AN INVESTIGATION OF NIGHT VISION AMONG PERSONNEL OF AN A.A. UNIT.

BY CAPTAIN BRIAN ST. J. STEADMAN,
Royal Army Medical Corps.

It is known that the quality of night vision varies considerably in individuals, who frequently have erroneous ideas of their powers in this respect, because of difficulty in comparing this quality. It was found that certain personnel of Searchlight Units known as “spotters” make operational use of their night vision. Their duties consist of searching the night sky with binoculars for hostile aircraft in and around the distal end of the searchlight beam.

The night vision of the “Spotters” of a Searchlight Regiment was investigated with the object of comparing the quality and eliminating those in whom it was deficient in an endeavour to increase the operational efficiency of searchlight work. Firstly, the physiology of vision will be discussed briefly.

PHYSIOLOGY.

The duplicity theory of vision as expounded by v. Kries states that two types of activity exist in the retina. There is a photopic mechanism mediated by the cone cells, which concerns itself with form vision and colour vision, and has a relatively high threshold stimulus intensity, which is typically evident in the light adapted eye. There is also a scotopic mechanism, mediated by the rod cells, which is concerned with the appreciation of light and movement, and is achromatic, working with a low threshold stimulus intensity and, therefore, being particularly evident in conditions of dark adaptation.

The photochemical theory of vision which has more recently been advanced, particularly by Hecht, states that the sensitivity of the retina at any stage of adaptation is determined by the concentration of photoreceptor substance in the cone and rod cells—visual violet, or iodopsin, in the cones and visual purple, or rhodopsin, in the rods. During an exposure to light these substances are bleached and both the cone and rod thresholds are elevated. As they regenerate in the dark retinal sensivity increases and the familiar dark adaptation curve may be obtained.

The rods and cones lie in the layer next to the pigment cells, which form the outer layer of the retina. Both types of cells are distributed all over the retina except at the fovea centralis, which is covered almost entirely by cones, and at the point of entry of the optic nerve, which is devoid of either. The rods outnumber the cones.

Visual purple was found in the rods by Kuhne (1868) and has rarely been demonstrated in the human eye owing to difficulty in manipulation and
the impossibility of perceiving it with the ophthalmoscope because of its colour. It is a heavy protein molecule with vitamin A attached, and is broken down by light liberating a new carotenoid, retinene (which gives the visual yellow stage). The reaction is reversible. Retinene may be converted further to vitamin A but its regeneration to visual purple will then take longer.

Visual violet was demonstrated in the cones in chickens by Wald (1937) and in frogs by Chase (1938), and is probably three separate substances with slightly different spectral sensitivities. It is even more difficult to manipulate than visual purple.

**Dark Adaptation.**

The increase in sensitivity of the retina, caused by the regeneration of the photo-receptor substance in the cones and rods is known as dark-adaptation. It occurs rapidly in the first five to eight minutes of darkness or semi-darkness and is due to regeneration of visual violet in the cones. This is known as foveal dark adaptation and the retinal sensitivity is increased ten to twenty times. After a slight lag retinal sensitivity continues to increase rapidly for a further thirty to forty minutes after which the increase is more gradual. This is due to regeneration of visual purple in the rods. At the end of one hour the sensitivity of the retina may be increased to anything between 50,000 and 100,000 times. It may continue to increase for a longer time, and the sensitivity may be perhaps as much as five times as high at twenty-four hours as at one hour. For all practical purposes, however, the eye is considered to be fully dark-adapted at the end of one hour.

The area of sensitivity of the dark-adapted retina increases rapidly to five degrees eccentric from the fovea. It continues to increase more slowly, reaching a maximum at twenty degrees, and diminishes towards the periphery.

In investigating night vision (i.e. the sensitivity of the dark-adapted retina) we are concerned mainly with rod adaptation and visual purple.

Whether the rod mechanism is being used can be tested by looking directly at a star and then noting if it appears brighter when the line of vision is deviated by 6° or more. In the same way, after looking directly at a constellation such as Pleiades, one becomes aware of the presence of more stars if the line of vision be deviated slightly.

The fact that the periphery of the retina is more sensitive when dark-adapted than the fovea accounts for the ease with which moving objects are seen in semi-darkness compared with stationary ones.

These latter points are brought out in the training of the A.A. personnel under investigation and are generally known by them.

Dilatation of the pupil causes a direct fall in the achromatic threshold and mydriatics have been used with good effect in certain cases to aid the night vision of night pilots in the R.A.F. Paredrine hydrobromide (Menley
Night Vision among Personnel of an A.A. Unit

and James), the effects of which only last four hours, has less disadvantages than other mydriatics for this purpose, but, of course, can only be given under medical supervision which makes its use impractical on isolated A.A. sites.

No steps are taken to dark-adapt the eyes of "spotters" before they "take post" from lighted huts, and in short raids hostile aircraft must be long out of range before their eyes are adapted to their surroundings. It is of some importance that the eyes of all personnel of A.A. Units who make operational use of their night vision should be dark-adapted before "taking post," and this can be brought about by the wearing of dark goggles from at least forty-five minutes before black-out and not exposing the eyes to light again until dawn. On leaving the hut to go to their positions the goggles would be removed and replaced before re-entering the lighted hut. The men's eyes would thus be fully dark-adapted during the whole night. Suitable goggles can be made cheaply and should transmit about 5 per cent of light. No light should be allowed to enter at the periphery which must fit closely. Some form of ventilation should be provided, such as rubber sponge, and anti-dim compound is of value. Night-adaptation goggles of this type are in general use in the R.A.F. and are made by Messrs. J. and R. Flemming Ltd. After wearing these goggles for a few minutes games such as billiards and darts can be played but reading is difficult unless the light is strong. However, the wearer can carry on a reasonably social existence, which would be impossible if his eyes were dark-adapted in complete darkness. The spotter's present operational position is situated between 200 and 300 yards from the projector and must be adequately screened from ground glare and the source of light which would tend to diminish dark-adaptation. The distance between the spotter and the beam itself is thought to be sufficient to avoid interference with dark adaptation.

It is known that in Germany night pilots have been kept in total darkness for from twelve to twenty-four hours before flying in order to dark-adapt their eyes, but it is considered that this method causes depression and would adversely affect morale.

The only other member of a searchlight detachment who makes operational use of his night vision is the man on the Mark 9 Sound Locator, known as No. 6, but his maximum distance from the source of light is 75 yards and adequate screening therefrom is not possible without reducing his field of vision.

Method of Testing Night Vision.

Most apparatus for testing the degree of sensitivity of the dark-adapted retina depend on a ray of light of variable low luminosity but the quality which is now required and which is under investigation is the ability to perceive the slight difference in contrast between a dark moving object and a background of low luminosity, i.e. aircraft flying at night. Exact definition of form is not of great importance as the variety of objects which can travel through the sky is obviously limited.
The Livingston Rotating Hexagon is in general use in the R.A.F. for testing and comparing the night vision of pilots, prospective pilots, and air crews and was constructed by the Consultant in Ophthalmology with this object in view.

The apparatus, as its name implies, consists of a hexagon which can rotate and which is illuminated from within by light of extremely low, but variable, intensity. Six men can be tested at a time. Their eyes are dark-adapted by the wearing of dark goggles for thirty minutes before the test. They are then brought into the room and seated three feet from the apparatus, each opposite one of its facets. The light of the room is extinguished and the goggles removed. The men are kept for fifteen minutes in complete darkness whilst the test is explained.

The apparatus is then switched on, having an illumination in the first instance of 1/850 foot candles, and one minute is given to recognize and write down two objects or signs which are superimposed on each of the dimly lit translucent facets of the hexagon. With the same illumination six letters (Snellen’s Type 6 metre letters) must be recognized and written down within one minute. Some of the letters are reversed, inverted or lying sideways.

This test is repeated three times with increasing degrees of illumination but with variation of the objects and letters. Each test is marked out of eight, each object or letter counting one mark, making a total of thirty-two.

The results are divided into the following groups:

- Exceptional: 32-29
- Above average: 28-20
- Average: 19-9
- Below average: 8-3
- Poor: 2-0

One hundred and fifty-one spotters of the A.A. Unit were tested in this way. The men came from three batteries and the percentage in each group in comparison with 2,000 R.A.F. personnel is shown in the table below.

Fifteen officers were tested and their results are also shown in the table. Of these a large proportion are in the upper groups but the number tested was small.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number tested</td>
<td>48</td>
<td>56</td>
<td>47</td>
<td>151</td>
<td>15</td>
<td>2,000</td>
</tr>
<tr>
<td>Exceptional</td>
<td>4.2%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.4%</td>
<td>20.0%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Above average</td>
<td>29.2%</td>
<td>14.3%</td>
<td>11.1%</td>
<td>18.2%</td>
<td>26.7%</td>
<td>32.8%</td>
</tr>
<tr>
<td>Average</td>
<td>41.7%</td>
<td>50.0%</td>
<td>55.6%</td>
<td>49.1%</td>
<td>53.3%</td>
<td>49.6%</td>
</tr>
<tr>
<td>Below average</td>
<td>16.6%</td>
<td>30.4%</td>
<td>22.2%</td>
<td>23.1%</td>
<td>0.0%</td>
<td>13.1%</td>
</tr>
<tr>
<td>Poor</td>
<td>8.3%</td>
<td>5.3%</td>
<td>11.1%</td>
<td>8.2%</td>
<td>0.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Average marks scored (out of 32)</td>
<td>15.6</td>
<td>11.3</td>
<td>11.9</td>
<td>12.9</td>
<td>19.6</td>
<td></td>
</tr>
</tbody>
</table>

The A.A. results compared with the R.A.F. are poor and the problem of the reason for this arises. In order to elucidate the problem the etiology of the condition known as night blindness must be understood.
AETIOLOGY OF NIGHT BLINDNESS.

The clinical picture of night blindness presents characteristic features of an impairment or absence of the rod mechanism. The generally accepted etiology of the condition is that it is due to: (1) Structural deficiency of the rods; (2) deficiency of the visual purple; (3) functional causes.

Structural deficiency of the rods occurs in the congenital types and in those cases due to gross pathological changes, and the condition is permanent.

The second group occurs under conditions of malnutrition associated with a deficiency in vitamin A and the prognosis is consequently good.

It must be borne in mind that a number of cases have been reported wherein no pathological changes or nutritional disturbances were found, and these were associated with neurotic or other functional symptoms, and were typified by the "shell shocked" soldier of the last war. It was for this reason that night blindness was not discussed with the men taking part in this investigation, but the term night vision, with qualifications, was invariably used.

GENERAL.

The results of the test on the Livingston Hexagon indicated an impairment of night vision in a number of cases compared with the R.A.F. results, rather than its failure. This impairment is unlikely to be due to gross pathological changes in the retina in such a large number of cases although the congenital factor may be present.

The Livingston Hexagon test is extremely difficult and intelligence definitely plays a part in the results. The fact that R.A.F. flying personnel are selected men whilst A.A. Troops are not, undoubtedly has some bearing on the matter. The A.A. men under investigation require no technical skill or special knowledge and in these days of mechanized soldiering the men in a detachment who lack qualifications tend to gravitate towards the spotter's chair. These men are frequently not the most intelligent.

The prospective pilot, too, is endeavouring to qualify for the job he has long desired to do but none of boyhood's romantic dreams are fired by the desire to become a "spotter."

The age-group of the 151 men under investigation was from 19 to 35 years with an average age of 25·3. The average age of the men in each group of the Livingston test was between 24·3 to 25·5 except for the exceptional group which only two men reached. The ages of the officers tested varied from 26 to 48 with an average of 33·3.

The occupations of the men were legion and did not appear to have any bearing on the results. The vast majority were townsmen who have been employed on A.A. work for between eleven months and two years.

VITAMIN A DEFICIENCY.

There is also the question of vitamin A deficiency. Vitamin A is fat soluble and is found in most green vegetables, carrots, egg yolk, dairy produce and
meat. It is stored in the liver (of animals, birds and fishes) which is therefore the most fertile source of supply.

The fact that night blindness could be cured by liver was known to the Egyptians 1,500 years B.C.

For this condition Hippocrates, 460 B.C., advised taking, once or twice, as big an ox liver as possible, raw, and dipped in honey!

Its cure by eating the fresh liver of seagulls or fish was widely practised in the Middle Ages. Epidemics of night blindness have occurred in famines in Russia and Austria and during the last war among troops living under conditions in which feeding fell below standard.

In chronic cases other degenerative changes in the eye occur (i.e. xerosis, epithelialitis or keratomalacia).

Aykroyd describes cases occurring among the fisher folk of Newfoundland. For a considerable part of the year these people are completely isolated from the outside world. They live on a diet of white bread, molasses, fresh cod muscle, salt meat, beans, peas and some potatoes and are exposed to bright sunlight. No milk, butter, eggs, green vegetable or carrots are available. All cod-liver oil is exported but the fishermen prefer to cure the condition by eating a few meals of seagulls' liver, cooked or raw. Recovery usually occurs within two or three days.

Aykroyd found that all cases of night blindness were cured by vitamin A.

The rapidity with which the threshold of dark-adaptation rises during a diet deficient in vitamin A is an index of the body's vitamin A reserve which varies. Hecht and Mandelbaum carried out experiments on seventeen cases. Fourteen showed an immediate rise in the threshold of dark-adaptation when receiving a diet devoid of vitamin A. The remaining three cases took 22, 55 and 60 days respectively, to show a rise. A measurable response was elicited shortly after doses of vitamin A were given but the threshold rose immediately vitamin A was again withdrawn. Single doses of vitamin A had no effect. Vitamin A was administered for weeks, and in some cases months, before the threshold fell to normal again.

It is generally accepted that night vision is not improved by the addition of vitamin A to a diet that already contains sufficient, but improvement only occurs if the diet is lacking in the vitamin.

The men under investigation live on isolated sites which causes, a certain amount of delay in the delivery of rations. Two batteries (333 and 334) are on the system known as "centralized" cooking which means that the food is cooked at Battery Headquarters one day, sent out to site and heated up the next, i.e. twice cooked. In addition there is a certain shortage of dairy products, etc. All these factors may play a part in reducing the vitamin A content of the diet. As a matter of interest the Battery that obtained the worst results in the Livingston Test was not on centralized cooking.

It was decided to give vitamin A to 50 per cent of the men of each battery who were tested on the hexagon and then to re-test all the men.

Vitamin A in the form of Adexolin Capsules (Glaxo Laboratories Ltd.) was
Night Vision among Personnel of an A.A. Unit

given in doses of 12,000 international units daily for the first week, and the
dose was increased by 6,000 units daily per week until the third week, at the
end of which the men were re-tested. If there was an interval of a day or
two between the end of the third week and the re-test the men continued to
take 24,000 international units of vitamin A daily up to, and including, the
morning of the test. Of those originally tested 134 were re-tested, 68 having
had Adexolin, and 66 acting as control.

The results of the two tests are compared in the tables below:

<table>
<thead>
<tr>
<th>Vitamin A</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before vitamin A</td>
<td>After vitamin A</td>
</tr>
<tr>
<td>Exceptional</td>
<td>1-5%</td>
</tr>
<tr>
<td>Above average</td>
<td>16-2%</td>
</tr>
<tr>
<td>Average</td>
<td>51-5%</td>
</tr>
<tr>
<td>Below average</td>
<td>30-9%</td>
</tr>
<tr>
<td>Poor</td>
<td>10-3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marks</th>
<th>Vit. A</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>(15 + )</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>(10 to 15)</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>(5 to 9)</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>(1 to 4)</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>0</td>
<td>8</td>
<td>33</td>
</tr>
<tr>
<td>(5 to 9)</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>(1 to 4)</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>(10 to 15)</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(15 + )</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Marks</th>
<th>Vitamin A</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bty. (No.)</td>
<td>1st Test</td>
<td>2nd Test</td>
</tr>
<tr>
<td>332 (22)</td>
<td>12-6</td>
<td>16-9</td>
</tr>
<tr>
<td>333 (22)</td>
<td>13-6</td>
<td>17-6</td>
</tr>
<tr>
<td>333 (24)</td>
<td>12-3</td>
<td>18-7</td>
</tr>
<tr>
<td>Total (68)</td>
<td>12-9</td>
<td>18-0</td>
</tr>
</tbody>
</table>

The improvement shown by those who took vitamin A was only slightly
greater than that shown by the control. The diet of the men taking part
in this test is therefore considered to contain sufficient vitamin A.

If the results of the second test are added together the comparison with
the results of the first test and the R.A.F. results is of interest.

<table>
<thead>
<tr>
<th>1st Test</th>
<th>2nd Test</th>
<th>R.A.F. Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptional</td>
<td>(134)</td>
<td>1-5%</td>
</tr>
<tr>
<td>Above average</td>
<td>18-7%</td>
<td>20-2%</td>
</tr>
<tr>
<td>Average</td>
<td>49-2%</td>
<td>35-1%</td>
</tr>
<tr>
<td>Below average</td>
<td>23-1%</td>
<td>30-6%</td>
</tr>
<tr>
<td>Poor</td>
<td>7-5%</td>
<td>0-7%</td>
</tr>
<tr>
<td>Average Marks</td>
<td>13-1%</td>
<td>17-7</td>
</tr>
</tbody>
</table>
The results of the second test approximate more closely to the R.A.F. results, which are first test results. This may possibly be due to the A.A. troops being mentally slower than those selected as prospective pilots and air crews. An improvement is usual in the second test but it is not so great as the improvement shown in the table above.

**VISUAL ACUITY.**

Twenty-two of those tested twice had a visual acuity of less than \( \frac{8}{7} \) in one eye or both. This twenty-two included six men who had a visual acuity of \( \frac{8}{7} \) in one eye and \( \frac{7}{9} \) in the other and under A.C.I. 1428 of 1940 are in Visual Standard I. A comparison between the results with and without these twenty-two in both tests are tabulated below:

**1ST TEST.**

<table>
<thead>
<tr>
<th></th>
<th>All Spotters</th>
<th>V.A. less than ( \frac{8}{7} )</th>
<th>V.A. ( \frac{8}{7} ) or better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptional</td>
<td>1.8%</td>
<td>0.0%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Above average</td>
<td>18.7%</td>
<td>0.0%</td>
<td>22.3%</td>
</tr>
<tr>
<td>Average</td>
<td>49.2%</td>
<td>*27.3%</td>
<td>33.6%</td>
</tr>
<tr>
<td>Below average</td>
<td>23.1%</td>
<td>40.9%</td>
<td>19.6%</td>
</tr>
<tr>
<td>Poor</td>
<td>7.5%</td>
<td>31.8%</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

**2ND TEST.**

<table>
<thead>
<tr>
<th></th>
<th>All Spotters</th>
<th>V.A. less than ( \frac{8}{7} )</th>
<th>V.A. ( \frac{8}{7} ) or better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptional</td>
<td>8.9%</td>
<td>0.0%</td>
<td>10.7%</td>
</tr>
<tr>
<td>Above average</td>
<td>35.1%</td>
<td>9.1%</td>
<td>40.2%</td>
</tr>
<tr>
<td>Average</td>
<td>40.3%</td>
<td>59.1%</td>
<td>36.6%</td>
</tr>
<tr>
<td>Below average</td>
<td>15.0%</td>
<td>27.3%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Poor</td>
<td>0.7%</td>
<td>15.7%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

* Mostly in lower half of group.

It would appear that only men with visual acuity of \( \frac{8}{7} \) in each eye should be trained as "spotters."

**HEARING.**

The "spotter's" unaided ear plays an important part in locating the target, particularly at night, and the ears of "spotters" should therefore be free from disease and accumulations of cerumen. The opportunity was taken during this investigation to examine the ears of all the "spotters." Two out of the original 151 had a Hearing Standard II (A.C.I. 1428/1940), the remainder had Hearing Standard I, but in 40 per cent the removal of plugs of cerumen was required. It is therefore considered advisable to examine the ears of all "spotters" at three-monthly intervals and to syringe them if necessary.

---

1 Of these, those that normally wear spectacles did so during this test.
SIMPLE TEST.

To test the night vision of a large number of personnel, it is necessary to use a simpler form of test, owing to the cost of an apparatus of the Livingston Hexagon type and the time factor limiting the number that can be tested on this machine.

Such a test has been in use in the R.A.F. and consists of a large black letter on a white or grey background. The letter can either be changed or rotated into different positions and a number of men can be tested rapidly against men previously tested on the Livingston Hexagon, one of whom should have obtained fairly high marks in the average group, say twenty, and another about eight or nine marks. The distance between the letter and the candidates is gradually increased. Those who do not do so well as the man who had previously scored eight or nine marks are placed in the below average group and not trained as "spotters." Those who do better than the man who scored twenty marks are placed in the above average group from which "spotters" should be drawn. The remainder fall in the average group from which "spotters" may be drawn if there are not enough men in the higher group. The eyes of those taking part in the test must be dark-adapted by wearing dark goggles (or by being kept in darkness) for forty-five minutes preceding the test.

A useful size for the letters is 15 to 18 inches square and 3 inches thick and letters such as C and E, that can be placed in four positions, are the most convenient. The letters should be moved five feet further away for each test and the candidates should be shown three letters at each position. The results may be written down, but notches or studs should indicate to the man on which line to write.

If there are no men previously tested on the hexagon available the test can be carried out comparatively and "spotters" chosen from those who do better than the others.

In bright moonlight the scotopic mechanism is not functioning fully and this test should not be carried out under such conditions.

The type of test described is not standard owing to the variable conditions of light prevailing but can be of great value in eliminating those who would be useless as "spotters."-

TRAINING.

It is beyond the scope of this paper to discuss fully the training of the A.A. "spotters." An excellent article on this subject by Major (then Captain) Perowne, R.E. appeared in the Journal of the Royal Engineers in September, 1938. A few points only will be mentioned here. The quality of night vision may be improved with constant practice. With eyes fully dark-adapted "spotters" should endeavour to recognize at night the outlines of trees and buildings against the sky both with and without field glasses. Commencing with familiar outlines, the distance can be gradually increased, and use made of unfamiliar outlines. Large letters of the type used in the simple test may also be employed. The amount of training done in this way is only known to the "spotter" himself and depends very much on the individual's keenness.
The night vision of men who are congenitally deficient in red cells, or who are suffering from pathological changes in the retina or from myopia, will not, of course, be improved by these methods.

It is important to bear in mind that the object is always seen more clearly by the dark-adapted eye if it is not looked at directly but rather "out of the corner of one's eye." A clearer view of the object may also be obtained if the head is moved from side to side or up and down in order to obtain an image on a more sensitive portion of the retina. It is difficult to move the eyes slightly and accurately from side to side in darkness unless the head is moved.

A point which is probably not of great importance under present conditions is that excessive indulgence in alcohol or tobacco may adversely affect night vision.

The "spotter's" outlook towards his work is of great importance. If he is keen on his job and eager to see in the dark there is no doubt that he will see more than the man who is lethargic, even though the quality of their night vision be identical. In the past there has been a tendency to neglect the "spotter" and the other men in the detachment are inclined to look down upon him which causes him to lose interest in his work. Lectures on night vision were given to all "spotters" taking part in this investigation in order that they should know what was being done. Tremendous interest and keenness were shown and the improvement in their mental attitude on being "put on the map," as it were, was very marked. From experience gained during this investigation it is the writer's opinion that, although keeping men in darkness for forty-five minutes is an efficient method of dark-adaptation, the psychological effect on the man of providing him with dark glasses for this purpose is of value and should be fostered.

Conclusions.

(1) That "spotters" of searchlight detachments are using night vision (rod mechanism).

(2) That a number of personnel at present employed as "spotters" are valueless in this work owing to the poorness of the quality of their night vision.

(3) That the efficiency of searchlight work would be increased if the selection of those to be employed as "spotters" depended on the possession of a high night visual standard.

(4) That the night vision of personnel should be tested before training as "spotters" is commenced. Those who do badly in the test should not be employed as "spotters" but the actual standard set must depend to a certain extent on the personnel available.

(5) That, owing to the cost of elaborate apparatus and the time factor, where large numbers are involved a simple type of test must be used to eliminate those with a low night visual standard.

(6) That no other members of a searchlight detachment make operational use of their night vision except the man on the Mark 9 sound locator who is known as No. 6 but in this case it is not of great importance.

(7) That some means of dark-adapting the eyes of "spotters" before
Night Vision among Personnel of an A.A. Unit

they "take post" should be in operation on A.A. sites. This is best done by wearing dark goggles for forty-five minutes before dark.

(8) That intelligence and the desire to see in the dark play an important part in the "spotters" efficiency; and that the disparity between the A.A. and R.A.F. results is probably due to A.A. troops being less mentally alert.

(9) That "spotters" chairs should be adequately screened from ground glare and from the searchlight projector.

(10) That the results indicate that it is generally not worth while training as "spotters" those men with a visual acuity of less than 8 in either eye.

(11) That the use of mydriatics such as pareidrine hydro-bromide as an aid to night vision is impracticable in A.A. Units.

(12) That the diet of the A.A. Unit under investigation was not deficient in vitamin A.

(13) That a high standard of night vision is probably of importance in other branches of H.M. Forces. This particularly applies to look-out men on ships and to drivers of vehicles by night under the existing conditions of black-out and one wonders how many accidents have occurred owing to a sentry suffering from impairment of his night vision. The ideal, which is probably impossible to attain, would be for all personnel who are habitually employed during darkness to be chosen from the ranks of those who have a high night visual standard.

(14) That hearing is also of importance to "spotters"; that they should be examined at three-monthly intervals in order to remove plugs of cerumen if necessary.

My thanks are due to Group Captain Livingston, C.B.E., F.R.C.S., Consultant in Ophthalmology to the R.A.F., for his generous co-operation and advice and for the facilities he afforded me for using the Rotating Hexagon.

My thanks are also due to Flight Lieutenant Jeremy, M.B., B.Ch., and his staff for their able assistance.

I would also like to express my appreciation to Lieutenant-Colonel B. Chichester Cooke, R.A., Commanding Officer, 00th S.L. Regiment R.A. for his co-operation in this investigation.

I must also thank Messrs. Glaxo Laboratories Ltd. for their generosity with regard to the supply of Adexolin Capsules, Messrs. J. & R. Fleming, Ltd. for assisting me to obtain dark-adaption goggles and finally the Ministry of Aircraft Production for supplying a certain number of goggles on loan.

REFERENCES.