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An assessment of stereo fundus photography as an instructional medium of the Elschnig classification system

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An assessment of stereo fundus photography as an instructional medium of the Elschnig classification system

Abstract
This study is an investigation of stereo fundus photography as an instructional medium of the Elschnig classification of optic disc typing. Fourteen subjects from Pacific University College of Optometry were tested, 9 with stereo instruction (Group A) and 5 with non-stereo instruction (Group B). Both groups were tested with a random selection of stereo and non-stereo slides. Student's T analysis was performed, results revealed no significant difference between Group A and B in stereo slide and overall performance, however, Group B scored significantly higher on non-stereoscopic slides.

Degree Type
Thesis

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AN ASSESSMENT OF STEREO FUNDUS PHOTOGRAPHY AS AN INSTRUCTIONAL MEDIUM OF THE ELSCHNIG CLASSIFICATION SYSTEM
Submitted by: Kensey Inouye and Irene Mirikitani
Advisor: Lynn J. Coon, O.D.
Submitted on February 9, 1979
Pacific University College of Optometry
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>I-A</td>
</tr>
<tr>
<td>Abstract</td>
<td>II-A</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Background</td>
<td>3</td>
</tr>
<tr>
<td>Methods</td>
<td>9</td>
</tr>
<tr>
<td>Results</td>
<td>11</td>
</tr>
<tr>
<td>Discussion</td>
<td>12</td>
</tr>
<tr>
<td>Conclusion</td>
<td>14</td>
</tr>
<tr>
<td>References</td>
<td>15</td>
</tr>
<tr>
<td>Appendix</td>
<td>17</td>
</tr>
<tr>
<td>Elschnig Classification</td>
<td>18</td>
</tr>
<tr>
<td>Test Sheet</td>
<td>19</td>
</tr>
<tr>
<td>Release Form</td>
<td>20</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENTS

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ABSTRACT

This study is an investigation of stereo fundus photography as an instructional medium of the Elschnig Classification of optic disc typing. Fourteen subjects from Pacific University College of Optometry were tested, 9 with stereo instruction (group A) and 5 with non-stereo instruction (group B). Both groups were tested with a random selection of stereo and non-stereo slides. Student's t analysis was performed. Results revealed no significant difference between group A and B in stereo slide and overall performance, however, group B scored significantly higher on non-stereoscopic slides.
AN ASSESSMENT OF STEREO FUNDUS PHOTOGRAPHY AS AN INSTRUCTIONAL MEDIUM OF THE ELSCHNIG CLASSIFICATION SYSTEM

INTRODUCTION

The accuracy in estimation of the cup/disc ratio is one of the most important concerns during the ophthalmoscopic examination. In order for this evaluation to be of use to the optometrist, the system he employs should be reliable as well as repeatable. The Elschnig Classification of the optic disc, developed in 1904, is a system which classifies the nerve fiber distribution in the non-glaucomatous eye. It is a system which correlates the appearance of the disc with histologic structure. (Woodruff, 1970)

According to Bennett (1942 p. 259) the Elschnig system is of profound clinical importance because:

"1. It is an easy way to describe the appearance of the disc and the finding.

2. The physiologic excavation and its relation to visual comfort or discomfort become apparent. The deeper the physiological cup, the more possibility of retinal fatigue and visual discomfort.

3. Glaucoma is more easily recognized and differentiated from the physiologic excavation."

Physiological excavation can be objectively documented with fundus photography. Stereophotographs viewed binocularly allow a three dimensional viewing of the disc and contours which
CANNOT ORDINARILY BE SEEN MONOCULARLY CAN BE APPRECIATED. (WILEY, 1976) THE PURPOSE OF THIS STUDY IS TO ASSESS THE VALUE OF USING STEREOPHOTOGRAPHS IN THE INSTRUCTION AND VISUALIZATION OF THE ELSCHNIG CLASSIFICATION SYSTEM.
BACKGROUND

The basis of profound concern for accurate disc typing and measurement is twofold. One, it indicates to a certain extent whether the cupping is physiological or pathological; and two, it provides a means of comparison between sequential evaluations. (Hollows, 1966) In the early detection of open angle glaucoma, it is important to recognize signs as the enlargement of the cup. But as a preface, we must consider some factors which are associated with a normal disc.

It appears from Czechwoicz-Janicka et al. study (1977), that the shape of the optic disc and cup depend upon the age of the patient, and subsequently become less oval vertically. This is supported by Tomlinson and Phillips (1977). The study also showed that the most frequent area ratios of the cup/disc was 6.0/9.0 (optic disc was 6-9 times larger than the cup).

The size of the optic cup and its ratio depend on the size of the scleral ring and the "amount of atrophy of the hyaloid supportive tissue at the center of the disc." (Augsburger and Alexander, 1977) Hollows (1966) suggests that the cup/disc ratio does not appear to be related to sex or change with age.

Hollows and McGuiness (1966) in their study of the optic disc found the cup size in normal persons to be bimodal, i.e. size mode is 16mm and zero cupping. They implied that this bimodality shows that in normal persons, cup size does not change (or cup size is static) and that heredity plays a role
In influencing cup size. It was also implied that an increase in cup size was a definite indication of abnormality and a sign of future visual loss regardless of ocular pressure. Snydacker (1964) states that optic discs with physiologic excavations of diameters 2/3 that of the optic disc, is to be considered as pathologic until proved otherwise.

Tomlinson (1977) has listed some factors that may explain the variation of cup/disc ratios in the normal eye. Race, heredity, intraocular pressure, outflow facility, axial length, disc size and observer differences are amongst the factors which have had some influence in variability of cup size. Age, and sex variables showed no bearing on cup size.

The last point to be made about the normal disc, is that a disc type appears to remain stable throughout life. This is supported by Woodruff (1970) who showed in his study that there was little variation in percentage incidence of the disc types between children and adults.

The documentation of the excavation of the disc and estimations of cup/disc ratios are clinical guides to assessing the normality of the optic nerve head. Various methods of obtaining data on the cup and disc are widely described in the literature. An attempt will be made to describe some of these techniques.

In 1904, Elschnig introduced his system of classification of the optic disc. The classification was based upon "extensive comparisons between the in-vivo and the anatomical (after death) appearance of hundreds of normal human eyes." (Kronfeld, 1952 p. 157) Theodore Grosvenor (1978) has summarized the
Another technique used in documentation is direct ophthalmoscopy. Polse (1975) determined the horizontal width of the disc using the direct ophthalmoscope, divided the disc into 10 equal parts and then determined the cup size to the nearest tenth. Pickard (1948) used the direct ophthalmoscope and drawings were made of the apparent size of the optic disc and cup. They were then transferred to a graph paper and the cup was expressed as a percentage of the disc.

Snydacker (1964) expressed the size of the physiologic excavation as a ratio between the horizontal diameter of the cup and the horizontal diameter of the disc also using the direct ophthalmoscope as the basic means of measurement.

Augsburger and Alexander (1977) compared four methods of observation and their magnitude estimation of cup/disc ratios. They were: Direct ophthalmoscopy (spot illumination), Direct ophthalmoscopy (streak illumination), Binocular indirect ophthalmoscopy and photography having slightly higher estimates of the cup/disc ratio than those obtained with direct techniques.

A photographic method of determining the area of cup and disc was used by Halberg (1969). He found the index of cupping, $Io$, by taking the ratio of the circumference of the cup to the circumference of the disc margins, using a map measure. Gloster and Parry (1974) used photography through color filters to accentuate the color difference.
BETWEEN THE OPTIC DISC AND CUP IN ORDER TO ESTIMATE CUP/DISC RATIO.

Portney (1976) described a method of using stereophotography with computer-generated contour and cross-sectional maps in evaluating the three-dimensionality of the optic cup. He came up with six distinct three-dimensional shapes to characterize normal cups. The categories are: cone, cylinder, hemisphere, cone-cylinder, cone-hemisphere, cylinder-hemisphere.

Kottler et al. (1975) and Blodi and Allen (1964) have established the value of stereo-fundus photography in the documentation and assessment of the optic disc excavation. Stereo photographs allow observation of even the slightest contour changes of the physiological cup.

Stereo photographs can be taken using either of two methods: simultaneous or sequential exposures. In the case of simultaneous photography a double prism is placed before the objective lens of the camera, halving the frame and doubling the images. (Schirmer, 1974) (Kottler et al. 1975) The twin-prism effectively allows simultaneous viewing of the fundus from two different angles and controls the disparity of the half views.

Using the sequential exposure method two photographs are taken in close succession from different angles. Blodi and Allen (1964) used what they termed the "cornea-induced parallax method" where the first photograph was taken through
ONE SIDE OF A DILATED PUPIL AND THE SECOND THROUGH THE OTHER SIDE OF THE PUPIL. A VARIATION OF THE SEQUENTIAL METHOD WILL BE USED BY THE AUTHORS.


THREE DIMENSIONAL VIEWING OF STEREO PHOTOGRAPHS HAS THE POTENTIAL FOR CLASSROOM INSTRUCTION. (BLODI AND ALLEN, 1964) THE AUTHORS WILL ATTEMPT TO USE THIS METHOD IN THE INSTRUCTION OF THE ELSCHNIG CLASSIFICATION SYSTEM.
METHODS

1. An undetermined number of subjects will be photographed in order to obtain a total of $2^n$ stereoscopic slide pairs (giving a total of 6 slides for each classification type).

2. Prior to dilation, each subject will be examined using standard optometric procedure to minimize possibility of glaucomatous attack. Subjects will then be dilated.

3. Photographs will be taken with the Olympus Fundus Camera, model GRC-11S. Kodak Ektachrome color film, ASA 200.

4. The film will then be developed at a local laboratory.

5. 20 volunteer second year optometry students at Pacific University College of Optometry will serve as subjects. They will be randomized into groups of 10 and assigned to either group A or group B.

   Group A: Control group, receiving non-stereoscopic instruction.
   Group B: Receiving stereoscopic instruction.

6. General instructions will be given and procedures explained to both groups.

7. Each group will be presented with a written description of the Elschnig classification for a time limit of 15 minutes. During this period the subjects should read the material.

8. A slide presentation will be given in conjunction with an oral description of the disc types according to the defined categories.

   Group A: Nonstereoscopic instruction using non-disparate duplicate halfviews, viewed through polaroid glasses.

   Group B: Stereo instruction will be presented; 8 stereo slide pairs projected through two two projectors, with polaroid filters, and viewed through polaroid glasses.

9. A different set of 19 presentations will be viewed and subjects will identify classification type. Both groups A and B will view 11 stereoscopic and 8 nonstereoscopic slides given in predetermined random order.
10. Statistical analysis: The t-test will be used and conclusions will be drawn as to the effectiveness of stereoscopic instruction.
RESULTS

Fourteen subjects out of twenty were tested, nine with stereo instruction and five with nonstereo instruction. Each group was tested with both stereo and nonstereo slides, and scoring was based upon the number of incorrect responses made. An analysis of the mean number of incorrect responses is presented in Table 1. Using Student's t-test, the means between the two groups were compared, and t-scores for the mean stereo slide scores and the mean total scores were insignificant. However, comparison of the mean nonstereo slide scores showed the nonstereo instruction group B performing significantly better than the stereo instruction group A at the 0.05 level. This was the only significant trend revealed in this study. Stereoscopic instruction was not shown to be advantageous in the classification of physiological cupping.

<table>
<thead>
<tr>
<th>Group</th>
<th>Stereo Slides</th>
<th>Nonstereo Slides</th>
<th>Total</th>
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<tbody>
<tr>
<td>A</td>
<td>4.4±2.2</td>
<td>4.0±1.1</td>
<td>8.4±2.4</td>
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<tr>
<td>B</td>
<td>4.0±1.6</td>
<td>2.4±1.8</td>
<td>6.4±2.9</td>
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<td>T-score</td>
<td>0.34</td>
<td>2.76</td>
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TABLE I
DISCUSSION

The results of this study indicate that stereo instruction does not aid in learning the classification of physiological cupping according to the Elschnig system. Although the stereo instruction group A did report improved visualization of physiological cupping, very slight differences in inclination of cup walls created ambiguity in classifying the cups with the Elschnig system. Observer variation also contributed to different interpretation of border line cups. Snydacker (1964) reported that the Elschnig classification system did not cover borderline cups but it was our belief that stereoscopic viewing would help and not hinder classification. Both investigators experienced difficulty in classifying some of the cups when viewed stereoscopically, but on the whole, stereoscopic viewing aided them in classification possibly due to experience.

Perhaps another possible system worth investigation is one previously mentioned which was developed by G.L. Portney. It utilizes six basic three-dimensional shapes to describe physiological cupping: cone, cylinder, hemisphere, cone-cylinder, cone-hemisphere, and cylinder-hemisphere. The Elschnig classification system does not encompass all physiological cup shapes, but it still is a useful aid in disc typing.

Although stereo enhancement of disc contours did not prove to be effective in teaching the Elschnig system, stereo fundus photography may still be useful in the instruction of
DISC TYPING USING THE Portney CLASSIFICATION SYSTEM THAT NECESSITATES A FINE DISCRIMINATION OF CONTOUR.
CONCLUSIONS

This study has shown that stereoscopic instruction does not significantly improve assimilation of the Elschnig classification system. The Elschnig Classification system is of value in ophthalmoscopic examination but it is limited in the confines of the stereoscopic medium. Further investigation is necessary to assess the validity of stereoscopic instruction and its applicability to optic disc evaluation.
REFERENCES


Figure 1. Elschnig disc typing.
Elschnig's Type I disc has no physiological cup, the surface of the nerve head being essentially flat and in the same plane as the retinal surface.

In Elschnig's Type II, a physiological cup is present and is cylindrical in shape, as shown in both the surface and cross section diagrams. Depth of the cup may vary.

Elschnig Type III is a saucer shaped cup. The central retinal artery and vein may be displaced toward the nasal edge of the cup. Depth of the cup may also vary.

A rather wide and deep cup is present having its greatest depth nasally and becoming increasingly shallow temporally. This is the typical myopic cupping. The vessels are usually displaced towards the nasal border of the cup.

A rather wide and deep cup is present resembling a bean pot. The vessels may be displaced nasally.

This disc type includes a number of miscellaneous categories including glaucomatous atrophy, myelinated nerve fibers, edematous or atrophied discs. Glaucomatous cupping resembles Type IVb and differential diagnosis should not be made solely upon ophthalmoscopic observation.
Instructions: Please put a check mark in the column that would best describe the disc type according to Elschnig classification. Elschnig Type V has been omitted.

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<th>Type I</th>
<th>Type II</th>
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RELEASE FORM

I. Institution
A. Title: An Assessment of Stereofundus Photography as an Instructional Medium of the Elschnig Classification System
B. Principle Investigators: Irene Mirikitani
               Kensey Inouye
               Advisor: Dr. Lynn Coon
               Location: Pacific University College of Optometry, Forest Grove, Oregon
               Date: 1979

II. Description of Project

This project is designed to assess the use of stereoscopic photography as an instructional aid for the Elschnig Classification System of the disc types. Photographs will be taken through the dilated pupil of both eyes. In order to perform the above photography, a drug to dilate the pupil, and a drug to anesthetize the surface of the eye will be used. The health of the eye will be assessed by appropriate procedures prior to the instillation of the above drugs.

III. Description of Risks

Instillation of the drugs to be used may cause temporary mild irritation or stinging. Allergic reactions to local anesthetics used in this study are rare. Since the health of the eye is assessed prior to instillation of dilating drugs, risks of angle closure are minimal. Any cameras used in this project are designed for clinical use and as such, they provide no risks.

The effect of the anesthetic drugs will wear off after approximately half an hour. Rubbing of the eyes while they are numbed by the anesthetic is to be avoided, since it can cause damage to the cornea. Dilation of the pupils can last from 5 to 6 hours up to two or three days. Sunglasses should be worn while the pupils are dilated because lights will seem much brighter and may cause discomfort. Driving should be avoided immediately following dilation, and reading or other near tasks may be difficult for a period of several hours. If symptoms persist beyond the time limits given above or if any other symptoms appear please contact researchers of Dr. Steven Dipple at the College of Optometry immediately. If help is unavailable in the event of an extreme reaction, an immediate examination by an ophthalmologist or by a physician at a hospital is necessary.

IV. Description of Benefits

This study will serve to increase the basic understanding of the Elschnig Classification System and will provide information regarding potential of stereophotographs in the instruction of disc evaluation.
V. Alternatives Advantageous to Subjects
   none

VI. Offer to Answer Any Inquiries
   The experimenters will be happy to answer any questions that you may have at any time during the course of the study.

VII. Freedom to Withdraw
   You are free to withdraw your consent and to discontinue participation in this project or activity at any time without prejudice to you.

VIII. Subjects History:
   Have you or anyone in your family been diagnosed as having any eye disease?
   no
   yes If yes, please explain: ____________________________________________

   Have you ever had any adverse reactions to drugs or medications?
   no
   yes If yes, please explain: ____________________________________________

I have read and understood the above. I am 18 years of age or over.
Signed ____________________________ Date ____________