To Honor Former Faculty: Thomas Madden and Stanley Rafalko

Associated Phorias at Four Near Test Distances and Reading Eyestrain

Current Clinical Vision Science Articles of Interest
The optometry school at Indiana University has now been in existence for over 60 years. Because of that, most current faculty, staff, and students have probably never heard of many faculty members who made significant contributions to the school in its early years. To honor the memory of two of those early faculty members, this issue features excerpts from the IU Bloomington Faculty Council Memorial Resolutions for Thomas Madden and J. Stanley Rafalko. This issue also includes reviews of some notable papers from the clinical vision science literature and a research paper on associated phoria testing distance.

David A. Goss
Editor

ON THE COVER: Group photo in 1953 of the first Optometry entering class at Indiana University and members of the faculty

Correspondence and manuscripts submitted for publication should be sent to the Editor: David A. Goss, School of Optometry, Indiana University, Bloomington, IN 47405 USA (or dgoss@indiana.edu).
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Statement of Purpose: The Indiana Journal of Optometry is published by the Indiana University School of Optometry to provide members of the Indiana Optometric Association, Alumni of the Indiana University School of Optometry, and other interested persons with information on the research and clinical expertise at the Indiana University School of Optometry, and on new developments in optometry/vision care.

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THOMAS MICHAEL MADDEN
(1922-1977)
By Henry W Hofstetter, Merrill J. Allen and Rogers W. Reading

Thomas Michael Madden was born in Indianapolis on March 29, 1922. Shortly after graduating from Cathedral High School, he entered the U.S. Navy Construction Battalion in the Pacific theatre. In 1946 he matriculated at Purdue University and a year later transferred to Butler University to complete his pre-optometry requirements for admission to the Southern College of Optometry at Memphis, Tennessee, where he received the Doctor of Optometry degree in 1953.

He practiced optometry in Beech Grove, Indiana, until 1959--at which time he decided on a change of career and enrolled at Indiana University as a graduate student in Physiological Optics and as a recipient of the Continental Optical Company Fellowship. Awarded the Master of Science degree in 1961, he continued his graduate studies while working part-time as a Clinical Associate. During this period he assisted in the development and construction of several pieces of intricate and ingenious research equipment.

In 1963 he was appointed Assistant Professor of Optometry and given immediate assignment as Director of the Optometry Clinic, then located in Foley House at 744 East Third Street, and to teach the final year clinical courses. He developed the plans for the present clinic in the Optometry Building, constructed in 1967, and directed its operation until 1971. Subsequently he organized and--in his remaining years--taught the core courses of the newly-established Optometric Technician Instructional Program of the Division of General and Technical Studies. He also continued to monitor the financial detail of the rapidly expanded Optometry Clinic.

Tom, as it was so natural to call him, was undoubtedly one of the most fondly regarded persons in his wide circle of acquaintances, whether colleagues, students, patients, or neighbors. Totally unassuming, gentle, soft-spoken, and ever thoughtful--he dedicated himself to the service of others--with never a trace of bias for status, rank, creed, color, politics, or sex.

His service-oriented mission and a phenomenal memory for names made him the perennial Registrar for conventions and seminars of the Indiana Optometric Association. He not only knew virtually every one of the 600 Indiana optometrists personally, but he could easily identify most of the spouses and children also.

His other, similarly justified, services throughout his 14 years on the faculty included that of Chief Proctor for...
the National Board of Examiners in Optometry, Treasurer of the Indiana University Optometry Alumni Association, Manager of the Public School Vision Screening Program of the School of Optometry, and Optometry Liaison Officer to the Indiana State Agency for the Blind. For 7 years he was Editor of the quarterly Indiana Journal of Optometry, and for 6 years he was the chief I.U. delegate at the meetings of the Association of School and Colleges of Optometry. There was probably never a time during his professional and academic career when he was not serving on 2 or more committees at the campus, community, state, or national level.

In no sense a joiner, but rather with a genuine sense of duty, he maintained active membership in the Omega Epsilon Phi fraternity, the American Optometric Association, the Association of Optometric Editors, the American Academy of Optometry (fellow), and the American Association for the Advancement of Science (fellow). His honors included membership in Sigma Xi (scientific) and Beta Sigma Kappa (optometric) honorary societies.

While most of Tom's acquaintances will long remember him for his unfailing service to humanity, his utter fairness and sense of justice, his meticulous concern for orderliness, organization, and personal responsibility, and his creative designs of systems and procedures--those of us who worked with him daily in and year out will also recall again and again such things as his gentle--always victimless--wit, his fascination for ingenious and intricate mechanisms, his quiet hobby of collecting foreign postmarked envelopes, and--yes--his delight in repairing umbrellas, especially for friends. His most relaxing recreation was driving an automobile, undoubtedly the remaining trace of his earlier motorcycling interests. For example, on trips with colleagues to conferences even in another's car he never hesitated to solicit, however weekly, the privilege of driving--and he drove extremely well.

Dr. Madden, Tom, died on July 18, 1977 following a lingering illness, the terminal nature of which he was well aware, but which he faced so gracefully as to win the deepest admiration of simply everyone who attended or visited him. His survivors include his wife Mary Rita (nee Murphy), two daughters at home, Lisa Marie and Susan Mary, and two brothers, Richard C. and Harry E. Madden. Funeral services were held at the St. Charles Catholic Church and interment was in the Valhalla Memory Gardens.

J. STANLEY RAFALKO
(1905-1988)
By Gordon G. Heath

Joseph Stanley Rafalko was born December 6, 1905 in Scranton, Pennsylvania, and raised there. He received his A.B. degree in biology with high honors from Villanova College in Philadelphia in 1929. Special accreditation enabled him to immediately obtain a teaching permit, so he was able to teach part time in West Philadelphia high schools for the next two years while also completing his M.S. degree in zoology at the University of Pennsylvania. He accepted a faculty position at LaSalle College in Philadelphia where he served as Professor of Comparative Anatomy and Embryology from 1931 to 1943. He then gathered his courage and his meager savings and returned to graduate school at the University of Pennsylvania for three years in order to earn his Ph.D. degree. It was there that he met and married Margaret Miskell, a fellow graduate student in zoology.

After a one-year appointment as assistant professor of zoology at Syracuse University's "Triple Cities" branch in Endicott, New York, he accepted appointment as associate professor of zoology at Southern Illinois University in Carbondale from 1947 to 1950 where, in addition to his teaching, he also co-authored a textbook of general zoology. From there he went to Memphis, Tennessee, to become Chairman of the Department of Anatomy at the Southern College of Optometry.

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principles who willingly went out of his way to help others, he was never able to comprehend, much less condone, rudeness or cruelty to others. Segregation of public facilities in Memphis offended him and he often spoke out against these practices.

It was just at this time that Indiana University was initiating a new program in Optometry and seeking faculty to develop courses in the anatomy and physiology of the eye. The late Professor Richard Webb, then Chairman of the Department of Anatomy in the IU School of Medicine, learned of Professor Rafalko’s reputation as an outstanding teacher and at once proceeded to recruit him for this purpose. From 1953 until his retirement in 1976 his nearly total dedication was to his teaching. At various times during this period, he taught histology to both medical and dental students, histological techniques to medical technology students, and both histology and gross anatomy to optometry students. He published a few papers on cytological observations. With his heavy teaching loads he had little time for personal research; therefore he long ago had decided anyway to devote his career to teaching and advising his students, activities he thoroughly enjoyed and in which he excelled.

It was often said by his students that the notes for Dr. Rafalko's class contained all the information needed for the subject, for they were indeed meticulously detailed. It was also frequently supposed that the subject of anatomy, and hence his notes, did not change from year to year; but that simply was not true. He carefully studied the other courses in the optometry curriculum to be sure his courses remained relevant and met the needs of the students. The changes he introduced were usually small, but important, in keeping his teaching up to date.

Professor Rafalko's excellence as a teacher was demonstrated by the high ratings he received in student evaluations each year, by the high rankings consistently achieved by his students on National Boards and other professional examinations, and by the many dozens of unsolicited letters of gratitude and praise that he received from former students over the years.
Previously, at the Southern College of Optometry, he had received the L.A. Farmer Award for Distinguished Teaching, and at IU he was three times nominated jointly by the Division of Optometry and the Department of Anatomy and Physiology for the Frederic Bachman Lieber Award for Excellence in Teaching. On the first of these three occasions, he withdrew his own name from nomination because he was a member of the University Committee for Improvement of Teaching, which selected the winners.

Professor Rafalko retired from the teaching he loved in 1976, thereafter devoting himself to his many community interests. He was a permanent member of the board of directors of the Hoosier Hills Art Guild, of which he had served as president for two years. He was Deputy Grand Chancellor of the State of Indiana Domain of the Knights of the Order of Pythias, having earlier served the Bloomington Lodge as its Chancellor Commander. He served on the board of directors of the Bloomington Boys' Club and was a long-term member of Torch International, serving at various times in all the offices of the Bloomington chapter.

Stanley Rafalko, although not an optometrist, dedicated much of his career to the profession and was a Special Member of the American Optometric Association and a Fellow of the American Academy of Optometry, as well as holding honorary membership in the two leading optometric fraternities, Omega Delta and Omega Epsilon Phi. As a final gesture of gratitude and allegiance to the professional school he had come to regard as his true home base, he bequeathed his entire estate—a substantial sum accumulated through the years of frugal living after he and Margaret were divorced—to the IU Foundation for use by the IU School of Optometry in support of optometric education. Professor Rafalko died September 19, 1988. The J. Stanley Rafalko Memorial Trust Fund will serve as a perpetual reminder of the dedicated life and work of this good man who often proudly declared, "I live a life of service--service to my students."
INTRODUCTION

Associated phoria is the amount of prism required to reduce fixation disparity to zero.\(^1\) The presence of fixation disparity, and thus a non-zero value for associated phoria, is related to nearpoint vision symptoms.\(^2,3\)

Various instruments are available for the measurement of associated phorias at near, including the Saladin card, Mallett unit, Borish card, and Bernell lantern.\(^4,5\) Nearpoint associated phoria testing is typically conducted at 40 cm.\(^6\) Because fixation disparity varies as a function of viewing distance,\(^7\) we could ask whether other test distances for associated phorias would be as effective as 40 cm for distinguishing between symptomatic and asymptomatic individuals. Accordingly, we compared symptom questionnaire scores in subjects with zero associated phoria to those with non-zero associated phoria for each of four test distances (25, 33, 40, 50 cm).

METHODS

A total of 99 subjects, ages 20 to 30 years, all of whom were optometry students, participated in this study. Subjects had a best-corrected near visual acuity of 20/20 or better in both eyes and had no self-reported history of strabismus, amblyopia, suppression, extraocular muscle disorders, nerve palsies, or ocular disease. The study protocols were approved by the Institutional Review Board at Indiana University for Human Subjects. Written informed consent was obtained from all the subjects before enrollment in the study.

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ASSOCIATED PHORIAS AT FOUR NEAR TEST DISTANCES AND READING EYESTRAIN

MEREDITH ROGERS, O.D., AIMEE STASKAL-BRECHT, O.D., AND DAVID A. GOS, O.D., PH.D.

ABSTRACT

Background: Nearpoint visual fatigue is more likely to occur in patients with a fixation disparity at near. Near associated phorias are typically done with a test distance of 40 cm. This study was conducted to compare symptom levels in subjects with zero associated phoria to those with non-zero associated phoria at 40 cm and at three other near test distances.

Methods: Saladin card associated phorias were measured at four different near distances (25 cm, 33 cm, 40 cm, and 50 cm), and a ten question symptom survey was administered.

Results: The mean symptom scores showed statistically significant differences between those with zero associated phoria and those with non-zero associated phoria for testing at 33 and 40 cm, but not for testing at 25 or 50 cm.

Conclusion: For associated phoria testing with the Saladin card, 33 and 40 cm are more appropriate testing distances than 25 or 50 cm.

The subjects attended scheduled appointments on Mondays and Wednesdays during the hours of 1, 2, 4, and 6 pm. Prior to any testing procedures, subjects completed a Reading Eyestrain Symptom Questionnaire. Subjects responded never, infrequently, sometimes, fairly often, or always to each of the following ten questions:
1. Do your eyes feel tired when reading or doing close work?
2. Do your eyes feel uncomfortable when reading or doing close work?
3. Do you have headaches when reading or doing close work?
4. Do you feel sleepy when reading or doing close work?
5. Do you have double vision when reading or doing close work?
6. Do the words seem to move or jump when reading or doing close work?
7. Do your eyes ever hurt when reading or doing close work?
8. Do your eyes ever feel sore when reading or doing close work?
9. Do you feel a ‘pulling’ around your eyes when reading or doing close work?
10. Do you notice the words blurring or going in and out of focus when reading or doing close work?

Symptom scores were determined by adding points as follows for each of the 10 questions’ answers: never-0, infrequently-1, sometimes-2, fairly often-3, always-4. Potential scores could thus range from 0 to 40 points. This questionnaire, which is very similar to the...
Convergence Insufficiency Symptom Survey,8,9 was used in one previous publication.10

Each subject was instructed to place his or her head in a chin rest and forehead rest that was clamped to a table. Lateral dissociated phorias were taken using the modified Thorington test target on the Saladin Near Point card.11,12 Lateral associated phorias for each subject were measured using the Saladin Near Point Card. Subjects placed polarized glasses over their current spectacle correction. A Saladin card was placed on the subject’s eye level at a distance 50 cm from the forehead rest. Participants were asked if they noticed a misalignment of the vertical lines on the associated phoria circle while focusing on the central fusion lock dot on the Saladin card. If no misalignment was observed, zero associated phoria was recorded. If misalignment was reported, a horizontal prism bar was used over the subject’s right eye to measure his or her associated phoria. The minimum prism that resulted in alignment was recorded as the associated phoria. After testing at 50 cm, associated phorias were determined at 40 cm, 33 cm, 25 cm, in that order.

Mean symptom scores were calculated for subjects with zero and non-zero (base-in or base-out) associated phorias at each of the four test distances. Statistical significance of the difference between subjects with zero associated phoria and subjects with non-zero associated phoria in mean symptoms scores was tested using a one-tailed t-test. A p value of 0.05 was used to establish statistical significance.

RESULTS

Mean symptom scores are given in Table 1. The mean symptom score was 1.4 lower in those with zero associated phoria at 25 cm than in those with non-zero associated phoria at that distance, but that difference was not statistically significant by t-test (t=1.302, p=0.099). The difference between the two groups at 50 cm was only 1.0 and was also not significant (t=0.848, p=0.199). The symptom score differences between the two groups were 2.0 and 2.1 for 40 cm and 33 cm, respectively, with statistical significance of the differences for both distances (t=1.814, p=0.036 for 40 cm testing and t=1.864, p=0.033 for 33 cm testing).

Modified Thorington dissociated phorias at 40 cm were examined as a secondary analysis. The mean symptom scores were: for subjects with more than 6 prism diopters of exo, 8.5 (n=23, SD=6.6); for subjects with phorias in the range of ortho to 6 prism diopters exo, 7.1 (n=55, SD=4.8); for subjects with eso at 40 cm, 8.6 (n=21, SD=6.5). The difference between the three groups was not statistically significant by one-way ANOVA (F=0.773, p=0.464). Dissociated phoria at 40 cm showed a statistically significant Pearson coefficient of correlation with associated phoria at 40 cm (r=0.56, p<0.001). A scatterplot of dissociated phoria and associated phoria is shown in Figure 1.

DISCUSSION

The results of the present study are consistent with previous work showing that near fixation disparity measurements are affected by viewing distance.7,13 The results of this study are also consistent with studies showing that fixation disparity parameters are good

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<td>25 cm</td>
<td>7.0 (n=44, SD=5.1)</td>
<td>8.4 (n=55, SD=6.0)</td>
<td>0.099</td>
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<tr>
<td>33 cm</td>
<td>6.5 (n=39, SD=5.3)</td>
<td>8.6 (n=60, SD=5.8)</td>
<td>0.033</td>
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<tr>
<td>40 cm</td>
<td>6.5 (n=37, SD=5.1)</td>
<td>8.5 (n=62, SD=5.8)</td>
<td>0.036</td>
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<tr>
<td>50 cm</td>
<td>7.2 (n=41, SD=5.3)</td>
<td>8.2 (n=58, SD=5.8)</td>
<td>0.199</td>
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Table 1. Mean symptom scores in subjects with zero associated phoria and subjects with non-zero associated phoria with statistical significance of difference by t-test. (n=number of subjects; SD=standard deviation)

Figure 1. Scatterplot of associated phoria at 40 cm with dissociated phoria at 40 cm. Points representing multiple subjects have the number of subjects given just above each point.
discriminators between symptomatic and asymptomatic individuals. 2,3

The results suggest that 33 cm or 40 cm are better associated phoria testing distances than are 25 cm or 50 cm with the Saladin card. Further study might be advisable to determine whether this is also true with other associated phoria testing devices and whether similar results would be obtained with subjects less aware of testing procedures or the nature of asthenopic symptoms.

One limitation of this study realized in hindsight is that no inquiry was made of the subjects concerning usual reading distance. The better discrimination of the 40 cm and 33 cm testing distances may reflect the fact that these are typical distances for reading and near work. With that fact in mind, it may be noted that Carlson and Kurtz14 recommended that associated phoria be tested at either 40 cm or the patient’s customary nearpoint working distance.

CONCLUSION
For associated phoria testing with the Saladin card, 33 and 40 cm are more appropriate testing distances than 25 or 50 cm.

REFERENCES

Meredith Rogers and Aimee Staskal-Brecht were members of the Indiana University School of Optometry Class of 2011.

This study sought to find which binocular vision tests best distinguished between symptomatic subjects with large exophorias at near and asymptomatic subjects with normal phorias at distance and near. Subjects were recruited from among 18 to 35 year old patients at the Optometry Clinic of the University of Alicante in Spain. Subjects in both groups did not have strabismus by cover test and had distance and near visual acuity of at least 20/20, no ocular motility disorders, no vertical deviation, and no ocular disease.

The symptomatic high exo group (n=33) had moderate to severe symptoms on the Conlon symptom survey and more than 6 prism diopters exophoria at 40 cm by prism neutralized cover test. The asymptomatic group (n=33) had a low symptom level on the Conlon symptom survey.

The tests performed were: (1) monocular and binocular accommodative facility with +2/-2 D flippers, 40 cm test distance, and a target with suppression control, (2) MEM dynamic retinoscopy at 40 cm, (3) negative and positive relative accommodation (NRA and PRA) with 20/30 letters at 40 cm, (4) base-out fusional vergence range at 40 cm with Risley prism and a 20/30 letter target, (5) near point of convergence (NPC) break and recovery with 20/30 target, (6) vergence facility at 40 cm with 20/30 target using 3 Δ BI and 12 Δ BO loose prisms, (7) gradient AC/A ratio with -1.00 D lenses using cover test, (8) monocular push-up amplitude of accommodation, and (9) stereopsis with graded circles on the Randot SO-002 test.

Tests which showed a statistically significant difference between the two groups by Mann-Whitney U test were: monocular accommodative facility (p<0.001), binocular accommodative facility (p<0.001), MEM (p=0.002), NRA (p=0.02), NPC break (p<0.001), NPC recovery (p<0.001), and vergence facility (p<0.001). The mean base-out blur findings of 19.7 Δ (SD=6.1) in the normal group and 16.7 Δ (SD=6.5) in the high exo group were not significantly different (p=0.09), perhaps due to the test’s large variability. Base-out fusional vergence breaks, averaging 25.6 Δ (SD=7.1) in the normal group and 22.9 Δ (SD=8.4) in the high exo group, likewise did not show a significant difference between the two groups (p=0.10). Other tests not showing a significant difference between groups were gradient AC/A ratio (p=0.25), amplitude of accommodation (p=0.83), PRA (p=0.10), base-out recovery (p=0.90), and stereopsis (p=0.31).

The authors ranked the diagnostic accuracy of the tests which were significantly different between groups by the area under the receiver characteristic (ROC) curve. The ROC curve is a plot of sensitivity versus one minus specificity for various test cut-off values. The ranking of the tests was: NPC recovery, binocular accommodative facility, NPC break, monocular accommodative facility, vergence facility, MEM, and NRA.

By balancing sensitivity and specificity, the authors came up with the following cut-offs to best distinguish the symptomatic high exo group from the asymptomatic group: NPC recovery, at least 8.25 cm; binocular accommodative facility, 8.25 cycles per minute or less; NPC break, at least 5.35 cm; monocular accommodative facility, 8.25 cycles per minute or less; vergence facility, 14.75 cycles per minute or less; MEM, 0.63 D or less; and NRA, 2.38 D or less. The cut-off for MEM seems unusual because high values for MEM are considered abnormal, but their result may be explained by the fact that the study involved separating subjects with high exophoria from normal. The mean MEM findings in this study were 0.62 D (SD=0.23) in the normal group and 0.34 D (SD=0.37) in the high exo group. As a general rule, exophores tend to have lower lags and esophores tend to have higher lags than normals under binocular conditions.

The authors suggested that their study showed that the tests having the best diagnostic accuracy for symptomatic high exophoria at near are the near point of convergence and binocular accommodative facility. However, they did acknowledge that this study was “based on a limited number of subjects and should be confirmed in forthcoming studies.” (p. 8)

Noting that the modified Thorington dissociated phoria test is a highly repeatable test and that it has gained acceptance among clinicians, the authors of this study compared it to three other lateral dissociated phoria tests. All four tests were done in free space without a phoropter, using a 40 cm target distance. Subjects were 49 students, ages 18 to 26 years, at Manipal University in India. All subjects had distance visual acuity of at least 6/6 in each eye and they did not have ocular disease, strabismus as determined by cover test, or history of eye surgery.

The tests which were compared were the modified Thorington, Maddox rod, von Graefe, and alternating cover test. The Bernell Muscle Imbalance measure card for near was used for the modified Thorington test. On the Maddox rod test loose prisms were used to align the red streak with the white light. On the von Graefe test, the eyes were dissociated with a 6 Δ base-up prism while subjects viewed an N8 line on a nearpoint chart; alignment was achieved with horizontal loose prisms in one prism diopter steps. For the alternating cover test, subjects viewed a 6/9 letter on a nearpoint stick and prism neutralization was done using a prism bar with two prism diopter steps.

The authors determined the mean difference between the modified Thorington and each of the other three tests. They also calculated the standard deviations of the differences for each of the comparisons.

The modified Thorington averaged more exo than the Maddox rod and less exo than the von Graefe test and the cover test. The mean differences were: modified Thorington minus Maddox rod, -0.42 Δ (SD=1.49); modified Thorington minus von Graefe, +0.53 Δ (SD=1.88); modified Thorington minus cover test, +0.88 Δ (SD=1.86). Expressed as mean differences plus or minus the 95% limits of agreement (standard deviation of the differences X 1.96), the differences become, modified Thorington minus Maddox rod, -0.42 Δ +/- 2.92; modified Thorington minus von Graefe, +0.53 Δ +/-3.68; modified Thorington minus cover test, +0.88 Δ +/-3.64. Bland-Altman plots suggested that the magnitudes of the differences were not dependent on the magnitude of the averages of the two phorias being compared for any of the three comparisons.

The authors suggested that the modified Thorington might have had the best agreement with the Maddox rod because they use the same method of dissociation. Because of the relatively high limits of agreement, the authors concluded that “the Maddox rod, the von Graefe and the alternate cover tests cannot be interchanged with the modified Thorington test for near phoria measurements in free space.” (p. 642)

Cebrian JL, Antona B, Barrio A, Gonzalez E, Gutierrez A, Sanchez I. Repeatability of the modified Thorington card used to measure far heterophoria. Optometry and Vision Science 2014;91:786-792.

The authors of this study recognized that several studies have shown the modified Thorington test to be the most repeatable of commonly used dissociated phoria tests at near, but that it had not been studied as much for distance testing. Therefore they examined the repeatability of; and the agreement among, four dissociated phoria tests at distance. The four tests were prism neutralized cover test, Maddox rod, von Graefe, and modified Thorington.

Their subjects were first year students in the optics and optometry program at the Universidad Complutense de Madrid in Madrid, Spain. Subjects had visual acuity of at least 0.9 at distance and near in each eye; no history of eye disease, strabismus, nystagmus, amblyopia, or refractive surgery; no medication or disease that could affect accommodation, fusional vergence ranges, or ocular motility; and no accommodation or vergence anomalies from testing amplitude of accommodation, near point of convergence, 4 Δ base-out test, prism bar vergence ranges, and Randot near stereopsis test. The 94 subjects had an age range of 18 to 32 years.

The Bernell Muscle Imbalance Measure distance card was used for the modified Thorington test. For the cover test, a single row of 0.8 visual acuity letters was used as a target, and a prism bar was used to neutralize movement on the alternating cover test. On the von Graefe test, the fixation target was single column of 0.8 visual acuity letters. A 6 Δ base-up prism over one eye eliminated fusion and a prism bar was used to align the two images. For the Maddox rod test, subjects reported when the prism in a prism bar made the red line seen by one eye pass through the white spot of light seen by the other eye. At one testing session, two optometrists did each of the four tests. At a second testing session, averaging a week later, the same two optometrists again performed each of the four tests.

Interexaminer and intraexaminer coefficients of repeatability were calculated by finding the standard deviations of the differences between examiners and between sessions, respectively, and multiplying those standard deviations by 1.96. The coefficient of repeatability (COR) gives an estimate of the range of
differences within which repeat measurements would be expected to fall 95% of the time. Coefficients of agreement between pairs of tests were found by finding the standard deviations of the differences between pairs of tests and multiplying by 1.96. The coefficient of agreement (COA) provides an estimate of the range of differences that would be expected between two tests 95% of the time.

The mean phorias for both sessions by both optometrists were: cover test, 0.2 Δ exo (SD=1.3); von Graefe, 0.9 Δ exo (SD=1.9); Maddox rod, 0.3 Δ eso (SD=2.6); and modified Thorington, 0.4 Δ eso (SD=1.6). Although the mean differences between tests were all small, the differences were statistically significant for all comparisons except for Maddox rod with modified Thorington.

The lowest coefficient of agreement (COA) was for cover test with modified Thorington (COA = 2.2 Δ), followed by von Graefe with modified Thorington (COA = 2.5 Δ), cover test with von Graefe (COA = 2.9 Δ), Maddox rod with modified Thorington (COA = 3.0 Δ), von Graefe with Maddox rod (COA = 3.5 Δ), and lastly, cover test with Maddox rod (COA = 3.8 Δ).

The modified Thorington showed the best interexaminer repeatability (COR = 1.4 Δ), followed by cover test (COR = 1.7 Δ), and von Graefe (COR = 2.2 Δ), and with Maddox rod showing the worst interexaminer repeatability (COR = 3.5 Δ).

The cover test had the best intraexaminer repeatability (COR = 1.3 Δ). Next was the modified Thorington (COR = 1.5 Δ) and then the von Graefe (COR = 2.2 Δ). The Maddox rod had the poorest intraexaminer repeatability (COR = 4.0 Δ).

The authors suggested that the poor repeatability of the Maddox rod may be due to the poor control of accommodation associated with using a light for fixation. The authors recommended the modified Thorington because of its good repeatability and its good agreement with the cover test and because it is “quick, simple to perform” and “easy for patients to understand.” (p. 791)


The Saladin Near Point balance Card is a multipurpose test card with targets for several different nearpoint tests. The fixation disparity measurements obtained with the Saladin card have not been studied extensively. The Sheedy Disparometer was used for several fixation disparity studies, resulting in more established expected values. However, the Disparometer is no longer commercially available. This study was done to compare fixation disparity measurements obtained with the Disparometer and the Saladin card.

Serving as subjects were 43 optometry students at Illinois College of Optometry, ages 23 to 34 years. They had near visual acuity of at least 20/20 in each eye, no strabismus, no diplopia or eyestrain from near work lasting for at least an hour, and no use of medications that could affect accommodation.

Testing with Saladin card and Disparometer was done by different examiners at different stations. Both devices were 40 cm from the subjects during testing. Fixation disparity was determined with no prism and then with loose prisms with the following powers: 3 Δ BI, 3 Δ BO, 6 Δ BI, 6 Δ BO, 9 Δ BI, 9 Δ BO, 16 Δ BO, and 20 Δ BO, in that order.

There was no difference in the distribution of fixation disparity curve types in the two instruments by the Mann-Whitney rank sum test. Type I curves were found in 86% of the subjects with the Saladin card and 88% of the subjects with the Disparometer. Type II curves were found in 12% of subjects with the Saladin card and 9% of subjects with the Disparometer.

The median fixation disparity with no prism (y-intercept on the fixation disparity curve) was 2.0 minutes of arc eso fixation disparity with the Disparometer and 1.0 minutes of arc exo with the Saladin card. Fixation disparity with no prism was significantly different in the two instruments by Wilcoxon signed rank test (p<0.0001). Fixation disparity was significantly more eso on the Disparometer with 3 Δ BI, 6 Δ BI, and 9 Δ BI. There was a trend toward less exo on the Disparometer with 3 Δ BO. The authors suggested that the absence of significant differences between the two devices for base-out prism may have been due to greater variability found with base-out prism compared to base-in prism.

The median fixation disparity curve slopes between 3 Δ BI and 3 Δ BO were -1.1 minutes of arc per prism diopter for the Disparometer and -0.7 minutes of arc per prism diopter for the Saladin card. Slopes with the two instruments were significantly different by Wilcoxon signed rank test (p=0.048).

The authors concluded that they “do not believe that norms developed for the Disparometer can be applied directly to the Saladin card. We do believe that the
Saladin card is a useful clinical instrument, but further study is needed to establish appropriate norms for interpretation of its findings.” (p. 740)


This study compared visual fatigue from 3D movie viewing using a polaroid system and a liquid crystal shutter system. The 30 subjects were 20 to 30 years of age and had no more than 3 D of myopia, less than 1 D of anisometropia, stereopsis of at least 60 seconds of arc, and no strabismus.

On one morning subjects watched a 3D movie for 20 minutes with polaroid glasses and on another morning they watched the same 3D movie for 20 minutes with liquid crystal shutter glasses. Half of the subjects used the polaroid glasses on the first day and half used the shutter glasses on the first day.

Before and after movie viewing study participants were interviewed concerning visual discomfort, including questions about dizziness or nausea, headache, blur, ghost images, eye pain, eye dryness, eye burning, eyestrain, and heavy eyelids. Subjects were also asked to rate their visual fatigue on a scale from 0 to 5. The following tests were performed before and after viewing the movie: monocular amplitude of accommodation, monocular and binocular accommodative facility, negative and positive relative accommodation, near point of convergence break and recovery, base-in and base-out fusional vergence breaks and recoveries at distance and near, and AC/A ratio.

The mean visual fatigue score was significantly greater (p=0.02) after viewing with the shutter glasses (1.7) than after viewing with polaroid glasses (1.2). The results on the separate visual discomfort questions were not significantly different between the two different modes of 3D viewing.

Several accommodation and vergence tests suggested more fatigue with the liquid crystal shutter system than with the polaroid system. There was a significantly greater reduction in amplitude of accommodation with the shutter glasses (right eye, p<0.001; left eye, p=0.01). The near point of convergence break receded more with the shutter glasses (p=0.007). The near point of convergence recovery did not change with polaroid glasses, but receded with shutter glasses. Binocular accommodative facility increased with polaroid glasses, but decreased with shutter glasses. Relative accommodation findings did not change significantly with polaroid glasses, but showed small but significant reductions with shutter glasses (NRA, p=0.008; PRA, p=0.007).

The authors noted that the results may have been limited by the fact that the movie was viewed for only 20 minutes. They concluded that the liquid crystal shutter system led to greater visual fatigue than the polaroid system, as shown by the subject’s subjective rating of fatigue as well as by the results of accommodation and vergence tests.


This study was conducted at an ophthalmology department in Korea to evaluate discomfort from 3D television viewing in persons with abnormal binocular vision compared to normal. Ninety-eight patients who were at least nine years of age and had strabismus, amblyopia, or anisometropia were recruited for the abnormal binocular vision group. Of these 98, 49 were classified in the strabismus subgroup as determined by cover test, 22 were in the amblyopia subgroup (visual acuity less than 16/20 or more than two lines difference between the eyes), and 27 were in the anisometropia subgroup (difference of more than 2 D between the spherical equivalents of the two eyes). Subjects were considered to be in the amblyopia subgroup whether they had strabismic amblyopia or anisometropic amblyopia. The abnormal binocular vision group was compared to a control group of 32 subjects. The phoria and accommodation status of members of the control group was not stated.

Stereoacuity with both the Frisby-Davis distance stereotest and the Stereo Optical Stereo Fly test was significantly better in the control group than in the abnormal binocular vision group (p<0.001).

Subjects viewed a 3D video on a high definition television for 20 minutes. A survey with 13 items, each of which was answered on a five category scale from 0 (no symptom) to 4 (extremely severe symptom) was completed by the subjects after viewing the video. The 13 symptom items were dizziness, headache, nausea, eye fatigue, eye pain, tearing, eye dryness, blurred vision, difficulty in focusing, double vision, transient dimness after watching TV, lack of perception of
stereoscopic vision, and difficulty in tracking motion on the TV.

Symptom levels did not differ significantly between the abnormal binocular vision group and the control group on any of the 13 individual items. However, interesting results were found in additional analyses. Symptom levels differed between the three subgroups of those with abnormal binocular vision only for not perceiving stereoscopic vision, with the symptom level for lack of stereoscopic perception being greatest in subjects with amblyopia and the lowest symptom level in subjects in the anisometropia subgroup.

The authors divided subjects into those with good stereopsis (which they defined as stereoacuity of 60 arcsec of better on the Stereo Fly test) and those with moderate to poor stereopsis (defined as worse than 60 arcsec). Those with good stereopsis had significantly higher symptom levels for dizziness, headache, eye fatigue, and eye pain. The symptom level for not being able to perceive stereoscopic vision during 3D television viewing was greater for the moderate to poor stereopsis group.

The authors also compared symptoms in the subjects with abnormal binocular vision but good stereopsis to symptoms in the control subjects. Symptom levels were significantly higher in the abnormal binocular vision group for eye fatigue and nearly significantly greater for headache.

The authors suggested that their study showed that visual discomfort from viewing 3D television is more likely in persons with abnormal binocular vision but good stereopsis and that inability to observe stereo effects is related to abnormal binocular vision, such as in strabismus, amblyopia, or anisometropia. They did not evaluate the relation of 3D visual discomfort to other binocular vision characteristics, such as phorias, vergence ability, or accommodative characteristics.
The first 42 volumes (1970-2011) of the Optometric Historical Society’s publication Hindsight: Journal of Optometry History are now online. Over 2,500 pages of high-quality, OCR enhanced, searchable, digital documents are now freely accessible to researchers at IUScholarWorks (http://scholarworks.iu.edu/journals/index.php/hindsight/issue/archive). This was made possible by a joint effort of the Optometric Historical Society and IUScholarWorks. IUScholarWorks is a service of the Indiana University Libraries with additional technology support from Indiana University Information Technology Services.

Examples of the scholarship found in Hindsight include:

- Biographical sketches of influential figures such as John Eberhardt (1857-1927), who championed the term “optometrist” to unite those who identified themselves as “refracting opticians”, “sight-testers” or other related terms (volume 18, pages 43-44) and Frederic Woll (1874-1955), whose tours and reviews of optometry schools in the 1920s served to strengthen the standards of optometric education (volume 42, pages 63-66);
- Personal memoirs and reflections of educators, innovators, practitioners, advocates and leaders in the profession;
- Historical research on individuals, events and trends in vision care, the profession and legislation;
- Book reviews and historiographies.

OHS founder, Dr. Henry W Hofstetter, noted that studying optometry history can lead to an appreciation of its “centuries-long existence and emergence from a prestigious and sophisticated handicraft to its present academic stature, a truly proud history which includes many prominent and accomplished personalities.” (Hindsight, volume 27, pages 17-18).

Hindsight is a publication of the Optometric Historical Society (OHS). OHS was formed in 1969 through the efforts of Dr. Hofstetter, then outgoing president of the American Optometric Association (AOA), and Maria Dablemont, librarian and archivist for the AOA. Presidents of OHS have included six Deans of optometry schools, two AOA presidents, an editor of the Journal of the American Optometric Association, and other noted educators and practitioners. The current president of OHS is Dr. John F. Amos.

The first publication of OHS, the Newsletter of the Optometric Historical Society, appeared in January, 1970. OHS has produced a quarterly publication ever since. Starting with volume 23 (1992), the title of the publication became Hindsight: Newsletter of the Optometric Historical Society. Beginning with volume 38 (2007) and continuing to the present, it has been titled Hindsight: Journal of Optometry History.

The Optometric Historical Society has always had a strong IU and Indiana connection. Dr. Hofstetter, the first director of the IU’s optometry school, was editor of the OHS publication for most of the first 25 years. Taking over for Hofstetter at various intervals during that time or serving as co-editor were John R. Levene, an IU faculty member, and Douglas Penisten, an alumnus of the IU O.D. and Ph.D. programs. David Goss, a current IU faculty member, has been editor since 1995. Only four of the thirteen OHS presidents over its 43 year history have not either been an IU faculty member, IU alumnus, or Indiana practicing optometrist. IU faculty or alumni who have been OHS presidents include Hofstetter, Levene, Penisten, T. David Williams, Charles Haine, Walter W. Chase, and John F. Amos. Indiana practicing optometrists Jerry Abrams and James Leeds are among the former presidents of OHS.

In 2009, members of the Board of Directors of OHS and Optometry Cares – The AOA Foundation signed a Memorandum of Understanding that places OHS under the umbrella of Optometry Cares. The AOA Foundation is also in charge of the AOA Archives and Museum of Optometry (http://www.aoafoundation.org/archives-museum-of-optometry/).

New issues of Hindsight can be obtained in print form as they are published by joining the Optometric Historical Society. One year membership in the Optometric Historical Society and subscription to Hindsight is $25 for regular membership and $50 for patron membership. A lifetime membership is $250. Membership can be obtained by sending name and address and check made out to the Optometric Historical Society to Kirsten Hébert, Optometric Historical Society, Archives and Museum of Optometry, 243 N. Lindbergh Boulevard, St. Louis, MO 63141.