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Abstract

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A STUDY OF THE RELATIONSHIP BETWEEN THE SIZE OF THE PHYSIOLOGICAL BLINDSPOT AS PLOTTED WITH THE DAVIDSEN-WOTTRING CAECANOMETER AND VISUAL ACUITY UNDER REDUCED OR MINIMAL ILLUMINATION

CLINICAL YEAR PROJECT

By

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We express our appreciation to Dr. D. T. Jans, Professor of Optometry, and Dr. William R. Baldwin, Dean of the College of Optometry, for their guidance and interest in our project.

To A. L. Curtis, and E. K. Ragsdale, both of whom began work on this project in May 1963, our thanks for the contribution of their basic research and data from twenty subjects which combined with our data has made the population for this project more significant.

We also wish to thank the Diagnositic Instruments Company of Muskogee, Oklahoma, for making the Caecanometer instrument available to us and for suggesting this project. In addition we wish to thank those who so willingly cooperated with us by serving as subjects for this study.

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PURPOSE

This project was undertaken at the suggestion of the Diagnostic Instruments Company (DICO) of Muskogee, Oklahoma. They were interested in determining if any correlation exists between the size of the physiological blindspot as plotted by the Davidsen-Wottring Caecanometer Model 75, which they manufacture, and the visual acuity of a patient under reduced or minimal illumination.

In addition to the information wanted by DICO we added a second variable which was visual acuity under reduced illumination after twenty minutes dark adaptation.

INTRODUCTION AND REVIEW OF LITERATURE

In order to investigate the possibility of any existing correlation between the size of the physiological blindspot and the visual acuity of a patient under reduced illumination, as stated in the purpose of this project, it was decided that the data collected by Curtis and Ragsdale would be added to our data consisting of an equal number of subjects.

This has enabled us to correlate the findings of forty subjects (eighty eyes). The data was collected in both cases in the same manner consistent with that given in the "procedure" of this paper.

A discussion of the history, development, and clinical significance of the Davidsen-Wottring Caecanometer will serve as an introduction to this project. Dr. I. O. Davidsen, one of the designers of the instrument, has given his views on what prompted investigations of the blindspot and development of the caecanometer.

Ideally, patients desire to see clearly and comfortably. Lowered visual perception of an elusive nature, which impaired vision from unfamiliar causes, distressed I. O. Davidsen very much. He noticed these patients with "lowered visual performance," more often than could be explained by mere coincidence, to be the same patients known to be suffering from mild pathological conditions.

Three areas of study were therefore initiated. The first to be studied in a search for methods of correlating known pathological conditions with retinal response was the macula, which is known to be the most sensitive area of reception. This holds true if the retina is in a light adapted eye, the reverse situation is seen in the dark adapted eye. The fovea exhibits a relative scotoma in low illuminations. Highly sensitive and controlled field plotting techniques were used for the macula, but did not present the answer in consistent recognizable signs.

The next work was directed to the detailed study of peripheral fields and again no significant correlation between known pathological conditions and certain typical signs in the peripheral fields was found.

The third area of study was the optic nerve head. A relatively consistent size and position has been established for the nerve head. It was realized that known pathological involvements such as oral, sinus, and throat infections resulted in an increase in the plotted size and shape of the nerve head. The statistical outcome of the study after treatment for pathological conditions did not indicate changes in the blindspot area as often as was expected. From these clinical data discrepancies Dr. Davidsen's curiosity was aroused to the extent that he altered the technique of measuring the blindspot.

He set out to find a method to obtain repeatable and more dependable chartings. The big surprise came when the target was moved from the seen to the unseen. It was found that typical changes were taking place in the nerve head size and shape when the known pathological conditions were eliminated. By using the technique of moving the target from seen to unseen, a zone of indecision of two to three millimeters was reduced to an average of only one-half millimeter. Best results were obtained by moving the target at a steady rate of speed, approximately eight millimeters every three seconds.

Two more problems were encountered which influenced the reliability of the blindspot plotting. The first was the distance the fixation target is placed from the patient. A distance of ten to thirteen inches was used in an attempt to determine the best distance. Also, an exact fixation target, was a must.

The second problem was that the usual wand aroused entirely too much peripheral rivalry causing mental-visual confusion. To eliminate the handle of the wand a set-up was designed so that a magnet would guide the target from beneath the chart so that only the target would be observed.

This was the beginning of a new technique of measuring the physiological blindspot from the seen to the unseen and a new instrument having a minute foveal fixation target and a small remotely controlled test object at eight inches from the eye. The instrument was named the caecanometer from the Greek words "caecus" meaning blind and "metry" which means to measure.

By researching three-thousand patients under professional care he concluded the following:

"1) The area within the blindspot does, in the presence of certain types of infection, show a constriction in the plotted size as compared to the normal or expected average area; 2) that such restricted area always regains its own normal size when the source of infections has been eliminated; 3) that a restriction of the blindspot almost invariably accompanies cases of drainage types of infections above the shoulders."[1]

Research has confirmed the value of this new technique. Dental patients under the control of oral surgeons were charted before and after surgery and the typical changes in size and shape of the blindspot were noted.[2] Optometric patients whose discomfort had not been amendable to standard optometric procedure were referred to and treated by Ophthalmologists, and ear, nose, and throat specialists. After treatment, blindspots showed an increase in size and visual involvements were reduced.[3]

Clinical significance of data obtained from research involving caecanometry is varied. Symptomatology resulting from infections have been successfully treated due to caecanometry detection, such as complaints of photophobia, accommodation and convergence function discomfort during examination, lowered night-sight light levels, contrasts of visual acuity, i.e., with 20/20 vision yet complaining, "I do not see clearly", unequal acuity of the two eyes, altered depth perception, and combinations of the above complaints.

Many practitioners in the visual care field have attached great significance to the caecanometer and its value in the detection and diagnosis of glaucoma. The Standard Technique of plotting from unseen to see is used in glaucoma studies.[4]

PROCEDURE

A. Plotting of the physiological blindspot.

The physiological blindspot of each eye of each patient was plotted using the techniques outlined in the Manual of Operation of the Davidsen-Wottring Caecanometer Model 75.

1. The instrument was set at medium illumination level.

2. Plotting was from seen to unseen in the vertical and horizontal meridians.

3. A 1.5 mm target was used.

4. Target was moved at 8mm per 3 seconds.

B. Visual Acuity Under Minimal Illumination.

1. The subject was seated with subjective refraction for best visual acuity in place.
2. The room was darkened completely for thirty seconds.

3. One eye was occluded.

4. The Powerstat Type 116 was wired into the electric circuit to the projector so voltage could be gradually increased until the subject could recognize at least four out of six 20/20 acuity letters (TZVECL).

5. The voltage required was obtained from the voltmeter scale on the Powerstat.

6. The procedure (1-5) was repeated for the other eye.

7. The above procedure (1-6) was repeated on the subject after twenty minutes dark adaptation.

Instrument List:

1. Model 75 Davidsen-Wottring Caecanometer
2. American Optical Projector
3. American Optical Rx Master
4. Refraction Room #24 Optometric Clinic
5. Visual Fields Lab Optometric Clinic Pacific University
6. Powerstat Type 116 0-140 Volt Range
7. 1.5mm Steel Ball Bearing Targets

ORGANIZATION OF THE DATA

Forty subjects with an age range from ten to forty-seven years were tested. A distribution by age and sex is as follows:

Age	Subjects	Sex
10-20	10	7 F 3 M
20-30	22	4 F 18 M
30-40	5	2 F 3 M
41-47	3	1 F 2 M
	40	14 F 26 M

Of these, 20% were non-college students, 60% were college students, and 20% were in various occupations. Fifty percent were myopes, 37.5% were hyperopes and 12.5% were emmetropes.

Table #1 lists percent of reduction in blindspot area, voltage for 20/20 acuity after thirty seconds dark adaptation and voltage for 20/20 acuity after twenty minutes dark adaptation.

Figure No. 1 is a scattergram representing the voltage required for the subject to attain 20/20 acuity after thirty seconds dark adaptation in relation to the size of the blindspot in percent reduction in area. Figure No. 2 is a scattergram representing the voltage required for the subject to attain 20/20 acuity after twenty minutes dark adaptation in relation to the size of the blindspot in percent reduction in area.

The formulae used in the statistical analysis are given on page 14 and the statistical results on pages 14-15.

DATA

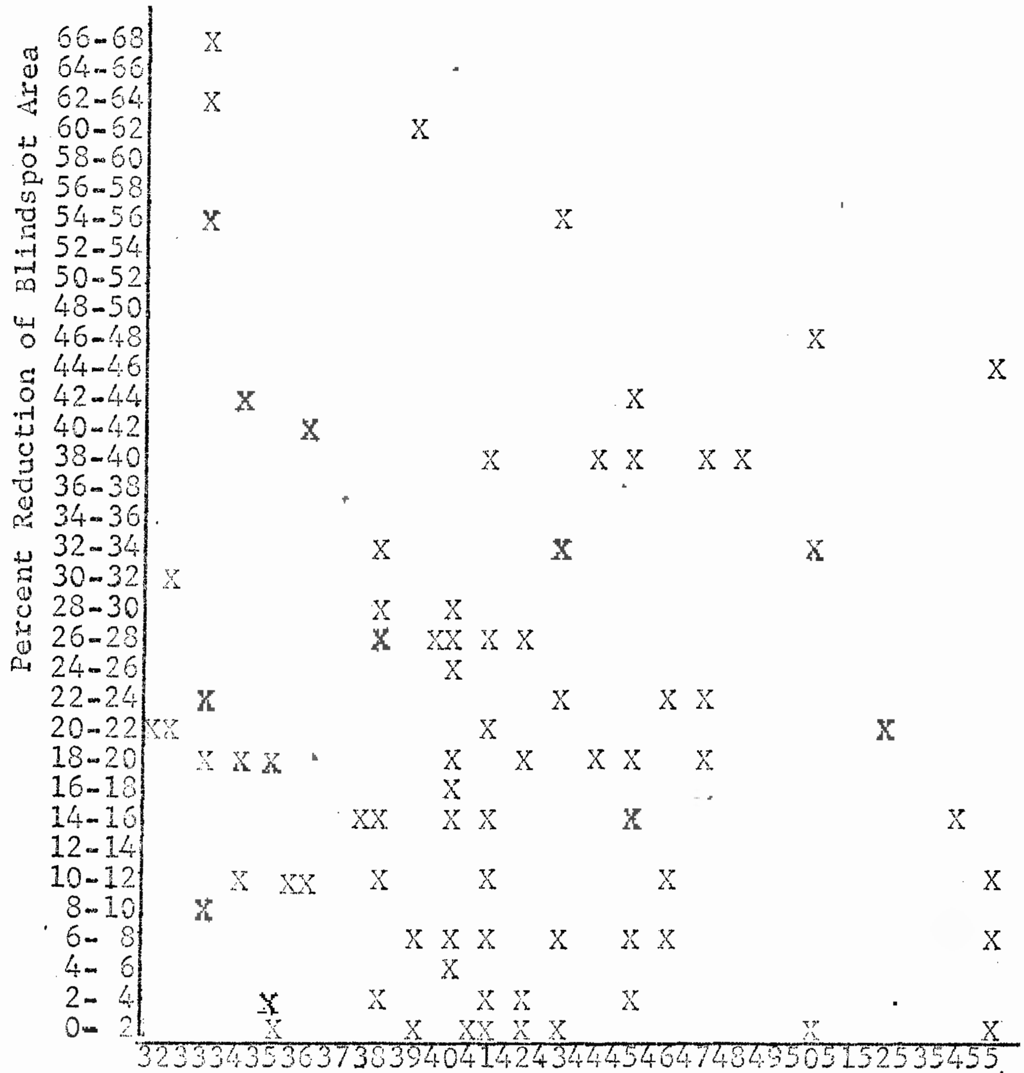
Table I

Subject	Percent Reduction In Blindspot Area	Voltage Required For 20/20 Acuity After 30 Seconds Dark Adaptation	After 20 Minutes Dark Adaptation
1.	20%	42	42
	28%	38	42
2.	33%	43	42
	16%	45	45
3.	12%	55	43
	22%	52	40
4.	12%	36	35
	00%	35	35
5.	28%	41	39
	25%	40	35
6.	18%	47	41
	12%	46	41
7.	20%	44	41
	28%	42	40
8.	12%	38	33
	44%	34	31
9.	00%	43	45
	08%	41	45
10.	28%	40	39
	28%	40	41
11.	08%	43	41
	08%	46	42
12.	20%	40	39
	16%	38	40
13.	40%	46	44
	56%	43	42
14.	16%	40	37
	04%	38	37
15.	18%	41	39
	00%	42	40

16.	12% 04%	51 42	50 45
17.	00% 00%	55 50	55 46
18.	08% 08%	40 46	50 49
19.	00% 00%	41 41	42 42
20.	20% 48%	45 50	40 45
21.	12% 00%	40 44	36 39
22.	04% 08%	43 43	35 39
23.	25% 12%	41 39	33 34
24.	12% 16%	65 55	55 54
25.	06% 18%	45 47	40 40
26.	08% 20%	37 35	33 35
27.	04% 16%	41 38	41 38
28.	63% 33%	42 43	39 38
29.	08% 04%	50 58	45 45
30.	40% 40%	43 45	44 48
31.	24% 39%	46 47	46 47
32.	41% 29%	38 33	36 38

33.	63% 24%	39 37	33 32
34.	43% 45%	45 55	45 55
35.	57% 68%	33 33	33 33
36.	40% 24%	37 49	41 47
37.	34% 24%	40 40	32 31
38.	24% 31%	46 55	43 50
39.	20% 20%	35 36	34 33
40.	29% 20%	41 43	40 41

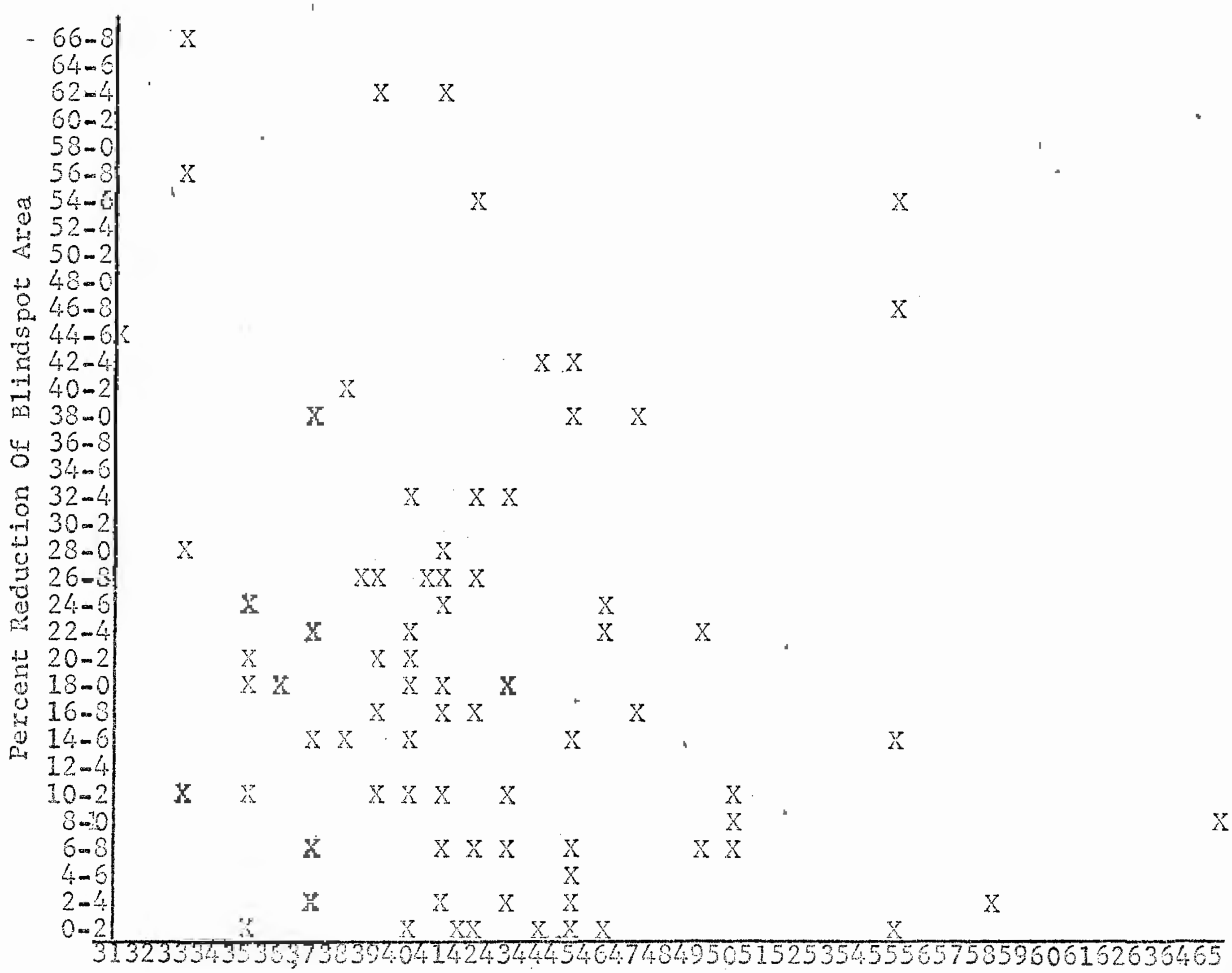
Figure 1 is a scattergram representing the voltage required for the subject to attain 20/20 acuity after 30 seconds dark adaptation in relation to the size of blindspot in percent reduction of area.



Voltage Required For 20/20

Fig. 1

Figure 2 is a scattergram representing the voltage required for the subject to attain 20/20 acuity after 20 minutes dark adaptation in relation to the size of blindspot in percent reduction of area.



Voltage Required For 20/20

Fig. 2

STATISTICAL ANALYSIS:

Formulae

Mean ($\overline{X}$ and $\overline{Y}$) $\overline{X} = X/n$, $\overline{Y} = Y/n$

where X = voltage for 20/20 visual acuity
Y = minus percentage reduction of blind-spot area
n = number of values
= sum

Standard Deviation (s)

$s = \sqrt{\Sigma x^2/n-1}$ (X values)

where $x = X - \overline{X}$

$s = \sqrt{\Sigma y^2/n-1}$ (Y values)

where $y = Y - \overline{Y}$

Variance (s^2)

$s^2 = \Sigma x^2/n-1$ (X values)

$s^2 = \Sigma x^2/n-1$ (Y values)

Correlation Coefficient (r)

$r = \Sigma xy/n-1 / \sqrt{(\Sigma x^2)/n-1)(\Sigma y^2/n-1)}$

Test for significance (t)

$t = \left(r/\sqrt{1-(r^2)}\right)\sqrt{n-2}$

Statistical Results

Results after 30 seconds dark adaptation

$\overline{X}$ (X values) = 43.025
$\overline{Y}$ (Y values) = -21.600

s (X values) = 6.12
s (Y values) = 16.11

s^2 (X values) = 37.47
s^2 (Y values) = 259.69

r correlation of X and Y = +.397

t test for significance = 3.84

Results after 20 minutes dark adaptation

$\bar{X}$ (X values) = 40.7625
$\bar{Y}$ (Y values) = -21.6000

s (X values) = 5.77
s (Y values) = 16.08

s^2 (X values) = 33.22
s^2 (Y values) = 258.42

r correlation of X and Y =+0.24

t test for significance = 3.60

DISCUSSION AND CONCLUSION

This study was conducted on the premise that subjects with reduced blindspot areas would require a higher minimal voltage to read 20/20 acuity letters than subjects with normal blindspots.

Based on the sampling of forty patients (eighty eyes), the data, the scattergrams, and the statistical correlations indicate low association of the variables compared in this project.

The correlation coefficients, +0.397 for the thirty second dark adaptation, and +0.240 for the twenty minute dark adaptation, are not great enough to indicate a definite relationship of the reduced blindspot areas to the amount of voltage required to read 20/20 acuity letters.

Our sampling contains a good variation of types of individuals but the data indicates variability of voltage requirements as compared to equally constricted blindspots.

In view of the values obtained for the standard deviations, correlation coefficients, and tests of significance, we feel that the premise on which this project was conducted is clinically non-usable.

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