SOUTHERN COLLEGE OF OPTOMETRY

Validation Study of New LCD Based Contrast Sensitivity Testing Method

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INTRODUCTION

Contrast sensitivity (CS) measurement is useful to gain insights into one's visual function, assess various ocular conditions and monitor for visual improvement during vision therapy.

Various clinical testing methods are available to assess one's CS, including the Pelli-Robson test, the Bailey-Lovie chart, and the Vistech chart. The validity and reliability of these tests are well established and they are widely used in clinic as well as for research purposes. The Pelli-Robson chart has the set letter size in suprathreshold with varying contrast levels. It measures one's peak contrast sensitivity and is commonly used for occupation screening purposes. The Bailey-Lovie chart is available in high and low contrast versions. The high contrast version serves as visual acuity chart in which letters are equally spaced and each row contains the same number of letter optotypes. The low contrast version shows the same design as its high contrast counterpart, except the contrast level is set at 18% Weber contrast level. It is commonly used in specialty clinics such as low vision and binocular vision clinics and clinical research setting due to its convenience to measure one's CS at higher spatial frequency. The Vistech chart consists of series of grating panels with varying contrast levels. It provides one's complete CS function across various spatial frequency spectrum *(Figure 1)*. However, its clinical application is limited due to its nature of being more time consuming and less consistent (i.e. difficulty to illicit the same endpoint when performed on regular patient basis).

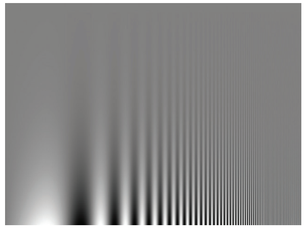

Figure 1. *Demonstration of the Contrast Sensitivity Function (CSF). The spatial frequency decreases as moving from left to right, while the contrast decreases as moving toward the top of the figure. Our visual system is not sensitive beyond certain contrast levels for each spatial frequency level as shown in this demonstration.*

In order to conveniently test one's visual functions, many electronic tests have been developed and are becoming more popular among eye care providers. The commonly used electronic tests include, but not limited to, visual acuity charts, binocular vision tests, Amsler grid, and contrast sensitivity tests. The major challenges with these emerging electronic tests are lack of research to demonstrate the validity and reliability compared to more traditional and established counterparts.

The Harris Contrast test (M&S Smart System®) has been developed to incorporate various features displayed on a LCD monitor to establish a contrast threshold *(Figure 2)*. It allows the tester to manipulate the contrast level while varying the optotype size with Sloan letters or varying the spatial frequency provided with grating patterns. The Harris Contrast test has a potential to be used in clinic in lieu of other traditional methods.

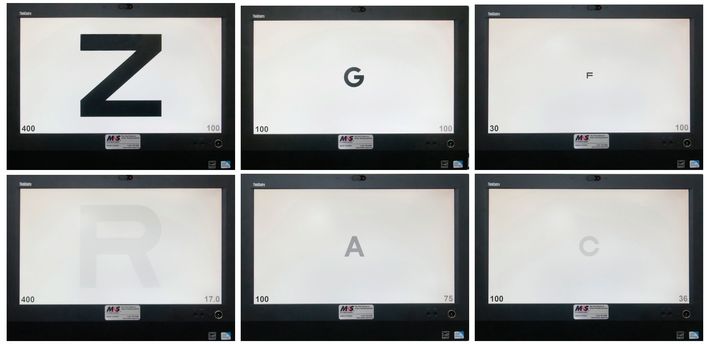

Figure 2. *Examples of the Harris Contrast test displayed on a LCD monitor. The tester can vary the contrast level and/or the optotype size using the Sloan optotype or sine wave grating pattern (not shown in this figure).*

PURPOSE

To evaluate the validity and reliability of the Harris Contrast test (M&S Smart System®) in comparison to the Bailey-Lovie low-contrast chart on young healthy adults. To establish the CS function using the Sloan optotypes using this testing method.

METHOD

The data of 53 healthy adults between the ages of 23 and 65 were examined under binocular conditions for this study. Inclusion criteria included best corrected visual acuity (BCVA) of 20/20 or better and absence of systemic and/or ocular conditions that can potentially result in CS reduction. The high-contrast Bailey-Lovie chart was used to measure initial BCVA. Visual acuity (VA) thresholds from the low-contrast Bailey-Lovie chart were obtained and compared with ones from the Harris test set at the constant 18% Weber contrast level. Contrast thresholds, which were compared against varying acuities, were measured and compared using 20/400, 20/200, 20/100, 20/50, 20/40 and 20/30 Sloan optotypes on the Harris chart.

RESULTS

The mean age of the subjects was 29 years (+/- 10.5 years).

Mean VA from the low-contrast Baily-Lovie chart was logMAR of -0.006 (+/- 0.11), while the Harris contrast equivalent was logMAR of -0.0038 (+/-0.09). Unpaired, unequal variances 1-tailed T-tests showed no significant difference between two thresholds *(Table 1)*.

TABLE 1.

Visual acuity (expressed in logMAR) comparison with the low-contrast Bailey-Lovie chart and the Harris contrast equivalent.

Bailey-Lovie low-contrast acuity	Harris contrast acuity at 18%
-0.006 (+/-0.11)	-0.0038 (+/-0.09)

LogMAR acuities measured from the Harris contrast test (contrast set at 18% contrast level) and the Bailey-Lovie low-contrast chart were not statistically significantly different (p=0.45)

Mean contrast thresholds (expressed in LogCS) from various acuity levels using Sloan optotypes on the Harris contrast chart were as follows: 1.65 (20/400), 1.66 (20/200), 1.63 (20/100), 1.45 (20/50), 1.35 (20/40), and 1.20 (20/30). Contrast thresholds were not statistically significantly different among 20/400, 20/200, and 20/100 acuity levels (p>0.05), while they were significantly different in 20/50, 20/40 and 20/30 acuity levels when compared with lower spatial frequency groups or amongst themselves (p<0.001). Overall, mean logCS followed a similar pattern of changes at different target sizes, which was consistent with the established standard CS function *(Figure 3)*.

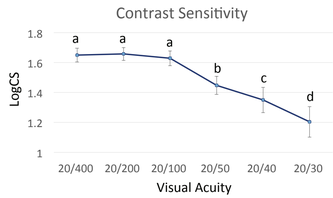

Figure 3. *Mean logCS from various acuity levels on the Harris contrast test. LogCS values were not statistically significantly different among 20/400, 20/200, and 20/100 acuity levels (p>0.05), while they were significantly different in 20/50, 20/40, and 20/30 acuity levels when compared with greater acuity levels or amongst themselves (p<0.001). Overall, mean logCS followed the expected contrast sensitivity function.*

CONCLUSION

This study demonstrates the utility and efficacy of the computer-based CS testing technology. The results suggest the potential to incorporate this electronic application in a routine eye exam to gain additional insights into the patient's visual function and better manage ocular conditions that affect one's CS.

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