

COLOR VISION TEST COMPARISON BETWEEN THE HRR AND D15

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Introduction

- Color vision deficiencies affect an estimated 300 million people worldwide. They can profoundly impact an individual's daily life, as well as limit career options. Color vision testing attempts to make these patients aware and educated.
- Two tests that are regularly used to clinically identify color deficient individuals are Hardy-Rand-Rittler (HRR) 4th Edition Pseudoisochromatic plates and the Farnsworth D15 (D15).
- MCOLES (standards for law enforcement personnel) requires that candidates must pass the D15. The pass-fail criteria itself is controversial however, as individuals with mild color vision defects will typically pass and individuals with severe defects will typically fail. But the decision for a fraction of individuals with moderate defects is somewhat arbitrary in nature.
- In color deficient individuals, passing D15 results have been shown in literature to be achievable through practice.¹
- This study aims to determine if the HRR 4th Edition is a viable replacement for the D15, and/or if it could help a MCOLES pass/fail determination if D15 results are suspect.

Methods

- A record review of all University Eye Center examinations between the years 2003 and 2018 was conducted. Patients under the age of 18, those of incarcerated status, and those with incomplete data (missing HRR 4th Edition or D15) were excluded.
- Seventy-one (71) total patients, anonymized via assignment of a random subject number, represent the data comprised in this study.
- HRR 4th Edition results were hand scored. Subjects were classified as Protanopes or Deuteranopes, and as Mild, Moderate, or Severe.
- Vingrys and King-Smith Scores (including Bowman CCI Score, C and S-index Scores) were generated from D15 data using the program Color Vision Recorder. These index scores were compared to the MCOLES pass-fail determination.
- S-index quantifies the amount of polarity or lack of randomness in cap arrangement. C-index quantifies the degree of color vision loss relative to perfect cap arrangement (a larger value may indicate greater severity). Bowman CCI score represents a quantitative method to estimate total error within a patient's D15 cap arrangement.²
- Statistical analysis compared the 3 results of HRR 4th Edition classification, Bowman CCI Score, C-index and S-index Score, and the MCOLES pass-fail D15 criteria.

Results

Figure 1 – HRR Severity Classification Per Number of Subjects in Study

	Protanomaly	Deuteranomaly	Unclassified
Mild	8	20	6
Medium	1	22	0
Strong	2	12	0
Total	11	54	6

Figure 2 – Average Bowman CCI

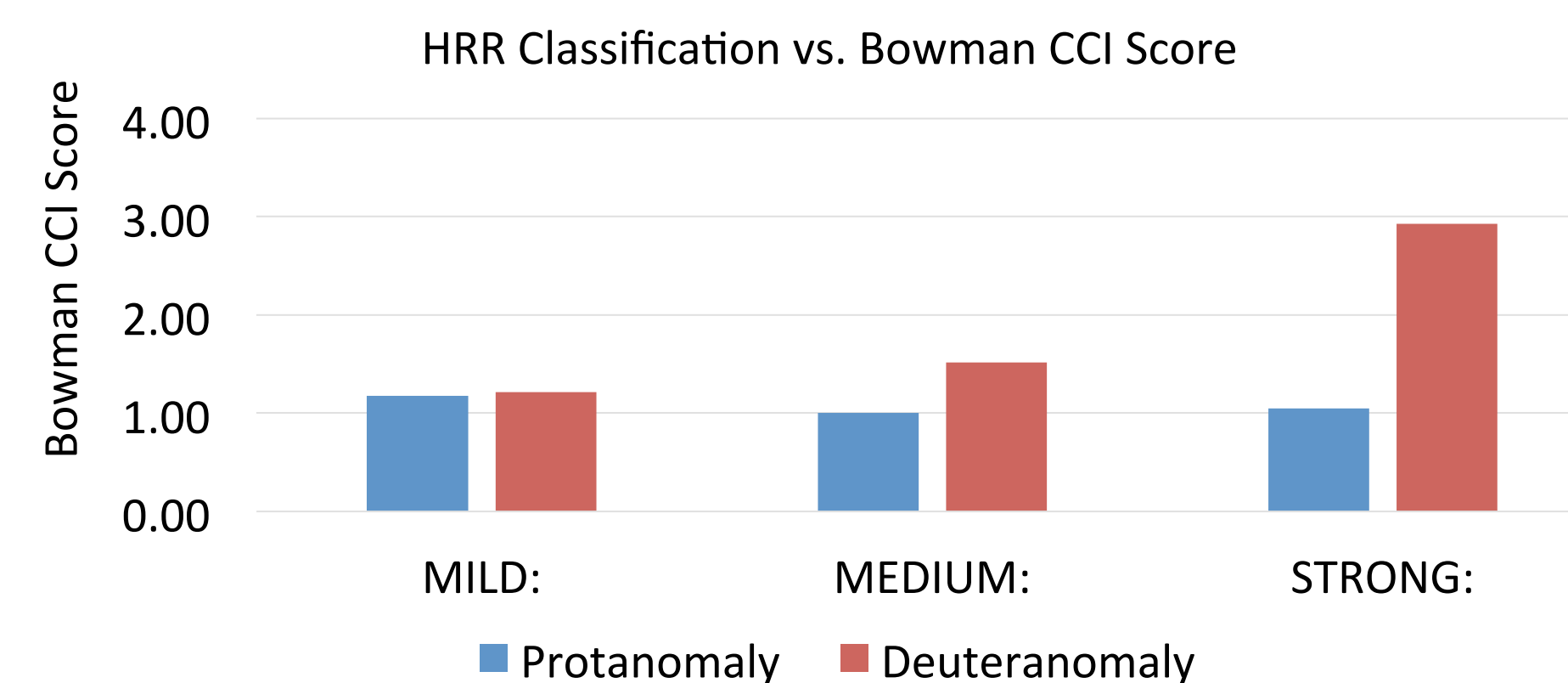
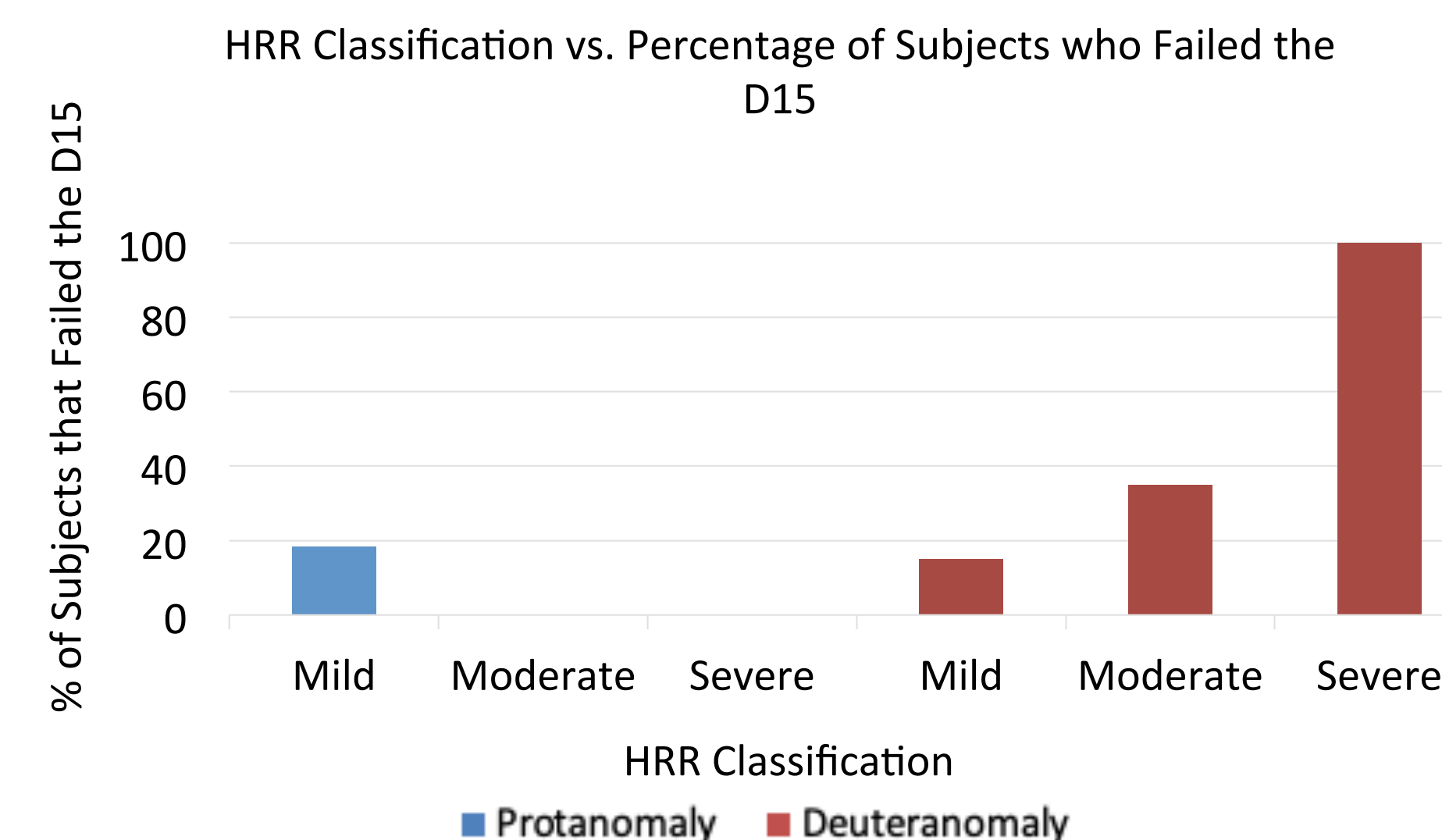


Figure 3: HRR Classification in Reference to MCOLES Pass/Fail Criterion



Conclusions

- The HRR 4th Edition is not a viable replacement for the D15 for classifying the type and severity of color vision defects.
- No relationship was found between the HRR 4th Edition and D15 for Protanomaly. The small number of Protanomaly subjects (11) renders the data analysis inconclusive.
- A statistically significant relationship was discovered that differentiates severe deuteranomalous individuals from those with mild or moderate defects. This can be helpful when interpreting D15 test results that are inconclusive.
- As a group the average Bowman CCI score, and C-index score for deuteranomaly increased as severity of the defect increased. However, consistent cut-off scores for severity classification could not be determined.
- For Deuteranomalous subjects, a range of S-index scores was observed: Mild (1.00 to 1.145), Medium (1.145 to 1.77), and Strong (1.77 to 4.02). Those that failed the D15 had a S-index greater than 2.00.

Discussion

- The small number of Protanomalous subjects rendered data inclusive for this subject population. Further determination of a relationship between the HRR 4th Edition and the D15 (specifically for Protanomalous) is recommended using larger sample sizes.
- A downfall of the HRR 4th Edition is that the subject can be rendered as "unclassified" due to scoring limitations. Further tests such as the D15, Nagel Anomaloscope, or the 100-Hue may be required in these cases if advanced assessment is required.
- Values such as the C and S-index (as calculated by the Vingrys and King-Smith Score) can correlate with the approximate HRR classification. This can be correlated with the approximate likelihood of pass-fail on the D15, an important connection given that the results of the D15 can be falsely passed through practice. There was no literature found to support these findings.¹
- Small data inconsistencies may be eliminated by the use of a single test administrator (for both the D15 and the HRR 4th Edition) in future studies.

References

- Ng, J. S., & Liem, S. C. (2018, May). Can the Farnsworth D15 Color Vision Test Be Defeated through Practice? Retrieved April 12, 2020, from <https://www.ncbi.nlm.nih.gov/pubmed/29683989>
- Atchison, D. A., Bowman, K. J., & Vingrys, A. J. (1991). Quantitative Scoring Methods for D15 Panel Tests in the Diagnosis of Congenital Color Vision Deficiencies. *Optometry and Vision Science*, 68(1), 41-48.

A further list can be supplied upon further inquiry.