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LATERAL SPREADING OF VISUAL ADAPTATION. (U)  
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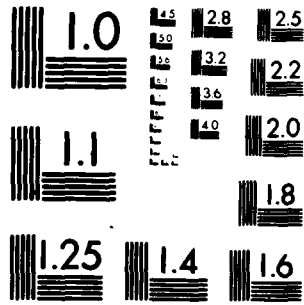
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## LATERAL SPREADING OF VISUAL ADAPTATION

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Most previous studies of dark adaptation have first light-adapted a portion of the retina and then determined the subsequent course of sensitivity changes (threshold changes) within the area just adapted. In the operational environment, however, adapting sources and target lights seldom occur in such an orderly fashion; we are interested in knowing the sensitivity changes produced not only within an adapting source but also outside of it. For example, we are often concerned with the effect of an adapting source at Point A upon sensitivity at Point B or the effect of adapting sources at Points A and B upon sensitivity at Point C. We would often like to know the effect of adapting sources such as instrument panel lights, farm lights, and muzzle flashes upon an individual's ability to see objects in other parts of his visual field. Since these adapting sources vary in color we must also determine the effect of chromaticity upon these sensitivity changes.

In Figure 1, the large circle represents the red or blue-white adaptation field, the small circles represent the unfiltered tungsten white threshold test probes located either  $3^{\circ}$  inside of the left edge of the adaptation field or  $3^{\circ}$  outside of it and the dot at the extreme right edge of the adaptation field represents the fixation point. Also, in some conditions, the entire area was covered with a green light having a luminance of  $2.4 \times 10^{-3}$  footlamberts to simulate the luminance of grass on a clear night with a full moon.

minutes and a second threshold judgment was obtained in the same way. Immediately after this, two more threshold judgments were made after 2-minute adaptation exposures at the same adaptation field intensity but on these two trials the threshold probe was presented outside of the area directly illuminated (Point 2). Next, the intensity of the adaptation field was increased to the next highest level and the same procedures were repeated. After threshold judgments had been obtained at all adaptation field intensities, the same pattern was repeated in another session except that this time the adaptation field remained on while the threshold judgments were made. In still other sessions, judgments were obtained for the blue-white adaptation field in the same manner described above. Finally, the moonlight field was added and all of these procedures were repeated. Although not analyzed in a formal factorial manner, we can, for convenience sake, describe this study as an AXBXCX DXE(2X2X2X2X6) study in which factor A was the location of the test stimulus (either inside or outside of the adapting field), factor B was the color of the adapting field (either red or blue-white), factor C was the presence or absence of the adapting field during the presentation of the stimulus, factor D was the presence or absence of the moonlight field, and factor E was the intensity of the adapting field.

In studying the spreading of adaptational effects (sensitivity changes) to areas outside of the adaptational field we are also interested in discovering the mechanisms which produce such a lateral spreading so that we can construct better predictive models. One of the most obvious mechanisms that must be considered is the effect of stray light, i.e., to what extent is the threshold performance outside of the area directly illuminated determined by light scattered within the eye. That is, the border of an image formed on the retina is never sharp but rather consists of a luminance gradient extending from the image all the way out to the edge of the retina. Our strategy for assessing the effects of stray light is as follows: since stray light at any given point will be a constant proportion of the adaptation field intensity, to the extent that stray light is determining the thresholds at Point 2 the curves for Point 1 and Point 2 can be brought into congruence by simply shifting the Point 2 curves a certain constant amount to the left (along the adaptation field intensity axis).

It will be noted that achieving congruence by a leftward shift of the Point 2 curves does not prove that stray light is producing the results. However, a failure (in certain directions) to achieve congruence by such a shift does prove that stray light alone cannot be producing the threshold curves at Point 2.

It will be seen that in a number of instances a leftward shift of about 1 log unit of the Point 2 curves produces some congruence with the Point

Figure 1

Two observers were first dark adapted for 45 minutes and then exposed to the lowest intensity of the red adaptation field for 5 minutes. At the end of this time, the adaptation field was turned off and 10 seconds later the observer used the method of adjustment (ascending trials only) to determine his threshold within the area directly illuminated (Point 1). The observer was then re-exposed to the same adaptation field for 2

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1 curves. Figure 2 shows the threshold curves for the condition in which the thresholds were determined 10 seconds after the adaptation field was turned off. The curves for inside (Point 1) and outside (Point 2) of the adaptation field have been superimposed after shifting the Point 2 curves 1 log unit to the left. It can be seen that the congruence is quite good except at the highest intensity.

Figure 2

In Figure 3, the Point 1 and Point 2 curves for the condition in which the adaptation field remains on during threshold determination are superimposed after a 1 log unit leftward shift of the Point 2 curves. A vertical shift also had to be made in order to bring the two sets of curves into reasonable agreement. It will be noted that the temporary levelling-off in the blue-white curves at Points 1 and 2, which probably represents the rod-cone break, occurs about 1 log unit later in the Point 2 curve than in the Point 1 curve. Finally, Figure 4 shows what happens when the moonlight field is added. The conditions otherwise

Figure 3

Figure 4

are the same as for Figure 3. Again, some congruence is produced by shifting the Point 2 curves leftward by 1 log unit. In this case, the crossover points of the Point 1 and Point 2 curves are brought into congruence by such a shift. The addition of the moonlight field, however, has reduced the overall congruence of the two sets of curves as compared to that in the other figures.

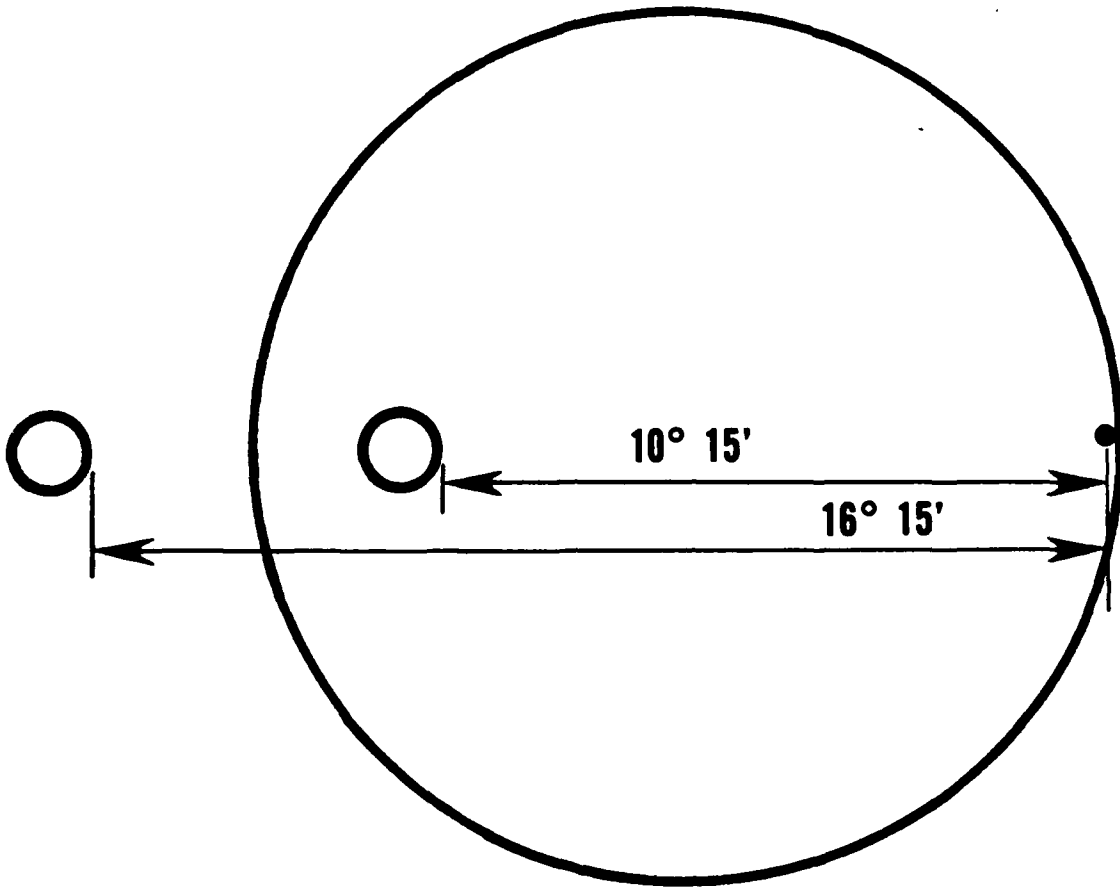
In general, there is some congruence in all of Figures 2 through 4 and a considerable amount of congruence in Figures 2 and 3. This indicates that stray light may play a large role in determining sensitivity outside of the adaptation field. However, in no case is there complete congruence which indicates that some additional, physiological, factor(s) must be at work in determining the Point 2 sensitivities. Furthermore, the rather large vertical shifts required in some instances are incompatible with an explanation based upon stray light alone.

#### CONCLUSIONS

- 1) With no moonlight field, under the stimuli configuration used in this experiment a large proportion of the sensitivity changes outside of the adaptation field can be accounted for by assuming a stray light background approximately 1 log unit less intense than the adaptation field;
2. The failure to achieve complete congruence of the Point 1 and Point 2 curves, however, indicates that the sensitivity changes outside of the adaptation field cannot be completely accounted for by stray light;
- 3) The addition of the moonlight field causes a curious reversal, such that at the lower adaptation field intensities the blue-white adaptation field produces lower thresholds than does the red adaptation field.

#### DISCLAIMER:

The views of the author do not purport to reflect the positions of the Department of Defense. Para. 4-3, AR 360-5).



**LARGE FIELD =  $13^{\circ} 15'$**   
**SMALL FIELD =  $1^{\circ} 30'$**

Figure 1

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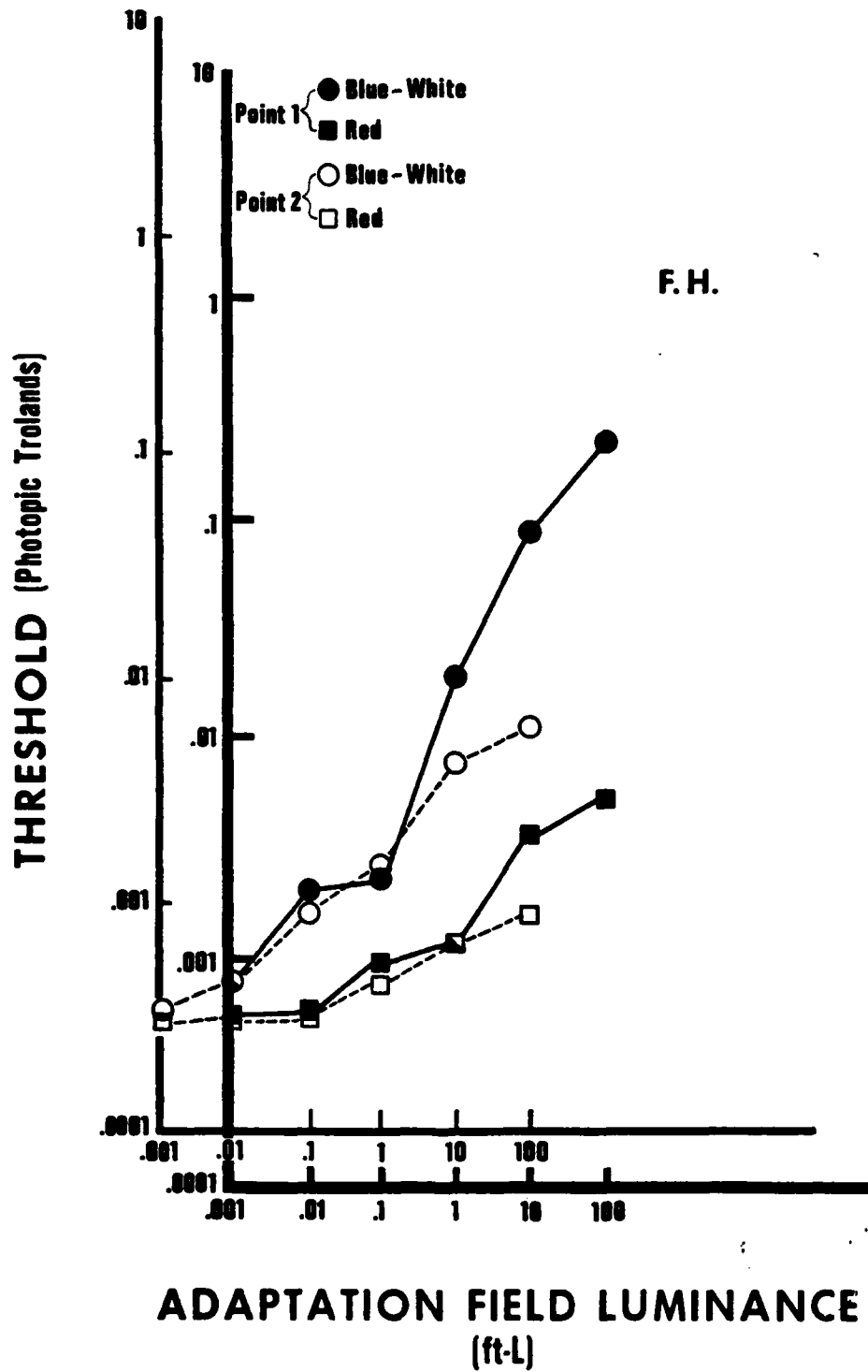


Figure 2

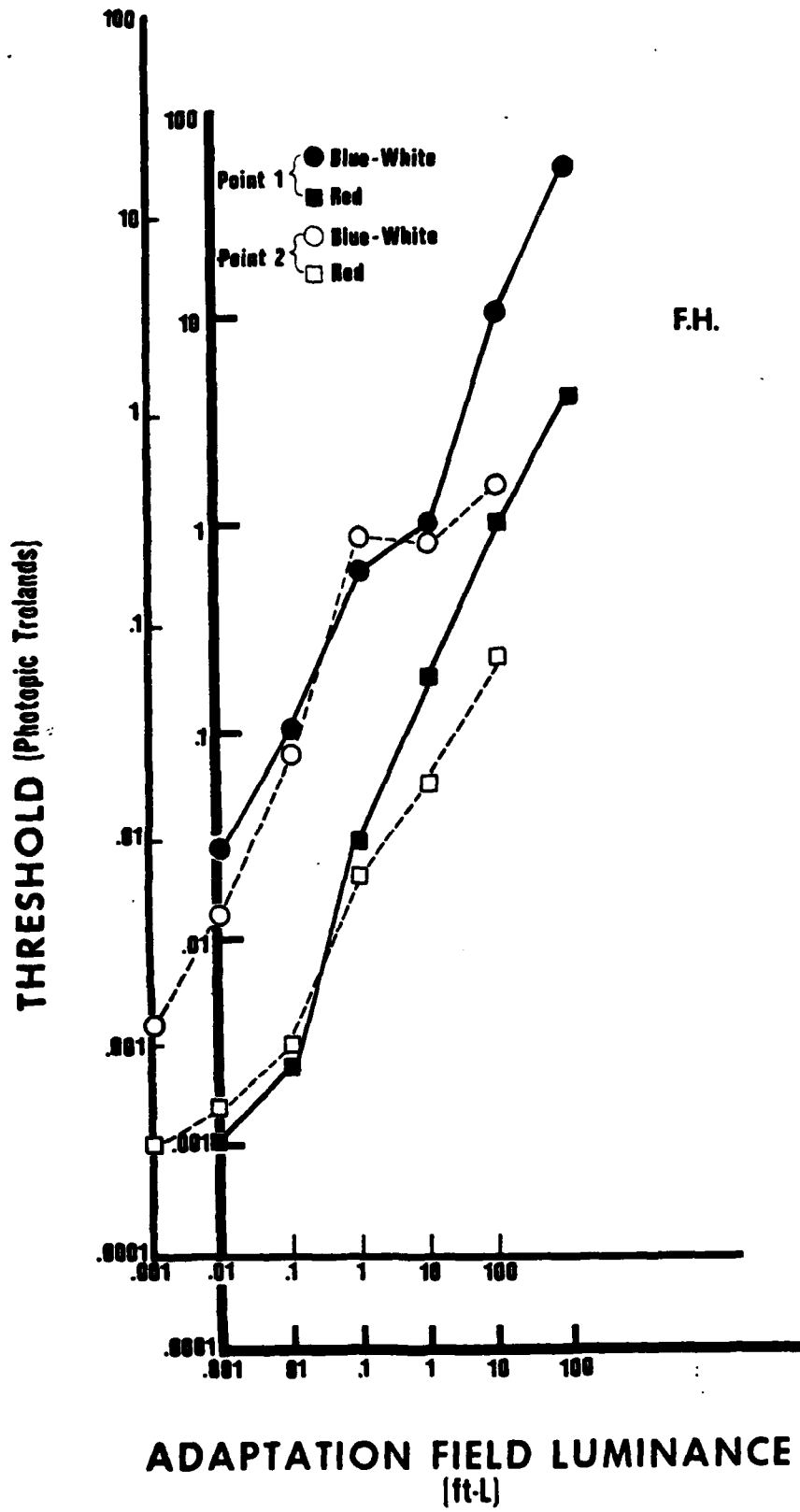


Figure 3

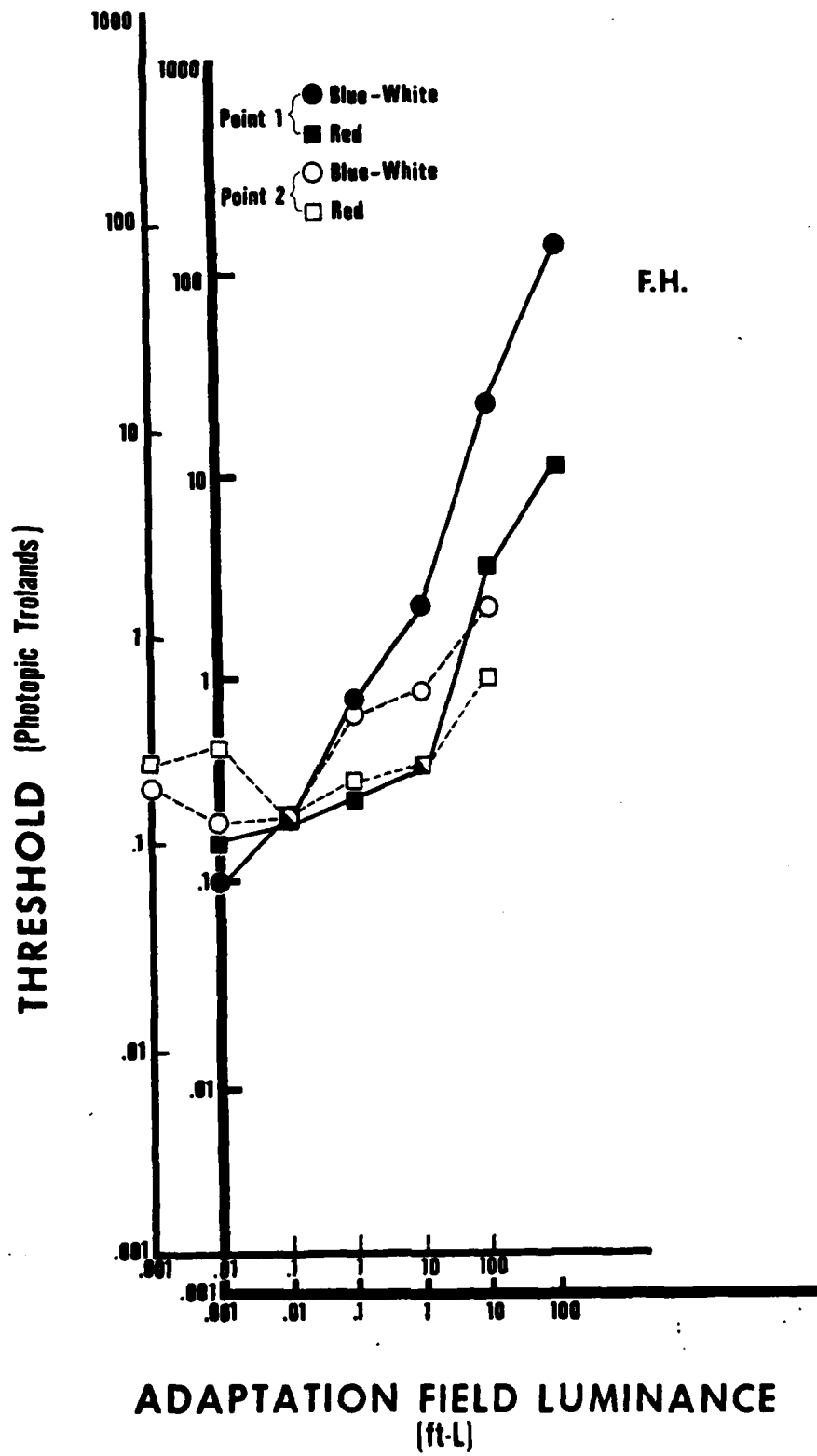


Figure 4

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