The effect of higher order wavefront aberrations on binocular summation

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Objective

- To determine the effect of individual Zernike terms of wavefront aberrations on binocular summation and binocular visual acuity
Introduction

- Most studies on higher order aberrations done monocularly
- Post refractive-surgery loss of binocular summation/binocular rivalry?
What we know so far…

- Different aberrations affect monocular visual performance differently
- Aberrations in the centre of the Zernike pyramid cause greater loss of monocular visual performance
Binocular summation

- Improvement of binocular visual acuity over monocular visual acuity
- Magnitude of ‘normal’ binocular summation varies greatly in published literature
- Actual mechanism is not known
  - Neural summation
  - Miosis
Method

- 0.25µm wavefront aberration (for 6.0mm pupil) convolved into a series of LogMAR VA charts using CTView 5.0
- 2\textsuperscript{nd}, 3\textsuperscript{rd}, 4\textsuperscript{th} order Zernike modes tested
  - 12 Zernike and 1 unaberrated
  - 3 different charts for each mode
  - Total of 39 charts
- 10-foot testing distance
Method

• 4 subjects (age 24 to 31 years)
• Eyes dilated, artificial pupil of 3.0mm used
Method

- OD, OS and OU VA taken for each Zernike term

- Binocular summation =
  - Mean BVA - Mean MVA
  - (Mean BVA - Mean MVA)/Mean MVA (Percentage)

- Normalized gain/loss in BVA =
  - BVA(unaberrated chart) - BVA(aberrated chart)
  - Loss of BVA caused by aberration
Aberration induced loss in MVA

- No. of letters lost
- Zernike Coefficient
- Second order
- Third order
- Fourth order
Aberration induced loss in BVA

No. of letters lost

Zernike Coefficient

Second order

Third order

Fourth order
Binocular vs Monocular

![Graph showing comparison between BVA and MVA for various Zernike modes.](image-url)
Binocular Summation
Findings

• Binocular summation is found in all Zernike terms
• Different Zernike terms, different amount of binocular summation
• Binocular summation occurs even when pupil size is controlled
Findings

• Terms in the centre of Zernike pyramid adversely affect BVA more than terms at the periphery.

• For the same amount of wavefront aberration, decrease in average BVA is greater the higher the Zernike order.

  • 2\textsuperscript{nd} order - 4.83 letters
  • 3\textsuperscript{rd} order - 5.56 letters
  • 4\textsuperscript{th} order - 7.20 letters
Conclusions

• Different Zernike terms affect binocular summation differently
• Terms in the centre of Zernike pyramid have greater effect on BVA than terms at the periphery
Thank you.