Quantifying Patient Lighting Needs To Improve Low Vision Clinical Practice and Patient Performance: A Preliminary Study

Gregory L. Goodrich, PhD, FAAO, Shanida Ingalla, OD, Megan Dolkas, O.D., & Faydim Rassamdana, OD
VA Palo Alto Health Care System

Purpose:

The lighting needs of aged and low vision patients has long been recognized as critical in maximizing reading and other daily living tasks. However, the lack of a clinical tool to quantify illumination has limited the ability to prescribe optimum illumination. Prior research has suggested that light provided by light emitting diodes (LEDs) may be beneficial to low vision patients. [2,3] In this study we pilot test a new device, the LuxIQ, which allows clinicians to quantify patient preferred illumination (up to 5000 lux) and color temperature (2700 – 6300^{o}K) using acuity charts and/or reading material.

Method:

We conducted a controlled study assessing the number of characters read using the Colenbrander Mixed Contrast Intermediate chart by normally sighted and low vision subjects. The Colenbrander Chart has 65 high and 65 low contrast letters. The criteria was the total number of letters read until 3 errors were recorded. Data was recorded as number of letters read under four lighting conditions: 1) clinic illumination (754 lux) 2) brightness (lux), 3) color temperature (degrees kelvin) and 4) brightness of the green (525 nm) light. Also recorded was the brightness and color temperature of white light and the brightness of the green light. All participants set their preferred level of brightness and color temperature. All subjects wore habitual correction or prescribed reading glasses. Clinic illumination of the chart was 754 lux. Data analysis including descriptive statistics, t-tests, and analysis of variance were conducted using SPSS 18.0.

Subjects:

Subjects (N = 30) were recruited from a VA Blind Rehabilitation Center population. Controls (N = 10) were recruited from the staff of the Center. All signed an approved consent form and the study was conducted in accordance with VA regulations for research using human subjects. The most common causes of vision loss in subjects were AMD and glaucoma (8 each). Other causes were TBI (hemianopia), NAION, diabetic retinopathy, trauma/TBI, interstitial keratitis, CRAO, and macular edema.

Results:

Figure 1 shows results for controls and subjects by age, working distance, preferred illumination, preferred color temperature, and preferred illumination with green light. Both controls and subjects had similar ratios of male to female. Subjects were significantly older than controls. Controls had a significantly greater working distance. Controls set the brightness (lux) for the white LuxIQ illumination significantly higher than controls, however there were no significant differences between the two groups for preferred color temperature or brightness of the green light.

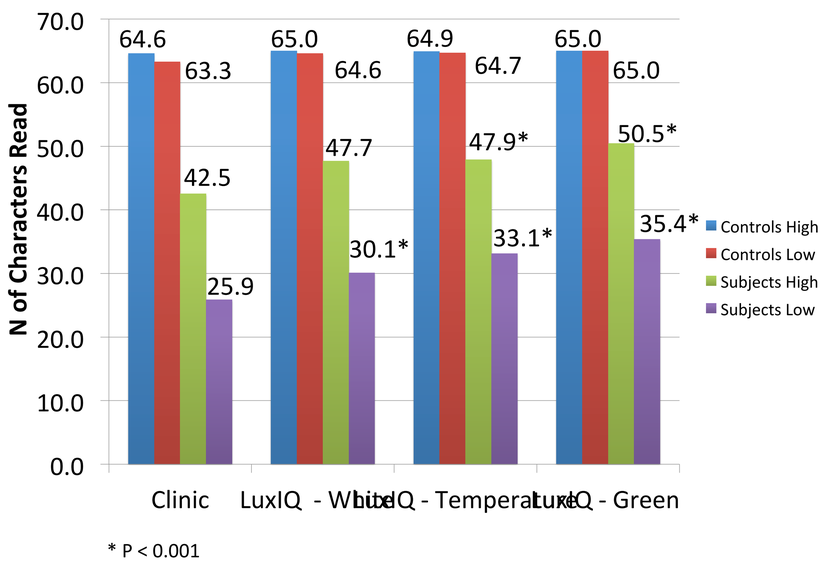
The number of high and low contrast letters read by the controls were similar between the clinic lighting and that using the LuxIQ (brightness, color temperature, or brightness of the green light) with all conditions yielding an average of about 65 characters. (See Figure 2)

Figure 1. LuxIQ, Colenbrander Chart, and reading stand.

Table 1. Comparison of control and subject means (range) for age, working distance, and preferred lux and color temperature.

	Controls (N = 10)	Subjects N = 30)
Mean Age	55.5 (40 - 68 yrs.)	70.7 (51-90 yrs.) *
Working Distance	44.7 (32-56 cm)	26.3 (12-45 cm) **
Preferred White Lux	2825 (500-5000 lux)	1954 (700-5000 lux)**
Preferred Color Temp.	4260 (2700-5500 ^{o}K)	4400 (2700-6500 ^{o}k)
Prefered Green Lux	2750 (500-7500)	2527 (750-6500 lux)

* P < 0.05; ** p < 0.001



* P < 0.001

Figure 2. Number of high and low contrast letters read by controls and subjects with clinic illumination and when preferred illumination, color temperature, and green illumination were set by the participant.

Results Continued:

Subjects varied considerably in the number of letters read, with six subjects reading 60 or more letters in the clinic condition and nine reading 10 or fewer characters.

Compared to clinic lighting subjects read about 5 high contrast letters more when able to set white light illumination to their preferred level but the difference was not significant. The difference became significant when subjects were able to set the preferred color temperature with an increase of 5.4 letters. The preferred illumination of the green light yielded a significant increase of 8 letters.

Similar differences were obtained for low contrast letters with the illumination yielding 4.2, 7.2, and 8.5 more letters over the clinic illumination when subjects set white light illumination, color temperature, and Illumination of green light. All differences were significant.

Discussion and Conclusions:

Study subjects were significantly older than controls and, as expected, had significantly shorter working distances. Both subjects and controls preferred significantly brighter (3.7X and 2.6X respectively) lighting with the LuxIQ white light than provided in the clinic. Unexpectedly, controls and subjects did not differ on preferred color temperature or green illumination of the LuxIQ compared to clinic illumination.

Greater illumination increased letters read for subjects and optimizing color temperature further increased this advantage over clinic lighting. Green light yielded the greatest increase in subject performance. The increase was greater for some subjects and less for others.

The results suggest that low vision patient reading performance may be enhanced, for some but not all patients, by optimizing illumination. Optimization should be defined as brightness and color temperature. The large increase in letters read provided by green suggests that colored lighting may improve both high and low contrast reading compared to white light.

New technology which provides a calibrated, inexpensive light source warrants further research on reading and near tasks that may be of benefit to elderly individuals and low vision patients.

References:

1. Bowers, A. R., Meek, C. and Stewart, N. (2001) Illumination and reading performance in age-related macular degener ation. *Clin. Exp. Optom. 84*, 139–147.
2. Ramane DV, Shaligram AD. Design of multispectral reading light for individuals with low vision. *J Biomed Optics, 17*(1), 2012.
3. Wolffsohn, JS, Palmer, E., Rubinstein, M, Eperjesi, F. Effect of light-emitting diode colour temperature on magnifier reading performance of the visually impaired. *Clin Exp Optom, 95*(5), 510-14, 2012.

Conflict of Interest:
The authors report no financial conflict of interest.