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Abstract

The relationship between scotopic viewing conditions and the need in some patients for a relatively more myopic correction has been known for some time. This study compared clinical refraction findings, as measured under standard examination conditions with findings under conditions of decreased illumination and contrast, using an innovative mirror/lens system to control contrast while maintaining average luminance nearly constant. Changes in refractive findings were statistically ($p<0.003$) and clinically significant (mean change = 0.65D, SD = 0.20) . This indicates that decreasing the contrast of test letters in this manner can be a clinically useful aid to determination of refractive correction under conditions of low illumination and contrast.

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CLINICAL REFRACTIVE CORRECTION UNDER CONDITIONS OF LOW ILLUMINATION AND CONTRAST: TEST OF A NEW DEVICE

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BIOGRAPHICAL SKETCH

My undergraduate studies were conducted at Iowa State University in Ames, Iowa, from August 1979 to May 1982, with my final year being completed at Pacific University, Forest Grove, Oregon. I received a Bachelor of Science Degree, major in Visual Science, in May of 1983 from Pacific University. I will receive the Doctor of Optometry Degree from Pacific University College of Optometry the 18th day of May 1986. I was honored with inclusion into the international optometric honor fraternity, Beta Sigma Kappa, during my optometric education.

Upon graduation I plan to return to my home state of Iowa in either a solo or partnership mode of practice.

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my sincere gratitude to Dr. Niles Roth for his invaluable assistance and advice. I would also like to credit the innovative procedure used during this research to Dr. Roth.

Many thanks to Lee Cornforth for his help in the construction of the equipment.

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ABSTRACT

The relationship between scotopic viewing conditions and the need in some patients for a relatively more myopic correction has been known for some time. This study compared clinical refraction findings, as measured under standard examination conditions with findings under conditions of decreased illumination and contrast, using an innovative mirror/lens system to control contrast while maintaining average luminance nearly constant.

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INTRODUCTION

A significant percentage of the general population becomes nearsighted under dim illumination. An accurate, clinically feasible measurement of the amount of night myopia a patient exhibits has been a concern to optometrists for years.[1]

The two questions investigated in this study were: (1) under customary clincial test conditions, does decreasing ambient illumination and target contrast affect refractive findings in patients with subjective complaints of reduced night vision? (2) would lowering contrast by the method used in this study (described below) be a clinically feasible aid to arriving at a refractive correction under the above-described conditions?

The procedure used in this study emphasized contrast reduction while most others emphasize illumination reduction.[2] As Leibowitz has noted, most clinical tests utilize very high contrast levels, whereas real world night viewing generally provides low contrast stimuli.[3] Hence the need for another clinical approach to night myopia assessment.

SUBJECTS

The twelve subjects selected for this study complained of reduced clarity of vision at night, but had no detectable pathology. Refractive error was not a criterion for selection, but normal binocular vision was required. Ages ranged from 22 to 44 years (mean = 31.5).

APPARATUS

A mirror/lens system (Fig. 1) was designed to control contrast of test letters while simultaneously maintaining average luminance of the test chart nearly constant. The device attaches to the end of a standard chart projector (American Optical Model No. 11082). The upper mirror (M1), 45 degrees to the projector axis, redirects part of the projector output downward while the accessory plus lens (L) is the first element of the two-element stray light producer (L and F) that reduces contrast by distributing stray light over the projected letters. The lower mirror (M2) redirects the light through a partially diffusing plastic film (F). The combination of defocus due to L (+0.75D power) and partial diffusion by F results in a copy of the projected chart that has its details "washed out". Superposition of this "copy" on the test chart degrades contrast of the letters by an amount that depends on how much of the projector output is diverted by M1. The amount of light so diverted is controlled by moving M1 along an axis perpendicular to the projector axis. It can be seen that, except for minor reflection and absorption losses in M1, M2, L, and F, the total amount of light delivered to the test chart area remains constant. Thus, average luminance across the chart is constant, regardless of contrast level.

Luminance values (nits) for determining letter contrasts were obtained with a Tektronix J-16 photometer coupled to a luminance probe. The same instrument, coupled to an illuminance probe, was used to measure ambient light levels (in Lux). The latter were

measured just outside the border of the test chart (peripheral surround).

M1 was set to provide three different contrast levels: 0.96, 0.70, and 0.45. The highest contrast was the maximum obtainable (no light diverted by M1), and represented customary clinical test conditions.

METHOD

A distance refraction was performed, consisting of static retinoscopy, red/green, JCC, MSBVA, 20/40 equalization, and 7A. End point of 7A was determined by the last lens change which enabled improved visual acuity. Only the right eye's sphere findings were recorded throughout the procedure.

During Condition 1 (standard testing situation) the illumination level at the screen periphery was 41 lux with a target contrast level of 0.96.

The room lights were dimmed and the subject was allowed to dark adapt for ten minutes. Under these conditions (Condition 2) illumination level was 0.30 lux at screen periphery and target contrast was 0.70. Plus lens power was added to achieve a 20/40 blur level followed by binocular reduction of plus to best visual acuity.

Test Condition 3 had the same ambient light level as Condition 2 (0.30 lux at screen periphery), but target contrast was reduced to 0.45. A 20/40 blur level was again achieved followed by binocular reduction of plus to best visual acuity.

Calibration of the equipment was re-checked after all the data was collected and a maximum retest variation of $\pm$ 12% was found.

RESULTS

The data obtained is presented in Table 1.

Statistical analysis of the data consisted of multiple t-test for significance of difference between related measures. Results of this anlaysis are summarized below (Table 2) and it is seen that refractive results among the three conditions differed significantly at a corrected alpha level of 0.003.

TABLE 2

Conditions Compared	t-Test for Related Measures and Corrected Significance Level	
1 vs 2	t = 4.75	$p < 0.003$
1 vs 3	t = 11.29	$p < 0.003$
2 vs 3	t = 7.42	$p < 0.003$

The data was also examined for clinical significance. The mean dioptric change and deviation between conditions is shown below (Table 3). Most practitioners would agree upon the clincial significance of about 0.7D increase in relative myopia along with subjective complaints.

TABLE 3

Conditions Compared	Mean Change	Standard Deviation
1 vs 2	0.23D	0.17
1 vs 3	0.65D	0.20
2 vs 3	0.42D	0.20

DISCUSSION

Since the subject population was limited to those with subjective complaints of reduced night vision, it wasn't very surprising that differences among refractive findings determined under the three test conditions were highly significant ($p<0.003$).

However, based on patient response of letters being "too washed out", a contrast level of 0.50 to 0.55 would probably be more suitable for customary clinical use than a 0.45 contrast level (Condition 3).

The device designed for this study for purposes of varying contrast with a standard chart projector has shown its worth, but one area of needed improvement is a firmer attachment which would enable more precise control of mirror position and hence contrast.

The procedure used here takes approximately twenty minutes. It is non-invasive and easy to perform. As a diagnostic tool alone, or in conjunction with other tests, it should prove useful.

Based on results of this study, the goal of evaluating effects of reduced illumination and contrast on examination findings with the aid of a simple accessory to a standard chart projector has been achieved.

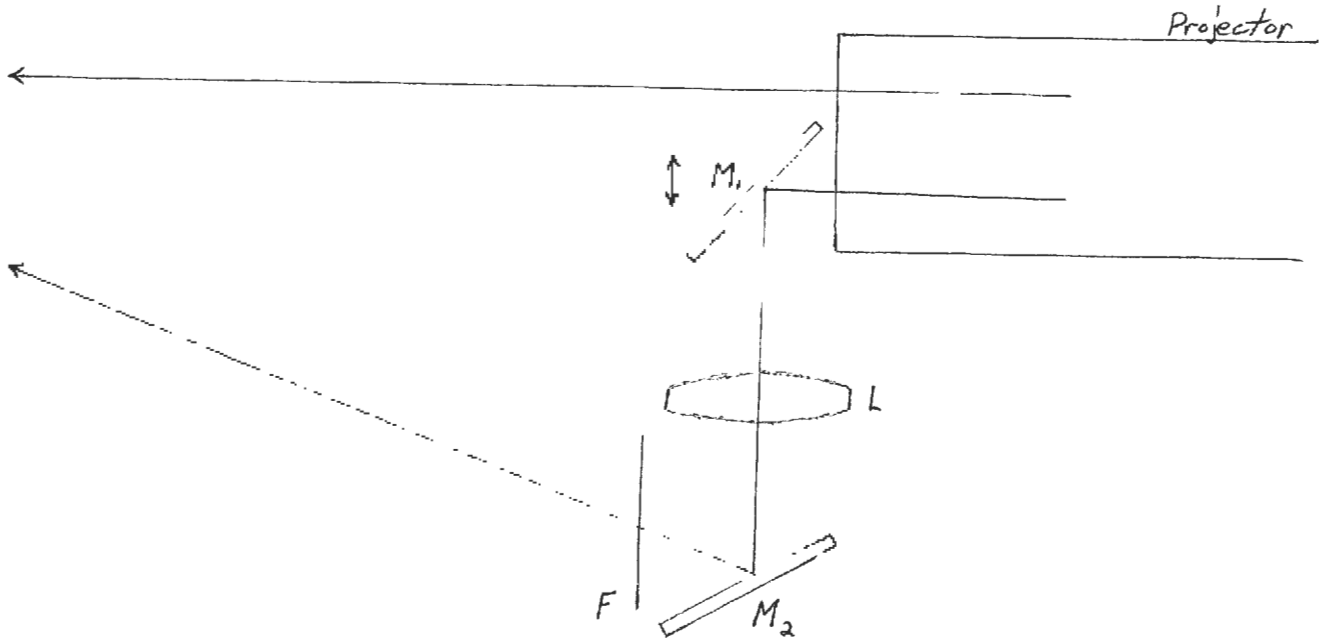
TABLE 1

Refractive findings among the three test conditions.

SUBJECTS	TEST CONDITIONS 1	2	3
BB	+ .50	+ .25	PL
PS	- .50	- .75	-1.00
JW	+ .50	+ .50	- .25
CR	- .25	- .25	- .50
JG	+ .50	+ .25	- .50
LP	PL	PL	- .50
MT	-9.50	-9.75	-10.25
ML	-4.75	-5.00	-5.25
BJ	-3.25	-3.50	-4.00
RL	+ .75	+ .50	PL
JH	-1.75	-2.25	-2.50
MM	+1.50	+1.00	+ .75

FIGURE 1

Schematic diagram of apparatus for changing target contrast. M_1, mirror one; L, convex lens; M_2, mirror two; F, plastic film.



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