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Comparatuve effects of red-green anaglyphs and polarizers on motor fusional responses evoked by crossed and uncrossed disparities

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Abstract

Recent studies have indicated differences due to chromatic imbalances between red-green filters and polarizers when performing stereoaccuracy tasks. The goal of this study is to evaluate the effect of chromatic imbalances on motor fusional ranges through red-green filters and polarizing materials. Targets consisted of a Bernell BC 510 anaglyph and Quoits Circle Vectogram. A slight size difference of 1.4 cm existed between the two targets and was compensated for by the use of a projection system on a ground glass screen. Crossed and uncrossed disparities were presented in a predetermined random order to 20 subjects. Testing consisted of three conditions. To simulate standard testing and training procedures, both targets were presented to subjects in the first condition at 40cm without compensation for size difference. Secondly target to subject distance was kept at 40cm but target size was equalized using the projection system. In the final condition, an intermediate testing distance of 1 meter was used and target size was again equalized. All conditions showed a general trend of increased ranges with crossed and uncrossed disparities with the polarizing materials. Of significance were the uncrossed disparities of the projected 40cm distance (P=.0001, F=4.00) and projected 1 M distance (P=.0001 , F=2.332). In the projected 40cm test distance the average difference between red-green materials and polarizing materials was 5.0 prism diopters. In the case of the projected 1 M target, the average difference was 4.0 prism diopters. Polarizing materials demonstrate greater motor fusional ranges for uncrossed disparities as compared to red-green materials of similar size and form.

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COMPARATIVE EFFECTS OF RED-GREEN ANAGLYPHS AND POLARIZERS ON MOTOR FUSIONAL RESPONSES EVOKED BY CROSSED AND UNCROSSED DISPARITIES

By

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A thesis submitted to the faculty of the
College of Optometry
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Biography

Jona Pradhan

Pre-optometry, and Optometery education completed at Pacific Univ. and Pacific Univ. College of Optometry respectively. I recievd a bachelors degree in visual science in May 1984, and will recieve a doctorate in optometry on May 22, 1988. I hope to return to California and practice there.

Becky Fujiura

Degree earned: Bachelor of Science in Visual Science, Pacific University; May 1984.

Plans to practice in the Northwest, with an interest in developmental optometry, low vision and visual therapy.

Abstract:

Recent studies have indicated differences due to chromatic imbalances between red-green filters and polarizers when performing stereoaccuracy tasks. The goal of this study is to evaluate the effect of chromatic imbalances on motor fusional ranges through red-green filters and polarizing materials. Targets consisted of a Bernell BC 510 anaglyph and Quoits Circle Vectogram. A slight size difference of 1.4 cm existed between the two targets and was compensated for by the use of a projection system on a ground glass screen. Crossed and uncrossed disparities were presented in a predetermined random order to 20 subjects. Testing consisted of three conditions. To simulate standard testing and training procedures, both targets were presented to subjects in the first condition at 40cm without compensation for size difference. Secondly target to subject distance was kept at 40cm but target size was equalized using the projection system. In the final condition, an intermediate testing distance of 1 meter was used and target size was again equalized. All conditions showed a general trend of increased ranges with crossed and uncrossed disparities with the polarizing materials. Of significance were the uncrossed disparities of the projected 40cm distance (P=.0001, F=4.00) and projected 1M distance (P=.0001, F=2.332). In the projected 40cm test distance the average difference between red-green materials and polarizing materials was 5.0 prism diopters. In the case of the projected 1M target, the average difference was 4.0 prism diopters. Polarizing materials demonstrate greater motor fusional ranges for uncrossed disparities as compared to red-green materials of similar size and form.

Key Words: Motor fusional ranges, red-green filters, polarizing filters, anaglyphs

Introduction:

Red-green filters are materials commonly used in visual training and testing procedures. Tranaglyphs are useful in visual training primarily because of the wide variety of materials commercially available and low cost. These materials are used to train motor fusional ranges, stereopsis and provide one of the few ways to train monocularly in a binocular field. Red-green filters are also used clinically in concommitancy and suppression testing. However, despite these advantages currently commercially available anaglyphic materials induce visual imbalances of two types. Prior studies have shown that an illuminance imbalance is induced by differing luminous transmittances of the red and green filters.[1] While this difference does not affect stereoaccuracy, it may increase the likelihood of suppression if the filter with the lower transmittance is placed before the suppressing eye.[2] In addition to this photometric imbalance a chromatic imbalance is induced by the filters as well.[1] If eyes of similar refracting power are used, the image viewed through the red filter is larger than the green image. The red image is also focused farther from the principal plane than the green image. Due to chromatic aberration this chromatic imbalance simulates the refractive conditions of aniseikonia and anisometropia and significantly affects stereoaccuracy judgements.[2]

The goal of this study was to assess motor fusional ranges through anaglyphic materials when compared to polarizing targets of similar size and form. Polarizing materials were chosen for comparison to the red-green materials as these are free of chromatic effects associated with anaglyphic materials. Due to the imbalances in binocular presentation of the red-green materials, we expected that motor fusional ranges would be greater for those targets constructed of polarizing materials as compared to targets using red and green filters to separate visual displays.

Methods:

Subjects:

Twenty subjects volunteered for this study. They consisted mostly of optometry and undergraduate students. There were nine males and eleven females with ages ranging from 20 to 30 years with an average age of 25. The subjects met or exceeded the standard criterion of 40 arc sec of stereoacuity as measured by a Randot Circle stereotest at 40 cm (16 inches).

Methods and Materials:

Standard Bernell red-green filters and polarizing glasses were used with the Bernell BC 510 tranaglyph and Quoits Circle vectogram. Since luminance factors are critical when working with these materials, various luminance measurements were made for each condition and are within +/-2% accuracy relative to a National Bureau of Standards traceable reference (Appendix A).

Patients were first tested for stereoacuity at 40 cm (16 inches) testing distance with the Randot Circle Stereotest. Measurements were then made for three set conditions. For each of the conditions the targets used were the Quoits Circle vectogram from Stereo Optical, and the Bernell BC 510 tranaglyph.

Condition A: Motor fusion ranges were measured at a testing distance of 40 cm. (16 inches), simulating standard clinical testing conditions. The targets were illuminated using a Polachrome trainer.

Condition B: Motor fusion ranges were measured at a testing distance of 40cm using back projected targets. Sizes of the targets were equated for each measurement, as explained below.

Condition C: Motor fusion ranges were measured at a testing distance of 1M. using back projected targets. Size of the targets were equated for each measurement as explained below.

Motor fusion ranges were randomly measured five times for each base out and base in recording, with polarized and anaglyphic targets for each condition. No preference was given to which material (BC 510 tranaglyph or Quoits vectogram) was presented first when making the measurements. All break measurements were recorded for each trial. For Condition A the targets used were presented at the standard testing distance of 40 cm as prescribed by the manufacturers. As mentioned, the target size varied slightly between the two targets. The diameter of the BC 510 tranaglyph is 10.8 cm, while the Quoits Circle vectogram measures 9.4 cm from outer edge to outer edge. For Condition B this size difference was corrected. Each target was used in conjunction with an overhead projector to compensate for the differences in size. Projected size of both targets was held at 10.8 cm for each projected condition. Target to subject distance was held at 40 cm. Thus, the effects of material on motor fusion ranges could be ascertained without the inherent size difference.

Results:

It was felt that a logical analysis of the data should be based on comparisons among similar stimuli rather than an analysis of opposing stimuli. Therefore base in data was compared only with other base in data and base out data was compared only with other base out data. Averages were obtained for each subject's 5 base in trials and 5 base out trials. In effect, Conditions A, B and C were broken down into: Base in : red-green standard(RG-STD) , red-green projected 40cm(RG-40), red-green projected 1M(RG-1M), polaroid standard(POL-STD), polaroid projected 40cm(POL-40) and projected 1M(POL-1M). Base out data was classified in the same manner. The means, standard deviations and standard errors were as follows:

Insert table 1 here

Uncrossed Disparities: Mean, Standard Deviation, Standard Error

Insert table 2 here

Crossed Disparities: Mean, Standaard Deviation, Standard Error

A repeated measures analysis of variance was run on the six base in and six base out categories. [3] If the F-value was significant, a Scheffe test was run using the .10 level of significance.[4] The Scheffe test was utilized as it yields significant differences between the means. Both Condition B and Condition C were significant for the base in category. The red-green projected at 40cm vs. the polaroid projected at 40cm showed a P-value of .0001 and an F-value of 4.00. In Condition C (the red-green projected 1M vs. polaroid projected 1M) the P value was .0001 and the F value was 2.33. Although there were no statistically significant findings for the base out demands, a general trend of increased ranges with polarizing materials was apparent.

Discussion:

The results indicate that for uncrossed disparities (BI), demonstrable significant differences exist between similar targets made of red-green materials and polarizing materials. In Condition B (projected targets presented at 40cm) the mean range was 7.9 prism diopters for the red-green target and 12.9 prism diopters for the polarized target, yielding a mean difference of 5.0 prism diopters. In Condition C, (projected targets presented at 1M) the average mean was 5.7 for the red-green target and 9.5 for the polaroid target, yielding a mean difference of 4.0 prism diopters. No significant differences between red -green and polaroid materials were found for Condition A. Possibly the uncorrected size difference of 1.4cm between the targets may have affected the results and reduced differences below significance level. A probable hypothesis for the lack of significance for the crossed conditions lies within the specific population selected for the experiment. Optometry students often exhibit elevated base out abilities and reduced base in abilities. If the population were less homogeneous the differences between the red-green materials and polarizing materials may have been more apparent. These differences may become more evident when utilized with visually compromised individuals, the type who would be using these materials while participating in a program of visual therapy.

Virtually all patients noticed an image bleed through with the red-green materials. The eye with the red filter over it was still able to see a faint image of the red target. This has been shown to affect stereovision but it is not currently known if it affects binocular vision.[1]

While red-green filters have the advantage of a wide selection of training and testing materials, there are significant considerations that affect the optical quality of these materials. Decreased stereoaccuracy, unequal retinal illuminances and decreased motor fusional ranges are unfavorable effects of the red-green filters that clinicians should be aware of during testing procedures and in visual training. Until better materials can be developed by the manufacturers these disadvantages must be taken into account.

TABLE 1. Uncrossed Disparities: Means, Standard Deviation and Standard Error

Condition	Mean	Standard Deviation	Standard Error
RG-Std	10.91	7.10	1.59
RG -40	7.93	6.29	1.41
RG-1M	5.69	5.17	1.16
POL-Std	12.67	7.46	1.67
POL-40	12.90	6.95	1.55
POL-1M	9.49	8.38	1.87

in prism diopters

TABLE 2: Crossed Disparities: Means, Standard Deviation, Standard Error

Conditions	Mean	Standard Deviation	Standard Error
RG-Std	25.03	20.46	4.57
RG-40	25.78	20.27	4.53
RG-1M	19.19	17.39	3.89
POL-Std	31.10	16.61	3.71
POL-40	29.41	17.89	4.00
POL-1M	23.71	16.30	3.65

in prism diopters

LUMINANCE LEVELS
(Appendix A)

Description	Center	12 o'clock	3 o'clock	6 o'clock	9 o'clock
Quoits vectogram projected	19.5×10^3 NITS	54.4×10^3 NITS	31.8×10^3 NITS	11.66×10^3 NITS	10.6×10^3 NITS
BC 510 tranaglyph projected	12.72×10^3 NITS	46.64×10^3 NITS	12.72×10^3 NITS	4.24×10^3 NITS	7.42×10^3 NITS
Quoits vectogram @ 40 cm.	1.06×10^3 NITS	$.53 \times 10^3$ NITS	1.06×10^3 NITS	1.06×10^3 NITS	1.06×10^3 NITS
B C 510 tranaglyph @ 40 cm.	1.06×10^3 NITS	$.53 \times 10^3$ NITS	1.06×10^3 NITS	1.06×10^3 NITS	1.06×10^3 NITS

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