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Measurement of Consensual Accommodation in Vision-impaired Eyes

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Abstract

Purpose—To measure the accommodative response in unsighted or profoundly vision impaired (PVI) eyes when accommodation is elicited in the fellow, sighted eye.

Methods—88 unilaterally unsighted (UPS) and 97 binocularly-sighted (BSS) subjects (10–45 years) were enrolled. Subjects had clear ocular media for auto-refraction and could steadily fixate targets with the sighted eye. For BSS subjects, a long-pass filter was placed in front of one eye to simulate unilateral blindness. Both eyes were measured with a Shin-Nippon auto-refractor while fixating a 4/40 letter at 4 meters and then a N8 letter at 40 cm and at 33 cm. Accommodation was calculated as the difference between distance and near refraction.

Results—Only subjects with repeatable alignment between measurements were included in the analyses (64 UPS; 95 BSS). Results were analyzed using t-test and a generalized linear mixed model (GLMM) including age, sightedness, distance spherical equivalent and accommodation as factors. The t-test found no significant difference between eyes for UPS ($p=0.981$ at 40 cm and $p=0.663$ at 33 cm). For BSS, the sighting eye produced statistically significant, but only slightly greater amounts of accommodation than the filtered eye (0.098 D, $p=0.002$ at 40 cm and 0.189 D, $p<0.001$ at 33 cm). The GLMM found no difference between BSS and UPS subjects in terms of difference in accommodation between eyes ($p=0.128$ at 40 cm and $p=0.157$ at 33 cm).

Conclusions—The PVI eyes of unilaterally PVI individuals display similar accommodative response to their fellow sighted eyes when accommodation is elicited by near target of up to 3 D to the fellow eye. But the difference in accommodative response between PVI and fellow sighted eye is related to the amount of accommodation elicited.

Keywords

auto-refraction; consensual; accommodation; astigmatism; spherical equivalent

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There is a paucity of reports on accommodation in eyes which are either unsighted or suffer from profound visual impairment (PVI), especially for the measurement of consensual accommodation; that is, accommodation in a PVI^a eye in response to a near vision stimulus presented to the fellow, sighted eye. This is not surprising since there has been little or no impetus to drive research in this area. However, knowledge about consensual accommodation in PVI eyes may become a prerequisite for any proof-of-principle human, 'blind-eye' trials of surgical vision treatment procedures such as those for the restoration of accommodation.

Auto-refractors have been widely used for measurement of accommodation in both clinical and research settings. In sighted eyes, they have been shown to provide accurate and repeatable measurements and their results are not influenced by operator bias. Many auto-refractors have internal fixation targets which can only be visualized by the eye being measured, and are unsuitable for refracting PVI eyes unless substantial modifications to the instruments are made. The NVision-K5001 auto-refractor appears suitable for refracting the PVI eyes of unilaterally PVI subjects because of its wide open-field design, permitting fixation by the fellow sighted eye. A clinical evaluation of the K5001 suggested that this instrument has good accuracy and reproducibility¹. This instrument has also been used in previous studies to provide objective measurements of accommodation^{2,3}. Although those results were obtained in sighted eyes, it would not be unreasonable to assume that the same level of accuracy and repeatability is achievable in PVI eyes provided (1) the ocular media of the PVI eyes were clear, and (2) the measurements were taken along what would normally be the eyes' visual axis.

Consensual accommodation between sighted eyes has generally been considered to be equal for direct accommodative stimuli⁴. It has also been found that consensual response is equal even for tonic accommodation and accommodative hysteresis⁵. One study on a small number of subjects did find that the consensual response can differ from the direct response especially in a post-surgical situation⁶. Some studies have measured accommodation in eyes that are not normally-sighted⁷⁻⁹. Those studies found reduced accommodation in amblyopic eyes, however their methodology was based on direct stimulation of the amblyopic eye and thus the apparent reduction might have been more a function of sensory loss in the amblyopic eye than a true reduction in response to an accommodative stimulus or a reduction in the accommodative function itself¹⁰. Unilaterally PVI subjects cannot be assumed to respond analogously to normal sighted eyes and differs from subjects with amblyopic eyes.

The objective of this study was to measure consensual accommodation in PVI eyes of unilaterally-PVI subjects and to compare them to the direct accommodation of their fellow, sighted eyes as well as the eyes of binocularly sighted subjects.

^aWhile functional distinctions exist between unsighted and PVI eyes, e.g. the latter still retaining some amount of 'useful' vision, in this paper we have grouped the two categories under the single "PVI" appellation.

MATERIALS AND METHODS

The prospective study comprised 88 unilaterally PVI subjects (UPS) and 97 bilaterally sighted subjects (BSS), male and female with essentially clear media, capable of steadily fixating targets for brief periods and was performed at a single clinical site.

Inclusion Criteria

1. UPS group: Profound visual impairment or unsighted in one eye (best-corrected visual acuity less than 20/400) and normally-sighted (best-corrected visual acuity better than or equal to 20/20) in the fellow eye.
2. BSS group: Best-corrected visual acuity better than or equal to 20/20 in both the eyes.
3. Both eyes with essentially clear ocular media as judged by biomicroscopic examination, i.e. media that are sufficiently clear so auto-refraction can be performed.
4. Ability (judged by external pen-light examination) to steadily fixate a target with the sighted eye.

Exclusion Criteria

1. Any anterior segment injury or pathology in either eye that could compromise accommodation.
2. Nystagmus.
3. Aphakia or pseudophakia in either eye.
4. Use of any ophthalmic pharmaceuticals that could affect accommodation.
5. Patent vertical tropia exceeding 3 degrees (i.e. observed with more than 0.5 mm vertical deviation of the corneal light reflex).

This study followed the tenets of the Declaration of Helsinki. All subjects signed an Informed Consent document after the nature and possible consequences of the study were explained. Following approval by the Institutional Ethics Committee, potentially eligible subjects who presented at the Hyderabad Eye Institute clinic were invited to attend the study visit on the same day. The 97 BSS were recruited from staff and students at the Institute. Following signing of the Informed Consent document, an ophthalmic examination was performed.

Of the 88 UPS, 55 eyes had optic nerve pathology, 18 had retinal pathology, 12 eyes had profound amblyopia and 3 glaucoma.

With the subjects fixating a 4/40 target at 4 m which is equivalent to 20/200, five distance refraction measurements were obtained using an infra-red auto-refractor (Shin-Nippon N Vision- K5001, Tokyo, Japan). This was followed by two sets of five measurements of near refraction at two accommodative states using an N8 (20/50 equivalent) fixation target at 40 cm, and then at 33 cm. Where necessary, when refracting a PVI eye with tropia, the

instrument was adjusted to ensure refraction was measured as close as possible to an on-axis alignment. Fixation targets used were aligned to be on-axis with the auto-refractor for both distance and near auto-refractions of the sighted eye. The fixation targets were off-set when a PVI eye with tropia was refracted. The positioning of the off-set fixation targets was such that the strabismic, PVI eye was correctly aligned with the measurement axis of the instrument. Alignment of the PVI eye's visual axis with the instrument's measurement axis was approximated by shifting the position of the fixation target by an angular offset equal to the estimated angle of tropia. However the deciding criterion confirming correct alignment was the appearance of reference points on the image of the eye on the instrument's LCD screen. Measurements were performed without mydriatics.

For BSS, a long-pass filter (75 mm × 75 mm Kodak Wratten #87 infrared transmitting filter; cutoff wavelength 740 nm) was placed over one eye to simulate unilateral blindness. As both eyes are sighted for BSS, the fixating was denoted as the "sighting eye" and the fellow non-fixating eye was denote the "filtered eye", corresponding experimentally to the "sighted eye" and "PVI eye" of the UPS respectively. To confirm that the infrared filter had no effect on the measured refractions, distance auto-refraction with and without filtering was performed on 102 subjects in a preliminary study and no significant difference between the two measurements in spherical equivalent parameter was observed ($P=0.79$).

The spherical and cylindrical refractive errors obtained from the distance and near auto-refractions of both eyes in both groups were converted to power vectors using published equations:¹¹

$$J_{45} = -C/2 \sin 2\alpha$$

$$J_{180} = -C/2 \cos 2\alpha$$

where C is the cylinder, α the cylinder axis, and J_{180} and J_{45} are the power vector components of the cross-cylinder components; J_{180} being the vertical/horizontal astigmatic component, and J_{45} the oblique astigmatic component. A total astigmatic power vector component, J, is also defined:

$$J = (J_{180}^2 + J_{45}^2)^{1/2}$$

Accommodative response (AR) was calculated as the difference between distance and near spherical equivalent;

$$AR = (D - N)$$

Where N is the spherical equivalent near refraction, and D is the spherical equivalent of the distance refraction

Statistical Analysis

Matched t-test was used to analyze differences in accommodation response measured directly in the sighted/sighting eye and indirectly in the PVI/filtered eye for each of the UPS and BSS groups and at both 40cm and 33cm.

Regression analysis on Bland-Altman plots was used to identify differences in accommodation response for sighted/sighting eyes and PVI/filtered eyes.

A generalized linear mixed model (GLMM) was used to analyze the difference in accommodation between sighted/sighting and PVI/filtered eyes as the criteria variable and group membership (UPS or BSS), age, refractive error (equivalent sphere) and average of accommodation for both eyes as predictors. Interaction terms were also tested including group by age, group by refractive error and group by mean accommodation.

RESULTS

To ensure good repeatable alignment of the eye to the auto-refractor had been achieved especially for the PVI/filtered eyes, we verified alignment indirectly using the results for astigmatism as the criterion. Since the typical eye is known to possess a pronounced oblique (radial) astigmatism aberration off-axis¹²⁻¹³, a change in the astigmatic power vector component (J) from distance measurement to near measurement will indicate that the two measurements have been made with different alignment of the eye to the auto-refractor; the greater the change in astigmatism, the greater the difference in alignment between the two measurements. While this, *per se*, does not check for correct alignment, it does check that alignment between distance and near measurements are comparable. Since it is known that accommodation measured in the periphery (i.e. peripheral refraction) differs only very slightly from that measured from central refraction¹³, ensuring repeatability of alignment should substantially eliminate errors in results for accommodation response due to misalignment.

Figures 1A and 1B are the cumulative frequency distribution of alignment criteria as difference in astigmatism (J) between distance and near measurements for UPS and BSS groups and the sighted/sighting and PVI/filtered eye. It can be seen that for both 40 cm and 33 cm target distances, the PVI eyes of the UPS group exhibited poorer alignment.

From Figures 1A and 1B, the 95th percentile for the BSS eyes and sighted eye of UPS lie below about 0.75 D. To reduce any between-eye or between-group errors or potential bias in the results that may be introduced due to misalignment, data in which the change in astigmatism components with accommodation was greater than 0.75 D was considered to be unreliable and excluded from the data set. This exclusion was conducted case-wise, i.e. if any of the four measurements (PVI eye at 40 cm, sighted eye at 40 cm, PVI eye at 33 cm, sighted eye at 33 cm) exhibited a change from distance total astigmatism (J) of greater than 0.75 D, the entire subject's results were excluded.

Descriptive statistics of the UPS and BSS subjects entered into the study are summarized in Table 1.

Applied to these data, the exclusion criterion reduced the final data set for analysis to 64UPS and 95BSS subjects. Of the UPS included for analysis, 44 eyes had optic nerve pathology, 10 eyes had retinal pathology, 7 eyes had profound amblyopia and 3 glaucoma.

The mean ($\pm$ 1SD) accommodative responses for targets at 40 and 33cm distances of all the groups are given in Table 2. Bland-Altman plots of difference in accommodation response between PVI and sighted eyes for UPS group are given in Figure 2A. Bland-Altman plots of difference in accommodation response between filtered and sighting eyes for BSS group are given in Figure 2B. Matched t-test showed that for the UPS group, there is no statistically significant difference between sighted (direct) and PVI (consensual) eyes in their accommodation response ($p=0.981$ and $p=0.663$ respectively for target distances of 40 cm and 33 cm). For the BSS group, there were differences between sighting (direct) and filtered (consensual) eyes in their accommodation response ($p=0.006$ and $p<0.001$ respectively for target distances of 40cm and 33cm). However, the differences were very small, being $-0.098D$ (i.e. filtered eye accommodating less) and $-0.189D$ for 40cm and 33cm, respectively.

Regression analyses (Table 3) on the Bland-Altman plots showed a statistically significant association between differences in accommodation response between eyes and the mean of the two eyes in accommodation response for the UPS group ($p=0.03$ and $p<0.01$ for 40cm and 33 cm, respectively). The slopes ($0.19D/D$ and $0.20D/D$) suggest that the PVI eye accommodates more than the sighted eye by about $0.2D$ per diopter of accommodation. The same regression analyzes did not reach statistical significance for the BSS group ($p=0.77$ and $p=0.11$ for 40cm and 33cm, respectively).

Output from the GLMM analysis is shown in Table 4. At 40 cm target distance, the only significant predictor variable is group by mean accommodation ($p=0.037$).

The number of predictive variables increases for 33 cm target distance. Within the main effects, age ($p<0.001$), spherical equivalent of sighted/sighting eye ($p = 0.025$), and mean accommodation response ($p=0.007$) are statistically significant predictors while the interaction effect of “group by mean accommodation” is also a predictor ($p=0.004$).

DISCUSSION

In this study, we attempted to identify any difference in the accommodation response between the sighted eye of a UPS individual receiving accommodation stimulus directly, and the consensual accommodation of the PVI eye. We also applied the same procedure to normally-sighted (BSS) individuals to determine whether any differences identified are due to the method of stimulation of accommodation.

From the t-test results, averaging consensual accommodation response across each group indicated that while there is no difference between sighted and PVI eye in the UPS individual, there was a statistically significant difference between the sighting (directly stimulated) and filtered (consensual) eyes in the BSS individuals. This difference was small, equating to less than $0.5D$ and so may be considered negligible in experiments involving large amplitudes of accommodation. Ball using his objective method and $1D$

accommodation stimulus found the average unequal accommodation to be 0.106D in ten normal subjects.⁴ With accommodation stimulus ranging up to 7D, another group found the 'consensual interocular lag' between eyes to be less than 0.8D for three normal subjects assessed using letter targets.⁴ In this study, within the BSS (normal) group, the filtered (non-sighting) eye accommodated 0.1 to 0.2D less than the sighting eye on average. This suggests that our measurement method and results are comparable to those of the earlier studies.

While the t-test results suggested no difference in consensual accommodation response overall for the UPS group, the GLMM results provided some additional insight.

Firstly, results with the 33cm target produced more statistically significant predictors of accommodation than with the 40cm target. In addition to the interaction effect of "group by mean accommodation" as a significant predictor for both target distances, at 33cm, age of subject, spherical equivalent and mean accommodation were also significant. One reasonable explanation is a 'flooring effect' in that the amplitude of accommodation elicited at 40cm may be insufficiently large above measurement uncertainties to reveal the contributions of the other effects.

Assuming this 'signal above noise' explanation, greater consideration of the nearer target results might provide more insight.

It is of particular interest that the interaction effect of "group by mean accommodation" is a predictor of the difference in accommodation response between the two eyes. The (negative) direction of the coefficient associated with this predictor and the group coding within the GLMM (normally-sighted is positive) indicate that the association of the difference in accommodation response between eyes of the same subject and the mean accommodation response of both eyes, differs between UPS and BSS individuals. Specifically, the magnitude of difference in accommodation response between PVI and sighted eyes is greater for the UPS individuals than that between filtered and sighting eyes in the BSS individuals for an equal increase in amplitude of accommodation response. This is also reflected in the bivariate regression analysis of Table 3 and the Bland-Altman plots of Figure 2.

Thus, as accommodation response increases, consensual accommodation in the PVI eye of the UPS individual increases relative to the directly stimulated, sighted eye. This phenomenon is not seen in the consensual accommodation response of the normally-sighted BSS individuals.

It must be emphasized here that the intercepts (from Table 3, -0.30D and -0.43D for 40 cm and 33cm) need to be taken into consideration. At low accommodation response (below about 2 D), the absolute difference between PVI and sighted eye is reversed with the sighted eye producing more accommodation than the PVI eye. By extrapolation of the regression equation for the 33cm target distance results, the absolute difference between PVI and sighted eye for UPS individuals would not exceed 1D until the accommodation response exceeds 7D. Thus, while this interaction effect may be statistically significant, it may have little practical relevance.

It is important to note that the age range for both groups included some near-presbyopes and possibly early presbyopes. These subjects may account for some of the lower accommodative responses in our measurements, presumably for both BSS and UPS groups. Thus, the relationship found by the GLMM that the difference between PVI and sighted eyes increases as accommodation increases might be at least partially an effect of age rather than accommodation amount per se. However, in the GLMM, the group by age interaction terms were not statistically significant ($p=0.19$ and 0.47 for 40cm and 33cm target respectively) suggesting that the difference found between the UPS group and BSS group is unlikely to be attributable to age. An additional factor that could possibly influence the results for the UPS group is the existence of peripheral vision in UPS subjects to guide accommodation. Of the sixty-six UPS subjects entered into the final analysis, the majority (44) of subjects had optic nerve abnormalities with little to no functional peripheral vision. A smaller portion (20) suffered from amblyopia and localized retinal abnormalities (e.g. macular hole, BRVO, CRVO). Thus, while a few of these subjects may have some peripheral vision to guide accommodation in the PVI eye, considering their relative portion in the group as well as the anticipated driving influence of the sighting eye in accommodation, we do not expect surviving peripheral vision to unduly influence the overall results.

One final point regarding the findings. The above hypothesis tests and findings were based on parametric statistical tests of inferences (t-test, linear regression and general linear model). It is understood that the robustness of parametric statistical tests may be unduly affected if the data departs significantly from a normal distribution. We tested whether our findings may have been thusly influenced. We used the Kolmogorov-Smirnov test for normality for each of the groups (BB/UPS) and test distances (40/30cm). Data sets were found to be not significantly different from a normal distribution ($p=0.158$ to 0.200) except for the criteria variable 'difference in accommodation between PVI and sighting eyes' used in the general linear model ($p=0.016$). Follow-up analyses revealed that the departure from normality was caused by three outliers rendering the distribution kurtotic. Re-running all statistical analyses with these three outliers removed did not change any of the statistical findings in terms of their statistical significance or non-significance. Thus, we conclude that the findings were unlikely to have been biased due to the application of parametric tests. In normal individuals, consensuality of accommodation is a well-established phenomenon. In this study, the small but detectable difference in consensual accommodation response, with the PVI eyes in the UPS groups showing less 'interocular lag' than the normal BSS subjects, points to the presence of an additional or modification to an existing unilateral control mechanism. The relevance of this in refining our understanding of the control system for accommodation warrants further investigation.

Cataract extraction with implantation of conventional, single-focus intraocular lenses has become a safe and effective procedure. As successful as this surgery has been, the visual outcome is limited by the absence of accommodative function, and several approaches, such as accommodating intraocular lenses and lens re-filling procedures have been proposed to address this shortcoming¹⁴⁻¹⁶. While human, unilateral 'blind-eye' trials might be a practical testing-ground to evaluate some of these experimental procedures, thus far, the validity of interpretation of results from such studies would be questionable given the dearth of knowledge on consensual accommodation in such eyes. This study demonstrated that

differences between accommodation in the PVI and sighted eye is not statistically significant when averaged over all subjects and amplitudes of elicited accommodation. Yet, this study also showed that the difference between eyes is correlated with the amount of accommodation actually elicited. Initially, at levels of accommodation below about 2 D, the PVI eyes accommodated less than its sighted fellow eye in a manner similar to normal individuals. However, as accommodation increase to above about 2D, the PVI eyes gradually begin to accommodate more than the normal fellow eyes. This suggests that, should such patient-types be used in studies of the accommodative performance of solutions for presbyopia, results from low amplitude devices may be treated similarly to results from normal individuals. But for high amplitude devices or solutions, a correction factor to compensate for potential over-estimations of accommodative performance may need to be applied. Such a correction factor may be based on the equations of Figure 2A.

This study has provided new data on the consensual accommodative response of unilateral PVI eyes, and proposes a method for excluding accommodative measurements rendered inaccurate by off-axis measurement in PVI eyes.

We observed that consensual accommodation in PVI eyes is comparable to the fellow, sighted eye's accommodative response within the range of accommodation response elicited. For the evaluation of accommodative devices and surgical restoration of accommodation, the findings suggest that at low to medium amounts of accommodation, no correction is required for measured accommodation elicited consensually in a patient. However, should the accommodation response become high, the error due to a greater consensual accommodation in the PVI eye might need to be taken into account.

CONCLUSIONS

The PVI eyes of unilaterally-blind individuals who exhibited repeatable fixation alignment display similar accommodative response to their fellow sighted eyes when accommodation is elicited by presentation of near target of up to 3 D to the fellow, sighted eye.

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Figure 1.

Cumulative frequency distribution of the alignment criteria based on the difference in astigmatism between distance and near refraction at (A) 40cm and (B) 33cm, for UPS and BSS groups and for both sighted/sighting and PVI/filtered eyes.

Figure 2.

Bland-Altman plots of difference between eyes versus mean accommodation response for the two eyes for (A) UPS and (B) BSS groups at 40 and 33cm target distances. Regression lines for 40cm (—) and for 33 cm (---) are shown as well as 95% confidence limits for 40cm (- - -) and 33 cm (— - —). The regression equations for 40cm are $D=0.19A-0.298$ (for UPS) and $D=-0.019A-0.067$ (for BSS) and for 33cm $D=0.19A-0.298$ (for UPS) and $D=-0.097A+0.007$ (for BSS) where D is the difference between eyes and A the average.

Table 1

Descriptive statistics of UPS and BSS groups for initial subjects entered into the study and final subjects (subjects with poor alignment excluded) analyzed. Means sphere and astigmatism values are for the PVI/filtered eye.

	Unilaterally PVI		Bilaterally Sighted	
	Subjects (UPS) Mean $\pm$ S.D (Range)		Subjects (BSS) Mean $\pm$ S.D (Range)	
	Initial	Final	Initial	Final
	(all subjects entered)	(selected for good alignment)	(all subjects entered)	(selected for good alignment)
Sample Size	88	64	97	95
Age (yr)	27.5 $\pm$ 9.4	28.3 $\pm$ 9.3	28.7 $\pm$ 6.8	28.77 $\pm$ 6.87
	(10 – 45)	(11 – 45)	(19 – 43)	(19 – 43)
Gender	27 female	22 females	26 female	24 female
	61 male	42 males	71 male	64 male
PVI/Filtered Eye	46 OD	31 OD	94 OD	87 OD
	42 OS	33 OS	3 OS	1 OS
Spherical Equivalent (D)	0.11 $\pm$ 3.036 (-14.31 – +16.12)	0.26 $\pm$ 2.65 (-9.18 – 16.12)	0.10 $\pm$ 0.49 (-0.88 – +1.56)	0.08 $\pm$ 0.44 (-0.88 – 1.44)
J180 (D)	0.09 $\pm$ 0.58 (-2.58 – 1.97)	0.05 $\pm$ 0.25 (-0.59 – 0.54)	0.11 $\pm$ 0.22 (-0.79 – 0.85)	0.11 $\pm$ 0.18 (-0.31 – 0.85)
J45 (D)	0.11 $\pm$ 0.42 (-1.12 – 1.53)	0.05 $\pm$ 0.21 (-0.43 – 0.81)	0.03 $\pm$ 0.16 (-0.46 – 0.52)	0.04 $\pm$ 0.15 (-0.29 – 0.52)

Table 2

The mean ($\pm$ SD) accommodative responses of all the groups for 2.50 D and 3.00 D stimulus.

Accommodative stimulus (D)	Unilaterally PVI		Bilaterally Sighted	
	Subjects (UPS)		Subjects (BSS)	
	Sighted eye Accommodative Response (D) Mean $\pm$ S.D (Range)	PVI eye Accommodative Response (D) Mean $\pm$ S.D (Range)	Sighting eye Accommodative Response (D) Mean $\pm$ S.D (Range)	Filtered eye Accommodative Response (D) Mean $\pm$ S.D (Range)
2.50	1.57 $\pm$ 0.66 (-0.25 – 2.50)	1.57 $\pm$ 0.78 (-0.75 – 3.15)	1.69 $\pm$ 0.51 (0 – 2.50)	1.59 $\pm$ 0.50 (-0.19 – 2.43)
3.00	2.06 $\pm$ 0.85 (-0.38 – 3.37)	2.03 $\pm$ 1.02 (-0.43 – 4.08)	2.11 $\pm$ 0.68 (-0.06 – 3.12)	1.92 $\pm$ 0.62 (-0.37 – 2.81)

Table 3

Regression analyses outcome on the Bland-Altman plots (Figures 2A and 2B) for UPS and BSS groups.

	Unilaterally PVI		Bilaterally Sighted	
	Subjects (UPS)		Subjects (BSS)	
	40 cm	33 cm	40 cm	33 cm
intercept (D)	-0.30	-0.43	-0.07	0.01
slope (D/D)	0.19	0.20	-0.02	-0.10
r coefficient	0.27	0.36	-0.03	-0.17
p-value	0.03*	<0.01*	0.77	0.11

Table 4

Output from generalized linear mixed model with difference in accommodation response between sighted/sighting and PVI/filtered eyes as the criteria.

	40 cm target distance		33 cm target distance	
	coefficient	p-value	coefficient	p-value
Constant	-0.329	0.153	-0.911	<0.001*
Main Effects				
Group (UPS vs BSS)	0.351	0.128	0.348	0.157
Age	0.004	0.374	0.018	<0.001*
Spherical Equivalent	-0.027	0.647	-0.134	0.025*
Accommodation	0.105	0.121	0.152	0.007*
Interaction Effects				
Group x Age	-0.007	0.190	-0.004	0.470
Group x Spherical Equivalent	0.074	0.203	-0.033	0.579
Group x Accommodation	-0.143	0.037*	-0.161	0.004*

* indicate statistical significance with $p < 0.05$