Exploration of the Minimum Visual Impairment Criteria for Para Nordic Skiing using Simulated Vision Impairments

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DISCLOSURES

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INTRODUCTION AND PURPOSE

- Classification in Paralympics
- Athlete Classification Code
- Evidence-based classification
  - Determining eligibility – Minimum impairment criteria
  - Allocation of athletes into sport classes
- Purpose
  - Investigate the minimum vision impairment criteria for Para Nordic Skiing using simulated vision impairments in skiers with normal vision in non-adapted Nordic skiing

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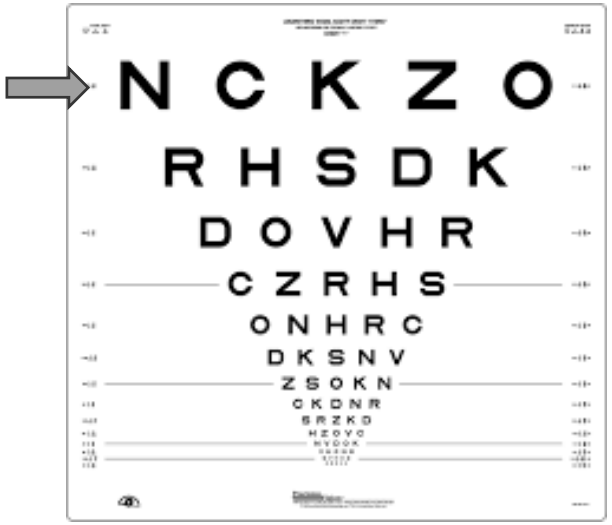
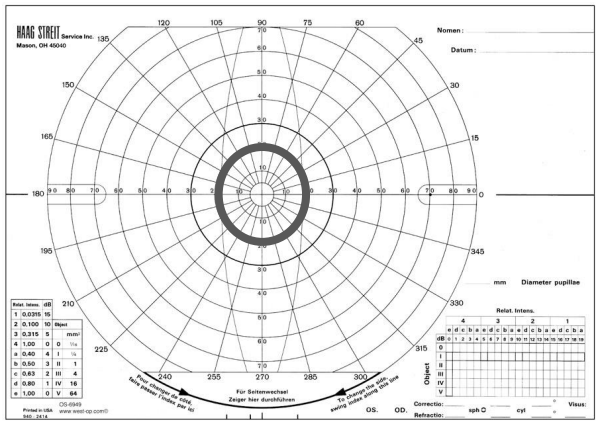
Current Minimum Impairment Criteria

Static Visual Acuity (SVA)
1.0 logMAR



Visual Field (VF)
20° visual field radius



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STUDY DESIGN

- With-in subject, repeated measures experimental design
- 2018 Para Nordic World Cup, Oberried, Germany
- Experienced adult ski racers
  - Guides, coaches, team members, members of the local ski club
- Two visits

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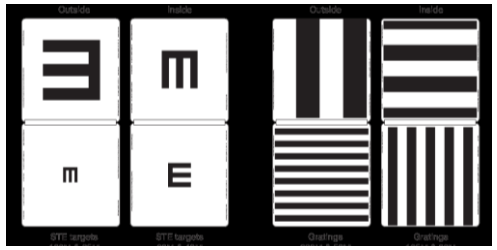
METHODS

Visit 1:

- Questionnaire
- Vision function assessment (binocular)
  - Static visual acuity – ETDRS, BRVT charts (logMAR)
  - Contrast sensitivity – MARs chart (logCS)
  - Visual field - Arc perimeter (Esterman scoring in %)



- Conditions: Habitual & Simulated impairments

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SIMULATED IMPAIRMENTS

Cambridge simulation glasses (8 levels)

- Visual Acuity
  - -0.02 to 1.36 logMAR
- Contrast Sensitivity
  - 1.77 to 0.34 logCS

Painted goggles (6 levels)

- Visual Field
  - 85% to 20% visual field extent

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VISIT 2: SKIING TRIALS

- 400 to 500m course
- 18 skiing trials total
- First and last trials with clear goggles
- Middle 16 trials included:
  - 2 clear goggle trials
  - 8 visual acuity + contrast sensitivity impairments
  - 6 visual field impairments
  - Randomly assigned
- Time to complete each run compared to baseline
  - Average of 4 clear goggle trials

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DATA ANALYSIS

- Normality: Shapiro-Wilk test, Q-Q plots
- Friedman's Two-Way Analysis of Variance ($p<0.05$) with Dunn post-hoc test
  - Order & fatigue effects on race time
  - Simulation effects on race time
- ROC analysis
  - Youden's J: optimum criteria - maximum sensitivity and specificity
    - Sensitivity: correctly include skiers with eligible vision impairments
    - Specificity: correctly exclude skiers without eligible vision impairments

POPULATION

- 22 sighted, experienced Nordic skiers (6 Females, 16 Males)
  - 28.09 ± 9.67 yrs; range: 16 to 50 yrs
  - Coaches (12), Guides (5), local ski club (4), Physio (1)
  - 11 Nations
- Years of experience: 21.59 ± 10.86 yrs; range: 5 to 44 yrs
- Total hours of skiing in a week: 8.90 ± 4.68 hrs; range: 1 to 20 hrs

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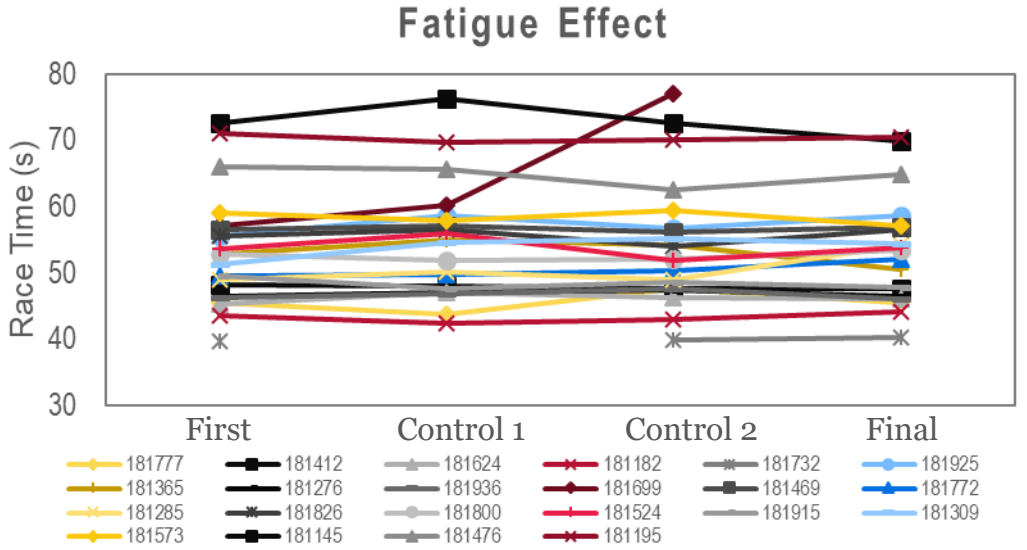
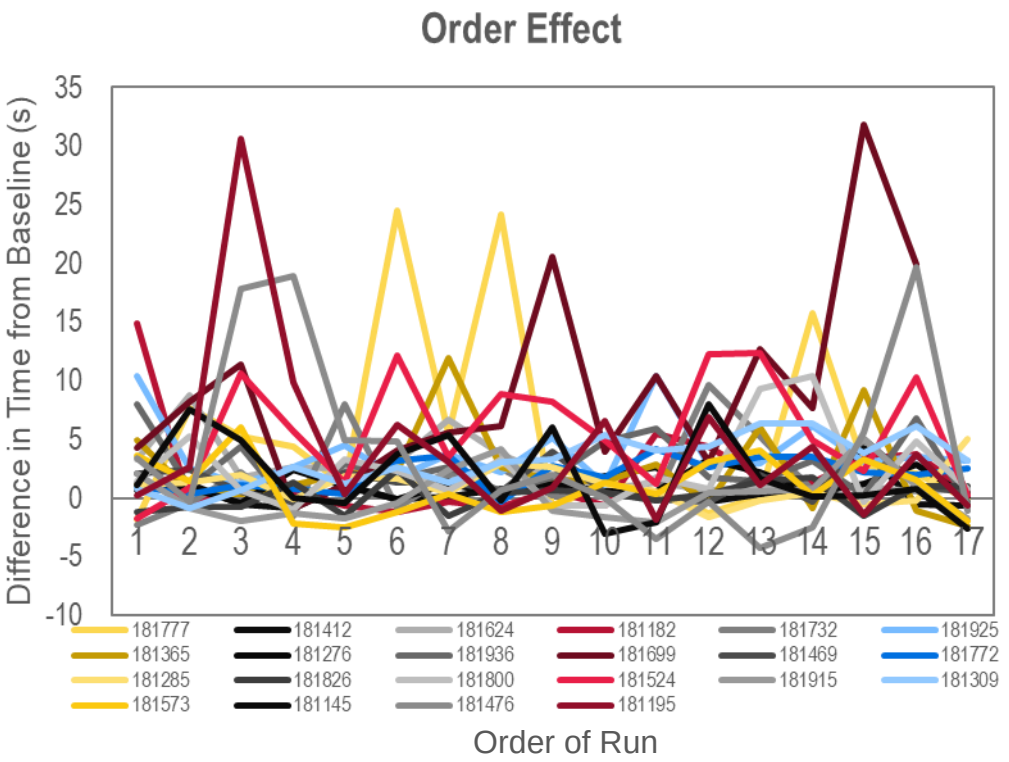
ORDER & FATIGUE EFFECTS

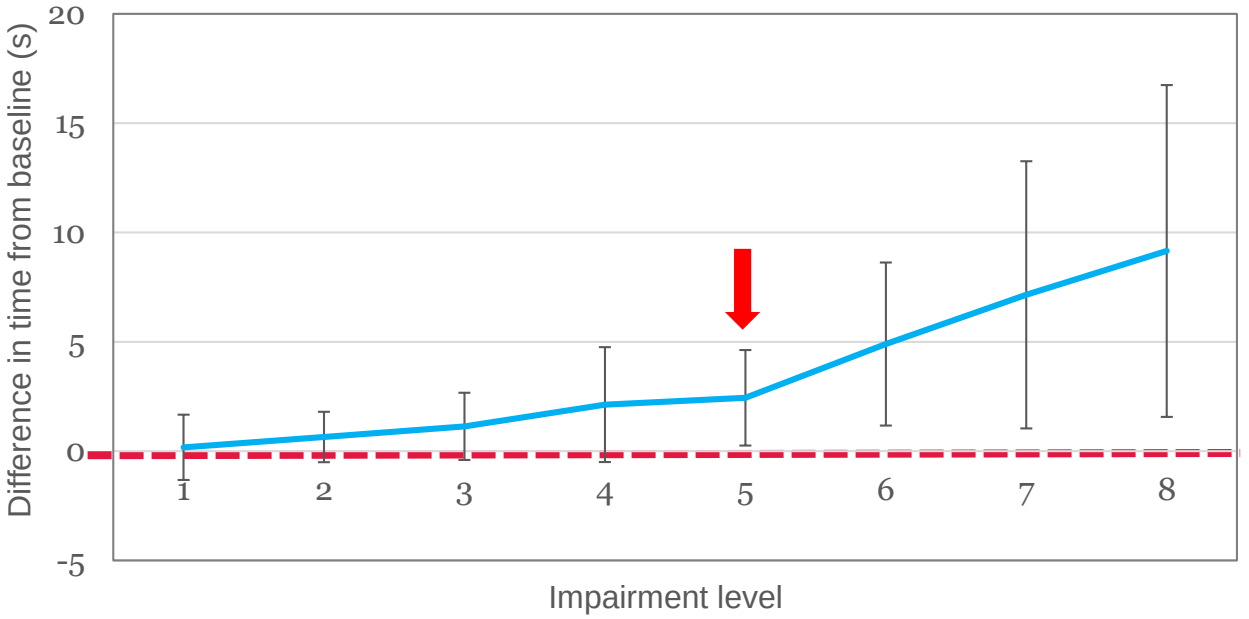
- No difference in race time was found across the clear goggle trials
  - Skiers could maintain a consistent race pace
- No systematic order effect on performance in the data
  - Skiers did not get progressively faster as they became more familiar with the course





SIMULATION EFFECT: VISUAL ACUITY & CONTRAST SENSITIVITY

- Simulated impairment trials compared to baseline time
- Race time increased gradually
  - Steeper increase from Level 5
    - **0.85 ± 0.1 logMAR**
    - **0.95 ± 0.11 logCS**



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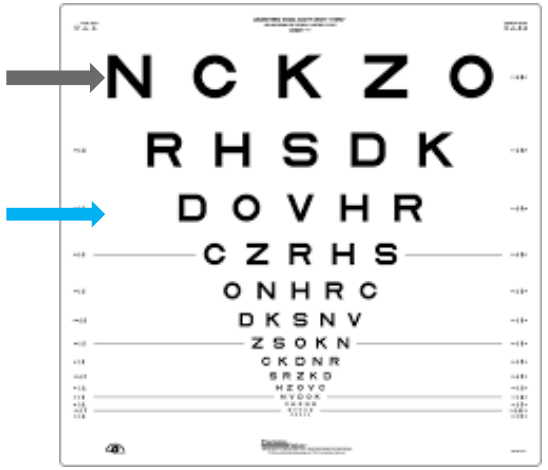
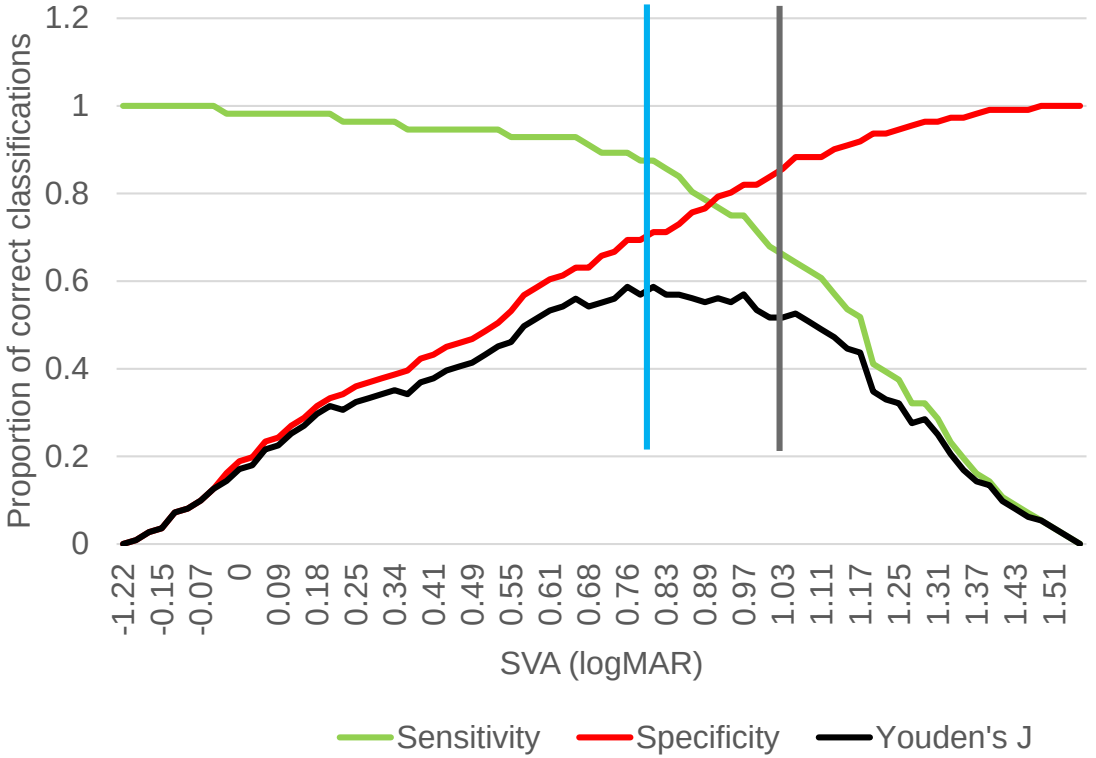
OPTIMUM CUT-OFF: VISUAL ACUITY

At 0.81 logMAR
Youden's J = 0.59
- Sensitivity: 0.88
- Specificity: 0.71



At 1.01 logMAR (B3)
Youden's J = 0.52
- Sensitivity: 0.68
- Specificity: 0.84



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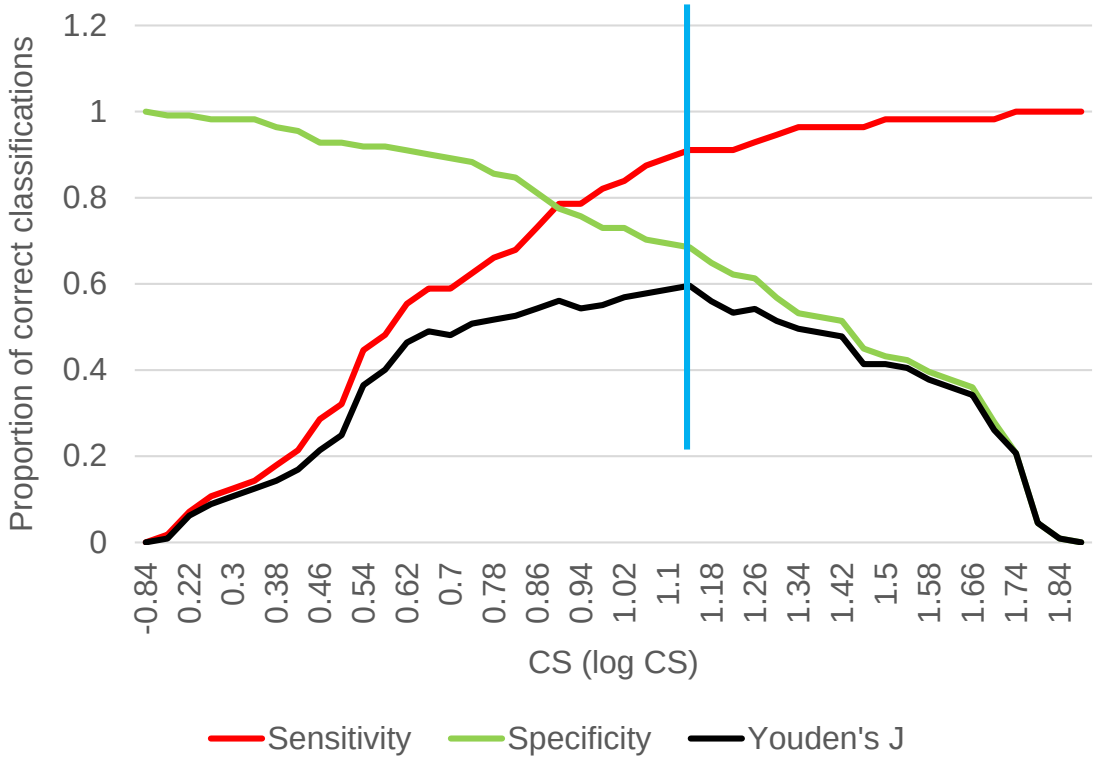
OPTIMUM CUT-OFF: CONTRAST SENSITIVITY

At 1.14 logCS
Youden's J = 0.60

- Sensitivity: 0.91
- Specificity: 0.69



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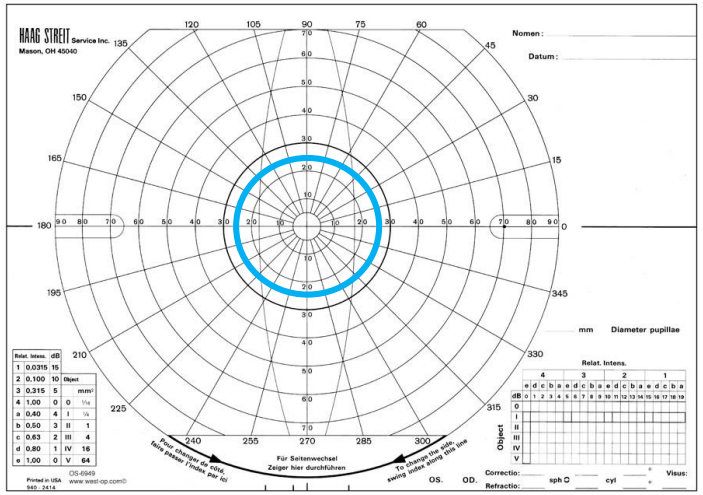
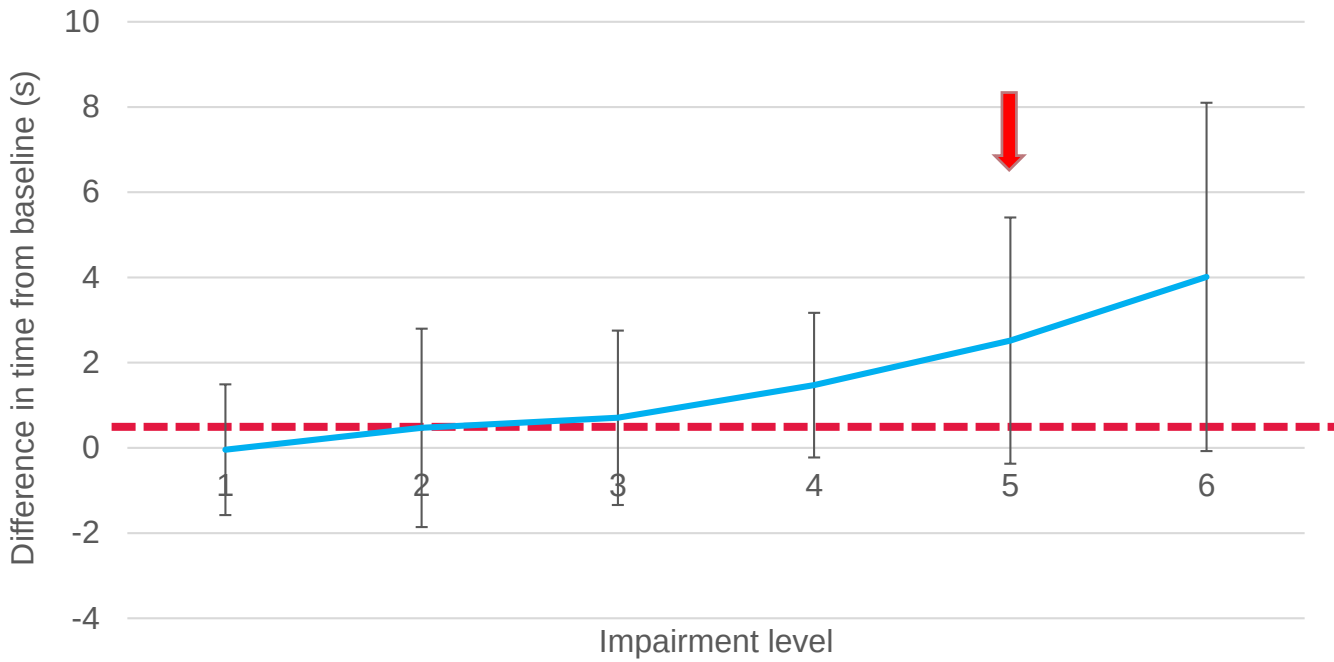
SIMULATION EFFECT: VISUAL FIELD

- Skiing performance decreased gradually
- Significantly different at Level 5
  - **33.4% visual field extent**





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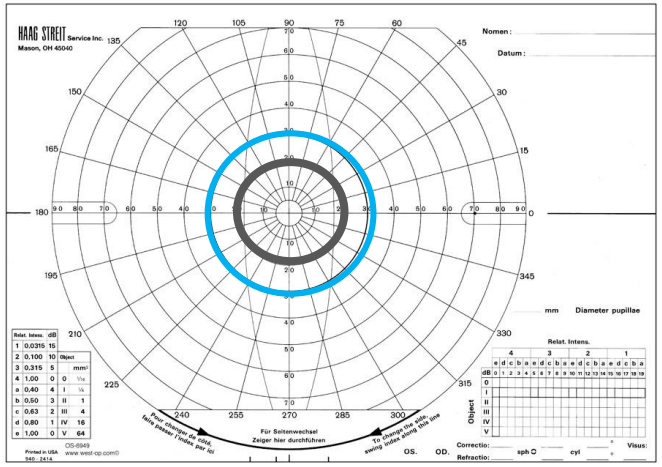
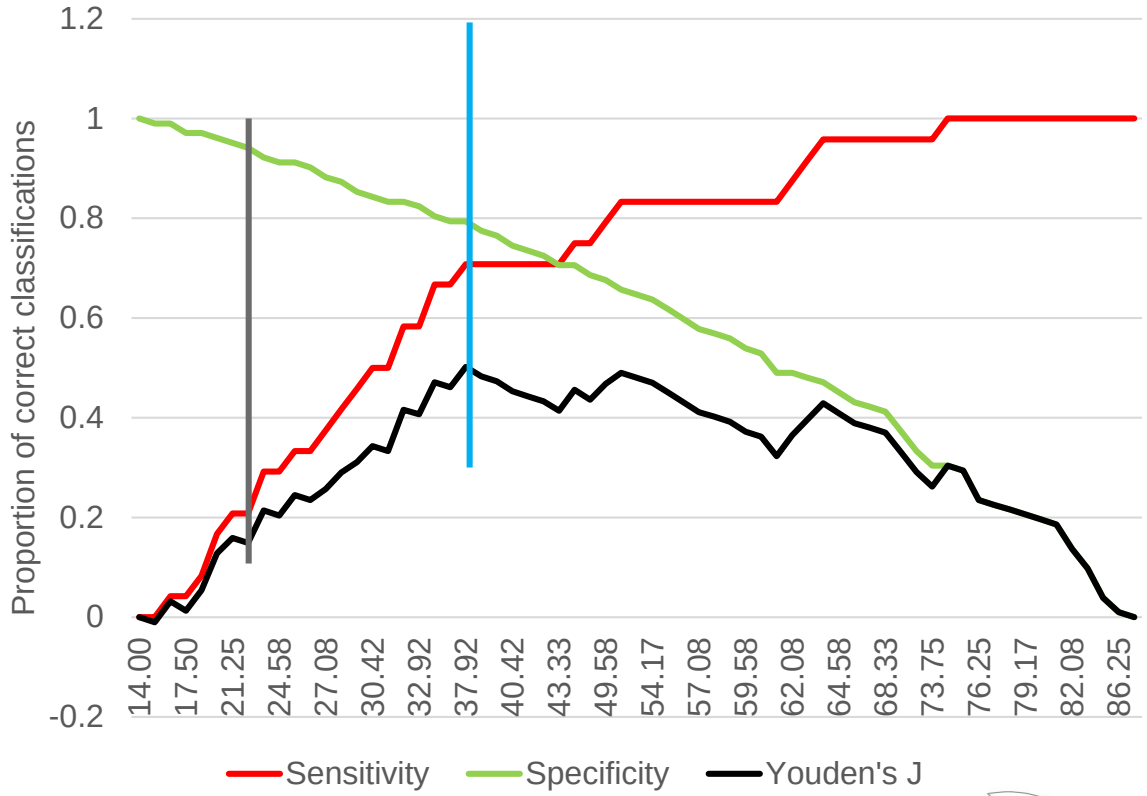
OPTIMUM CUT-OFF: VISUAL FIELD

At 37.9%
Youden's J = 0.50
Sensitivity: 0.71
Specificity: 0.79

at 21.7% (B3)
Youden's J = 0.16
Sensitivity: 0.21
Specificity: 0.95





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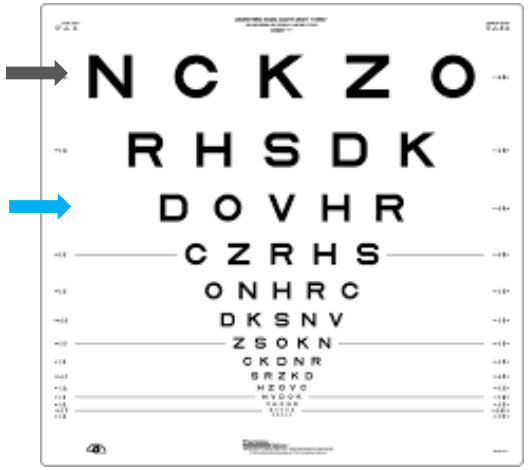
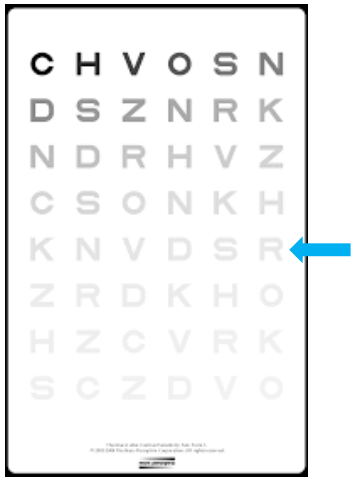
CONCLUSION

- Moderate reductions in visual acuity, contrast sensitivity, and visual field appear to affect skiing performance negatively

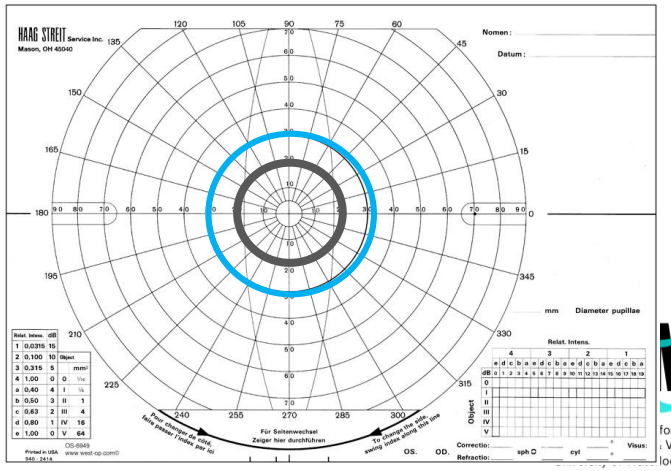
Visual Acuity
At 0.81 logMAR



Contrast Sensitivity
At 1.14 logCS



Visual Field
At 38% (Esterman score)



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Classification Research Partner

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