Relation Between Scotopic Vision as Measured by The Night Sight Meter, Daylight Vision and Age

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●THE HIGH frequency of nighttime traffic accidents and the frequent complaints about glare blindness calls attention to a very important phase of highway safety investigation. Up-to-date this phase has received only meager attention by students of highway safety.

There are several aspects to the night vision problem and it might be well to consider them in order. The hypothesis to be investigated may be stated as a question, "What relationship exists between vision measured in daylight and vision measured in very low illumination?"

The Night Sight Meter is an instrument designed to give three types of scores on phases of night vision which are commonly mentioned as important to motorists travelling the highway at night. The visual measurements for daylight vision were made with the regular Sight Screener made by the American Optical Company.

PLAN OF THE EXPERIMENT AND PROCEDURE

A set of instruments was installed in a booth at the Iowa State Fair and persons visiting the Fair were invited to serve as subjects. The instrumentation was screened off in the booth and was manned by trained examiners, one on each specific test. Each subject was read standard operating directions and then taken through the series of tests. They were requested to complete the series but for different reasons about one-fourth of the records were incomplete and could not be used. Of over 450 persons starting the tests only 288 had completed records.

The data were carefully analyzed, coded and put on IBM cards. Intercorrelations were run between age, miles driven, vision in low light, glare vision, glare recovery time and daylight vision as measured by the Sight Screener. The latter measurement was used as the criterion.

ASPECTS OF NIGHT VISION

First, there is the problem of night seeing efficiency in the absence of glare. Some persons see very well at night considering the amount of illumination available while others see very poorly. The first problem concerns the relationship between seeing in very low illumination and seeing in high illumination. By very low illumination we refer to levels of light less than $\frac{1}{10}$ ft candles, whereas levels of illumination of 10 ft candles and above as used for visual examinations, are arbitrarily referred to as high level or daylight vision.

The second score of interest was that of the ability to see against glare as determined by a second measurement on the Night Sight Meter. This is done by using the same low illuminated letters as the fundamental stimuli, at the same time introducing a glare light beam source thrown into the subject's eye. This materially raises the threshold for seeing and establishes a second score.

A third phenomenon is that of temporary blindness when a motorist meets a bright light. Is this related to the other two phenomena and what interrelationship exists with vision, age, and driving performance? To obtain a reasonable sampling of measurements the instrumentation was set up as described and all measurements on common subjects were obtained. From these scores intercorrelations were computed to determine the relationships desired.

Age was used along with the total mileage driven to determine whether these variables might influence results obtained. It is known that older persons are more affected by glare.

RESULTS OBTAINED

The booth was kept open for 10 days and about 400 subjects taken through. Of the

288 complete records six variables on vision were intercorrelated and the results are shown in Tables 1 and 2. Table 2 shows the means and standard deviations with the exception of mileage which turned out exceptionally high, being nearly double the mean. This would indicate that estimates on mileage differ widely and are perhaps not reliable.

TABLE 1

CORRELATIONS N = 288

1	2	3	4	5	6
Age	Total Miles Driven	Dim Light	Glare	Glare Recovery Time	Vision Sight Screener
1	+.4495	+.1270	+.0714	+.2070	-.2373
2	----	-.0423	+.0076	+.0928	-.1553
3		----	+.3921	+.1238	-.0579[a]
4			----	+.1758	-.1151[a]
5				----	-.0579[b]

$R_{6 \,.\, 12345} = .2632$

[a] Less acuity, more light needed.
[b] Less acuity, longer to recover.

As expected those older had travelled more miles. They had slightly poorer vision as measured by the Sight Screener. The average was somewhat less than 20/20 vision, being about 6.8 in Sight Screener units. The correlation of -0.24 indicates poorer vision for the older group. There was a slight negative correlation between scotopic and photopic vision as noted. The relationship is quite low. Glare recovery time also correlated negatively with daylight vision. Considering the nature of the scores this means that one with poor vision takes longer to recover from glare. The other correlations indicate relative independence of each of the separate Night Sight Meter measurements. The mileage relationships shown are probably due to the effect of age, experience being a doubtful factor.

A multiple R of 0.26 with daylight vision reflects mostly the effect of age on vision. A moderate correlation of +0.21 shows older persons have a slightly longer glare recovery time.

There was only a slight negative relationship between night vision and daylight vision scores as taken. This is mostly noticeable for glare recovery time.

The nature of the subjects used is shown quite well by the table of means.

TABLE 2

ALL SUBJECTS

Variable	Mean	S.D.
Age	23.90	9.40
Total miles driven	81,319.00	----[a]
Sight Screener	6.80	.84
Night or dim vision score	23.80	4.63
Glare vision score	51.98	14.30
Glare recovery time	2.70	.78

[a] Very large, not inserted.

CONCLUSION

Within the scope of this investigation and considering the various limitations the following tentative conclusions may be stated:

1. Night vision is different from daylight vision and should be measured separately.
2. The scores on the Night Sight Meter are relatively independent. All should be

taken to get a measure of one's vision for driving.

3. Age shows greatest effect on glare recovery of the variables considered.
4. Considering the direction of scores, one with good vision sees slightly better at night, but the two measurements overlap only slightly.
5. To secure an adequate appraisal of a driver's vision one should have both daylight and night vision scores.
6. The following tables of norms do not indicate sex differences of substantial magnitude.

Appendix — Norms

TABLE A

NIGHT SIGHT METER

Dim Light Scores	Women		Men		Men and Women	
	Frequency	Cumulative Frequency	Frequency	Cumulative Frequency	Frequency	Cumulative Frequency
36-37	2	87	8	290	10	377
34-35	3	85	7	282	10	367
32-33	4	82	11	275	15	357
30-31	6	78	17	264	23	342
28-29	3	72	30	247	33	319
26-27	10	69	30	217	40	286
24-25	17	59	46	187	63	246
22-23	21	42	47	141	68	183
20-21	14	21	47	94	61	115
18-19	4	7	25	47	29	54
16-17	3	3	22	22	25	25
	N = 87		N = 290		N = 377	
	My = 24.592		My = 24.252		My = 24.330	

TABLE B

NIGHT SIGHT METER

Glare Scores	Women		Men		Men and Women	
	Frequency	Cumulative Frequency	Frequency	Cumulative Frequency	Frequency	Cumulative Frequency
91-96	6	87	17	290	23	377
85-90	1	81	3	273	4	354
79-84	2	80	4	270	6	350
73-78	1	78	7	266	8	344
67-72	8	77	13	259	21	336
61-66	10	69	32	246	42	315
55-60	10	59	60	214	70	273
49-54	17	49	48	154	65	203
43-48	19	32	41	106	60	138
37-42	9	13	32	65	41	78
31-36	1	4	22	33	23	37
25-30	3	3	11	11	14	14
	N = 87		N = 290		N = 377	
	My = 55.916		My = 54.254		My = 54.638	

TABLE C

NIGHT SIGHT METER

Recovery Time	Women		Men		Men and Women	
	Frequency	Cumulative Frequency	Frequency	Cumulative Frequency	Frequency	Cumulative Frequency
4.0-4.2	3	87	13	290	16	377
3.7-3.9	1	84	11	277	12	361
3.4-3.6	0	83	7	266	7	349
3.1-3.3	10	83	10	259	20	342
2.8-3.0	7	73	20	249	27	322
2.5-2.7	11	66	29	229	40	295
2.2-2.4	6	55	36	200	42	255
1.9-2.1	12	49	36	164	48	213
1.6-1.8	18	37	63	128	81	165
1.3-1.5	14	19	39	65	53	84
1.0-1.2	5	5	26	26	31	31
	N = 87		N = 290		N = 377	
	My = 2.190		My = 2.173		My = 2.177	

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