Design and efficacy of a dual-focus soft contact lens for slowing myopia progression

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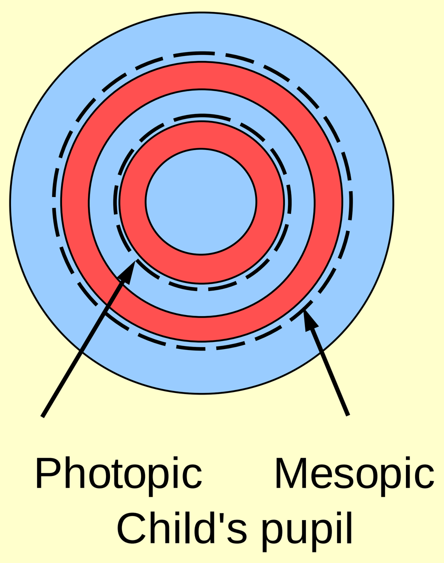
Purpose

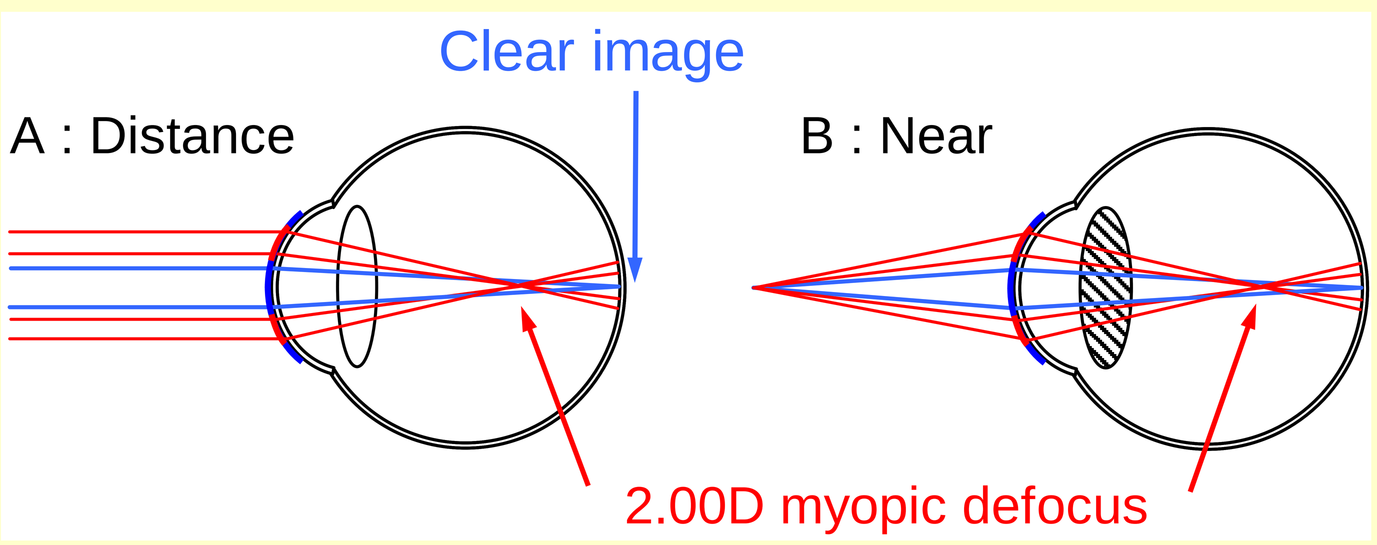
To report the design, efficacy and clinical potential of a Dual-Focus soft contact lens for slowing childhood myopia progression.

Methods: Dual Focus (DF) soft CL's



- designed for children's large pupils.
- **'Correction'** zones (blue), correct the refractive error.
- **'Treatment'** zones (red) provide 2.00 D of simultaneous myopic retinal defocus.

DF lenses: Visual Function



Accommodation: Children accommodate while wearing DF lenses (reported previously: Anstice, 2006*). Thus, correction zones provide a clear retinal image and treatment zones create 2.00 D of simultaneous myopic retinal defocus **during both distance (A) and near (B) viewing.**

Vision: Visual Acuity Rating (VAR: 100 ≡ 20/20 Snellen) with DF lenses (99.9 ± 3.5) and with Single Vision Distance (SVD) lenses (100.2 ± 2.9) were not different ($P = 0.68$, n = 40).

Contrast Sensitivity: Pelli Robson): mean log contrast sensitivities with DF lenses (1.56 ± 0.97) and with SVD lenses (1.58 ± 0.10) were not different ($P = 0.21$)

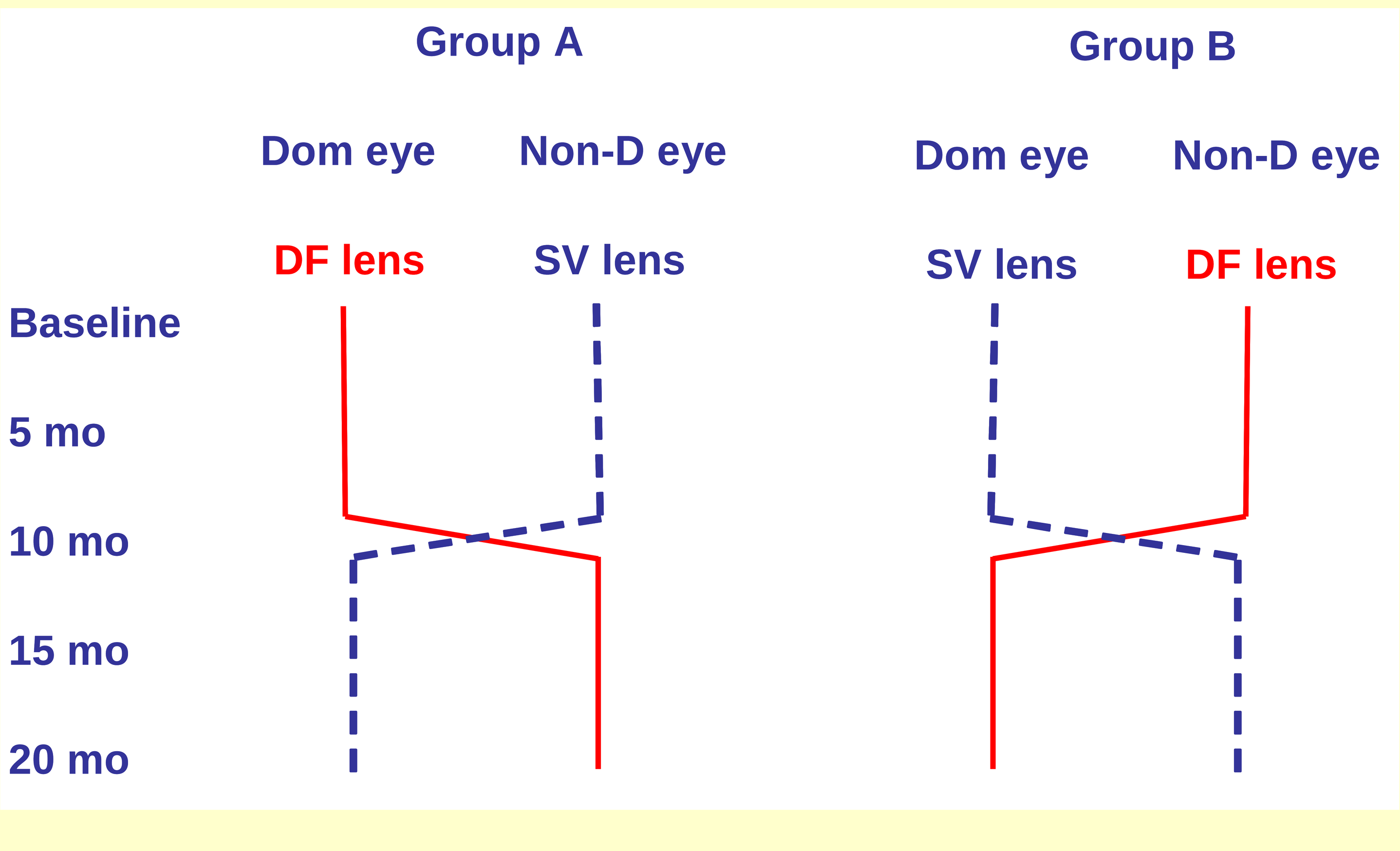
Study Design

Paired eye control: one eye wore the DF lens, the other wore a SVD lens; lenses were crossed over between eyes at 10 months. Group A wore the DF lens in the dominant eye first; Group B wore the DF lens in non-dominant eye first.

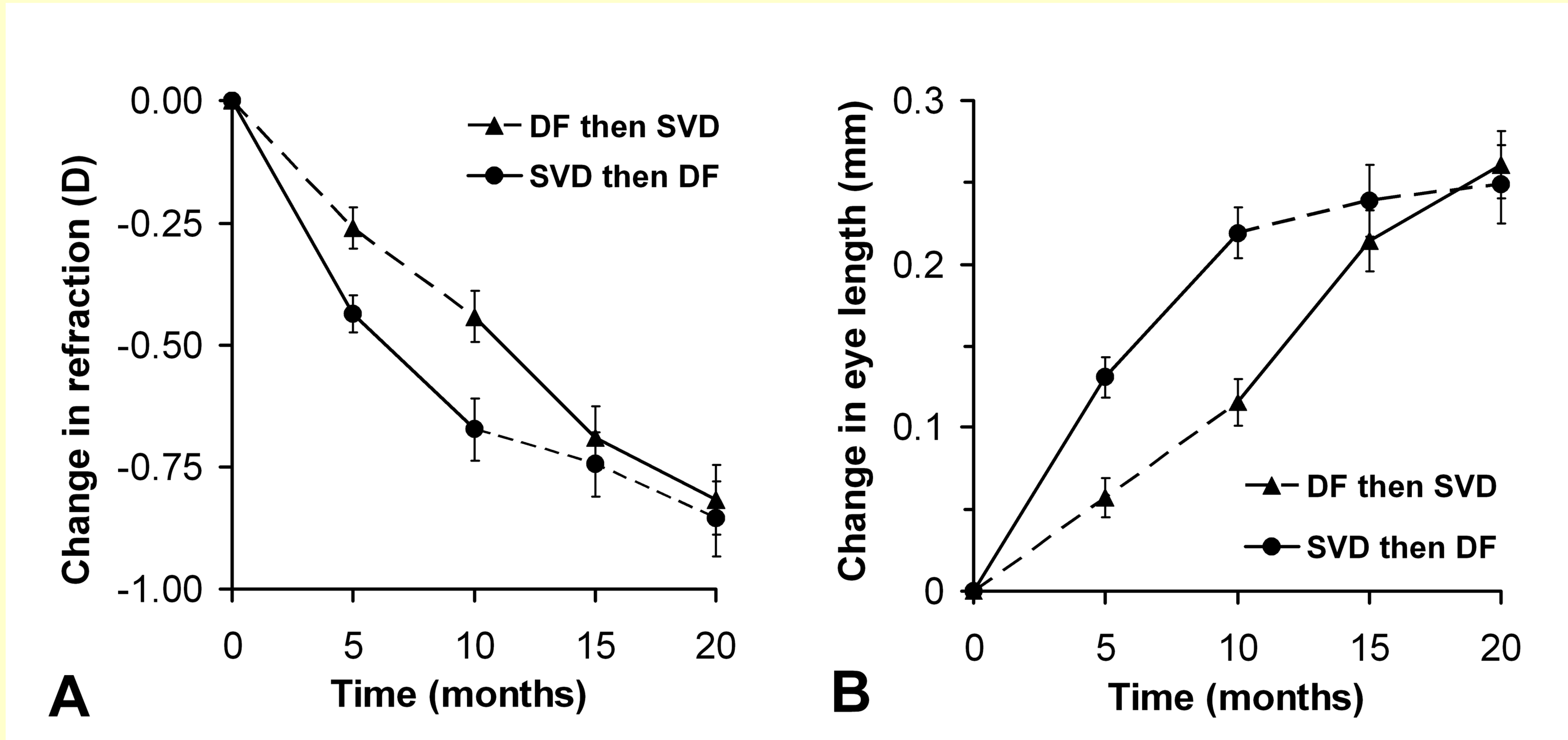
Participants: 40 children (11 - 14 yrs old) with progressing myopia: mean Spherical Equivalent Refraction (SER) at base-line: Group A = -2.86 ± 1.08 D: Group B = -2.46 ± 1.09 D ($P = 0.25$)

Outcome measures:

- Investigator-masked measures
- Change in SER (cycloplegic autorefraction) and
- Change in axial eye length (AXL) measured with IOLMaster at baseline, 5, 10, 15 and 20 months.

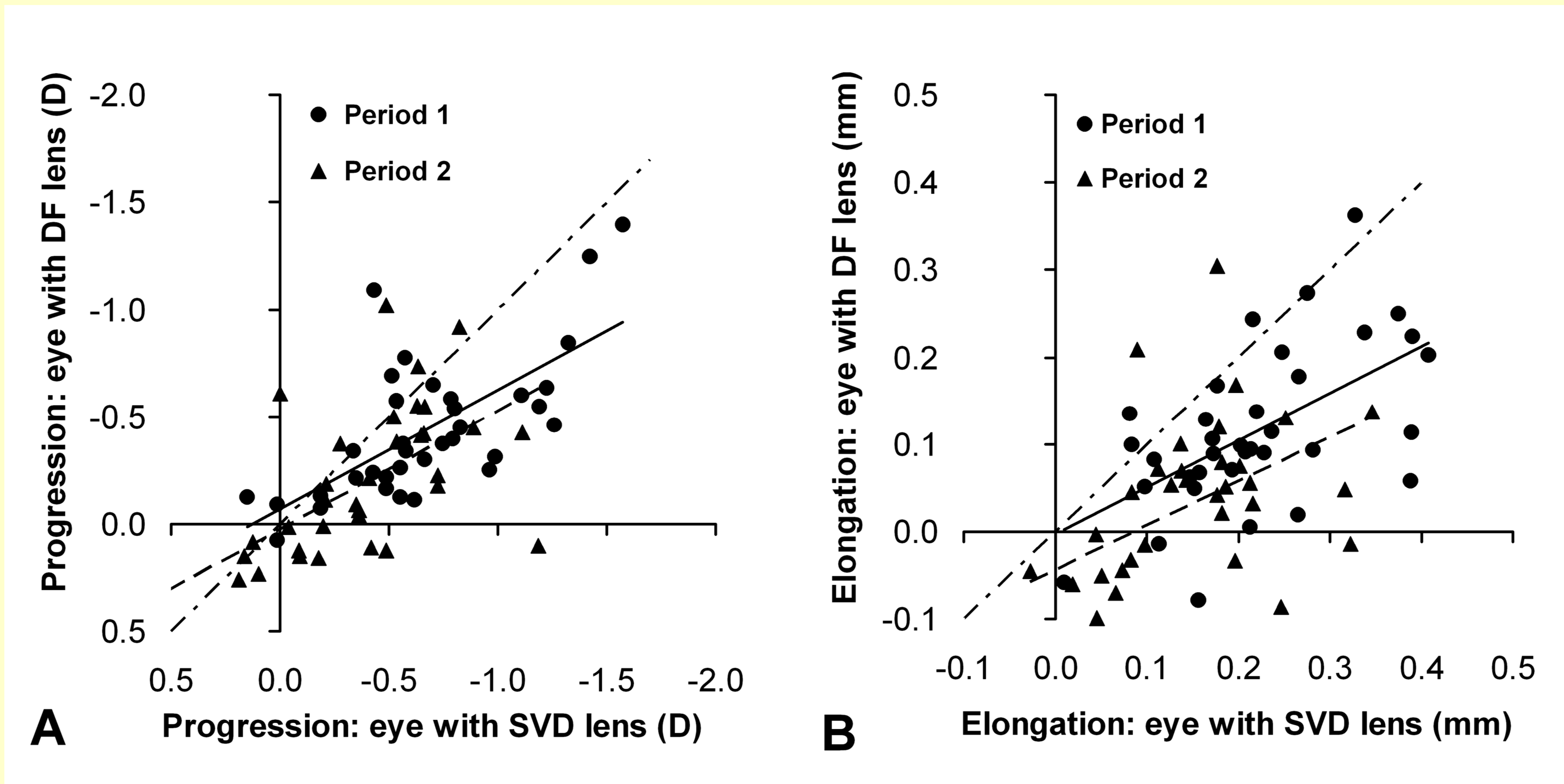


Results: mean data



Mean change in (A) SER (± 1 SEM) and (B) axial eye length over 20 months (n = 36). Dashed lines show periods of DF lens wear; solid lines show periods of SVD lens wear. During Period 1, the mean change in SER was significantly less ($P < 0.001$) with DF lenses (-0.44 ± 0.33 D) than with SVD lenses (-0.69 ± 0.38 D). Mean change in AXL was also less ($P < 0.001$) with DF lenses (0.11 ± 0.09 mm) than with SVD lenses (0.22 ± 0.10 mm)

Efficacy in individual children



Slopes of regression lines indicate that the ratio of progression with DF lenses vs progression with SVD lenses was approx 0.55 : 1 for progression between 0.0 and -1.50 D in each of the 10 month periods.

In Period 1, 70% of children had myopia progression reduced by 30% or more: 50% had progression reduced by 50% or more and 20% had progression reduced by 70% or more in the eye wearing the DF lens relative to the eye wearing the SVD lens.

Conclusions

The results suggest that myopia progression can be slowed significantly using DF soft contact lenses which are a safe and familiar option for refractive correction. In a clinical setting, a practitioner could set a treatment target (e.g., 30% reduction), prescribe DF lenses (or other available technology) and then monitor progression in a similar manner to glaucoma treatment protocols which employ targets for reducing intraocular pressure

** **Anstice NS, Phillips JR.** Accommodative Status of Adolescents Enrolled in the DIMENZ Trial. 11th International Myopia Conference, Singapore, August 2006.*

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nz national eye centre

SPECTACLES WITH SPECIAL PERIPHERAL POWER PROFILE AND THEIR IMPLICATION ON WEARER'S COMFORT

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PURPOSE

Defocus and its sign in the peripheral retina is proposed to promote refractive development. This opens the possibility of new spectacle lens designs that reduce relative peripheral hyperopia in the eye.
Due to the new lens design with large peripheral power gradients, the wearing comfort has to be tested thoroughly. Therefore, the aim of this study is

1) to generate spectacle lenses with special peripheral power profiles,
2) to investigate the implication of the lenses on wearer's comfort.

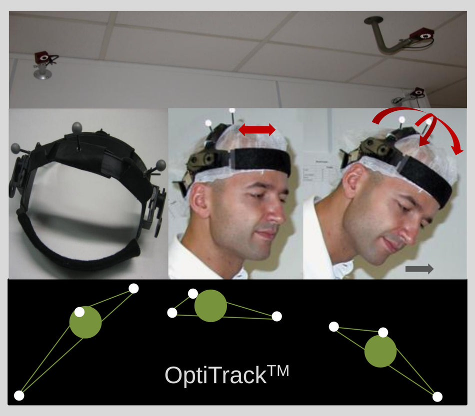
METHODS

Optical lenses

Proprietary optimization software and CNC freeform manufacturing process of Rodenstock to develop and produce the lenses (Individual Lens Technology).

Visual performance and wearability

Head tracker system to study effects on head movement patterns (OptiTrack™). **Subjective test** Questionnaire to evaluate the implication on wearer's comfort.



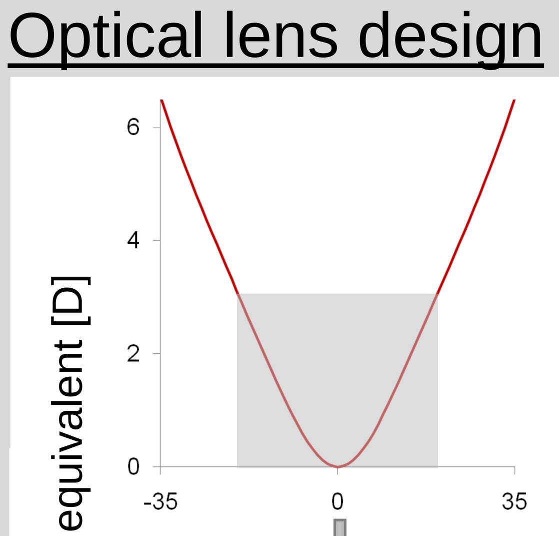
Subjects

5 subjects, emmetropic in relation to demanded distances (-1.0 to +0.5D, age range: 26-42 years).

Measurement conditions

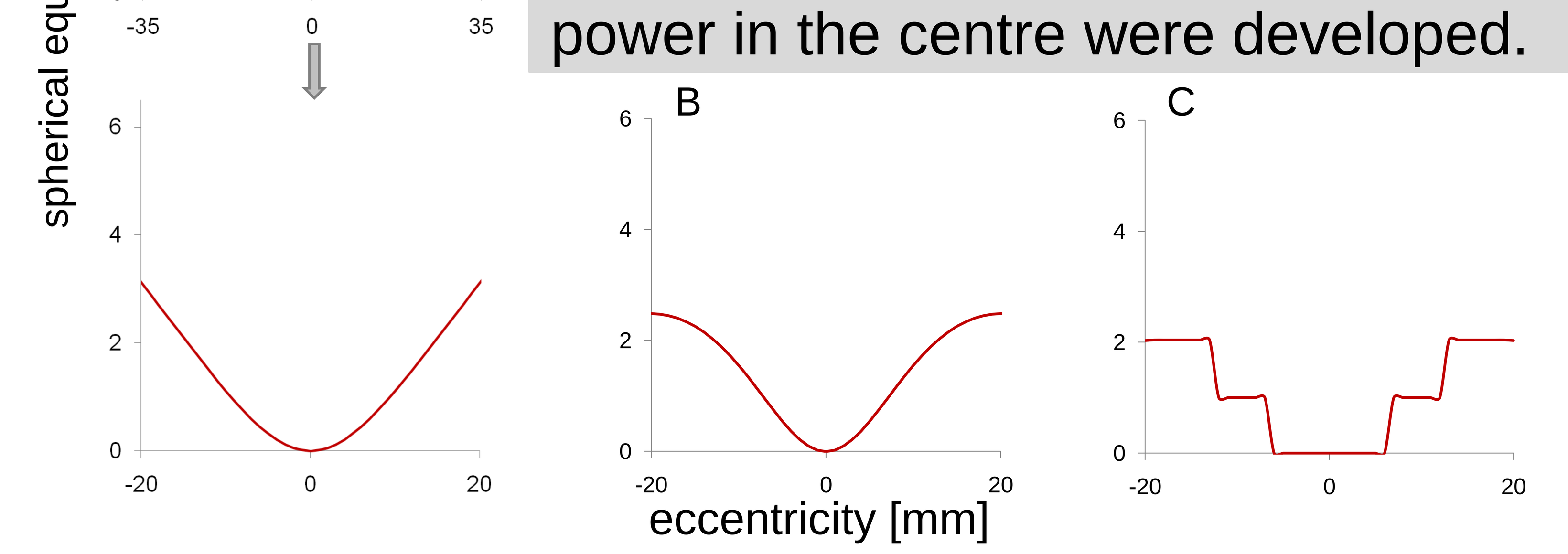
Typical PC work place with 2 distances:
computer screen at ≈ 70 cm (≈ 32 deg angular size), "near task" at ≈ 48 cm (≈ 40 deg angular size).
Viewing tasks 1) reading 2.5 lines at the top of the screen, 2) reading 2.5 lines at the bottom of the screen, 3) comparing 2 pictures + finding errors.
Lenses fitted binocularly into a trial frame (diameter 38mm).
Conditions: 3 lenses and the trial frame to evaluate the effect by itself.

Optical lens design



Since the trial frame limited the diameter to 38 mm, fig. A – C show the power profile of lenses within this area.

2 lenses (A + B) with different steadily increasing radial spherical equivalent and 1 lens (C) with stepwise radial increasing positive power, all with 0 power in the centre were developed.

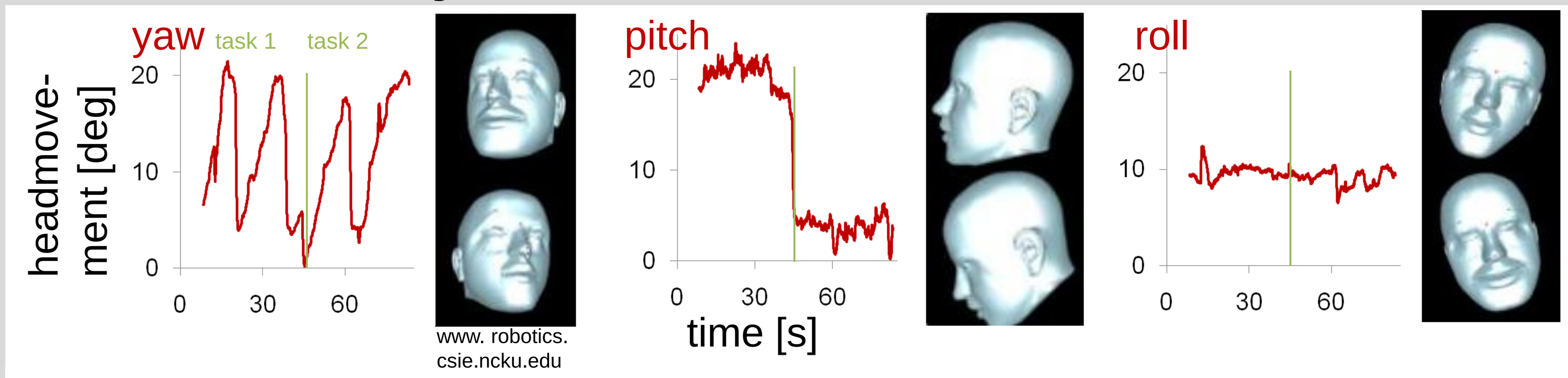


A: variation of spherical equivalent increases 1 D/10deg
B: steeper increase of spherical equivalent (not shown: in- and decreasing astigmatism)
C: refractive power increases stepwise to reduce astigmatic errors

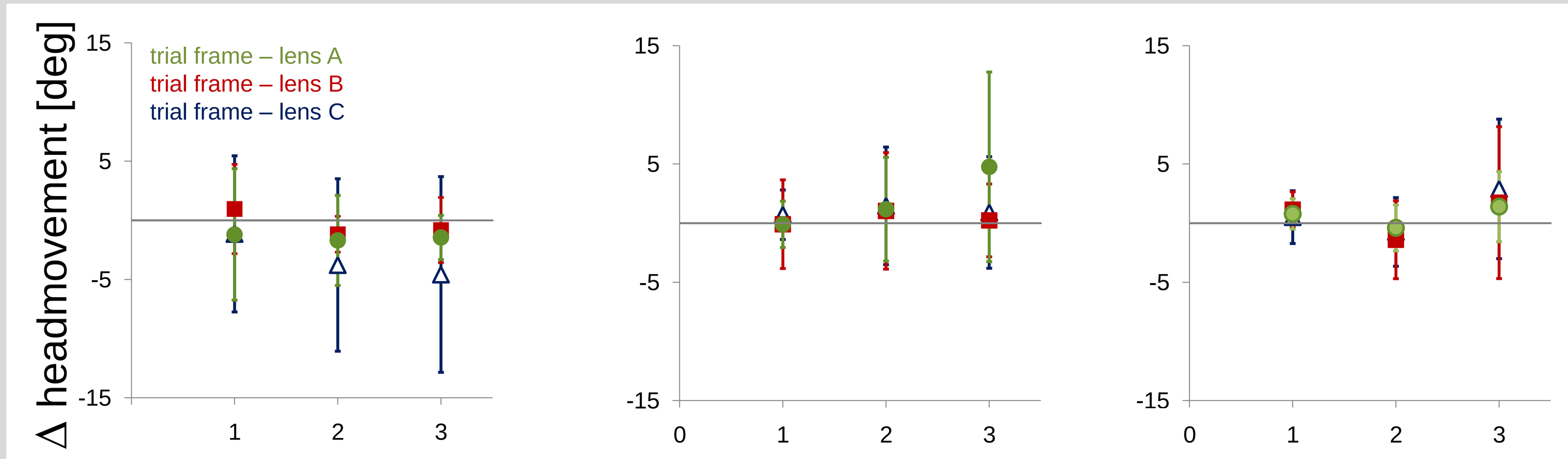
RESULTS

Visual performance and wearability

Head tracker system



Example of measurement for one subject viewing task 1 + 2.

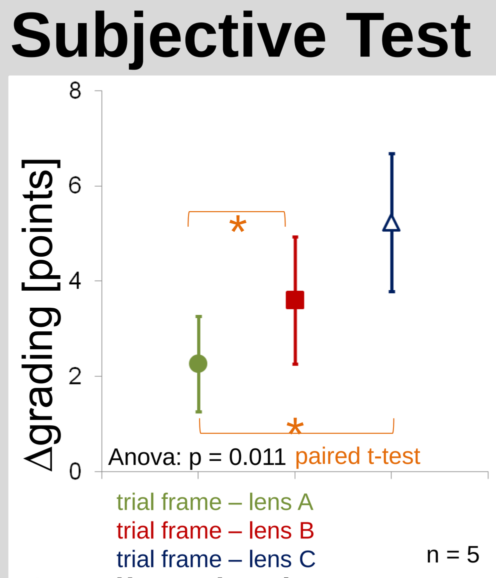


Yaw: no significant effect of the lenses (paired t-test, Anova). Lens C: slightly larger SD + slightly more headmovement
Pitch: no significant effect of the lenses (paired t-test, Anova)
Roll: no significant effect of the lenses (paired t-test, Anova)

Mean difference of headmovement while wearing "no lens" and wearing special lenses.

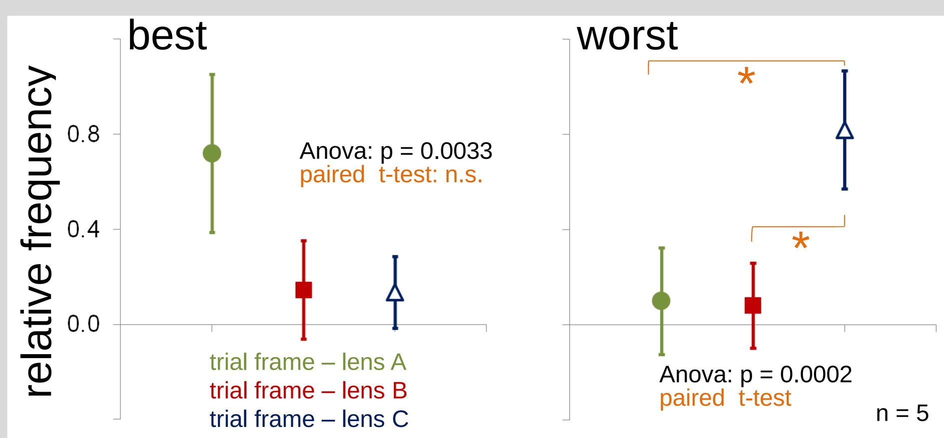
There is a slight trend (n. s.) of lens' influence on head movements performing computer and near tasks.

Subjective Test



Grading the lenses relative to trial frame

Questionnaire:
Subjects assess the lenses significantly different at a scale from 0 to 10. Small number of grading points hint at no (0) or small differences between the tested lens and "normal conditions", high number at large or maximal (10) differences. Due to this lens A has the best rating. In relation to normal viewing conditions comparison between the lenses show significant differences, particularly between lens A and the other ones.



Mean relative frequency for the best and worse grading for each lens.
The frequencies of best and worst grade over all questions (19) were counted as well as the frequencies for each lens in every subject. The frequencies per lens divided by the frequencies of best or worst grade yield the relative frequency for each subject.

Subjects grade the tested lenses with different frequency as best or worst. Lens C is rated significantly more often as the lens with the largest difference compared to "no lens".

CONCLUSION

Lenses with different radial peripheral refractive gradients have been developed.
Measurements show no significant implications on head movements in contrast to earlier studies with similar lenses but larger frames (ARVO 09 #3981).
Using subjective tests, there are different implications of the tested lenses on wearer's comfort.
To understand the influence on wearer's comfort in more detail further studies are proposed.

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See better. RODENSTOCK

The Effects of Simultaneous Optical Defocus on the Development of Mammalian Refractive Errors

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Background

The exact mechanism of how emmetropization functions in the presence of multiple defocus planes is unclear. Using concentric dual-power lenses (Fig.1a), we have previously shown that avian retina can recognize and integrate longitudinal competing defocus. Here we sought to investigate whether competing plus and minus defocus are integrated in normal and myopic guinea pig eyes (Fig.1b).

Purpose

We sought to investigate how refractive error and eye growth in guinea pigs are influenced by competing plus and minus defocus (Fig.3a).

Fig. 1a. Fresnel dual-power lens

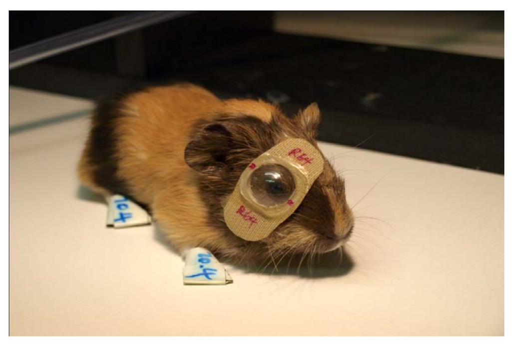

Fig. 1b. Guinea pig wearing a lens

Methods

Experiment 1: 65 guinea pigs were raised in white light (12 h light cycle) while wearing lenses in which the power either varied in consecutive concentric rings (fresnel dual-power: +5/-5D, 0/-5D, or 0/+5D) or was the same power throughout (single vision: +5D and -5D). A control group wore only the lens spacer (SP) mounting system without any lens. Lenses were attached using Velcro and worn from 4-15 days of age over one eye.

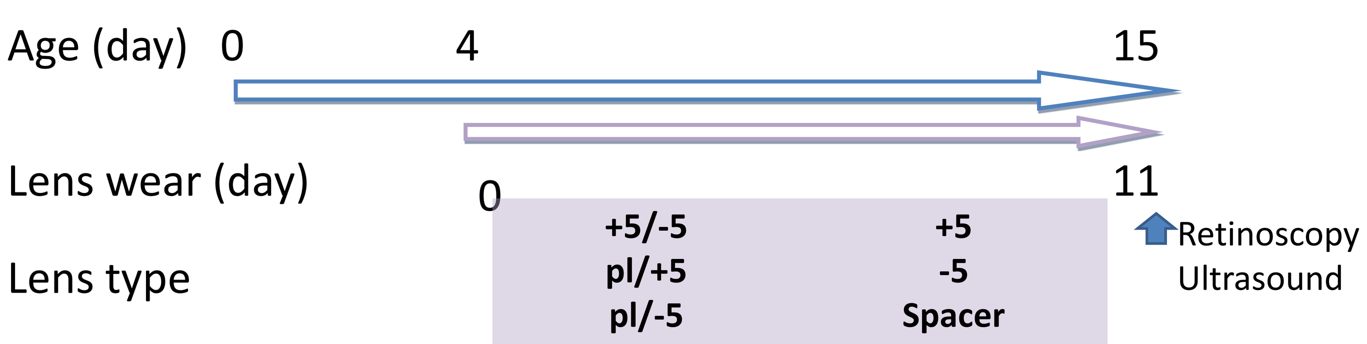

Fig. 2. Experiment 1 work flow

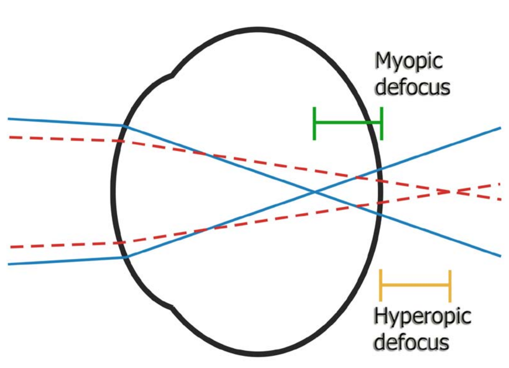

Fig. 3a. Defocus defined

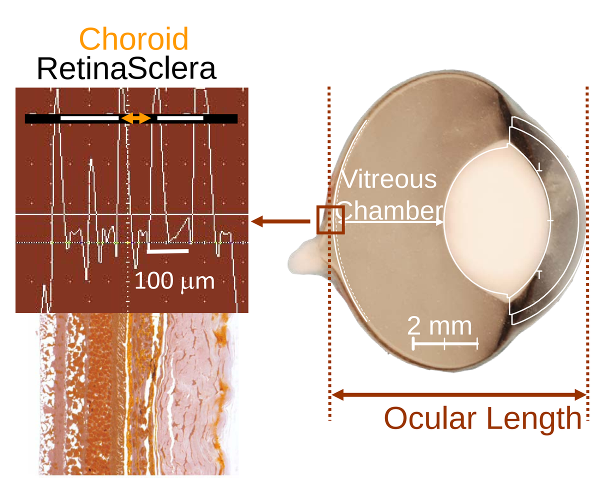

Fig. 3b. Ultrasound biometry with wave trace analysis

Experiment 2: 38 guinea pigs were made myopic by wearing a -5D lens over one eye for 4 days. Recovery from this myopia was studied over the following 14 days in 3 groups where the -5D lenses were either swapped with (1) +5D lens, or (2) a +5/-5D Fresnel lens, or (3) remained as -5D. Refractive error and axial dimensions were measured before and repeatedly during the recovery phase. One-way ANOVA and LSD post-hoc test were used for statistical analyses.

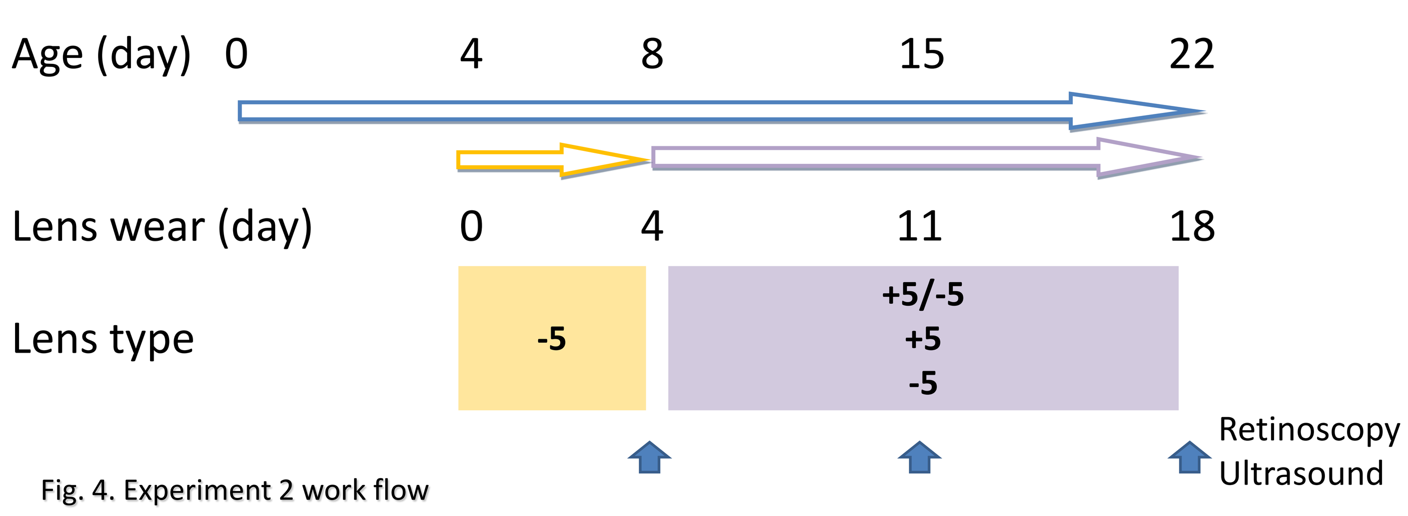

Fig. 4. Experiment 2 work flow

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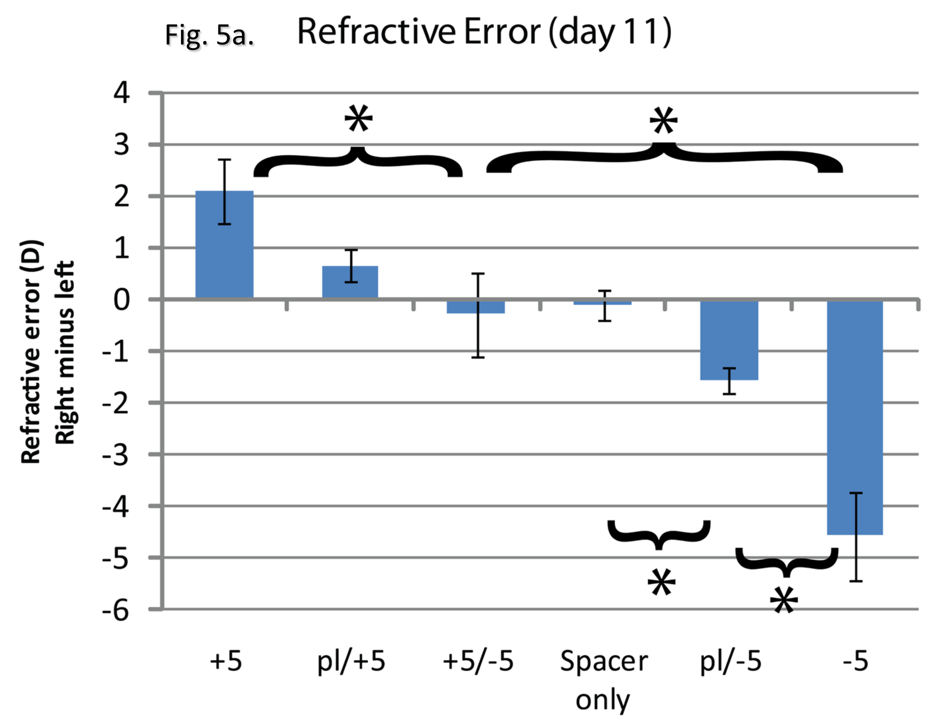
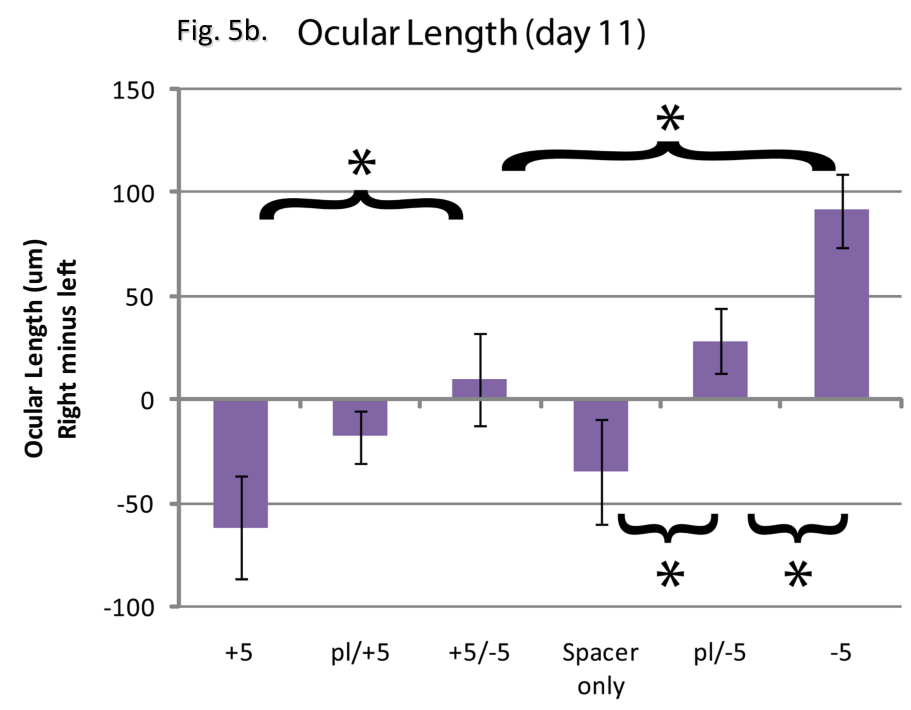
Results

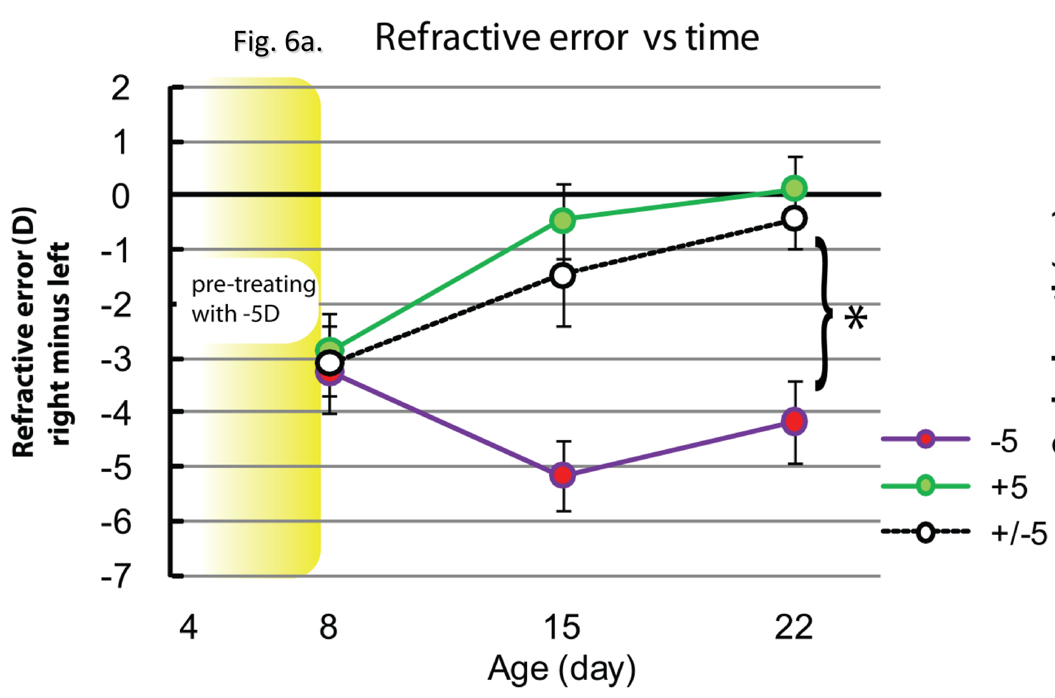


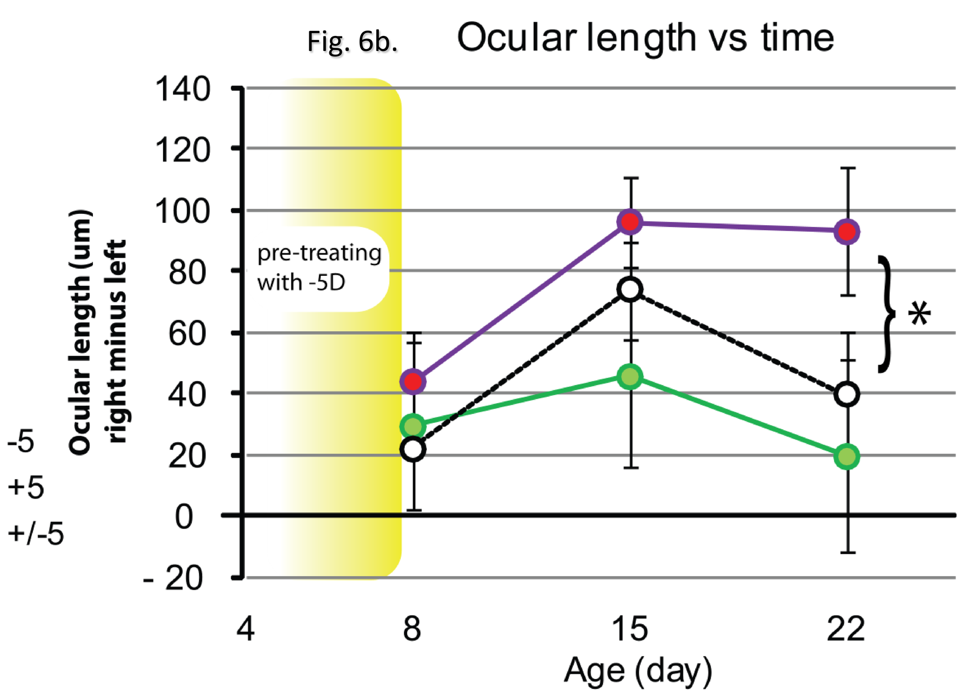


Experiment 1: After 11 days of lens wear, interocular differences in refractive error were +2.11, -4.56 and -0.09D for the +5D, -5D & SP groups respectively; and were -0.29, -1.56 and +0.66D for the +5/-5D, 0/-5D and 0/+5D groups respectively (Fig.5a).

Interocular differences in ocular length after 11 days of lens wear were -62, +91 and -34µm for the +5D, -5D & SP groups respectively; and were +10, +28, -18µm for the +5/-5D, 0/-5D and 0/+5D groups respectively (Fig.5b).

The +5/-5D group emmetropized to an intermediate set-point compared to those of the +5D group and -5D group ($p<0.05$). The 0/-5D group emmetropized to an intermediate set-point compared to those of the SP and -5D group ($p<0.05$). Its mean interocular refractive error was close to zero, and without the hyperopic shift like that previously shown in chicken.





Experiment 2: Eyes became about -3D myopic after 4 days of -5D lens wear. Two weeks after lens switching, the mean inter-ocular refractive error for the groups -5D, +5/-5D and +5D were –4.17, -0.43 and 0.12D respectively (Fig.6a). The +5/-5D group became significantly more hyperopic than the -5D group ($p<0.05$). The +5/-5D lens performed like a +5D lens in producing recovery from myopia, suggesting that the eyes were more responsive to the myopic defocus component (under competing defocus condition) when ocular growth had previously been accelerated.

Discussion and Conclusions

The mammalian eye was able to integrate opposite signs of defocus to modulate its growth. When myopic defocus is included in a dual-power concentric lens, it can inhibit the progression of myopia. This implies that similar dual-power lenses may inhibit myopia progression in humans while at the same time providing clear corrected vision. Hyperopic bias produced by opposing defocus, as reported in avian species, was found to be conditional in guinea pig.

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Family History, Near Work, Outdoor Activity and Myopia in Singapore Chinese Preschool Children

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Background

- Evidence shows that family history, near work and outdoor activities are important factors in determining myopia in children aged 6 years or more.[1-3]
- Our study aims to assess the roles of near work, outdoor activity and family history of myopia for early-onset myopia in Singapore Chinese children aged 6-72 months.

Methods

- The STrabismus, Amblyopia and Refractive error in Singaporean children (STARS) study is a population-based cross-sectional study of Chinese children aged 6-72 months old.
- Disproportionate stratified random sampling of 6-month age groups was performed.
- 3009 children (response rate = 72.3%) underwent eye examinations which included cycloplegic objective refraction using a hand-held autorefractor (Retinomax), a table mounted autorefractor (Canon RK-F1) and streak retinoscopy.
- Parents provided information on socioeconomic status, family history of myopia, children's near work and outdoor activities, and preschool activities. The outdoor activity questionnaire was similar to that used by the Sydney Myopia Study.[2]
- As the SER of the right and left eyes were highly correlated ($p<0.001$), only the right eye data were analysed.

Results

- The mean age of the children was 40.5 ± 18.6 months.
- The mean spherical equivalent refraction (SER) was 0.69 D ± 1.15 D.
- Based on cycloplegic refraction and myopia defined as SER < -0.5 D, the prevalence of myopia was 11.4% (95% Confidence interval (10.2, 12.7)) in very young age group.

Table 1. Risk factors Associated with Myopia among Singapore Chinese Preschool Children

	Myopia at least -0.5 D			
	Multivariate Odds Ratio*	95% Confidence Interval		*P*
Age (month)	0.97	0.95	0.99	0.01
Girl versus boy	1.02	0.79	1.31	0.91
Height (cm)	1.02	0.98	1.05	0.34
One myopic parent versus no myopic parents	1.04	0.75	1.46	0.81
Two myopic parents versus no myopic parents	1.91	1.38	2.63	<0.001
Time spent Outdoors (hours/day)	0.95	0.85	1.07	0.44
Read words or pictures (yes versus no)	0.80	0.56	1.15	0.23

*Model has adjusted for familial clusters and all other factors in the table.

- Children with two myopic parents had a two-fold greater risk of myopia compared to children with no myopic parents.

Table 3. Risk Factors Associated with Spherical Equivalent Refraction among Singapore Chinese Preschool Children

	Spherical Equivalent Refraction			
	Regression Coefficient*	95% Confidence Interval		*P*
Age (month)	0.01	0.00	0.02	<0.001
Girl versus boy	0.07	-0.02	0.16	0.12
One myopic parent versus no myopic parents	-0.11	-0.22	0.00	0.054
Two myopic parents versus no myopic parents	-0.35	-0.47	-0.22	<0.001
Height (cm)	-0.01	-0.02	0.00	0.01
Time spent Outdoors (hours/day)	0.03	0.00	0.07	0.07
Read words or pictures (yes versus no)	-0.06	-0.20	0.09	0.47
R^2	0.02			

*Model has adjusted for familial cluster and all other factors in the table.

- Children with two myopic parents compared to those with no myopic parents and taller children had a more myopic SER.

Conclusion

- Family history of myopia was significantly associated with early-onset myopia and a more myopic SER.
- No significant association of near work or outdoor activity with myopia was found in very young Chinese children aged 6 years and below in contrast to the association found in older children.
- Genetic factors may play a more important role than environmental factors in determining early-onset myopia in Singapore Chinese preschool children.

Acknowledgments

The STARS project was funded by the National Medical Research Council (NMRC/1009/2005).

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Effects of Semifield Form-deprivation on Eye Shape in Chicks

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BACKGROUND

In chicks, altered visual experience of part of the visual field induced ametropic eye growth restricted only to the affected region (ceiling height[1]; partial spherical defocus[2]; partial form deprivation[3,4]). This compensatory mechanism has been referred to as "local mechanism". More recently, the "local mechanism" has been suggested to promote axial myopia induced by form-depriving the peripheral vision of macaque monkeys[5]. In humans, it has been suggested that the differential susceptibility to altered visual experience across the visual field could predispose different ethnic groups to develop different eye shapes[6]. In line with this suggestion is the finding that Caucasian, but not Taiwanese-Chinese, anisomyopes had nasal-temporal axial asymmetry[7]. This study aimed to determine the susceptibility to abnormal eye shape induced by semifield form deprivation in chicks.

OBJECTIVE

To characterize the eye shape in chicks treated with semifield form deprivation.

METHODS

White Leghorn chicks were unilaterally treated with full-field (n=20) or semifield diffusers using translucent occluders (Nasal Retina (NRD), n=23; Temporal Retina (TRD), n=23; Inferior Retina (IRD), n=14; Superior Retina (SRD), n=17) from days 5 to 26 (Figure 1). Refractive errors along the pupillary axis were measured using Hartinger refractometer at the onset of the treatment period and weekly after that for 3 weeks. Refractive errors were represented as spherical-equivalent (M), most-hyperopic meridian (MHM), most-myopic meridian (MMM), astigmatism (Cyl), J0 and J45 astigmatic components. At the end of the treatment period, a subset of chicks were sacrificed and their eyes were enucleated, cleared off extraocular tissues, and photographed (FUL n=10; NRD n=10; TRD n=11; IRD n=8; SRD n=9). The digital images of individual eyeballs were later processed using a custom MatLab algorithm to extract features associated with eye shape. This study only reports the equatorial diameter and axial eye lengths (Figure.2) .

Figure 1

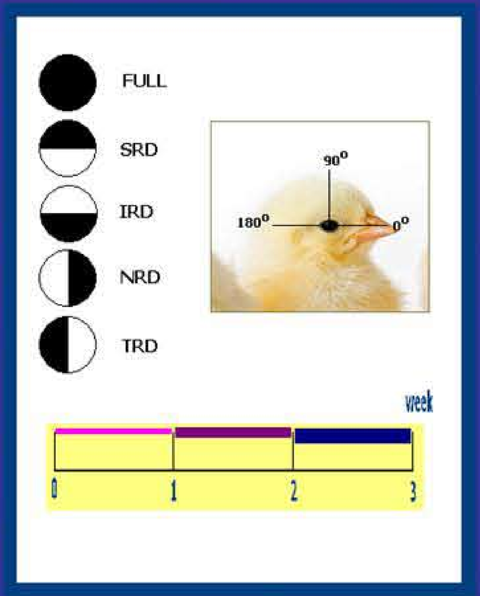
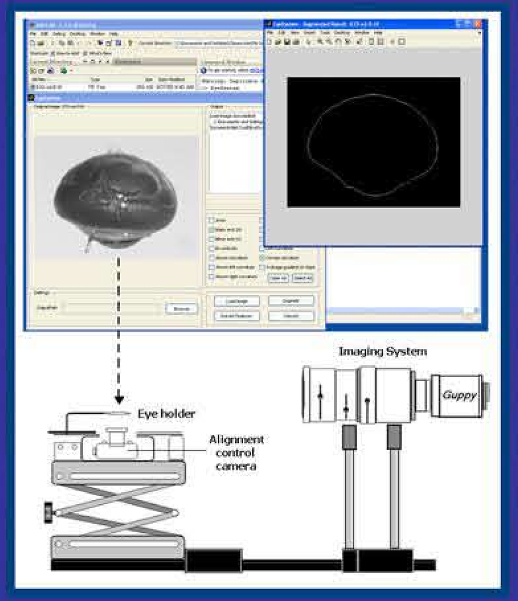


Figure 2



RESULTS

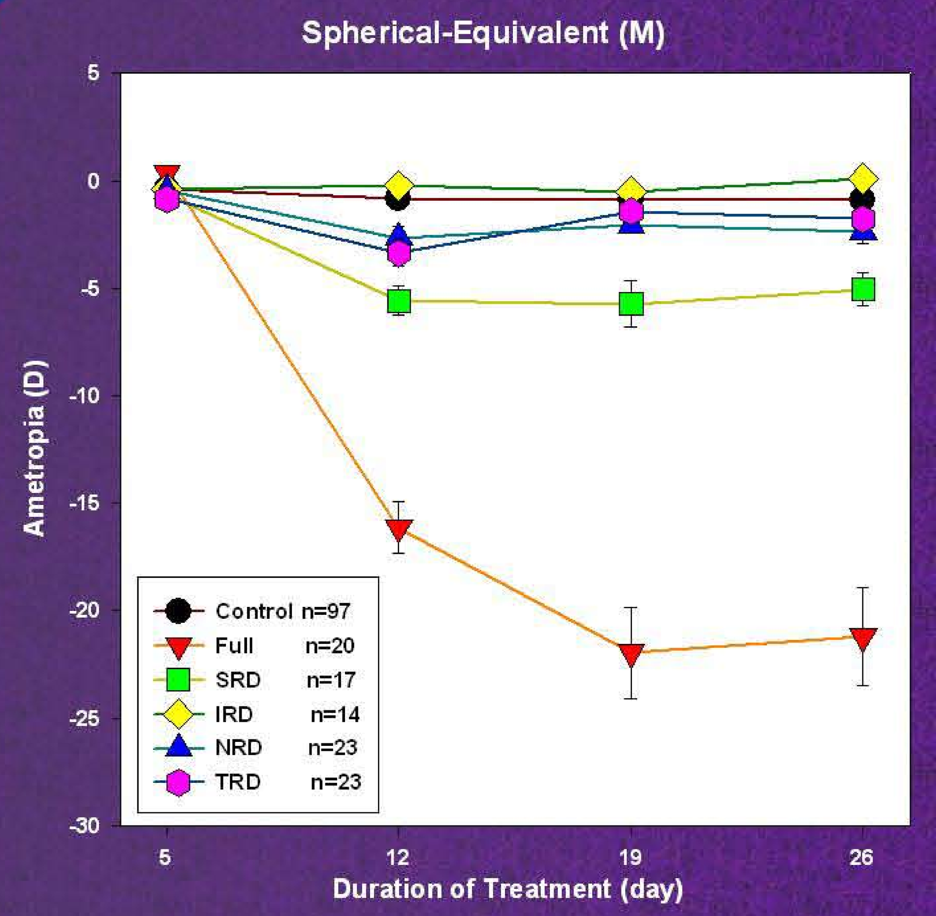


Figure 3. Longitudinal changes in spherical-equivalent refractive error (mean ± SEM) for different treatment groups. Data of all fellow untreated eyes were used as controls.

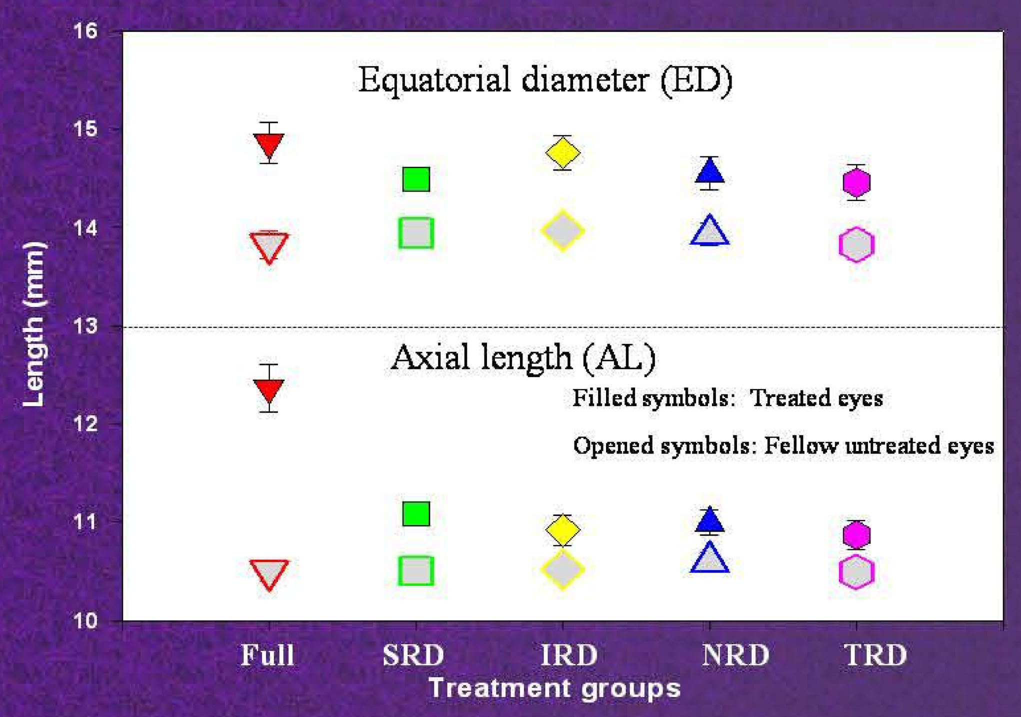
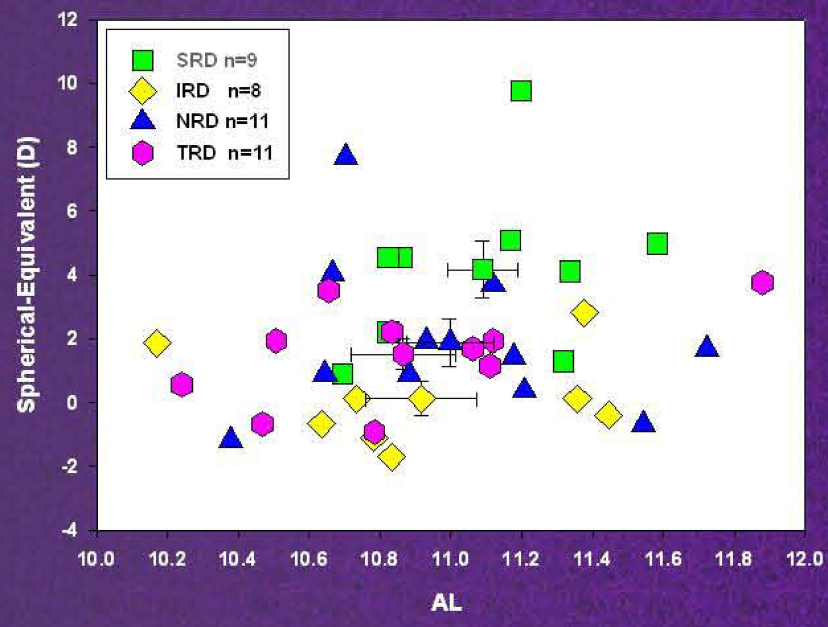


Figure 4. Axial length and equatorial diameter in the treated (colored symbols) and fellow untreated eyes (grey symbols). In general, the treated eyes were all significantly longer and wider than fellow untreated eyes. Note that compared to other semifield groups, IRD group had wider equatorial diameter.



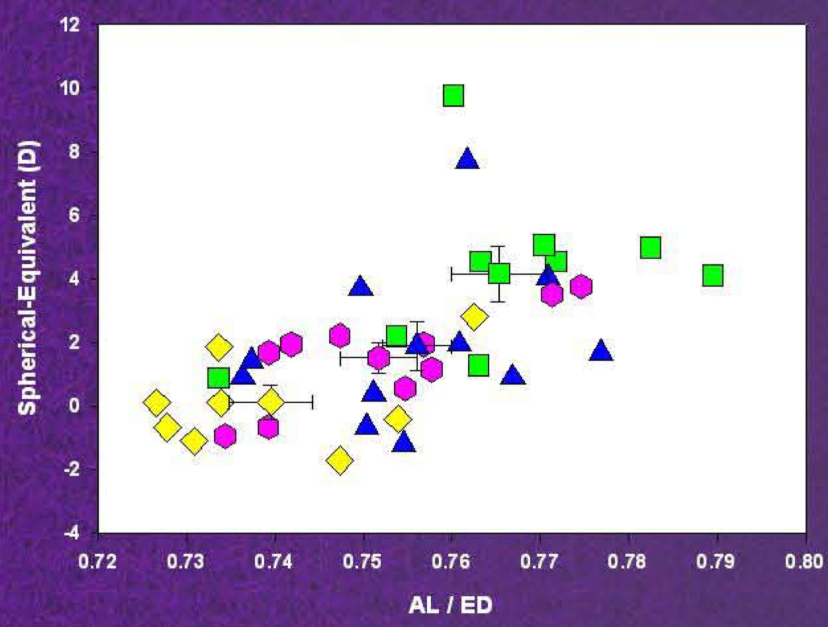


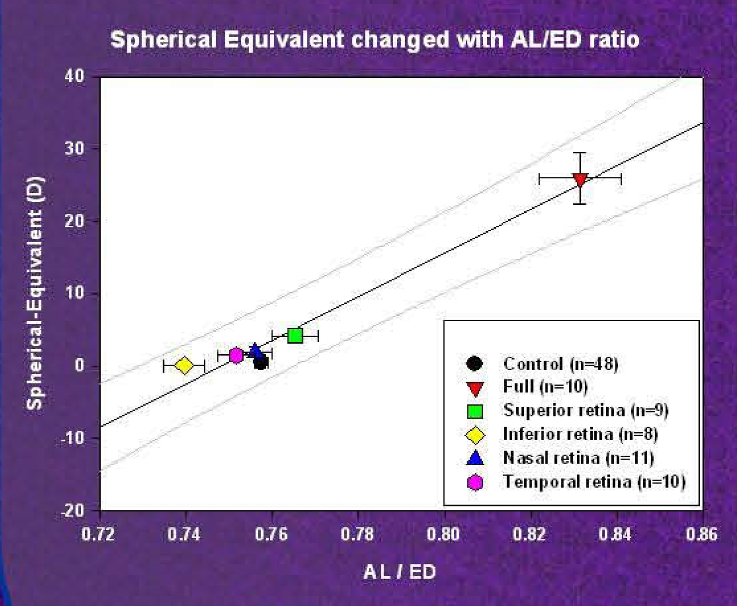
Figure 5, 6. Scatter plots of spherical-equivalent refractive errors with AL or AL/ED. See legend for treatment groups.

	AL		ED		AL/ED	
	with FUL	without FUL	with FUL	without FUL	with FUL	without FUL
M	**-0.59****	-0.23	-0.06	0.18	**-0.81****	**-0.65****
MHM	**-0.59****	-0.25	-0.06	0.15	**-0.80****	**-0.62****
MMM	**-0.57****	-0.20	-0.06	0.18	**-0.80****	**-0.62****
Cyl	**0.30***	0.02	0.25	0.05	**0.31***	0.05
J0	-0.18	0.17	-0.16	0.04	-0.17	0.18
J45	0.21	0.19	0.16	0.18	0.17	0.06

* <0.05 ** <0.0001

Table 1. Spearman's correlations between refractive components and eye shape's components in the treated eyes with and without the inclusion of full-field form deprivation group (FUL). In the fellow untreated eyes, no correlations were found between the refractive components and axial length (AL), equatorial diameter (ED), or the ratio of AL/ED (data not shown). In contrast, significant correlations were found between M, MHM, MMM and AL in the treated eyes. More importantly, the strongest correlations were found between M, MHM,MMM and AL/ED.

CONCLUSIONS



Susceptibility to semifield form deprivation varies across the visual field. Of particular interest is the biggest difference found between the two groups of birds treated by superior and inferior semifield form deprivation. Specifically, although both equatorial diameter and axial length were significantly greater than the fellow eye in the IRD group, the chicks developed slightly hyperopic refractive error. These results indicate the limitation of using only axial length in predicting refractive errors.

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RELATIONSHIP BETWEEN ANNUAL REFRACTIVE ERROR CHANGES AND CHANGES IN OCULAR BIOMETRIC DATA IN CHINESE CHILDREN

#39

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The Vision CRC Myopia Control Study Group

INTRODUCTION

- Several studies have investigated changes in ocular biometric data during normal eye growth in children from different ethnic backgrounds.[1-3]
- With respect to refractive development of the eye, research into impact of hereditary and environmental risk factors[4] as well as impact of different types of interventions are ongoing.
- Studies have shown that single vision spectacle lenses[5,6] and single vision hydrogel[5] or rigid gas permeable[6] contact lenses, have no impact on the progression of refractive error.

PURPOSE

To investigate the relationship between annual changes in spherical equivalent refractive error (SE) and changes in ocular biometric data of Chinese children.

METHODS AND MATERIALS

- Annual refractive changes were evaluated in 87 myopic Chinese children at Zhongshan Ophthalmic Center, Guangzhou, China:
  - aged 7 to 14 years of age (mean 10.7 ± 1.9 years)
  - with baseline SE ranging from -0.75 D to -3.50 D sphere and cylinder ≤ 1.00 D
  - Single Vision Spectacle Group (n = 36) and
  - Single Vision Silicone Hydrogel Contact Lens Group [Lotrafilcon B, CIBA VISION, USA] (n = 51)
- Cycloplegic autorefraction was performed using an open-field autorefractor (Shin-Nippon NVision K-5001, Japan) and ocular biometric data such as axial length (AL), corneal curvature and anterior chamber depth was measured using an IOL Master (Carl Zeiss Meditec, Germany).
- The investigation was conducted in accordance with the tenets of the Declaration of Helsinki.

STATISTICAL ANALYSIS

- Data from the right eyes of participants who completed the 12 month visit were included in the analysis.
- Changes in SE and ocular biometric data were correlated using linear mixed models, which were adjusted for age, gender, parental myopia and method of optical intervention.
- The level of statistical significance was set at 5% and data analysis was performed in SPSS (v17).

RESULTS

BASELINE DEMOGRAPHICS:

- No significant difference in age, gender and parental myopia distribution was found between the groups nor in AL, anterior chamber depth or corneal curvature ($p > 0.05$).
- No significant differences in SE were found between the spectacle lens and contact lens group (SE -2.02 ± 0.69 D and -2.21 ± 0.72 D, respectively, $p = 0.22$).

12 MONTH RESULTS:

- When both groups were combined, the change in SE was:
  - linearly correlated with the change in AL ($p < 0.001$). A 1-millimeter increase in AL induced a -2.1 D change in refractive error (95% CI = -1.8 to -2.5 D, $r^2 = 0.63$, adjusted for confounding factors).
  - associated with a change in corneal curvature for the steep meridian ($p = 0.04$) but not the flat meridian ($p = 0.06$) (Figure 1), age ($p = 0.003$) (Figure 2) and type of optical intervention ($p = 0.017$),
  - not associated with a change in anterior chamber depth ($p = 0.45$)
- When both groups were combined, the change in AL was:
  - associated with age ($p = 0.02$)(Figure 3),
  - not associated by gender ($p = 0.83$) or parental myopia ($p = 0.80$).
- The association between change in SE and change in AL was not different between the two intervention groups, i.e. spectacle lens versus contact lens group ($p = 0.79$).
- The linear mixed model showed that participants in the spectacle lens group which had no change in AL over time (intercept), showed a progression in SE of 0.18 D, in comparison to 0.03 D found in the contact lens group (Figure 4). This difference was significant ($p = 0.001$).
- The variance in the changes in SE can be explained by:
  - 62% with respect to AL changes,
  - 71% with respect to AL changes including corneal curvature, age and type of optical intervention.

DISCUSSION AND CONCLUSION

- From our 12 month results, there was a 2.10 D change in SE with a 1 mm change in AL for Chinese children. This change was higher than the 1.95 D/mm change reported by Zadnik et al.,[1] where the population group consisted mainly of Caucasians (88%).
- Despite the fact that changes in the steep corneal radius were associated with changes in SE ($p = 0.04$), the correlation was weak ($r^2 = 0.048$), suggesting that there is a small impact on changes in SE over time.
- A significant impact on changes in SE and AL was found for age, indicating the younger the children, the greater is the change in SE and AL (Figures 2 and 3).
- With respect to the type of intervention, a higher change in SE was found with spectacles lenses than with silicone hydrogel contact lenses for the same change in AL.
- Overall, it can be concluded that AL changes accounted for most of the variability (62%) in changes of the SE. Factors such as method of optical intervention, corneal curvature (i.e. steep meridian) and age had a small impact on the changes in SE, but other unknown factors also appear to contribute to these changes.

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RESULTS *continued*

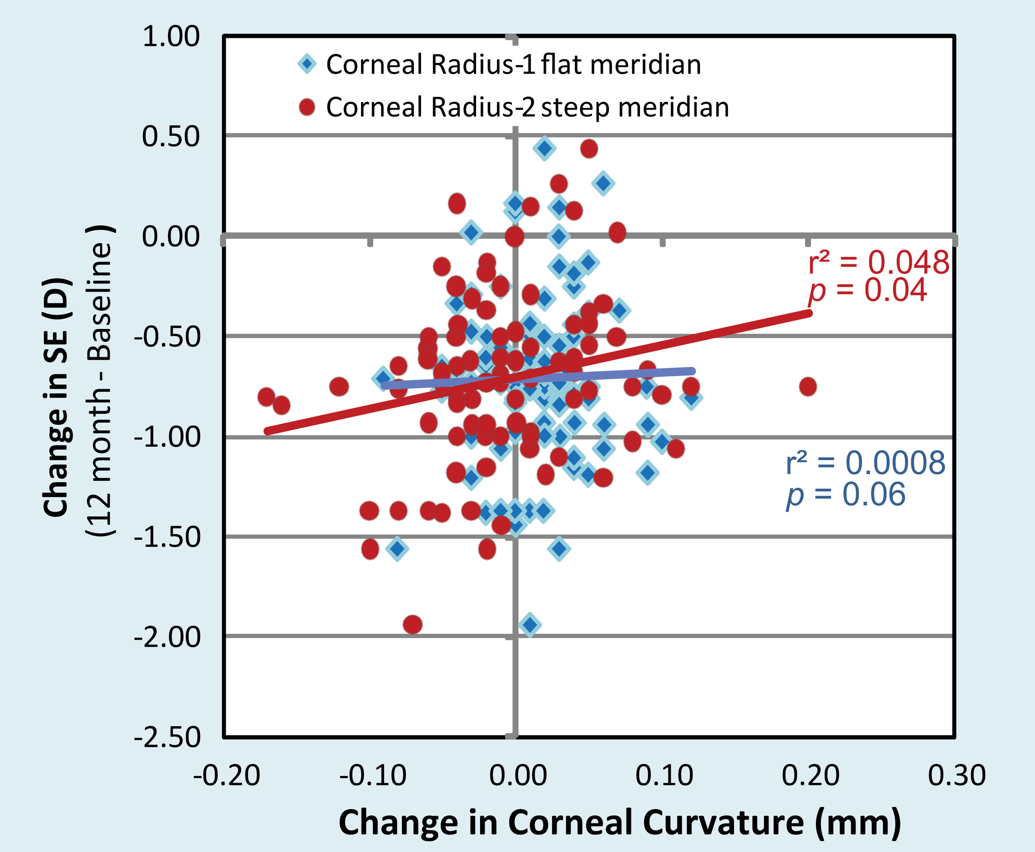

Figure 1: Relationship between change in SE and change in corneal curvature

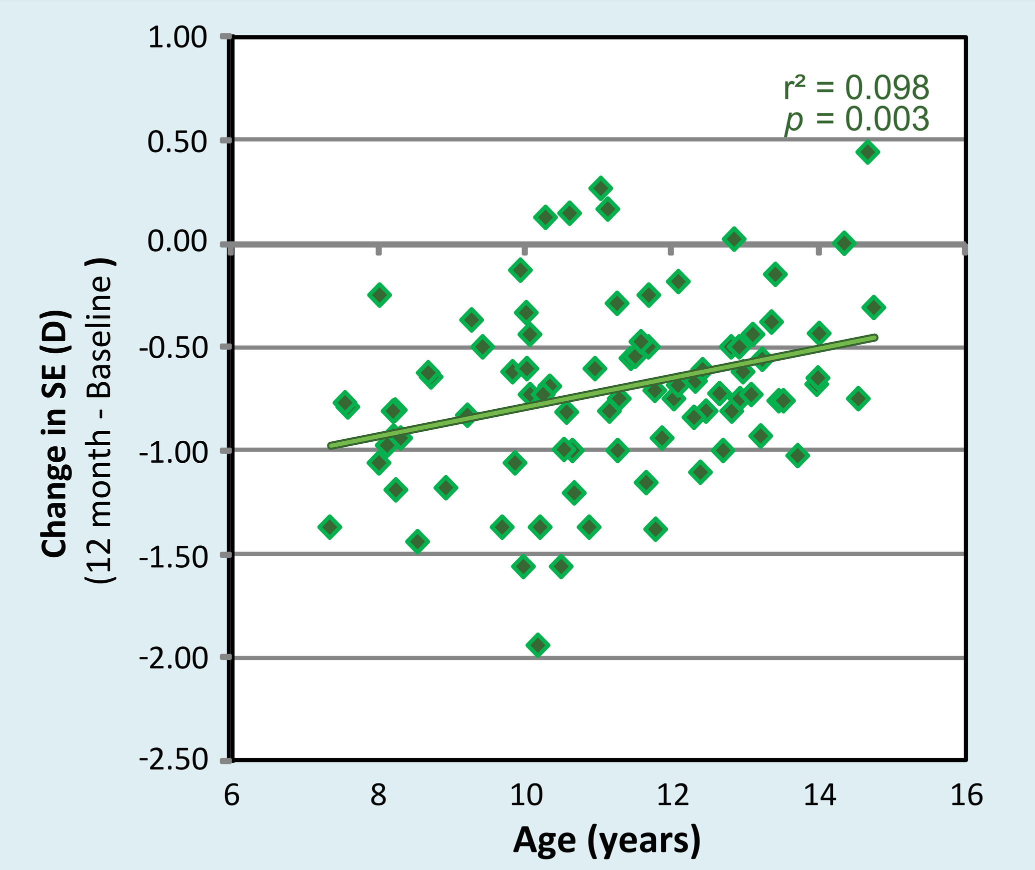

Figure 2: Relationship between change in SE and age

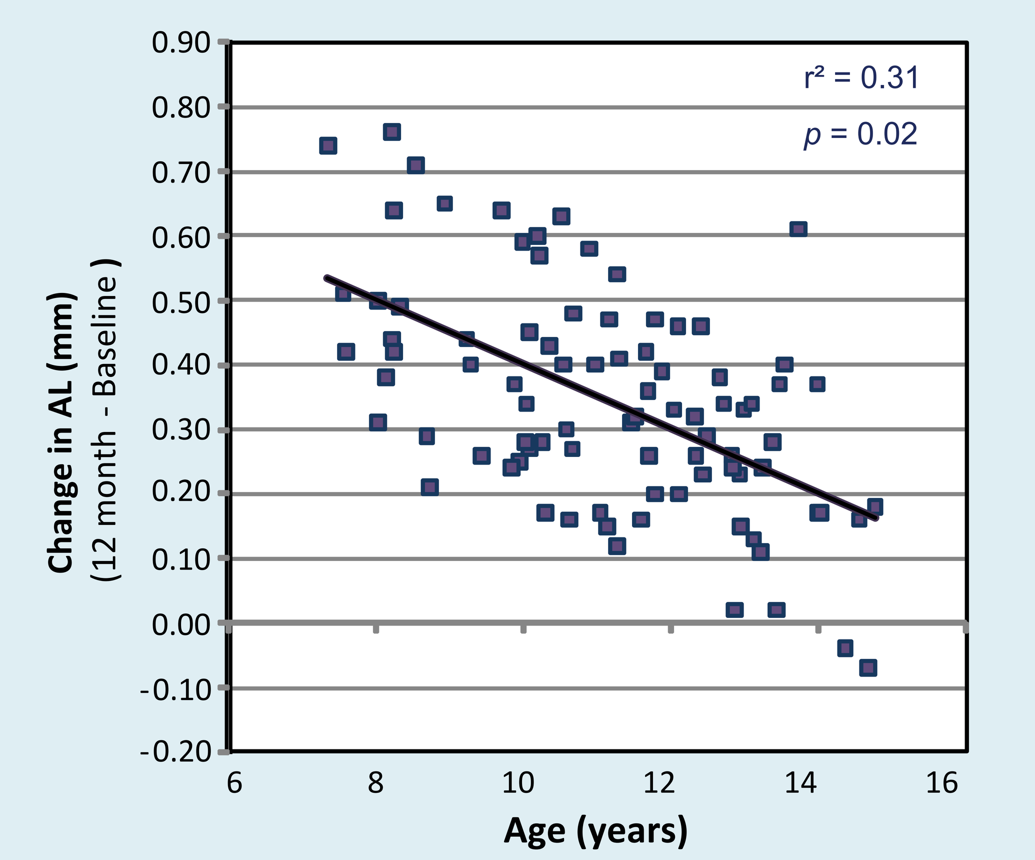

Figure 3: Relationship between change in AL and age

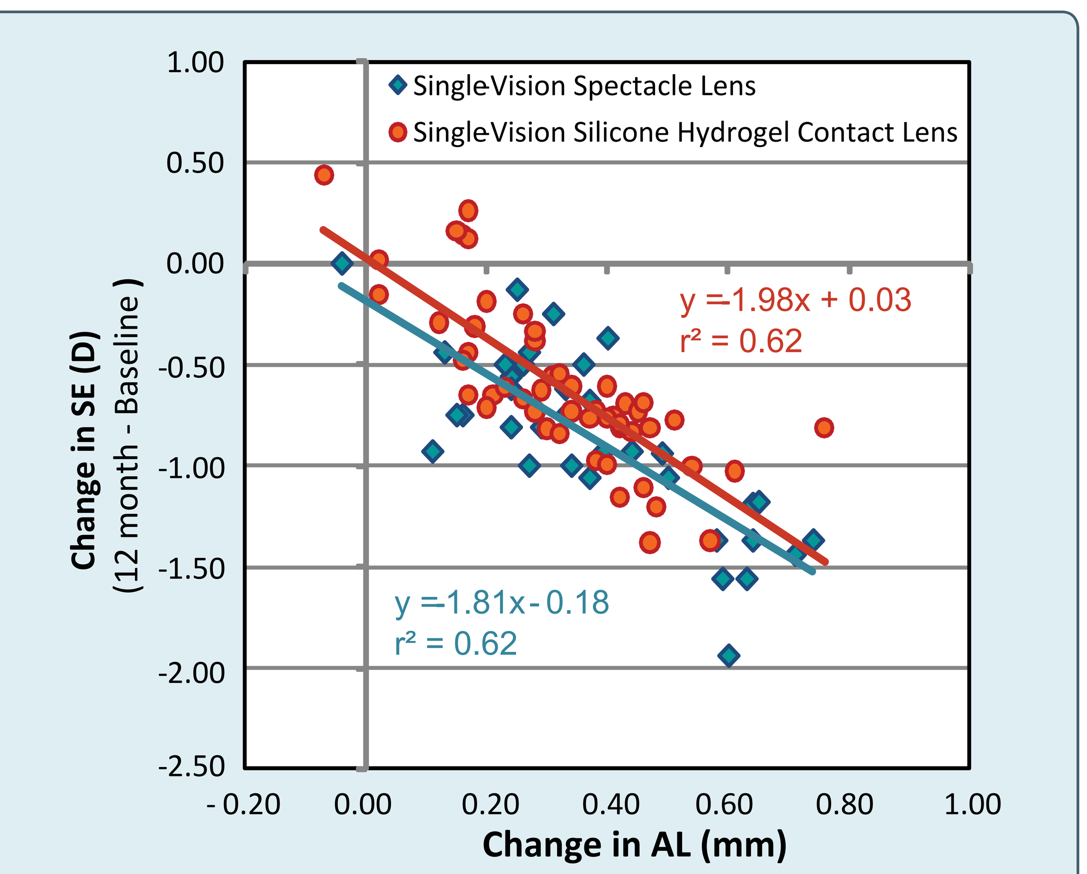

Figure 4: Relationship between change in SE and change in AL

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Sustained Nearwork on the Ocular Development in Juvenile Rhesus Monkeys

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Purpose

To characterize the effect of sustained nearwork on the ocular development in juvenile rhesus monkeys.

Methods

Eight 1.5 years old rhesus monkeys were randomly allocated into the experimental group (EG, n=4) and the control group (CG, n=4). After all were trained to make an acceptably high correct rate of response (ie., >85%) to a tailor-make video game (Figure 1), the monkeys in EG were required to sustain this visual task for 4h/day at a viewing distance of 38cm in the following six months. And then two monkeys in EG (EG2) was randomly selected and increased workload to 8h/day at a viewing distance of 28cm for another period of nine months, while the other two monkeys in EG (EG1) maintained the same workload. Monkeys in CG were reared without designated visual task. Ocular development was characterized via refractive status, axial dimensions and the corneal power, which were determined by retinoscopy, A-scan ultrasonography and corneal topographer, respectively.

Figure1. Rhesus Monkeys were trained to make positive response only if the direction of the central E turned upward, while all letters of E on the screen rotated simultaneously in a random pattern of directions.

Results

After 15 months' observation, there were no statistically significant differences between EG and CG in the change of vitreous chamber depth, corneal power or refraction (Figure 2). The differences of the change of vitreous chamber depth and refraction became significant in the stratified analysis between EG2 and the other two groups, which mainly exhibited in the last 9 months (Figure 3). The most obvious myopic shift occurred in the female monkey in EG2 with a change of vitreous chamber depth and relative refraction as 0.97mm and 1.04D, respectively.

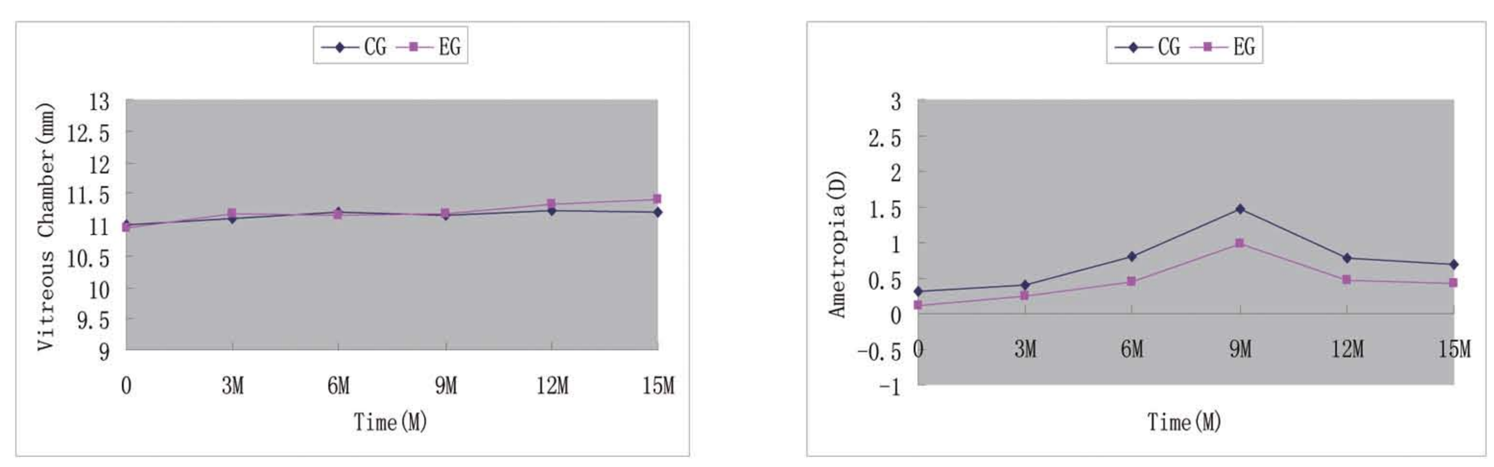

Figure 2. Ocular development between CG and EG after 15 months' observation in the vitreous chamber depth (A) and in the refractive error (B). The differences between either comparison were statistically insignificant.

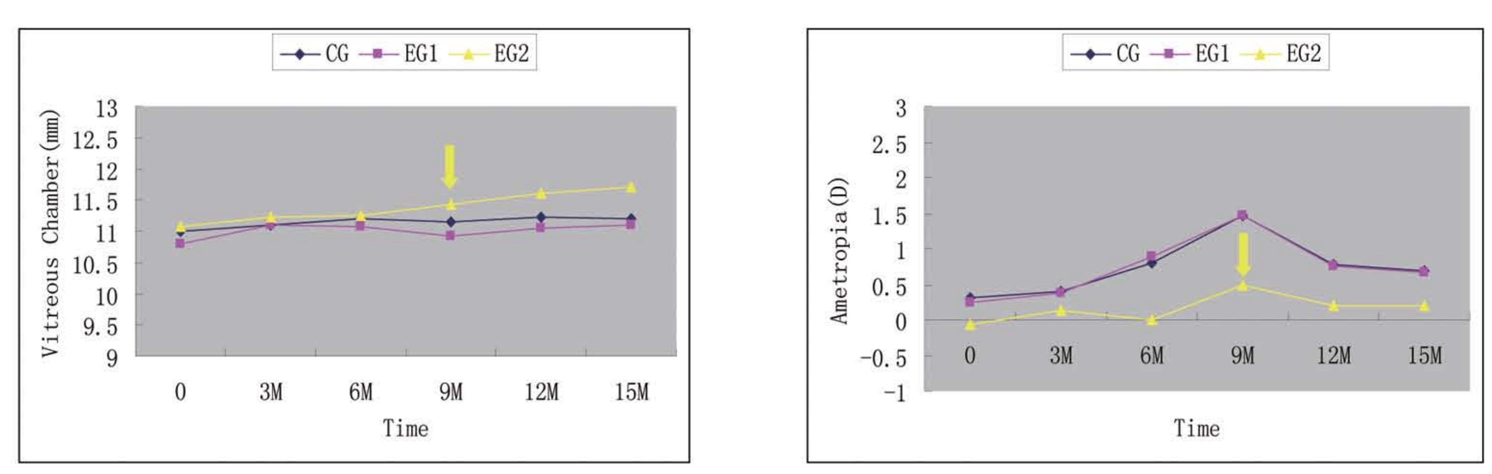

Figure 3. Ocular development among CG, EG1 and EG2 in the vitreous chamber depth (A) and in the refractive error (B). The differences of the changes in vitreous chamber depth and refraction webre both statistically significant between EG2 and the other two groups (P<0.05), which mainly exhibited in the last 9 months. The yellow arrows on the figures indicate the intensity of nearwork increase to 8h/d for EG2.

Conclusions

This study firstly offers direct evidence that certain amount of nearwork could accelerate the axial growth of the eyeball, which indicates that sustained nearwork plays a major but not an exclusive role in the pathogenesis of myopia in primitive animals.

Statement of proprietary interests: None

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