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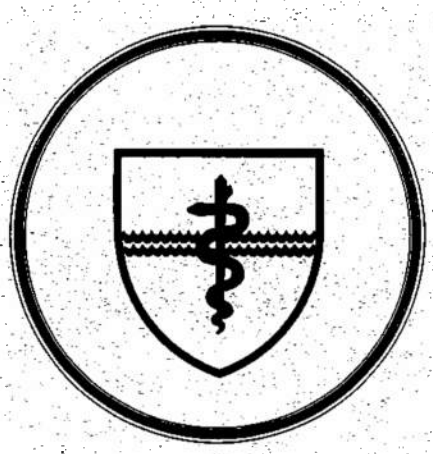

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Naval Medical Research and Development Command
Research Work Unit MF58.524.006-2195

Released by:

R. A. Margulies, CDR, MC, USN
Commanding Officer
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NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Research Work Unit MF58524.006-2195

Approved and Released by:

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Summary Page

PROBLEM

To determine if the improvements in the daytime visual performance of astigmats through the new periscopes are also obtained during nighttime viewing without the benefits of electro-optical aids.

FINDINGS

The improvements in the nighttime visual performance of astigmats produced by the new periscopes conform completely to their improvements in daytime viewing. For example, 4 diopter astigmats using the new 12X periscope perform as well as 2 D astigmats (the most currently permitted by Navy standards) through the old periscope.

APPLICATION

These results are pertinent to a review of the Navy's astigmatism standards for periscope operators.

ADMINISTRATIVE INFORMATION

This investigation was conducted as a part of Naval Medical Research and Development Command Research Work Unit MF58524.006-2195 -- "Feasibility of increased utilization of astigmatic periscope operators." The manuscript was submitted for review on 27 March 1980, approved for publication on 5 May 1980 and designated as NavSubMedRschLab Report No. 929.

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ABSTRACT

Detection thresholds for a target light by observers with various degrees of astigmatic error (ranging from 0 to 6 diopters) were compared through the old and new periscopes at night without the benefit of electro-optical aids. The results conformed with those obtained during daytime viewing using a completely different task. For example, observers with 4 D of astigmatism could see virtually as well through the new 12 power periscope as observers with 2 D (the maximum allowed under present Navy standards) could see through the old periscope.

INTRODUCTION

Previous experiments have compared the ability of astigmatic observers to perceive high and low contrast gratings through old and new periscopes in daylight.[1] There were two main findings. First, the higher powers of magnification on the new periscopes made up for an appreciable magnitude of cylindrical refractive error, at least with respect to the ability to resolve detail. This led to the conclusion that it would be possible to relax the visual standards for astigmatic operators wherever the new periscopes are installed.

However, a second finding was that at a given level of magnification, vision through the old periscope was better, because in the new periscopes part of the light is diverted from the observer to photographic and television equipment. This led to the question as to whether or not the results obtained in daylight would hold for nighttime viewing when the loss of light would be more critical.

This study investigated the effects of astigmatism on the ability to detect a target light through the old and new periscopes at night.

METHOD

Subjects

Six staff members of the laboratory with normal, uncorrected vision (emmetropes) served as observers. Emmetropes were chosen so that any magnitude and orientation of astigmatism could be induced with lenses.

Experimental Plan

The visual performance of the observers was compared at three levels of magnification: 6, 12, and 24. In addition, comparisons were made between the old and new periscopes at 6 power.

Cylindrical errors of 0, 2, 3, 4, and 6 diopters were induced under 12 and 24 power; this was compared with performance through the 6 power magnification with either 2 D of astigmatism or undistorted. The purpose was to see how much astigmatism can be overcome by the magnification of the optical system so as to equal the performance through the

lower power optical system of men who meet the current astigmatism standards. Astigmatism was always induced with plus lenses so that the observers would be unable to accommodate for it. The power meridian of the astigmatism was always horizontal.

Target

The target was a flashing square of light, 2.5 cm on a side. Since the light was positioned 2800 yards from the periscope, even at 24 power magnification it was essentially a point of light (.007°). The light flashed once every .75 sec, with a duty cycle of about 0.25. Luminance was attenuated with a set of neutral density filters.

Procedure

Thresholds were measured using the method of limits, always starting with a luminance level that was clearly visible to the observer. The various conditions of magnification and astigmatic error were presented in haphazard order.

RESULTS

The mean detection thresholds for the target light are shown in Figure 1. Thresholds are given for each magnitude of astigmatism induced at the various powers of magnification in the old and new periscopes. It is clear, first of all, that thresholds become worse as astigmatism increases. The rate of degradation appears to decline with increasing magnification.

Second, it is also clear, as was found before,[1] that less light is delivered to the eyepiece of the new periscope. At the same power of magnification, thresholds are worse through the new periscope by about .25 log unit at both 0 and 2 D of astigmatism.

The new periscope, however, allows much greater magnification, which, as in the case of daytime viewing, offsets the effects of astigmatism to some extent. Thus, at 12 powers of magnification, the mean target threshold under 3 D of astigmatism was slightly better than

the mean threshold through the old periscope at 2 D of astigmatism. Even at 4 D of astigmatism, thresholds were not appreciably worse through the new periscope under the higher magnification. And using 24 power of magnification, the thresholds under every degree of astigmatism tested (up to 6 D) were better than under only 2 D of astigmatism through the old periscope.

DISCUSSION

Astigmatism degrades the ability to detect a spot of light at night much as it degrades the ability to resolve an acuity target in daylight. The present results are, in fact, remarkably similar to the results obtained in daylight with a completely different task. In both cases, the observers using the 12 power magnification on the new periscope achieved slightly better performance with 3 D of astigmatism and slightly worse performance with 4 D of astigmatism than they did with 2 D of astigmatism using the six powers of magnification available on the old periscope. And in both cases all thresholds using the 24 power magnification were better than with the old periscope under 2 D of astigmatism.

One difference between the two sets of results is that the curve showing the degradation of acuity in daylight is positively accelerating with increases in astigmatism, whereas the curve for the detection of the light appears to be negatively accelerating. That is, with a sufficient magnitude of astigmatism, a point is reached at which an acuity target is not perceptible; but there is some suggestion in the present data that given a certain magnitude of astigmatism, the detection of a light will not be further impaired.

These results fully support, however, the conclusions that were reached in the study of daytime periscope viewing: that is, they suggest that astigmatism standards for periscope operators can be relaxed for the boats in which the new periscopes are installed.

There appears to be only one basis on which to question this conclusion. It is that the increased magnification is accompanied by a reduction in the field of view, which could degrade the ability to

search for new targets with the periscope. But even this possible handicap can be overcome with the eyepiece modification described in a separate report.[2] We conclude, therefore, that there is no reason why astigmatism standards could not be relaxed.

ACKNOWLEDGMENT

We thank the staff of SSEP for their cooperation in carrying out this study.

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(1) Luria, S. M., J. A. S. Kinney, C. L. Schlichting, and A. P. Ryan. The limiting effects of astigmatism on visual performance through periscopes. NSMRL Rep. No. 905, Sep 1979.

(2) Luria, S. M. and J. A. S. Kinney. A simple device for adding optical corrections to periscopes. NSMRL Rep. No. 927, Mar 1980.

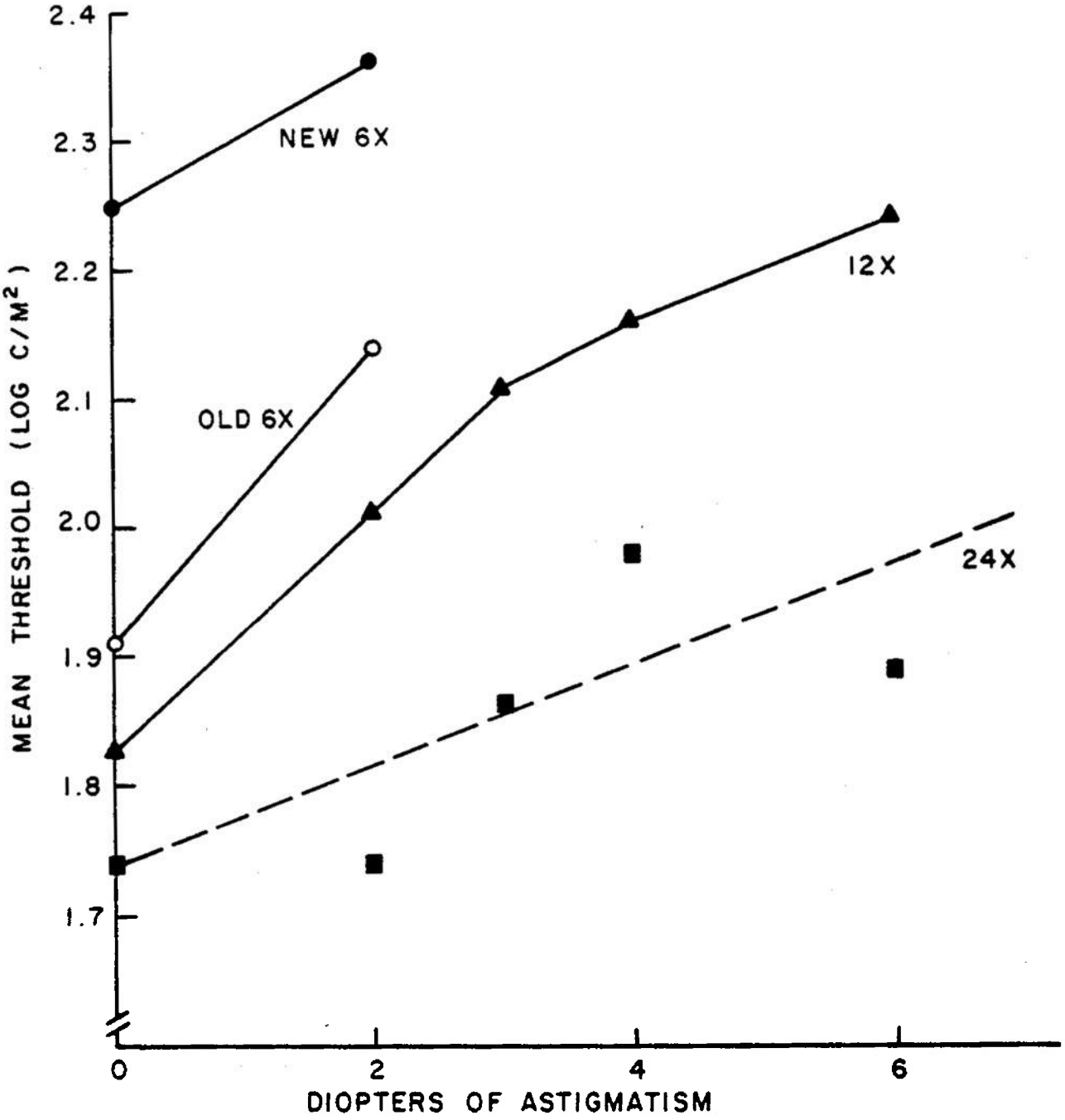

Fig. 1. Mean detection thresholds of a target light under various magnitudes of astigmatism through various periscope magnification.

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