommodation.

Method

Multiple measurements of refractive state using autorefractors were taken of human eyes under conditions that required different amounts of accommodation. Stimuli included light (0 D), dark (dark focus) and cycloplegic (dark focus) conditions (measurements taken using a Nidek ARK-700 autorefractor) as well as 1 D, 3 D and 0 D accommodative demands (measurements taken using a Hoya AR 550 autorefractor). At least forty measurements of refractive state were taken for each stimulus condition. For all measurements taken with the Nidek instrument the accommodative demand was determined by the lighting conditions of the target within the instrument. The 1 D, 3 D and 0 D demands were induced by positioning a target outside the instrument at 100 cm and 33 cm for the 1 D and 3 D demands while the 0 D demand was induced by observation of the target within the Hoya AR 550 instrument. Under the various conditions the accommodative responses included the usual stigmatic component and variation that has been shown previously[6, 7]. The emphasis of this pilot study is on the antistigmatic component of accommodation under various stimulus conditions.

Results

Figure 1 shows a fairly typical representation of autorefractor measurements taken under light (red data points) and dark (green data points) conditions. A number of important aspects are apparent in Figure 1. The red cluster of data points is positioned positively relative to the green cluster, a result of the dark refraction shift that occurred when these (dark data) measure-

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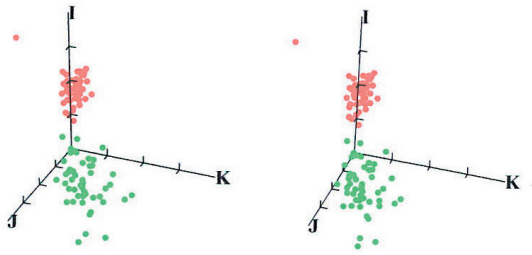

Figure 1. A scatter plot of 50 measurements taken under light (red data points), and 50 measurements taken under dark (green data points) conditions. The difference in position of the red points as opposed to the green points is a result of the dark refraction shift. The axis length in the figure is 1 D. The origin of this, and all other figures, is set at plano.

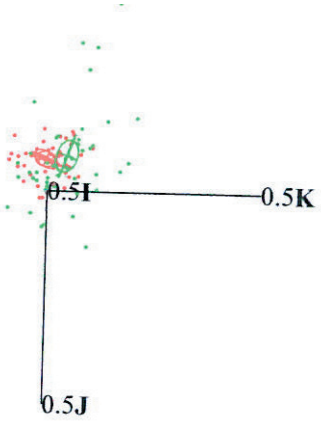

Figure 2. The scatter plot of figure 1 is viewed along the stigmatic, **I**, axis. This orientation emphasizes antistigmatic variation. The increased antistigmatic variation in the dark (green) is apparent. Also shown are the 95% confidence ellipsoids on the mean.

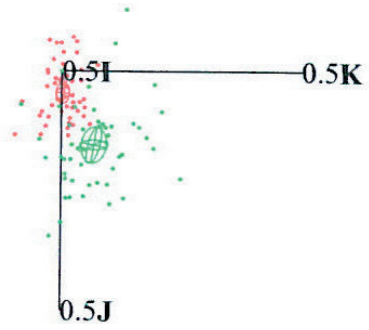

Figure 3. Data collected under 1 D accommodative demand (red points) and 3 D accommodative demand (green points) are shown (95% confidence ellipsoids are included). Separation between the red and green data points is a result of a difference in the mean antistigmatic accommodation that occurred under the two different stimulus conditions. Data from reference 7.

ments were taken. The red cluster is a tighter cluster than the green cluster both stigmatically (variation parallel to the **I** axis) as well as antistigmatically (variation occurring in the **J-K** plane). The green cluster reveals greater antistigmatic variation than the red cluster, shown by the increase in the size of the waist of the green cluster.

Figure 2 shows the same data as that seen in Figure 1 with the axes of the figure rotated so that the scatter plot is shown looking along the stigmatic axis. This rotation of the axes is done to emphasize the antistigmatic nature of the data. Included in Figure 2 are the relevant 95% confidence ellipsoids for each set of data. Only one half of the stereo-pair scatter plot is presented so that the usual rotations that are done to ensure a 3-D stereo-pair effect are eliminated.

Figure 3 shows another example of antistigmatic accommodation and in this case the red data points represent refractive behavior occurring under an accommodative demand of 1 D and the green data points, accommodative demand of 3 D. The difference in the means of the two sets of measurements is indicated by the separation of the two 95% confidence ellipsoids. The other aspect of importance is the increased amount of antistigmatic spread or variation of the data collected under the 3 D accommodative demand. The shift in the means as well as the increase in variation of the measurements gives an indication of the antistigmatic components of accommodative changes that occurred under the different conditions.

Discussion

This pilot study provides support for the contention that accommodation is not a purely spherical phenomenon. The results suggest that antistigmatic accommodation occurs under varying conditions of light and dark conditions as well as under different accommodative demands. Further research needs to be done on larger numbers of subjects to get a more complete understanding of this phenomenon.

Acknowledgments

Data showing accommodation under 1 D and 3 D demands was obtained from: Van Gool RD. *Refractive variation under accommodative demand.* DPhil Thesis, Rand Afrikaans University: Johannesburg, South Africa, 2000.

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