Effects of Zernike Wavefront Aberrations on Visual Acuity measured using Electromagnetic Adaptive Optics Technology

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Purpose

To measure the changes in visual acuity induced by various amounts of single Zernike aberrations

Methods

crx1 Adaptive Optics Visual Simulator

(Imagine Eyes, Orsay, France)

imagine eyes

<u>software kit:</u>

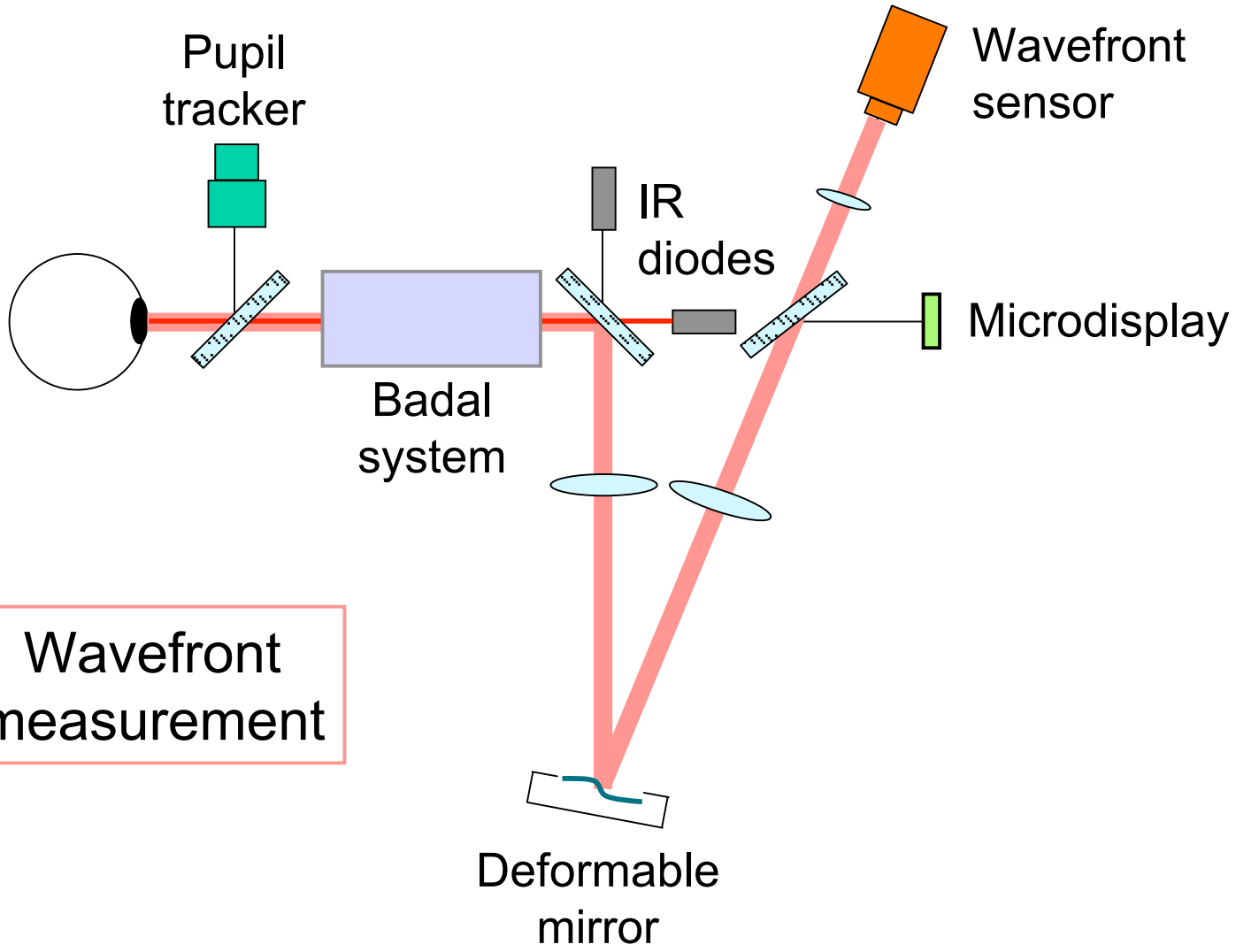
- **irx3 aberrometer software**
- **SVAO wavefront builder**
- **CSO adaptive optics software**
- **wavefront stroke 50µm**

UNIFESP

Methods

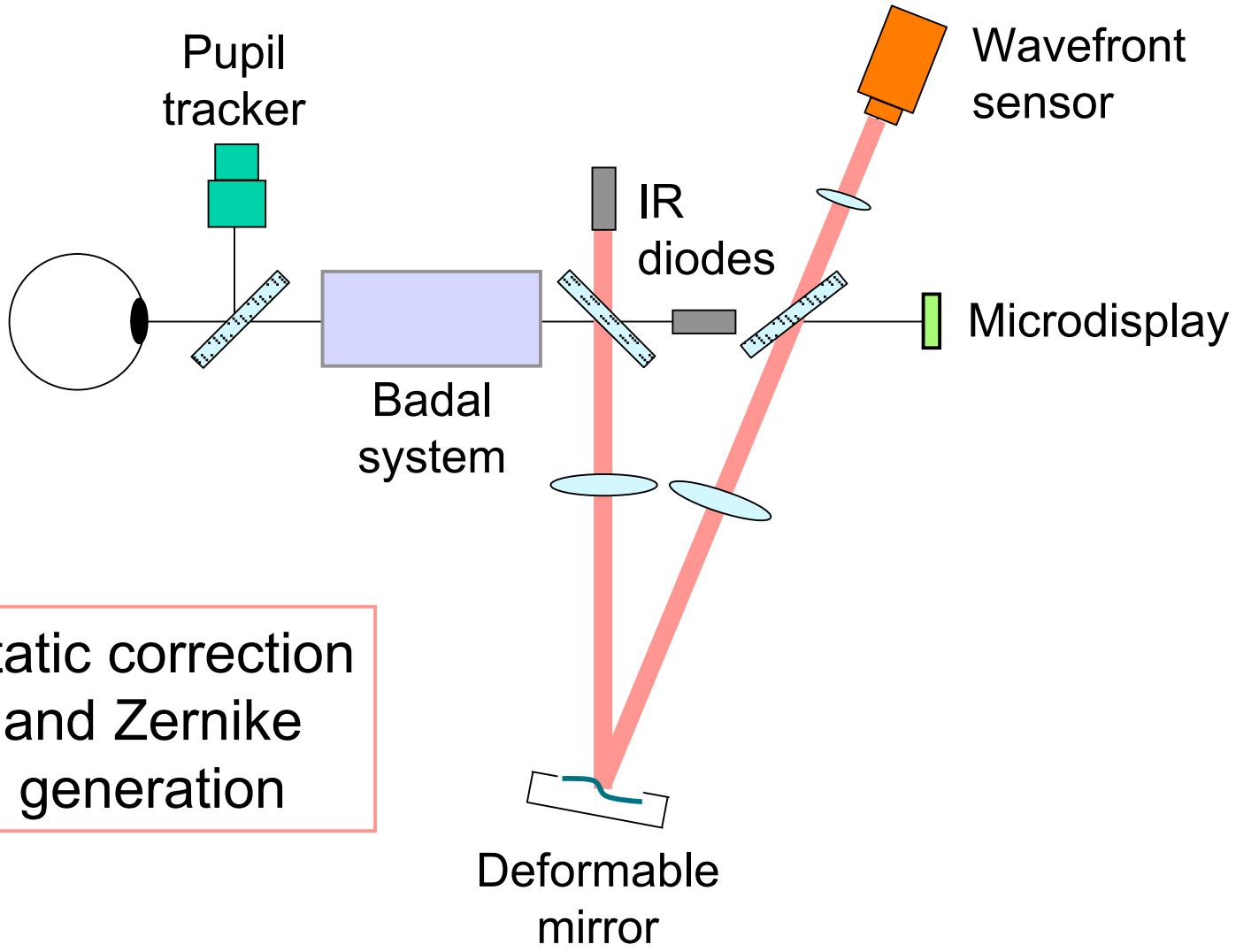
- 10 eyes (10 subjects);
- 1 eye excluded;
- initial measurement of the total ocular aberrations;
- static compensation for wavefront error;
- application of pure Zernike aberrations;

Methods



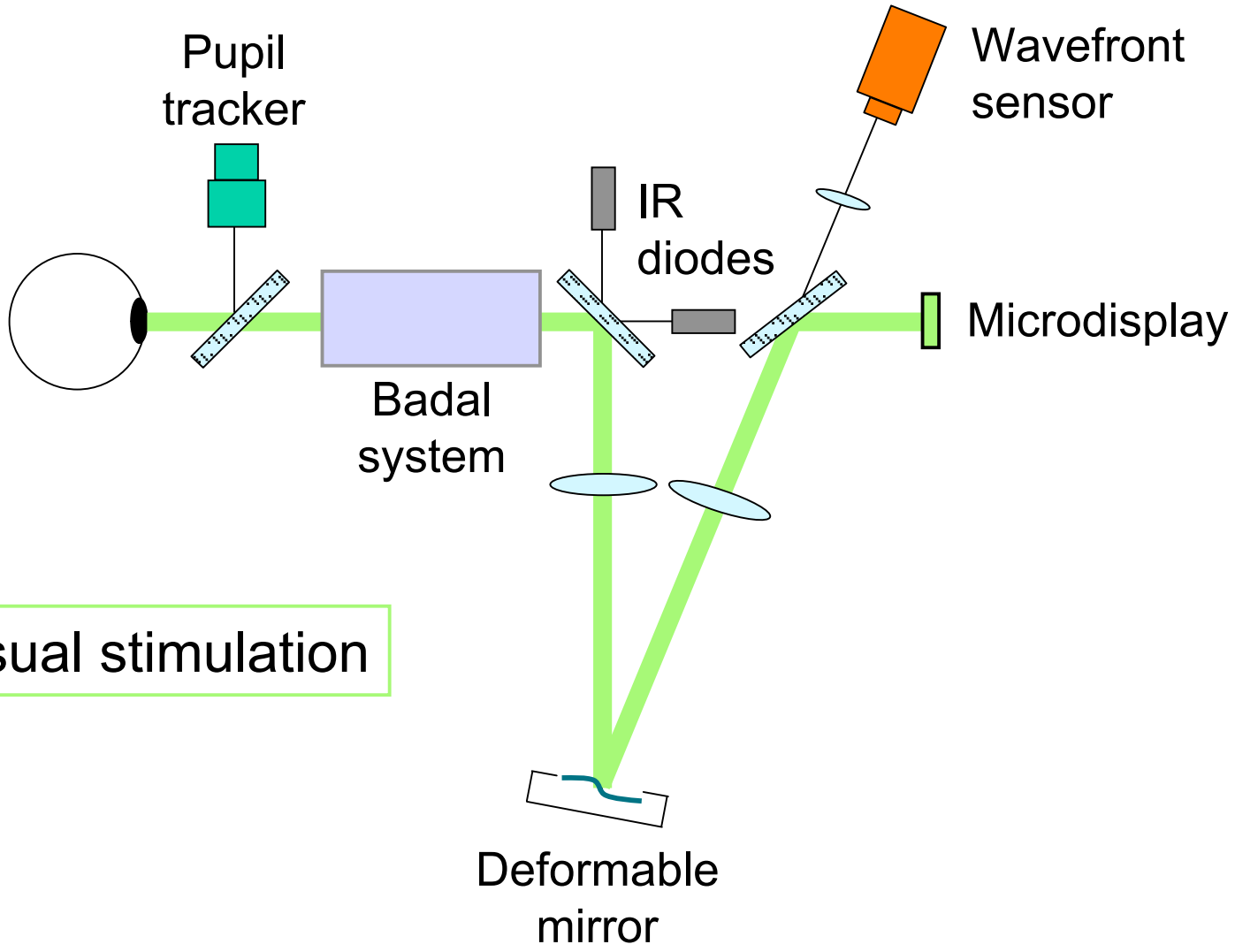
Wavefront measurement

Methods



Static correction and Zernike generation

Methods



Visual stimulation

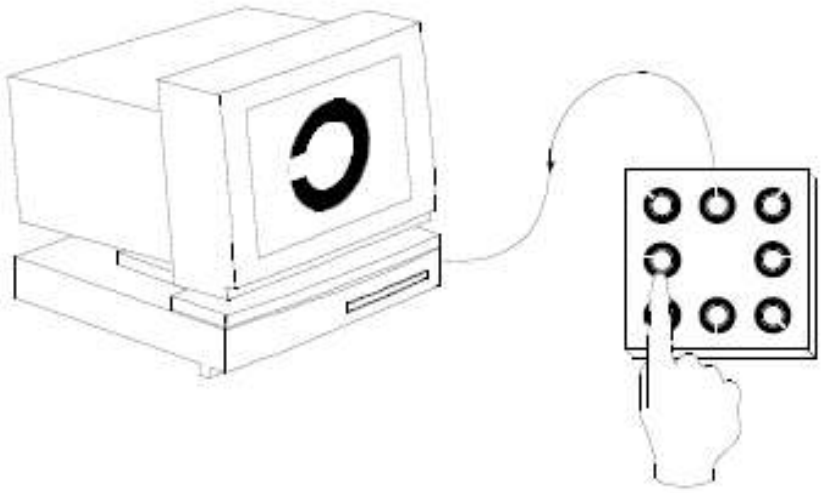
Methods

Visual Acuity:

Freiburg Acuity Test

- **Landolt C**
- **8 directions**
- **18 presentations**

50 cd/m²



Methods

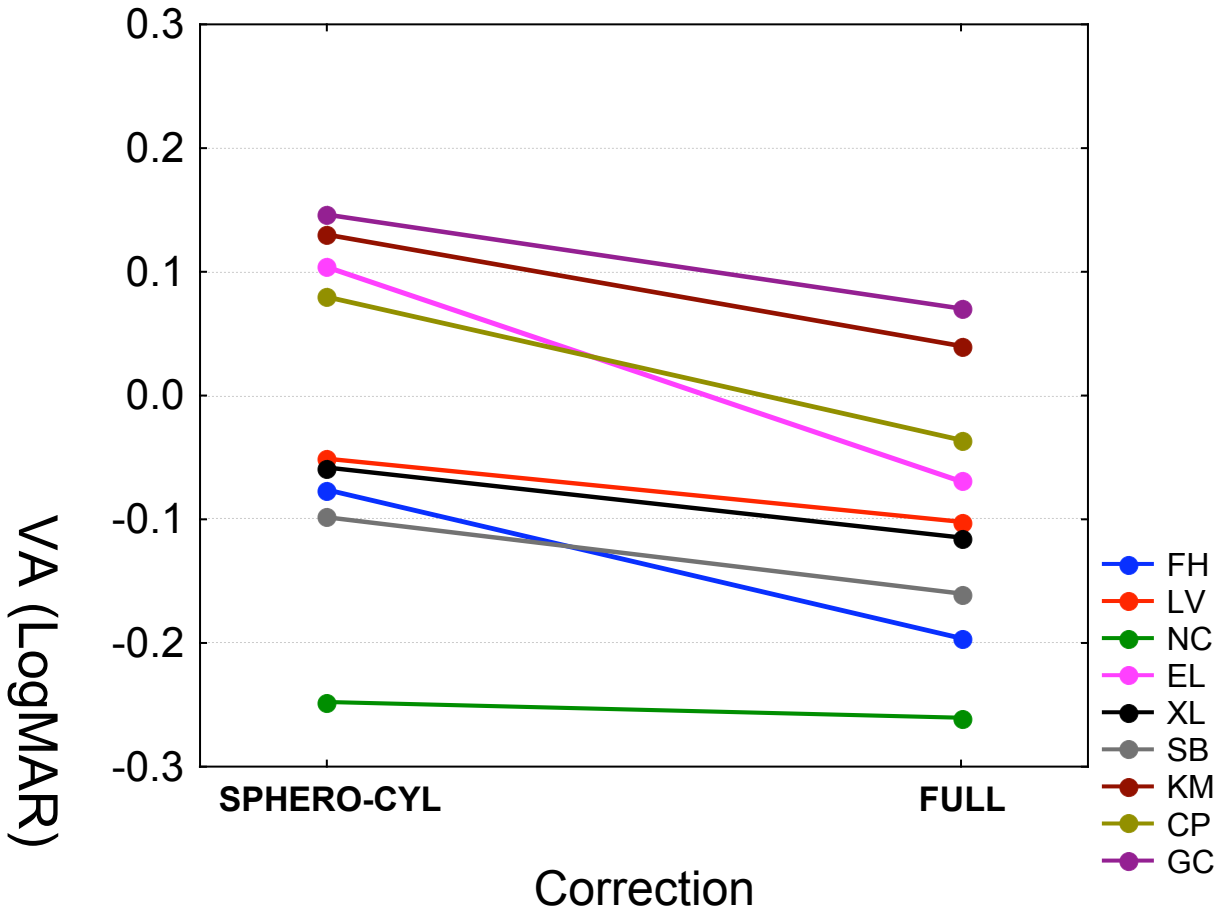
Simulator pupil diameter: adjusted to 5mm

Applied aberrations:

- none (uncorrected)
- sph/cyl correction
- full correction (2nd to 5th orders)
- full correction + single Zernike modes

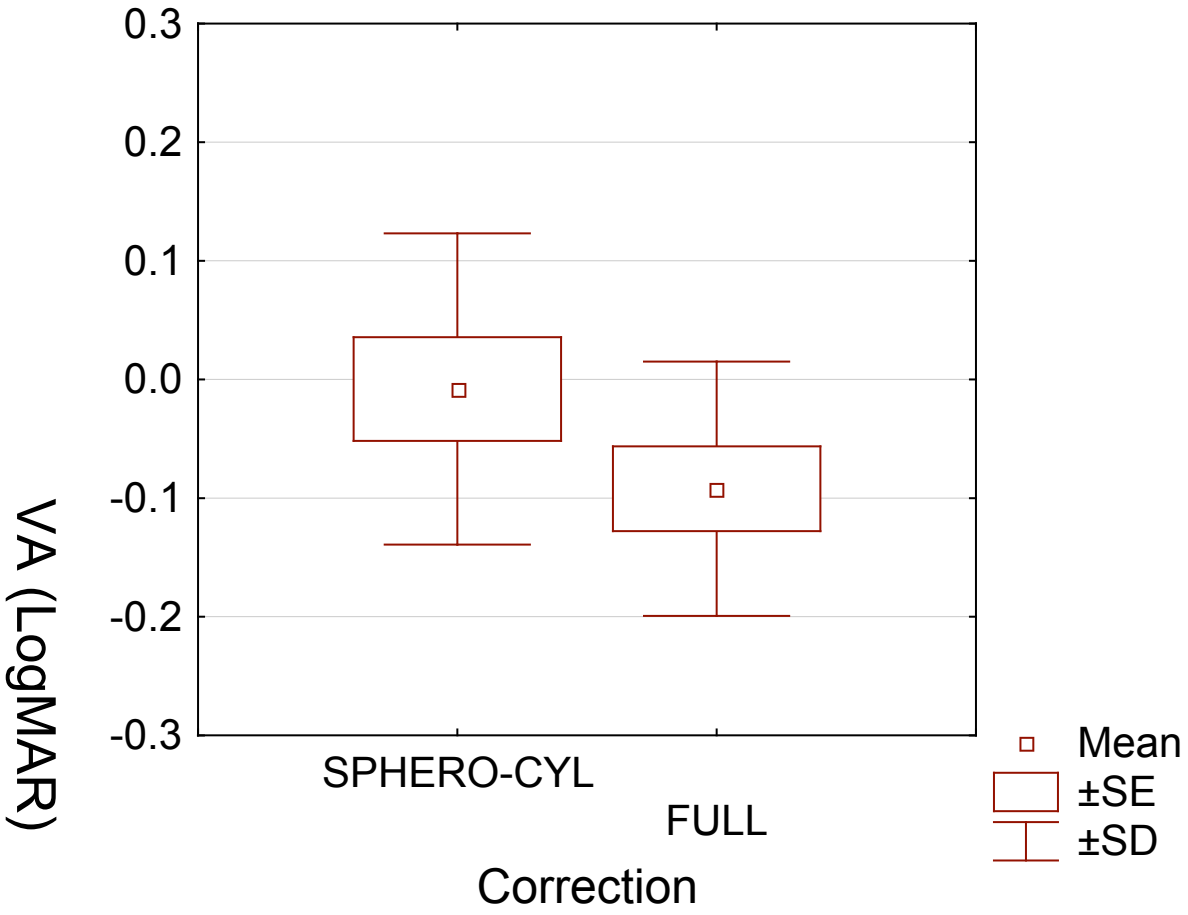
Results

Comparison between best sphero-cyl and full AO correction



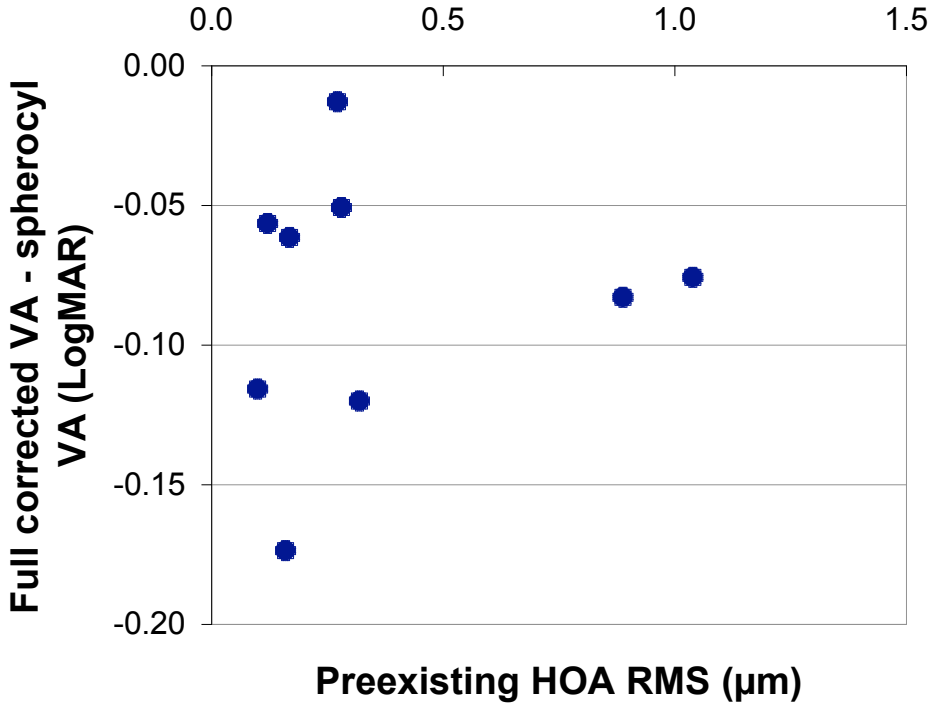
Results

Comparison between best sphero-cyl and full AO correction



Results

Is the improvement in VA with full AO correction related to the preexisting amount of HOAs ?



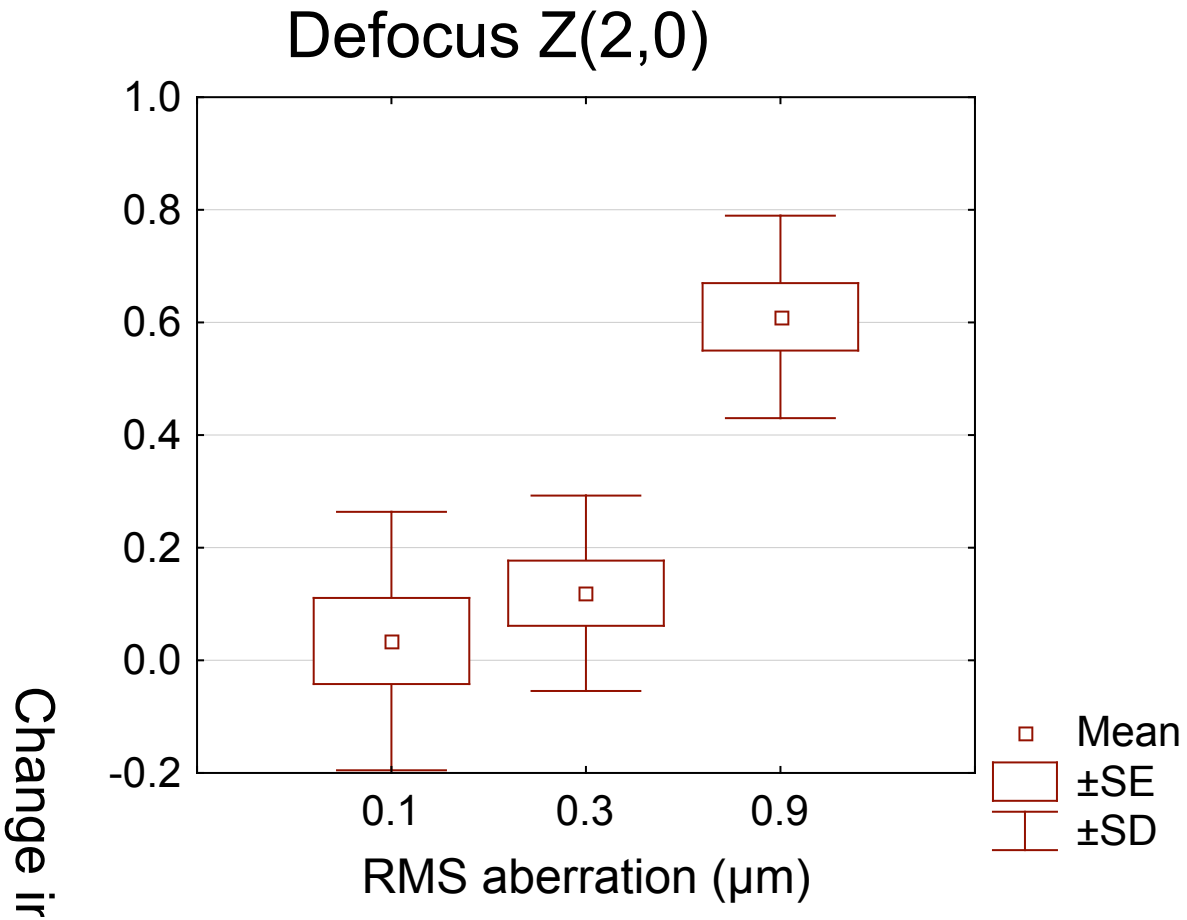
Methods

Zernike generation:

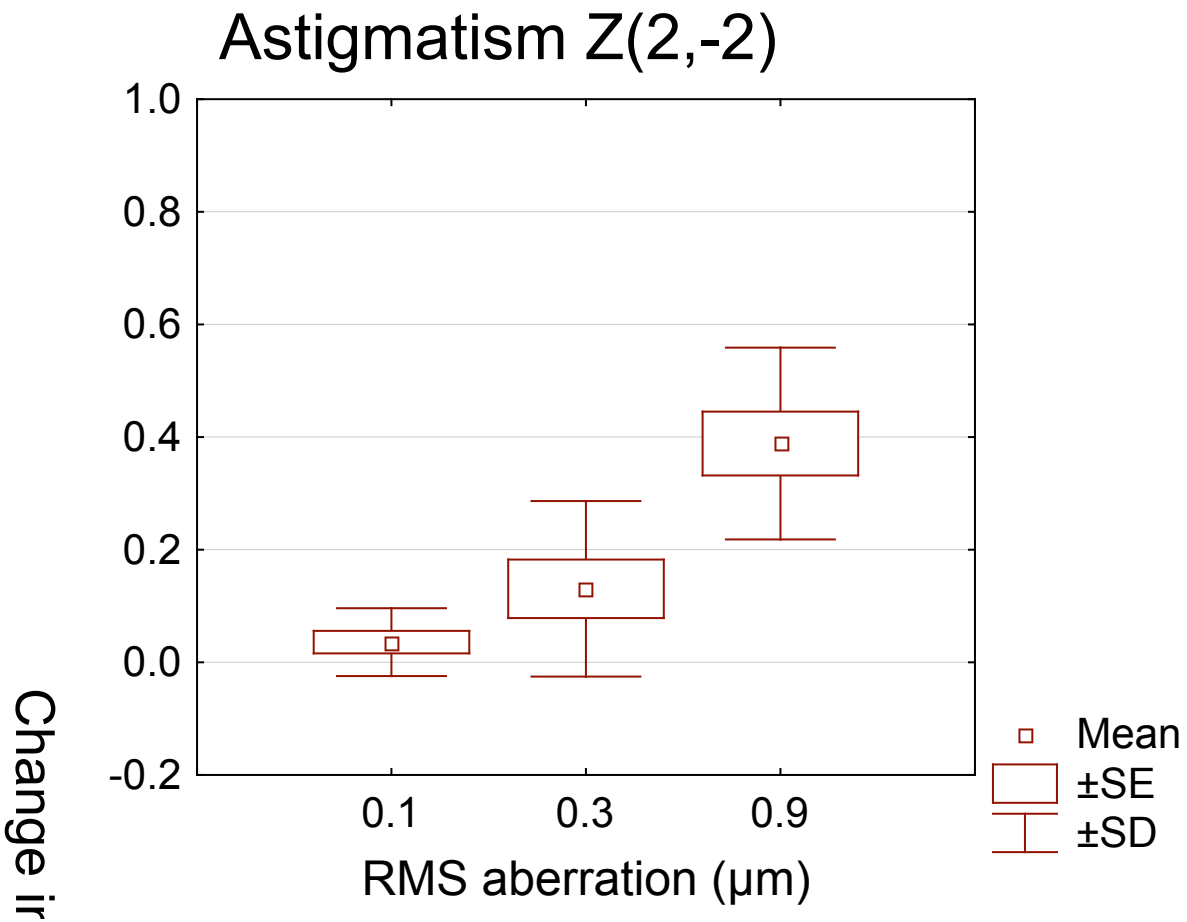
RMS 0.1 μm, 0.3 μm, 0.9 μm

- **defocus Z(2,0)**
- **astigmatism Z(2,2)**
- **coma Z(3,1)**
- **trefoil Z(3,3)**
- **spherical aberration Z(4,0)**

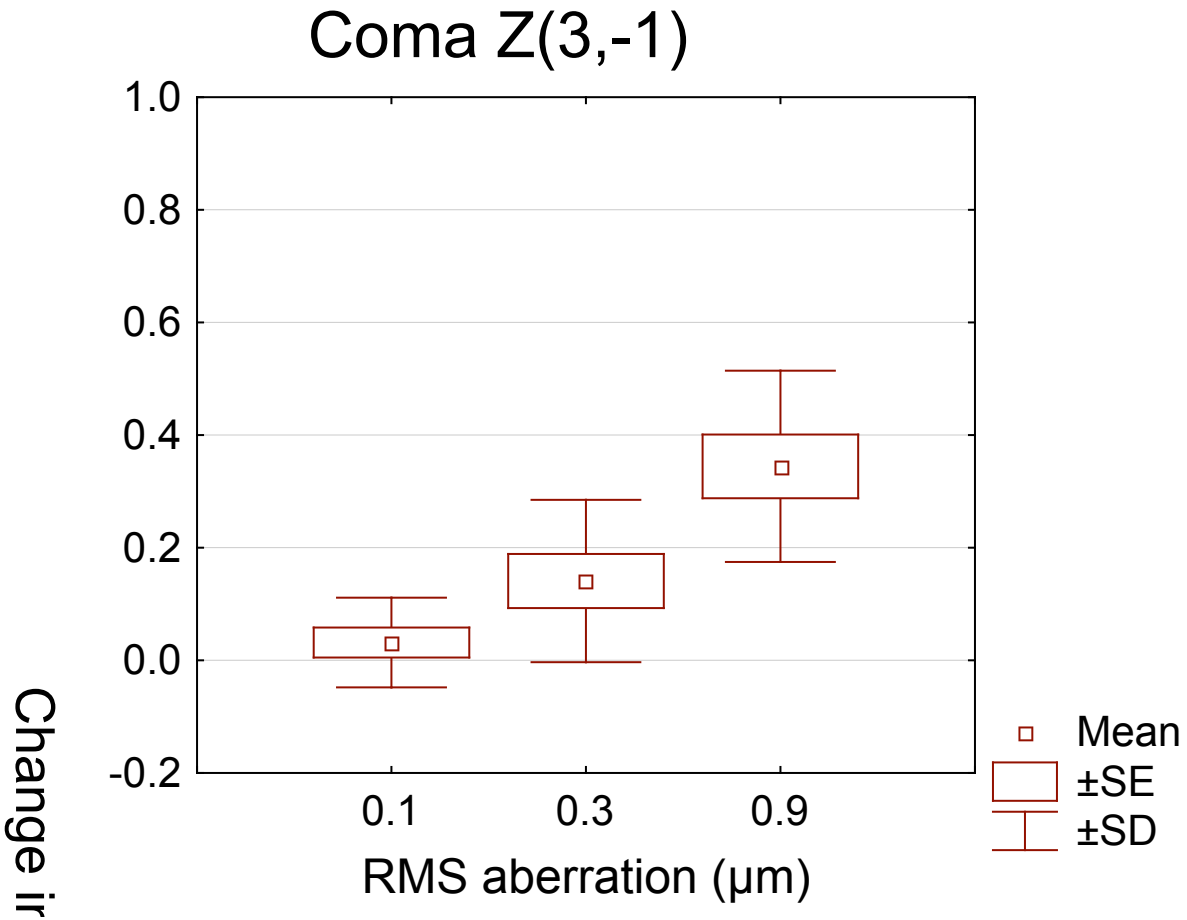
Results


Defocus Z(2,0)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Change ir
0.1
0.3
0.9
RMS aberration (µm)
Mean
±SE
±SD

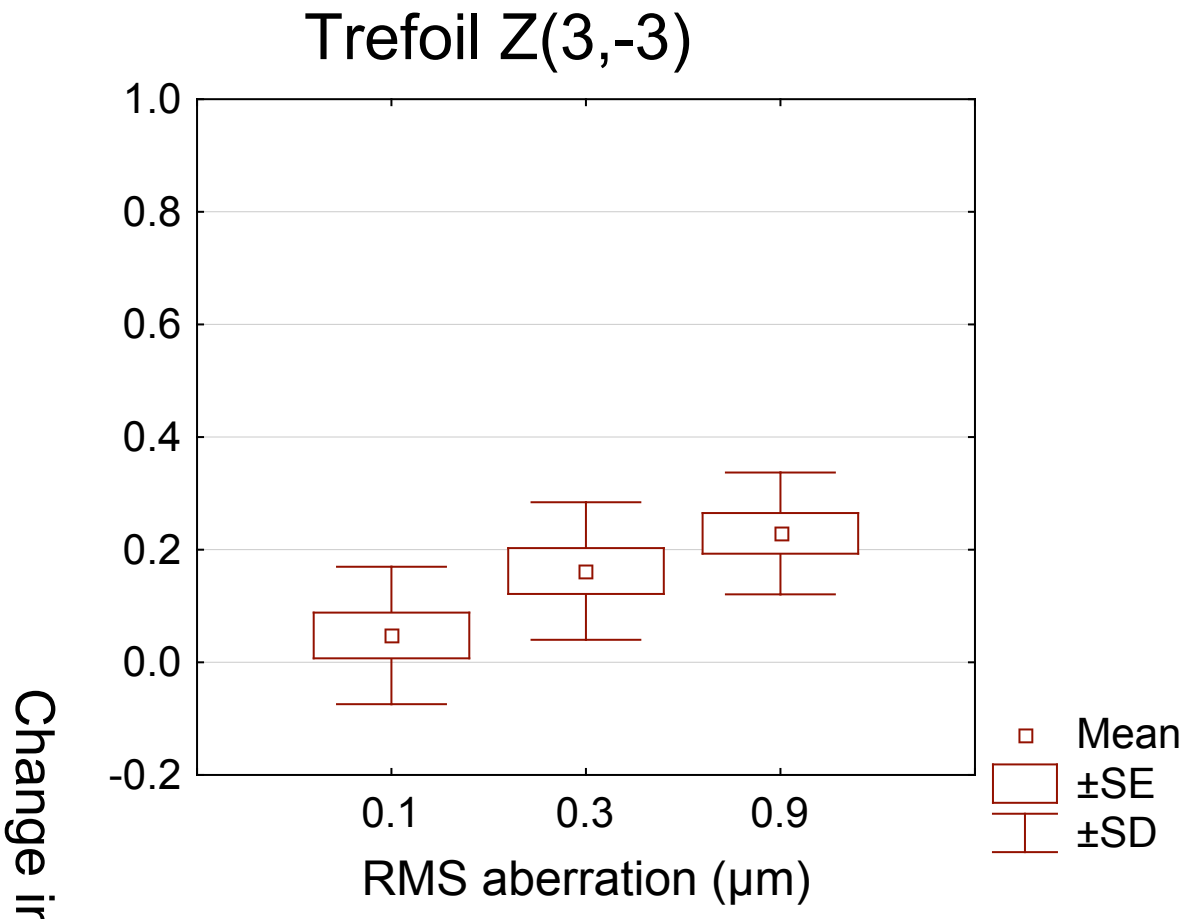
Results


Astigmatism Z(2,-2)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
0.1
0.3
0.9
RMS aberration (µm)
Change ir
Mean
±SE
±SD

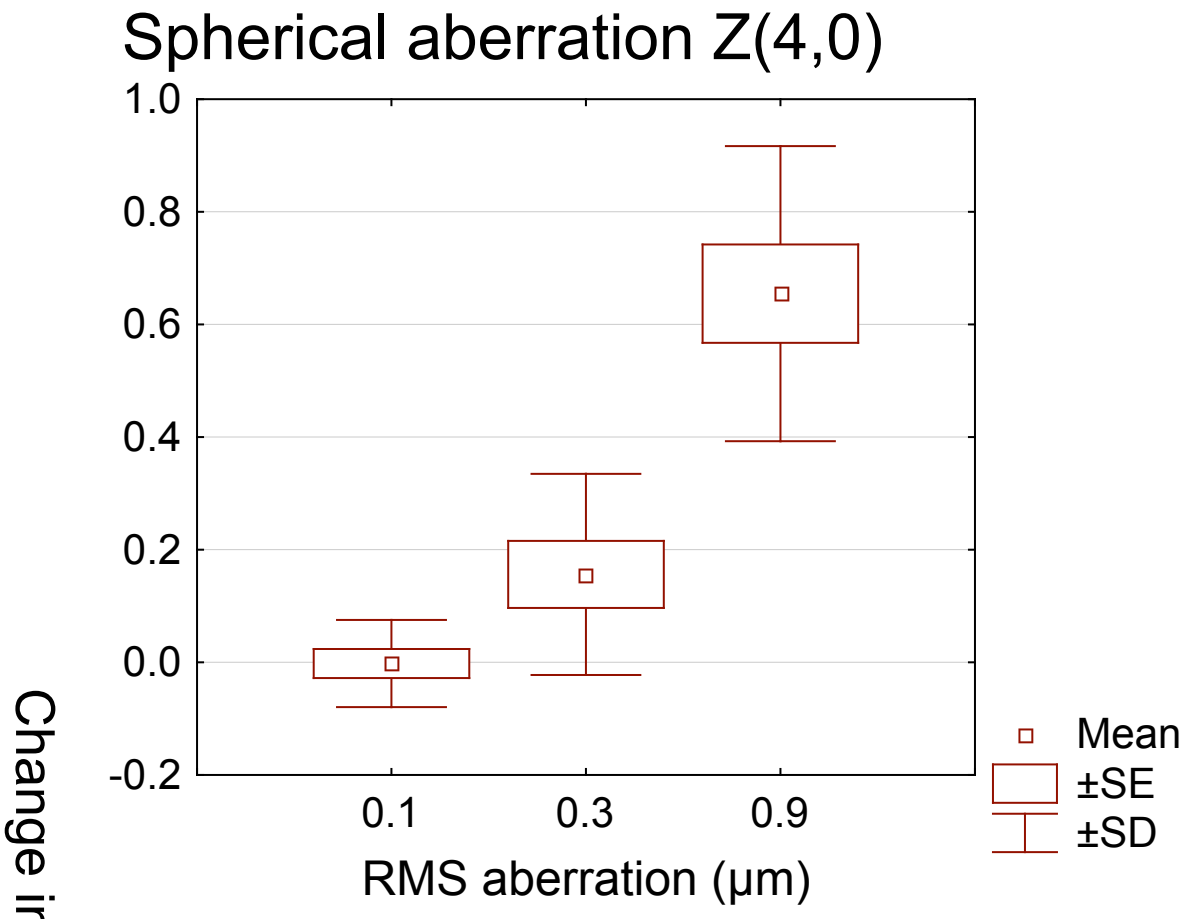
Results


Coma Z(3,-1)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Change ir
0.1
0.3
0.9
RMS aberration (µm)
Mean
±SE
±SD

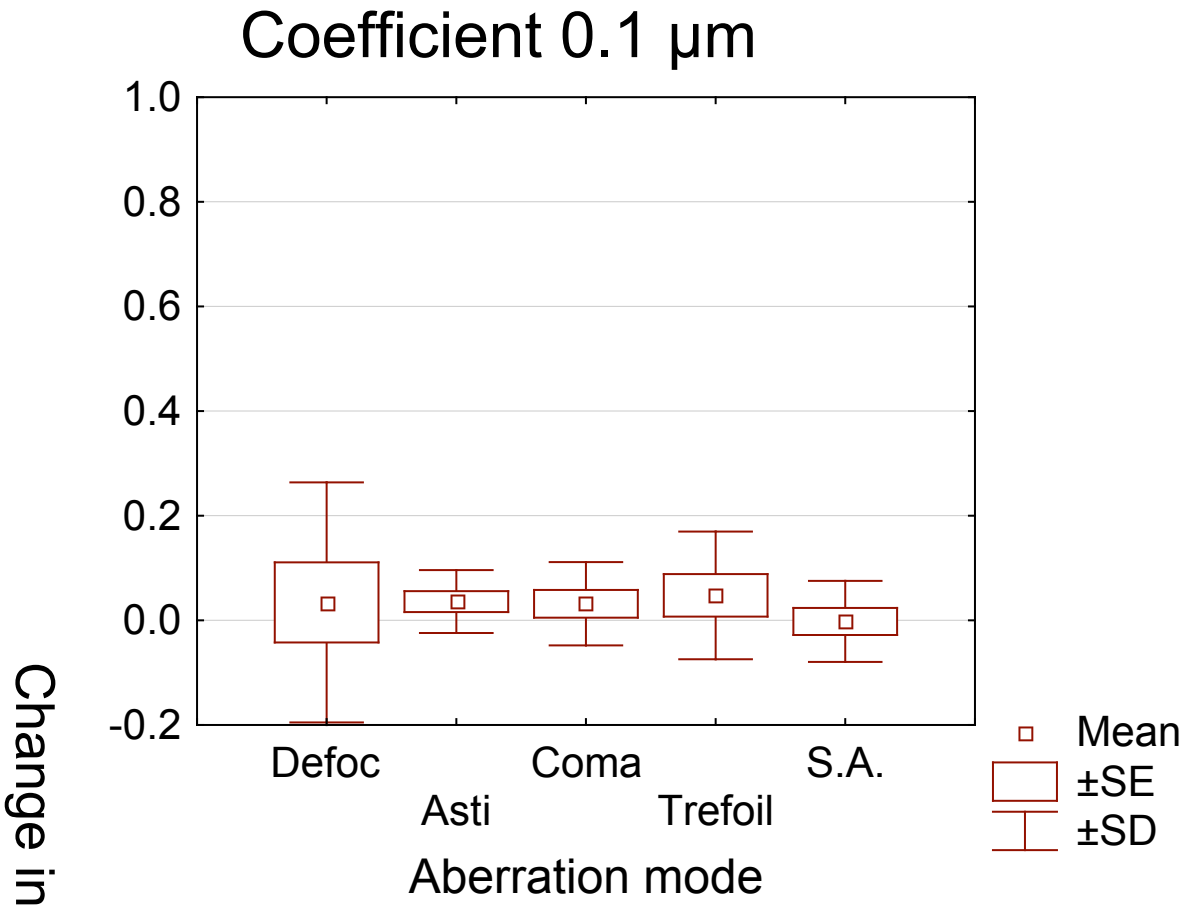
Results


Trefoil Z(3,-3)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Change ir
0.1
0.3
0.9
RMS aberration (µm)
Mean
±SE
±SD

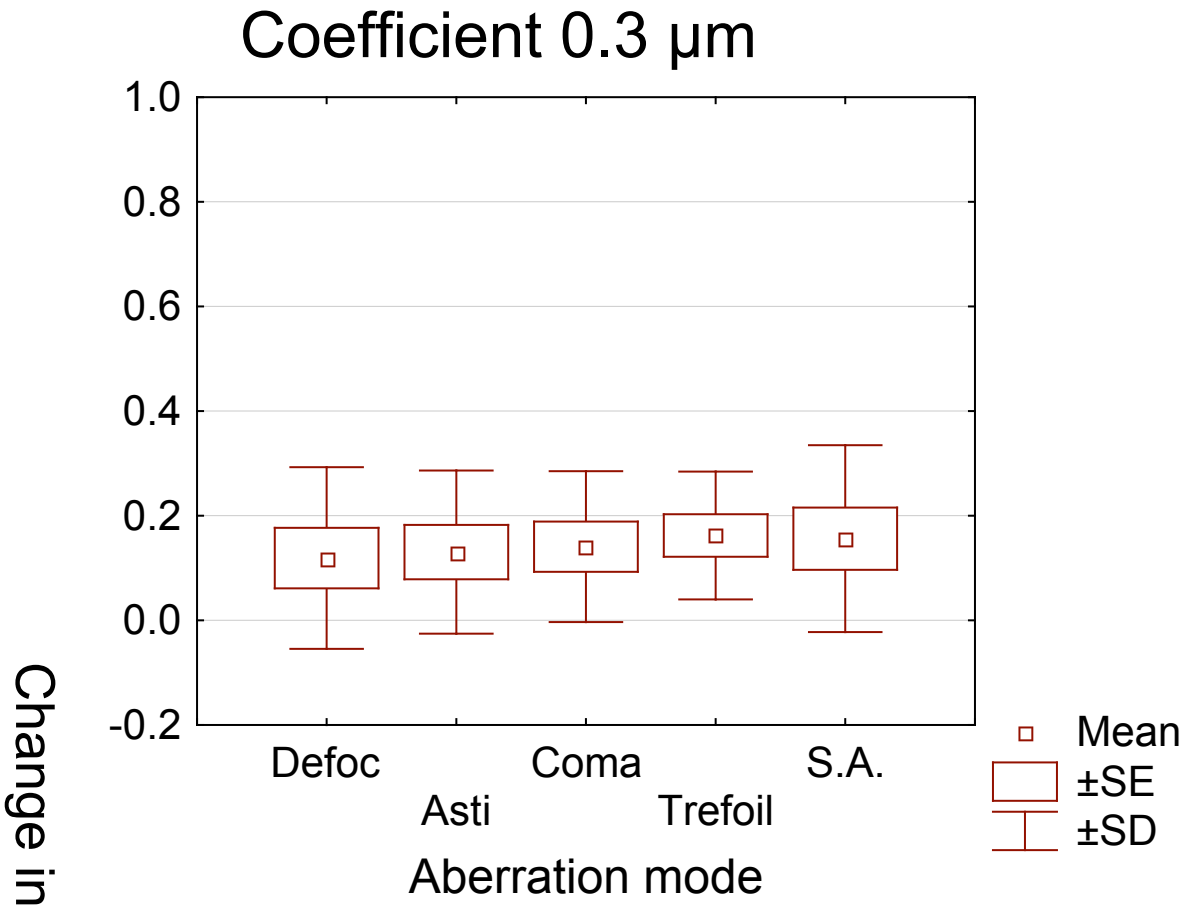
Results


Spherical aberration Z(4,0)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
0.1
0.3
0.9
RMS aberration (µm)
Change ir
Mean
±SE
±SD

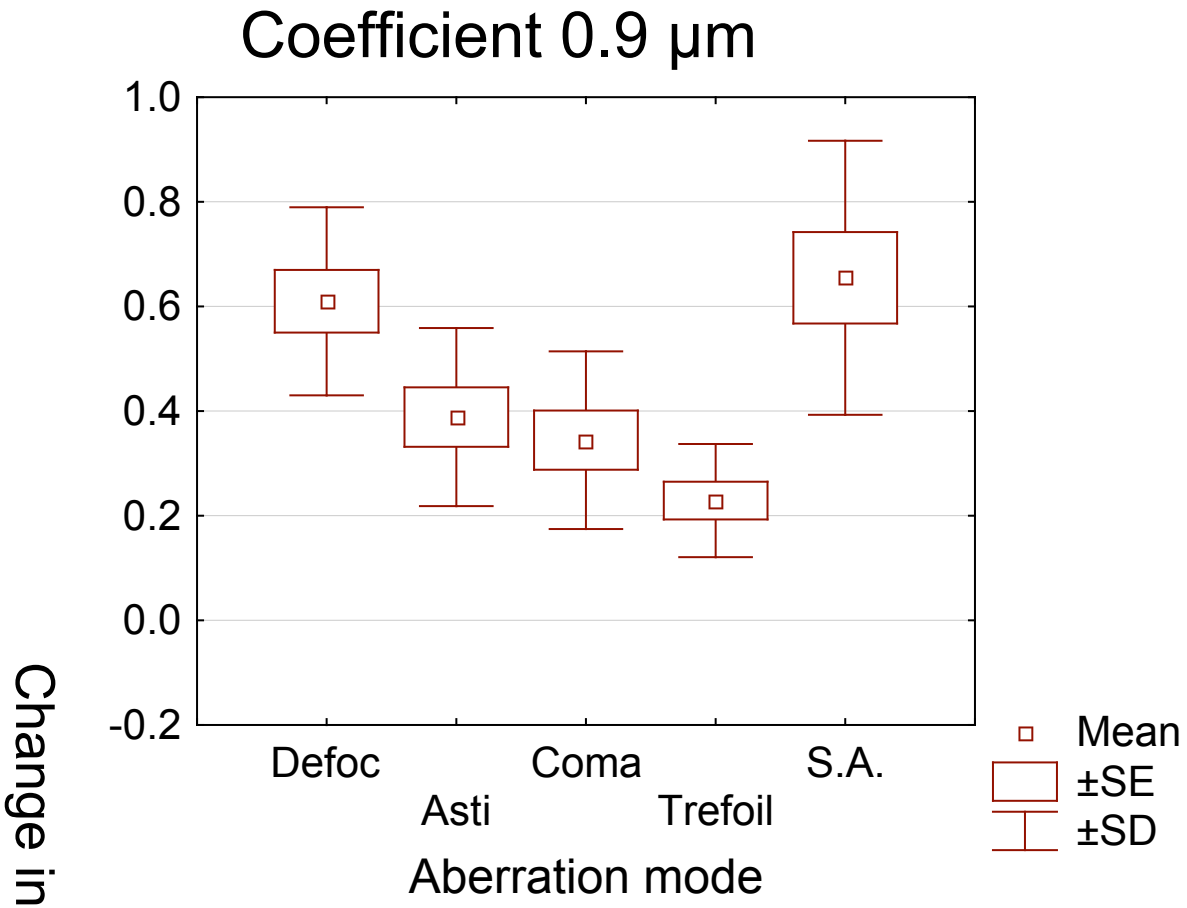
Results


Coefficient 0.1 µm
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Change in
Defoc
Asti
Coma
Trefoil
S.A.
Aberration mode
Mean
±SE
±SD

Results


Coefficient 0.3 µm
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Change in
Defoc
Asti
Coma
Trefoil
S.A.
Aberration mode
Mean
±SE
±SD

Results


Coefficient 0.9 µm
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Change in
Defoc
Asti
Coma
Trefoil
S.A.
Aberration mode
Mean
±SE
±SD

Conclusion

- The static correction of HOA improved visual acuity by one line in average, compared to sphero-cylinder correction.
- The generation of different Zernike aberrations of equal RMS resulted in different changes in VA.
- The more central aberrations in the Zernike pyramid, e.g. defocus and spherical aberration, had more detrimental effect on VA.
- Neural Adaptation could impact the difference in visual improvement with HOA compensation between subjects.