Validity of the Night Sight Meter

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● SEVERAL devices for checking night vision have been proposed, built and their possibilities explored. One is an adaptation of the Glarometer which was used by Lauer (5) and others for measuring night driving vision. Sometime later, De Silva (2) developed a device which was made to resemble a roadway situation. The scale-size figure of a pedestrian was shown in a dark chamber, and the light was turned up until the subject could detect the image. A glare source was also set up to simulate oncoming light.

The Allgaier Shops in connection with the American Automobile Association then developed a Night Vision Meter which was designed to measure two aspects of night vision: seeing against glare and vision in low illumination.

About the same time, the American Optical Company developed the Adaptometer which was used for measuring the adaptation time of the eye after looking into a glare source. Like its more technical predecessor, the Biophotometer, the purpose was to determine the need for vitamin A by measuring time for adaptation to a given level of illumination.

Neither of these devices proved very practical for measuring motorists' vision, since too much time was required to make the tests. An advantage of the Glarometer is its ease of use, whereas the first device built by the American Automobile Association had the disadvantage of not differentiating sufficiently between persons to be of diagnostic value. Average scores constituted a higher percentage of the distribution than warranted.

Three phases of the problem seem to be of interest to psychologists, driver's licensing bureaus, and students of driving and traffic. One phase concerns the ability to see in darkness without glare of any kind. Some individuals seem to have greater ability to see in the dark than others. Some eyes seem to be better equipped with rods for night vision than others. Rods are supposed to function mostly for seeing in darkness or for what is known as scotopic vision.

The second concerns the ability to withstand glare from headlights of an approaching car; the effects of light on visual acuity and seeing efficiency; and, conversely, the amount of reduction in vision from a glare source.

The third aspect of this problem involves recovery time or how long it takes to see after passing bright lights. Some have estimated this to range from one second to 10 or more seconds, at least with a mean of about 2. 5 seconds. Others have minimized this phase of night vision. Practically, it is an important point, and traffic engineers have been interested in this phenomenon which they have called the "blind spot" after passing a car at night.

Allgaier (1) has recently developed and improved the original apparatus built by the AAA, which makes it possible to measure the three phases of night vision described. It is the purpose of this paper to present data on the validity of this particular apparatus and for each of these separate measurements.

PROBLEM

The reliabilities of two aspects of the Night Sight Meter scores are shown in Table 1. These reliabilities have been established fairly well by Allgaier (1). The greatest remaining problem has to do with the validity of the instrument, or whether it measures what it is supposed to measure.

Here a number of difficulties arise. If one attempts to use any outdoor criterion such as a person walking, a standing target, car or other object, he is confronted with a number of complications. (1) Different kinds of clothing are worn by the various individuals used as subjects. (2) The presence of buttons and other objects on clothing might reflect light. (3) The face and hands will possibly show up to give cues. (4) Keeping illumination levels constant from period to period during the investigation is a problem. Very few nights of the year have an even distribution of light which remains constant. Any variations in the weather, such as storm, rain, mist, or low visibility due to fog, intense cloudiness, moonlight, etc., tend to invalidate observations and render them noncomparable.

In approaching the problem of testing validity, it became clear that laboratory tests would probably do the job better. At the Driving Research Laboratory at Iowa State College, the Scotometer was developed by Stalder, Hoppe, and Lauer (8). It had been used for the purposes of establishing the lower visibility thresholds for certain types of materials on stationary as well as moving objects. It seemed ideally suited for the purpose of establishing a criterion of visibility against which the validity of the Night Sight Meter could be checked.

More valid results could probably be obtained with 39 subjects on a very highly controlled illumination device of this type than with a larger number of subjects using a less reliable criterion. By actual computation the reliability of the criterion as used here was shown to be .96 or above.

Each subject was given a series of ten observations on each of four types of belts for determining the threshold of visibility. The subject was then measured on the three aspects of the Night Sight Meter in the following order: (a) night vision in low illumination, (b) glare tolerance, and (c) recovery time. Correlations were made between each of these and the criterion.

In addition, 34 other subjects were given the Night Sight Meter tests in order to establish the degree of correlation between the respective measures. This was thought necessary to determine whether all three measures were necessary and which, if any, were similar. Age of the subjects was also included in the matrix of correlations.

APPARATUS

The apparatus used was the Scotometer (8) and the Night Sight Meter which is shown in Figure 1. The subject is placed at the eyepiece with a black hood over the head to secure adaptation to some extent (about three or four minutes) while directions for the experiment are being read. The degree of dark adaptation sought was that which would be found inside the ordinary car or truck cab on the highway at night. This would not be, in any sense, total darkness since headlights extend ahead and there is some light reflected back to the cab. However, it is very low level illumination, probably of the order of 1/50 of a foot-candle, somewhat below the level of average moonlight.

METHOD AND PROCEDURE

The subject is instructed to look into the scope of the Night Sight Meter and fixate a red pilot light of very low intensity. Just to the left of the pilot light is a rotating disc on which are presented broken circles at a constant rate of speed moving past an aperture. The controls on the end of the instrument are shown as indicated by numbers 1, 2, 3, and 4 in Figure 1.

In the present study, the night vision test was given first. This is a different order from that originally proposed by Allgaier (1) in his report on reliability. The reason for reversal in procedure is that the opposing headlights which are turned on by the switch may well carry the person's adaptation level above that to which he was adjusted when the experiment began. It would seem better to have the test for dim light vision given first without the opposing lights. When the switch is turned to the left, the opposing lights are introduced; when turned to the right, these lights go off.

The procedure is to adjust the rheostat, increasing the illumination until the subject can identify properly the broken circles without glare. After one practice trial to emphasize the directions as read to the subject, three additional trials are made, and the mean of the three is recorded as the score for night vision in low illumination without glare.

The procedure was varied slightly for the test of glare tolerance. The subject was asked to read the broken circles against the opposing light, beginning at the 100 mark of the rheostat, which was gradually turned to reduce internal illumination. Otherwise the procedure was identical with that for night vision

TABLE 1

DATA ON NIGHT SIGHT METER

	Scotometer A	Age B	Night Vision C	Glare Tolerance D	Glare Recovery Time E
E	.0219 N = 39	.1778 N = 39	.1988 N = 39 .0392 N = 73	-.0257 N = 39 -.0025 N = 73	not available+
D	.2866 N = 39	.2514 N = 39	.6009 N = 39 .4404 N = 73	.98*	
C	.4266 N = 39	.1788 N = 39	.99*		
B	.0273 N = 39	should be 1.00			
A	.96*				

* Reported by Allgaier

+ Estimated from dates available to be comparable with others

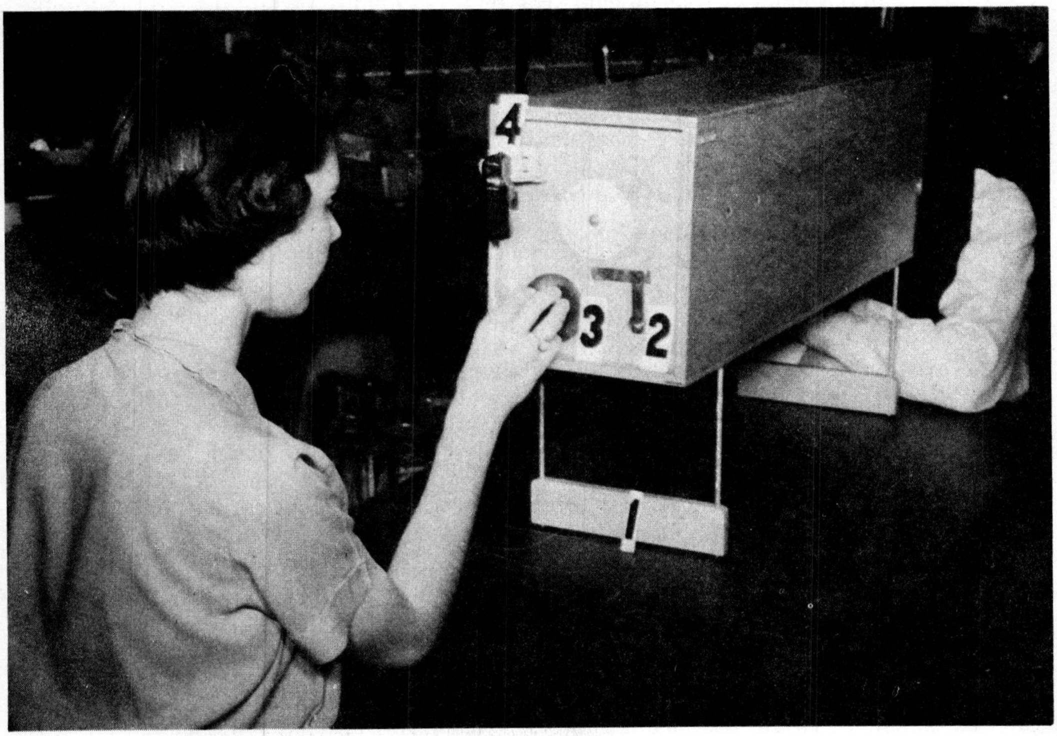

Figure 1. AAA Night Sight Meter. (1) Supports for instrument proper. (2) Switch. (3) Rheostat dial. (4) Pilot light and fixation point source.

except that the glaring lights to the subject's left were shining into the eyes.

The three readings were taken at the point where the breaks in the circles could not be reported correctly, and the mean constituted the score for glare vision. (The experimenter has an accurate check on the broken circles by noting the plate on the outside of the Night Sight Meter.)

A third test consisted of measuring the time required for recovery from glare in terms of seconds to the nearest ½ unit. Here the procedure was varied somewhat for convenience and to shorten the administration time. The dial was arbitrarily set 10 units above that found as the median score in the measurement of night vision in low illumination. The opposing lights were then switched on for ten seconds. At the end of ten seconds the lights were switched off, starting the rotating disc. At the instant the subject could read the broken circles he pressed a button which stopped the revolving dial measuring recovery time in half seconds.

This in essence describes the three procedures used for the Night Sight Meter test to secure scores for night vision, glare tolerance, and recovery time from glare.

RESULTS

As already stated, two groups of subjects were used, 39 of whom were given a carefully controlled criterion test along with the Night Vision Meter and 34 others were given only the Night Vision Meter test. The correlations obtained are given in Table 1 which shows that the measurements of night vision and glare tolerance are quite highly correlated, indicating that the two are fairly highly associated. Both correlate negatively with age. That is to say, the older persons make poorer scores on these two sets of measurements. This is in agreement with the results obtained by Allgaier (1).

However, recovery time does not seem to correlate with either night vision or glare tolerance. This result was not expected since it seemed logical to assume that one who is bothered more by lights would take longer to recover from glare after exposure. This is not the case. The low correlations obtained indicate very little relationship between either of these two measurements and recovery time.

Because of the length of administration time and the relatively high correlation between the night vision and glare tolerance tests, it is suggested that a device be designed which would measure either night vision or glare tolerance and, at the same time, incorporate some feature for measuring glare recovery. In other words, there would be two scores on the revised test rather than three.

To establish a criterion of glare recovery is quite difficult. It would require extensive road tests which would be subject to the same faults in any attempt to secure outdoor tests of visibility as the criterion. So far as recovery time is concerned it will suffice to say that the criterion is self-evident. The fact that one has a long recovery time would in itself be sufficient for the purpose. Professional drivers should have a short recovery time because of the necessity of maintaining night schedules.

The lay driver could be warned of such a condition. This is one of the most valuable aspects of psychophysical testing. Such a clinical approach to the problem of accident prevention seems to be effective, and, when measures which are reliable and valid can be used, eventually some form of them should get into the driver license examination.

It is probably just as important to have one's license marked "restricted to daylight driving" or restricted to slow speeds at night" as it is for having it marked "restricted to driving with glasses." It tends to shift responsibility for safe driving to the person behind the wheel.

SUMMARY AND CONCLUSIONS

In summary, in this study a reliable criterion of night visibility was first established by the use of the Scotometer using 39 subjects. After this the Night Sight Meter was used on 34 additional subjects to establish correlations and the validity of the instrument. The validity is of the order of .40 so far as night vision and glare tolerance in low illumination are concerned. The validity of glare recovery time was very low indicating need for further research in this area. All three tend to deteriorate with age.

It may be said that the validity of the Night Sight Meter is sufficient to warrant its use as a diagnostic instrument, but that the administration time should be reduced. It is suggested that either the night vision or the glare tolerance feature of measurement be omitted and that the glare recovery feature be used in connection with one of the former two. This would reduce the time for administration appreciably.

ACKNOWLEDGMENT

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