1-1-1964

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

A L. Curtis
Pacific University

E K. Ragsdale
Pacific University

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

Abstract
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

Degree Type
Thesis

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

A. L. Curtis

E. K. Ragsdale

— January 1964 —

ACKNOWLEDGEMENTS

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.

We also wish to thank the Diagnostic 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.

A. L. C.

E. K. R.

CONTENTS

PURPOSE

This project was undertaken on 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: REVIEW OF LITERATURE

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 curosity 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 the three-thousand cases showed that: "1) The area ... in 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, 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 seen is used in glaucoma studies.

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.

a. The instrument was set at medium illumination level.

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

b. Area of blindspot reduction was taken from table computed and furnished by DICO.

c. A 1.5 mm target was used.

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

B. Visual Acuity Under Minimal Illumination.

a. The subject was seated with subjective refraction for best visual acuity in place.

b. The room was darkened completely for thirty seconds.

c. One eye was occluded.

d. 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).

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

f. The procedure (a-e) was repeated for the other eye.

g. The above procedure (a-f) 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

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

Age	Subjects	Sex
12-20	3	1M, 2F
20-30	11	10M, 1F
30-40	4	3M, 1F
40-47	2	2M

Of these, 13% were non-college students, the remainder was college students of which 45% were Optometric students and 41% were college students of non-optometric areas.

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 acattergram 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 12.

On page 12 and 13 the statistical results are given.

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% -.28%	42 38	42 42
2.	-.33% -.16%	43 45	42 45
3.	-.12% -.22%	55 52	43 40
4.	-.12% -.00%	36 35	35 35
5.	-.28% -.25%	41 40	39 [illegible]
6.	-.18% -.12%	47 40	41 41
7.	-.20% -.28%	41 42	41 40
8.	-.12% -.44%	38 34	33 31
9.	-.00% -.08%	43 41	45 45
10.	-.28% -.28%	40 40	39 41
11.	-.08% -.08%	43 46	41 42
12.	-.20% -.16%	40 38	39 40
13.	-.40% -.56%	46 43	44 42
14.	-.16% -.04%	40 38	37 37
15.	-.18% -.00%	41 42	39 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

Figure 1 is a scatter gram 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.

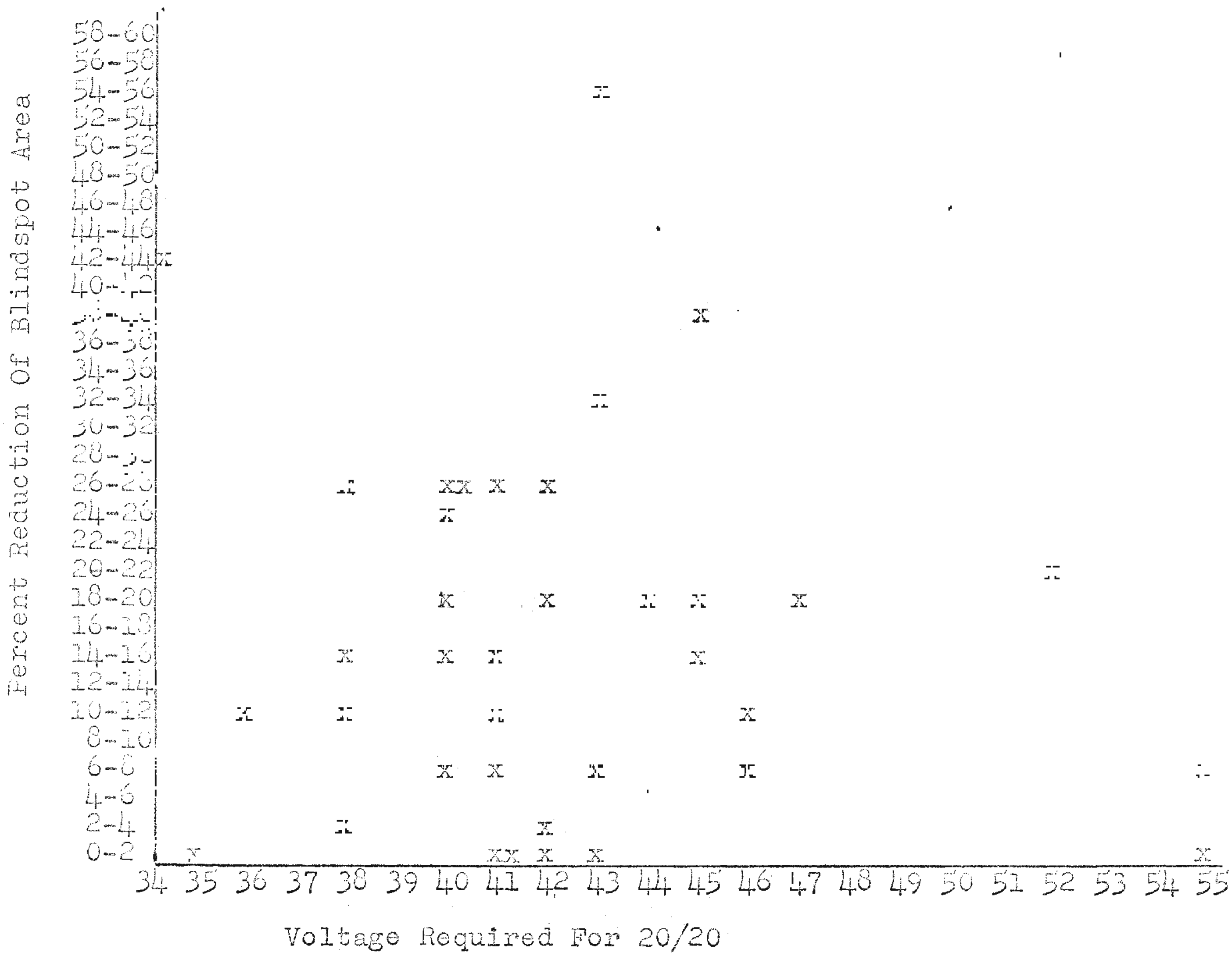

Fig. I

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.

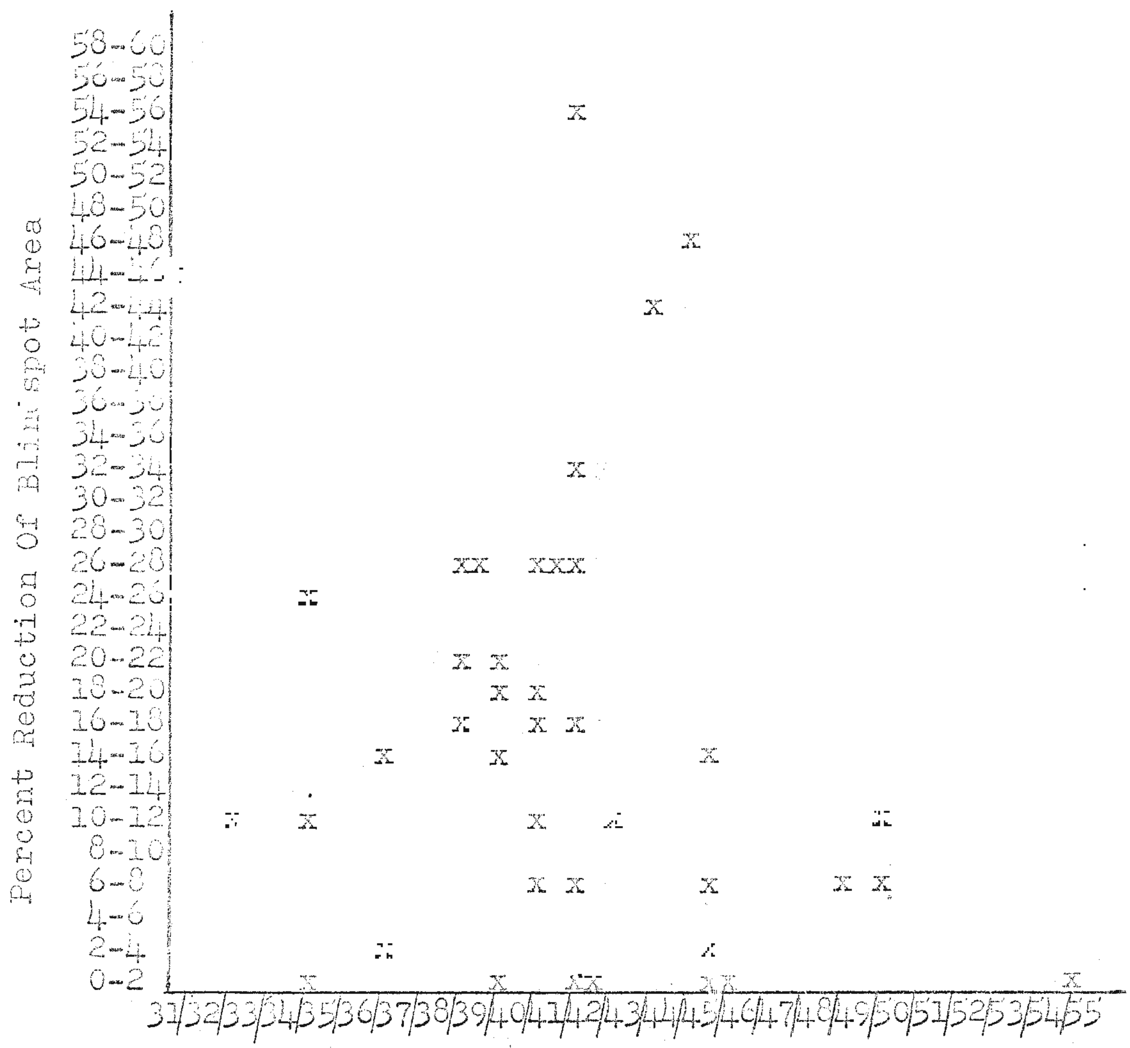

Fig. 2

STATISTICAL ANALYSIS:

Formulae[5]

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

where X = voltage for 20/20 visual acuity
Y = minus percentage reduction of blindspot area
n = number of values
Σ = 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)

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

Correlation Coefficient (r)

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

Test for significance (t)

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

Statistical Results

Results after 30 seconds dark adaptation

$\overline{X}$ (X values) = 43
$\overline{Y}$ (Y values) = 17

s (X values) = 4.97
s (Y values) = 13.96

s^2 (X values) = 24.7
s^2 (Y values) = 195.4

r correlation of X and Y = -.17

t test for significance = 1.11

Results after 20 minutes dark adaptation

$\overline{X}$ (X values) = 41.5
$\overline{Y}$ (Y values) = 17.0

s (X values) = 4.69
s (Y values) = 13.96

s^2(X values) = 22.1
s^2(Y values) = 195.4

r correlation of X and Y = -.24

t test for significance = 1.50

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.

In reference to Fig. 1 and 2, a trend is indicated in respect to the general population. There are however five variations from this trend which tend to distort the statistic... Disregarding these extremes, a low positive correlation seems to be indicated for both the thirty second and twenty minute dark adaptations.

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

Although our project indicates a low correlation other criteria related to reduced blindspot areas may show a much higher correlation since three of the five extreme variants showed significant blindspot reduction and are known to have pathological involvments. It is evident that further studies using some of the other clinical criteria should be considered.

REFERENCES CITED

1. I. O. Davidsen, O.D., "The Evolution Of A New Technique", Journal Of The A. O. A., Vol 34, No 9, pp 701, April 1963.

2. Guy Fenton, O.D., "Blindspot Restrictions", Optometric Weekly, January 7 and November 4, 1954.

3. I. O. Davidsen, O.D., "Blindspot Constrictions", Optometric Weekly, pp 1197, August 4, 1949.

4. Lin Moore, O.D. and John Bradley, O.D., "The Sinister Halo", Optometric Weekly, pp 2405, December 6, 1962.

5. Allen L. Edwards, "Statistical Analysis", Rinehart & Company, Inc., New York 1959, pp 40-53-68-167.

REFERENCES NOT CITED

1. Lin Moore, O.D., "Caecanometry For Complete Diagnosis", Optometric Weekly, September 22, 1955.

2. I. J. Davidsen, O.D., "Restrictions Of The Blindspot Area And Their Significance To Lowered Visual Achievement", Optometric Weekly, August 1949.

3. J. A. Shreve, O.D., "A Caecanometer Case Report", Optometric Weekly, October 1955.

4. C. H. Pheiffer, O.D., "An Analysis Of Clinically Obtained Caecanometer Data", A. O. A. Journal, August 1959.

5. M. J. Hirsch, O.D. & M. Schapero, O.D., "The Relationship Between The Size Of The Blindspot And The Presence Of General Infection", American Academy Of Optometry Journal, May 1951.

6. J. W. Kensett, O.D., "Experiences In Charting Blindspot Restrictions", A. O. A. Journal, April 1963.

7. G. A. Scott, O.D., "Instrumentation And Clinical Testing For Caecanometry", A. O. A. Journal, April 1963.