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Photometric Compliance of Standard and Digital Infant Acuity Tests

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Introduction

Amblyopia or "lazy eye" affects approximately 2–5% of the general population in the UK[1]. Treatment must be started as early as possible as it is less effective after age 8[2]. The current gold standards for infant acuity testing are based on printed cardboard targets ('standard tests') and have been in place for almost 35 years[3]. In spite of this, no national nor international standard criteria are in place to quality assure them. Electronic platforms show promise to replace card-based tests[4]. However, the fast-changing nature and photometric differences across manufacturers of electronic devices makes them potentially inaccurate when used for visual testing[5]. This work studied the photometric compliance of three standard tests (Teller cards, Keeler cards, Lea Paddles) and four electronic displays (phone, tablet, laptop and 4k monitor).

Methods

Luminance measurements were made of white, black, grey background, and two targets for the standard tests under fluorescent light, and under high Colour Rendition Index cold and warm lights. Measurements of white, black, and three grey-emulating grating patterns were also measured for the four electronic displays under two illumination conditions, with and without fluorescent lights. The luminance measurements were compared via ANOVA tests ($\alpha = 0.05$) and used to calculate target Weber contrast between gratings and backgrounds of the standard tests: a high Weber contrast might reduce effectiveness because targets would be visible due to luminance mismatch rather than perception of the target's gratings. Contrasts were not measured for electronic displays as their grey backgrounds are emulated with very fine gratings[4].

Results & Discussion

None of the colours had consistent luminance ($p\text{-value} \leq 0.001$) across the three standard tests under any of the three illumination conditions. The four electronic displays also had significant luminance disparity for all five colours under both illumination conditions ($p\text{-value} < 0.001$). All standard tests and electronic displays met the British Standards (BS) uniformity criterion and the ICO standard overall luminance criterion. None of the standard tests met the BS overall luminance criterion under fluorescent light, while all the electronic displays did. For standard tests, the contrast between gratings and background differed, with Keeler cards having the lowest contrast and Lea paddles having the highest.

Conclusion

The traditional gold standard tests for measuring infant acuity have significant inter-test variability in photometric compliance, i.e. luminance, luminance uniformity and background—grating contrast. The clinical relevance of these disparities is uncertain due a lack of published data. The electronic displays measured here comply with such standards as exist, and while disparities exist between devices, they could be calibrated to comply with any further specific requirements.

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