A TRIBUTE: Henry W Hofstetter (1914 - 2002)

FACULTY PROFILE: Steven A. Hitzeman, O.D

FEATURED ARTICLE: Visual Characteristics of Athletic Populations, by Steven A. Hitzeman

ORIGINAL RESEARCH: Heterophoria in a South African Primary School Population, by Solani David Mathebula

REVIEW OF ARTICLE OF INTEREST: More Evidence that Vision and Learning are Related, by David A. Goss and Bill B. Rainey
In This Issue

We open this issue with tributes to Henry Hofstetter and some reminiscences from a few of the very many people whose lives he influenced.

Profiled in this issue is Steve Hitzeman, who has been a member of the optometry faculty at Indiana University since 1976. He has particular expertise in sports vision and the screening of athletes. He writes about some of his work in vision screening of athletes.

Original research on heterophoria in school children in South Africa is presented in this issue by Solani David Mathebula, a faculty member at the University of the North in South Africa. And lastly we review two articles showing a relation between vision test results and learning.

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Henry W Hofstetter (1914 - 2002):
Tributes and Reminiscences

Editor's note: When Henry Hofstetter passed away on May 10, 2002, at Meadowood Retirement Community in Bloomington, Indiana, optometry lost one of its giants. Known locally primarily as the first Director of the Division of Optometry at Indiana University, Hofstetter had an extraordinary career in optometric teaching, administration, writing, and research. His mentorship, his work as an educator, his work in numerous organizations, his international optometry work, and his extensive correspondence greatly influenced the lives and careers of many people. We asked several people to write about their remembrances of such a remarkable person.

Remembrances of Henry Hofstetter
By William R. Baldwin, O.D., Ph.D.

Hank was my mentor. I have tried to emulate the candor, imperturbability, and pliancy that made him an able administrator. But his influence on my career goes deeper.

I had practiced one year in Beech Grove, Indiana (my wife Honey's home town) when Hank arrived in Bloomington and temporarily set up shop in Wylie Hall (in what must have been an abandoned broom closet). I was one of his early visitors. I had already discussed graduate study with Deans at other universities and decided that I could not leave a developing practice for the inevitable financial uncertainty. Hank, convinced by my commitment more than my credentials, contrived a plan whereby I could be a part-time student and part-time instructor, and also maintain the Beech Grove office. Soon after Tom Madden joined that practice (later he joined the IU faculty), Hank then cooperated in executing a scheme that allowed my family to move to Bloomington and continue this triple life for nine years in Bloomington.

Even before our family moved to Bloomington in 1954, Hank made certain that I and others shared in his encounters with international visitors. Because of his scholarship concerning optometry's past and its antecedents and his vision of what it might become worldwide, he responded to correspondents from all around the globe. Many found their way to Bloomington. Their visits had much to do with the remarkable evolution of optometry internationally and with my own involvement over the years.

One of Hank's great contributions was to help bring together practicing optometrists and their academic counterparts. As part of my academic apprenticeship I was sent to meetings of the Association of Schools and Colleges of Optometry beginning in 1954. It quickly became clear that most university-affiliated schools and private colleges of optometry did not view the profession through the same prism. Nor did optometrists in the American Optometric Association hierarchy look upon academicians as trustworthy consultants.

Hank's tutorship prepared me just once to exercise influence on his career. With Jane and Honey riding along, we drove to Louisville to an American Optometric Association regional seminar. I think that they were called "cracker barrel" conferences that year (1962). On the way home our wives had little chance to chat because Hank and I vied with each other to register disdain concerning both the program proposals and the presentation. Somewhere between Salem and Mitchell, I proposed that Hank should allow himself to be elected to the AOA Board of Trustees. He fell silent as did I in his pensive presence. Somewhere near Bedford, Hank announced he might decide to be a candidate; and in that eventuality I would devote myself to the successful outcome - as his campaign manager.

The trustee election at the 1963 annual meeting in Minneapolis was perhaps the closest in AOA history. At that time military optometrists cumulatively had one and one half votes, which they seldom recorded. They were persuaded to caucus and cast that precious vote and a half for Hank. It was his margin of victory.
Indiana optometry serves its public better because Hank guided the school through its fledgling years. U.S. optometry is more united and more respected because of his service. Optometry globally is better served and more widely dispersed because he inspired others to lead in that cause.

While pliant and empathetic, Hank was always in charge - except when Jane took over. Honey and I will not forget the congenial atmosphere Hank and Jane created and sustained throughout our happy years at IU.

*Bill Baldwin has had a distinguished career in administration, research, and teaching at Indiana University, Pacific University, New England College of Optometry and the University of Houston.*

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**Henry Hofstetter, O.D., Ph.D. - A Friend for all Seasons**
**By Neal J. Bailey, O.D., Ph.D.**

How fortunate I am to consider myself a family friend and close colleague of Henry Hofstetter's for nearly sixty years. His caring guidance influenced me both personally and professionally. He was the chairman of a one-man welcoming committee when I arrived at Ohio State University during the third week of August, 1944. I had driven down from Detroit to Columbus, Ohio, assuming that I was registered to begin optometric classes in the fall. The campus was not as large as it is today and I eventually found the optometry office tucked away on the second floor of the Physics Building.

Dr. Glenn Fry, who was Dean of the School, had encouraged me to pursue a career in optometry but I had not heard from him since I had applied for acceptance into the program. Henry Hofstetter was on the faculty and he knew more about Fry's sorting and filing habits than anyone. We searched diligently through many boxes of papers until we finally found the missing registration forms that I had sent weeks earlier. The three of us quickly walked across the Oval to the Administration Office and pleaded for immediate matriculation. Flanked by two professors, I was soon added to the list of 44 first year optometry students.

I was now enrolled but needed temporary housing until my wife and our new baby joined me. Once again, Hank had a solution. The Epsilon Psi Epsilon house had been rented to another fraternity during World War II. The war was ending and Hank knew that the house would be empty. Arrangements were made and I had ample space for my meagre possessions.

Already during my first day at Columbus, Hank had rescued me twice. Neither he nor I realized that he would become a regular benefactor during my education in Ohio. As a respected teacher, he had a unique ability to bring students to a higher level of understanding of complex material at a pace within their comprehension. As a life coach, I can remember him saying, "Life is full of problems. This one is yours to solve." He was compassionate and understanding but knew the value of self reliance.

Three years later I had won my license to practice optometry in Michigan and I had decided to attend the Michigan Optometric Convention in Detroit in the fall. At this meeting I met Jerry Garard, an optometrist from Escanaba in the Upper Peninsula of Michigan. Jerry had been the best man at Hank and Jane's wedding. He was looking for a partner in his practice and I was looking for a practice to join. Between Henry, Jerry, and myself, I was off to a promising start as the associate of one of Hank's best friends.

The practice flourished but in 1950 I decided (with Henry's help) that I should return to graduate school. Henry had received his Ph.D. in physiological optics in 1942 from O.S.U. My wife, Flo, our two daughters, and I left Michigan and headed back to Ohio to pursue a similar course. Unfortunately for me, in the meantime Dr. Hofstetter had accepted a position as Dean of the Los Angeles College of Optometry, which left me without a mentor. By the time I received my doctorate in 1954, Henry had moved to Bloomington and was busy building the Division of Optometry at Indiana University. During the time I was in graduate school at Ohio State University, Hank and I had frequently discussed a
potential position for me as the third member of his IU faculty. I was pleased to accept this appointment. Merrill Allen, O.D., Ph.D., and Ingeborg Schmidt, M.D., preceded me. Once again, Henry was at the helm guiding my professional life.

When we arrived in Bloomington in the summer of 1954, the Hofstetter family expected to be out of town for several weeks and graciously offered us their home while we looked for permanent housing. Our daughters, Nancy and Anita, were thrilled to be in Ann and Susan's beautifully decorated rooms during this transition.

Henry was at the helm guiding my professional life. When we arrived in Bloomington in the summer of 1954, the Hofstetter family expected to be out of town for several weeks and graciously offered us their home while we looked for permanent housing. Our daughters, Nancy and Anita, were thrilled to be in Ann and Susan's beautifully decorated rooms during this transition.

Hank and I decided during my first year at IU that our emphasis would be the contact lens area. We met with the IU Board of Trustees in 1955 to discuss a budget for a contact lens laboratory. A friend of mine in Chicago was dismantling his commercial contact lens lab and offered it to us for only $2500. I rented a panel truck, drove to the Windy City, and IU became the home of the first optometric facility to teach the manufacturing of contact lenses.

Although the College of Arts and Sciences at IU offered a professional degree in optometry, Dr. Hofstetter's budget only allowed one full time 12-month faculty member in addition to himself, and Merrill Allen occupied that position. In spite of his numerous requests to the Board of Trustees on my behalf for a third full-time salary, no additional money was available. Every spring I was looking for three months of summer work to augment my income. After four years without a contract, I felt compelled to find a 12-month position.

A former student of mine had a busy private practice in Columbus, Ohio and offered me a very comfortable arrangement in which money would no longer be an issue. It was a difficult decision to leave the academic environment and my close working relationship with Hank Hofstetter.

At the end of each year, we looked forward to the cleverly written Hofstetter family Christmas letter, which always concluded with his humorous poetry. He was a prolific wordsmith whose wide range encompassed everything from textbook material to human interest stories. He sharpened his appreciation of the printed word with frequent games of Scrabble and always tried to find time for a crossword puzzle with his morning coffee.

How fortunate for all of us to have known such a self-disciplined leader as Henry Hofstetter. His solid standing at the university level made it easier for the establishment of graduate degrees. As the first recipient of a Ph.D. degree in physiological optics, he was a pioneer in helping to establish optometry as a true profession.

The last time I saw him was in Bloomington at the Hofstetter Symposium on International Optometry and Vision Care on April 27, 1999. The meeting was attended by eye care practitioners from all over the world in recognition of his remarkable contributions. He was given the first Distinguished Service Award from the World Council of Optometry, and it was a well deserved honor.

Neal Bailey, noted optometric practitioner and educator, is Editor Emeritus of The Contact Lens Spectrum.
A Reminiscence of Henry W Hofstetter
By Douglas K. Penisten, O.D., Ph.D.

I have had ambivalent feelings about sitting down and writing a reminiscence of Henry Hofstetter. It saddens me because I miss him dearly. It's also a weighty challenge because I experienced and benefited so much by knowing him that I am fearful my few words won't do him justice.

I first met Henry Hofstetter in 1975 as a first year optometry student at Indiana University. We hit it off immediately. I had a keen interest in history and he definitely had a keen interest in those who liked history. His unassuming presence and his contemplative, deliberate speech made me feel comfortable. He encouraged me to pursue my historical interests, and as a first year optometry student, he directed me to one of his most cherished legacies, the Optometric Historical Society.

Over the twenty seven years I knew him, Henry served in many roles to me. He was a teacher, leader, research advisor, personal counselor, confidant, professional colleague, travel mate, and friend. With such a diverse collection of relationships which evolved over those many years, there was only one issue that I recall was ever a problem. Actually, the problem was mine. I always stumbled in how to address him. For Henry it was straightforward. After graduation one day I brought up the topic and he said, "Just call me Hank." Perhaps it was our age difference and that being informal conflicted with how I was raised, but saying "Hank" to a person I respected and revered so much was plain awkward for me. He realized this and continued to find it a point of amusement over the years. My solution was simple. In public I addressed him as Dr. Hofstetter and in private I didn't call him anything!

As I look back, I am astounded at the extent of the influence Henry Hofstetter has had on my career and life. On so many critical occasions he directed and advised me on paths that I eventually took. He was a very influential role model. I can attribute much of my interest in starting and completing the Ph.D. in Vision Science and Physiological Optics from him (what a surprise, my minor was in the History of Science.) It was Henry who steered me towards South Africa when I told him in 1980 that I wanted to leave the books for a while to teach and practice optometry overseas. "For a while" ended up being four years that changed my life. That experience opened many of the doors to my continued involvement in international optometry and with various professional organizations.

One can not talk about Henry without talking about Jane. They were a remarkable couple and I treasure my memories of being with them. They were always so gracious and we shared a great fondness for humor and the enjoyment of laughing. During my stay in South Africa I met my wife Alphie and in 1984 she came to Bloomington where we were married. It was an enormous leap for her to come to America and the Hofstetters were sensitive to this. They went out of their way to welcome her and to make her feel comfortable as she learned English and American cultural quirks. Alphie still laughs to tears when she recalls Jane inviting her to attend her first IU basketball game. Having never experienced such a spectacle, Alphie was totally dumbfounded when Jane suddenly transformed into a rabid fan yelling and whooping at a referee's call. They indeed had fun together.

When I think of Henry Hofstetter I am drawn to Robert Louis Stevenson's line, "Don't judge each day by the harvest you reap, but by the seeds you plant." Henry was one of those rare persons who was known by many people and truly admired by many people.

Doug Penisten is a native of Columbus, Indiana, and is currently Associate Dean and Professor of Optometry at the Northeastern State University College of Optometry in Tahlequah, Oklahoma.

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Henry Hofstetter - A Giant in International Optometry
By George C. Woo, O.D., Ph.D.

We are very much indebted to Professor Henry Hofstetter for having a deep interest in international optometry. As Director of the then Division of Optometry at Indiana University and a past president of the
American Optometric Association, he was instrumental in advising and counseling a fledgling profession in Hong Kong and elsewhere in Asia. Taking the Hong Kong Optometric Association under his wing, he helped to instill in us the principles of professional education and training. With great sensitivity, he emphasized that in order for the profession of optometry to advance there are two major steps: education and legislation. He was a familiar figure in this part of the world in the seventies and the early eighties. He not only lectured to us on optometric education and practice but also on many issues of concern to opticians, optometrists, and ophthalmologists.

A rudimentary program in Optometry began in 1978 in Hong Kong Polytechnic (now the Hong Kong Polytechnic University) thanks in part to his advice and encouragement. The profession continued to persevere and in 1996 legislation for licensure of optometrists was promulgated. Our program in Optometry has definitely been advancing at a steady pace. It has indeed emerged as the best Optometry program in Asia in recent years.

As a graduate student of Professor Hofstetter at Indiana University in the sixties, I not only acquired my research skills from him, but also learned to be patient, meticulous, open minded and tolerant. He taught me also that the advancement of the profession requires the continuing nourishment of research. In 1993, our family invited Professor Hofstetter to deliver the inaugural K.B. Woo Memorial Lecture at the 9th Asia Pacific Optometric Congress. It was fitting as K.B., my father and Henry shared the same vision for the development of quality eye care in Hong Kong and beyond. On behalf of the Woos, I thank Professor Hofstetter for impacting three generations of our family in the eye care professions. He was indeed one of the giants in international optometry.

George Woo served on the optometry faculty at the University of Waterloo for many years and is currently the Dean of the Faculty of Health and Social Sciences at The Hong Kong Polytechnic University.

Thank You, Dr. Hofstetter
By Edwin C. Marshall, O.D., M.S., M.P.H.

Professor Henry Hofstetter was one of the first persons I encountered in 1968 during my entry into what was then the Division of Optometry. Hank was the Director and I was a student about to embark upon a career that I knew little about. I feel very fortunate that Hank gradually assumed the role of personal mentor and helped to instill in me a sense of community and commitment to my newly chosen profession.

Service and dedication to the profession and the academy were landmarks of Hank's career. As a young faculty member, I was impressed by the fact that a member of our relatively small faculty could rise to become President of the American Optometric Association and be recognized as the spokesperson for U.S. optometry. His presence and stature as optometric ambassador to the world was without precedence. The ability to juggle a busy faculty appointment with the demands of association presidency and foreign consultancies was more than I could fathom in my young career as a clinic instructor.

Throughout the years I had the occasion and opportunity to consult with Hank on numerous issues, including the path that my career ultimately would take in response to his guidance (and sometimes insistence). I recall one day Hank called me to his office and asked if I wanted to go to India to teach a six-week course for Indian optometrists. Although initially flattered by the offer, I was overtaken by the
concern that, except for brief vacation visits to the Bahamas and Jamaica, this would be my first real international trip - for six weeks. I also was concerned that it would occur over the Christmas holiday and that I would spend Christmas and New Year's Day in an unfamiliar country somewhere many miles across the ocean and away from home, family, and friends. I remember Jane Hofstetter asking if that was what I really wanted to do, and if I was aware of what was at stake in such an undertaking. Not knowing what to expect, but challenged by the opportunity, I said yes. As it turned out, it was the beginning of a new and growing interest in international optometry.

Shortly after my trip to India and through Hank's continued support, I received an invitation to attend and speak at my first meeting of the International Optometric and Optical League (now the World Council of Optometry) in Dusseldorf, Germany, where I met many new friends and colleagues from a variety of countries. Hank introduced me to people like Svein Hommerstad of Norway, Peter Gunkel of Germany, Per Soderberg of Sweden, David Pickwell of the U.K., Damien Smith of Australia, Fumio Morie of Japan, who founded the Kikuchi College of Optometry, and Claro Cinco, the founder of the Cebu Doctors' College of Optometry in the Philippines. My collegial relationship with each of these individuals grew and many became cherished friends who, with Hank's prodding, helped extend my association with Hank in the development of optometry internationally.

In a note from Hank's daughters, Ann and Susan, the question was posed as to whether that trip to India, clarifying as it was, could have been the springboard to other professional successes. I can only respond with a resounding "most definitely." I can think of many other situations, as well, where Hank opened doors to new personal vistas, such as encouraging my research relationship with the Inter American University of Puerto Rico School of Optometry, facilitating my appointment to the Cebu Doctors' College of Optometry, and preceding me and paving the way for my position on the Board of Directors of the Bloomington, Indiana Hospital.

Over the years my relationship with Hank and Jane grew both professionally and personally. I remember faculty parties at their house where Hank offered up his famous "red punch." I remember Hank comfortably telling jokes to an international audience at a dinner party in Tokyo. And, I remember Hank executing the duties of elder statesman of organized optometry in both this country and abroad.

I am lucky to have had the experience and inspiration of Hank the educator, Hank the mentor, and, most importantly, Hank the friend. As Svein Hommerstad commented to me in a recent letter, "It is loss for international optometry, but we should however be thankful for all the years he and Jane have used for the benefit of international optometry."

Thanks, Hank.

Ed Marshall is Professor of Optometry and Associate Dean of Academic Affairs in the IU School of Optometry and Adjunct Professor of Public Health in the IU School of Medicine.

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Henry Hofstetter - A Short Biographical Sketch

By David A. Goss, O.D., Ph.D.

Henry Hofstetter was born in Windsor Hills, Ohio, on September 10, 1914, the eighth of eleven children of a Swiss father and a German mother. He was raised on his parents' farm near Huntsburg in northeastern Ohio. Growing up in such a large family may have been a factor in the development of his remarkable organizational skills. He later recalled that "neatness, tidiness, orderliness were paramount at all times in our home. There was one hammer in the house used by thirteen people, but it was always put back in its place and easily found when needed."1
With the help of an older sister, Frieda Shute, Hofstetter attended Western Reserve University for two years and Kent State University for a summer to obtain a teacher's certificate. He then taught all eight grades and handled the janitorial duties in a one-room country schoolhouse in Middlefield, Ohio for three years. During that time, Hofstetter lived with his sister Frieda and her husband, a jeweller who also fitted spectacles and who encouraged Hofstetter to pursue a career in optometry. Hofstetter received the B.S. degree in optometry, at that time a terminal professional degree, from The Ohio State University in 1939. He stayed at Ohio State to receive the M.S. and Ph.D. degrees in physiological optics in 1940 and 1942. His Ph.D. degree was the first one to be granted by a graduate program in physiological optics offered by an optometry school.\(^2\) At Ohio State, Hofstetter met Frances Jane Elder, whom he married in 1941.

For his dissertation research, Hofstetter performed a haploscopic investigation of accommodation and convergence relationships with the guidance of Glenn Fry.\(^3,4\) Their studies were important in advancing the knowledge of clinical applications of the relationship of accommodation and convergence. After graduate school, Hofstetter joined the Ohio State optometry faculty. Because of the crippling of his left hand by polio at the age of sixteen, he was classified 4F by the draft board. With the depletion of the Ohio State faculty and decrease in student enrollments during World War II, Hofstetter taught most of the courses in the optometry curriculum, a factor which may explain, in part, the broad range of his later publications.

From January, 1949 to July, 1952, Hofstetter was Dean of the Los Angeles College of Optometry, now known as the Southern California College of Optometry.\(^5\) In 1952, Indiana University Dean of Faculties Herman Briscoe convinced Hofstetter to become the first Director of the Division of Optometry. Indiana optometrists and the IU administration wanted a person with strong academic credentials to head the program, and Hofstetter was an obvious choice.\(^6\) In his first year on the job, Hofstetter recruited faculty members, ordered equipment, and designed a curriculum for the first optometry students who would be entering in the fall of 1953. His educational experiences and philosophies led him to draw up a curriculum with a broad base in physiological optics, visual function, and related topics, rather than simply an applied study. He often noted that optometrists were well educated in several scientific areas.

Hofstetter served as Director of the IU Division of Optometry until 1970. During these years, he saw the development of the graduate program in physiological optics, the construction of the building that the School of Optometry now occupies, the addition of an optometry branch library, and the recruitment of a very able faculty. Hofstetter continued service on the optometry faculty until his formal retirement in 1980. He was made Rudy Professor of Optometry in 1974. Hofstetter was the major advisor for 15 M.S. students and 11 Ph.D. students in physiological optics at IU, spanning thirty years from the beginning of the graduate program to 1985.\(^2\) His clear thinking, emphasis on the use of graphs to show data trends, patient encouragement, gentle guidance, and fatherly advice has aided those graduate students and many others.

Hofstetter was a prodigious writer, authoring four textbooks and over 500 papers. Probably his most notable book was \textit{Optometry: Professional, Legal, and Economic Aspects}, published in 1948 and reprinted in 1964. According to Gordon Heath, this book made his name "a household word in the profession."\(^6\) His book \textit{Industrial Vision} was published in 1956. He was a co-editor of five editions of the Dictionary of Visual Science. Its fifth edition, with a title change to \textit{Dictionary of Visual Science and Related Clinical Terms}, was published in 2000. His professional publications span a remarkable breadth of topics, including for example, accommodation, binocular vision, color vision, international optometry, occupational vision, optometric education, orthoptics, presbyopia, refractive errors, strabismus, and visual acuity.

One of his passions was optometric history. He felt strongly that most optometrists did not have an appreciation of the greatness of their profession due to lack of knowledge of the profession's history. He
observed that study of optometric history shows "optometry's 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" and that such study demonstrates that optometry is "a discipline with as noble and pervasive a heritage as any." Hofstetter was one of the founders of the Optometric Historical Society, which he served as president for several years. He wrote extensively for the Newsletter of the Optometric Historical Society, and was one of its editors for over thirty years.

Hofstetter was a member of and/or presided over dozens of organizations and committees - community groups, university committees, scientific organizations, national and international optometric groups, etc. A listing of the committees and organizations he served takes almost nine single-spaced typewritten pages. In his service he often brought new organizational vigor or broke new ground. When he was elected president of the Association of Schools and Colleges of Optometry in 1953, it was a loosely organized group, but he appointed committees who were expected to produce useful reports. When he assumed presidency of the American Optometric Association in 1968, he was the first educator to take that office.

Hofstetter received numerous awards and recognitions. Some of them are five honorary doctorate degrees, the American Optometric Association Apollo Award, the American Academy of Optometry Prentice Award, The American Optometric Association Distinguished Service Award, International Optometrist of the Year from the International Optometric and Optical League, the Indiana Optometric Association Distinguished Service Award, the Armed Forces Optometric Society Orion Award, and induction into the Optometry Hall of Fame. In 1999, he received the first Distinguished Service Award from the World Council of Optometry (WCO). WCO president Manfred Müller stated, "Dr. Hofstetter has influenced every region of the world. He has promoted optometry in every forum: education, health care, industry, and politics. WCO salutes a leader who has changed the path of our profession and, in doing so, has forged a new, global frontier for optometry." But it is probably on the personal level that Dr. Hofstetter is most revered. Like numerous others, I have fond memories of him. He was a teacher, mentor, advisor, role model, friend. He has left a legacy that will endure for many years.

References

David Goss is Professor of Optometry at IU and Editor of the Indiana Journal of Optometry.
When Dr. Steve Hitzeman, as an undergraduate student in biology at IU, expressed to his advisor his interest in the health care professions, the advisor suggested that one of the professions that he should consider was optometry. To look into optometry, Steve visited his home town optometrist, Dr. Milton Brackmann of Fort Wayne, Indiana. Brackmann, a graduate of IU's charter optometry class, told Steve that optometry was a great profession and that he had received an excellent education at IU. Taking to heart Brackmann's recommendation to study optometry at IU, Steve started on the road to his new profession in the fall of 1972 after receiving his B.A. in biology from IU.

After completing his O.D. degree in 1976, Steve joined the IU optometry faculty as a Visiting Lecturer and Clinic Consultant. The next year he took over as the Director of the IU School of Optometry's Community Eye Care Center (CECC) on the west side of Bloomington. He was charged with developing the clinic from its start as two modest exam lanes in a garage and very few patients. Twenty-five years later, CECC is undergoing its third expansion, which will provide 17 examination rooms plus special test rooms, offices, and a conference room. The clinics at CECC are very busy, with Primary Care, Low Vision, Ocular Disease, and Binocular Vision/Pediatrics services available. Steve served as Director of CECC until 1995, when he took over as Director of Clinics for all of the IU School of Optometry clinics.

When one peruses Steve Hitzeman's curriculum vitae, one is struck by his very extensive service to the School of Optometry, to the optometric profession, and to the Bloomington community. In addition to serving as the School as Director of Clinics, he is also Director of External Clinics, Director of Residencies, and Director of Rural Health and Community Based Clinics. He also is a member of numerous committees. Since 1990, he has been on the Board of Directors of the American Optometric Association (AOA) Sports Vision Section, serving terms as Secretary (1993-95), Vice Chair (1995-97), Chair Elect (1997-99), and Chair (2000-2002). He has chaired the AOA Sports Vision Section Research Committee since 1988. He is a member of the AOA Congress Committee and also of the AOA Continuing Education Committee. He is a Trustee of the Indiana Optometric Association.

Steve has been Director of the IU School of Optometry sports vision program since 1985. He annually screens Indiana University athletes and lectures to IU athletic trainers. He has lectured on sports vision in numerous continuing education programs, including the American Optometric Association, American Academy of Optometry, and Southeastern Council of Optometry. He has provided sports vision training to athletes at all levels from children's teams to professionals and for many sports ranging from football to golf to race car driving. In 1994, he founded the AOA Sports Vision Section Junior Olympics Screening Team and currently is its Co-Chair. He has involved optometry students from IU and several other schools in Junior Olympics screening programs. He has done many other sports vision screenings, including screenings at local high schools, at the 1991 and 1995 International Special Olympics, and at the 1996 Olympics in Atlanta.

These are just a few of Steve's service activities, which have been acknowledged by several awards, including the Annual Foley House Award for dedicated service to the development of the School of Optometry (1995) and the Indiana Optometrist of the Year award from the Indiana Optometric Association (2000). Away from work, Steve can be seen recording statistics at IU basketball and football games and sometimes getting in some golf and jogging.
The growth of sports as well as the number of individuals participating in organized athletic competition and recreational sports activities has been phenomenal over the last 10 years. You can't go anywhere, listen to the radio, or watch television without being bombarded with athletes, sporting events, or advertisements for recreational products or performance enhancers. The growth of sports vision and the development of the specialty of sports vision has mirrored this sports explosion. Yet many optometrists do not understand the sports vision needs of their patients and the opportunities for practice growth that sports and recreational vision care can provide.

Studies have shown that visual attributes of athletic populations mirror the visual attributes of the general populations in many ways, these attributes being visual acuity, reported visual symptoms, refraction, and eye disease. In addition, the role of visual skills as a necessary component of athletic success has been debated among eye care professionals for years. It has been commonly professed that superior athletes have superior visual systems. A review of the literature indicates contradictory results with regard to the research comparing athletic to non-athletic visual systems, with some researchers indicating superior visual attributes in the athletic population as compared to the general population and others demonstrating no differences. To this point there is no scientific evidence that the visual profile of the athletic population is different from the general population.

It is commonly thought that sports vision screenings are directed toward determining if visual performance attributes such as eye movement speed and accuracy, stereopsis, contrast sensitivity, speed of recognition, color vision, and eye hand coordination, are associated with superior athletic performance. But the majority of sports vision screenings are geared to assess the need for basic eye care services by evaluating visual acuity, refractive error, binocular status, and internal and external ocular health. I have been involved in sports vision screening at various venues for over 15 years. I have coordinated and participated in visual evaluations at the Olympic Games, the USA Olympic Festivals, the Pan Am Games, the AAU Junior Olympic Games and the Indiana University Athletic Department. These opportunities have demonstrated to me that there is a great need for vision care services as well as a general lack of education in the athletic population for the need of protective eyewear.

Evaluation results compiled from the AAU Junior Olympics and other screenings I performed along with Stephen Beckerman, of the Illinois College of Optometry, were compared to the reported prevalence of vision problems in the general population for age matched athletic populations. In that study we used standardized data collection forms and testing protocols from the American Optometric Association Sports Vision Section. A database of screening results from a variety of sports and competition levels was compiled and analyzed. In general, we found no clinically significant differences between the prevalence of vision problems in the athletic population as compared to those encountered in the general population.

The population used in our studies consisted of hundreds of athletes who participated in University Sports Vision Screening Programs or participated in the AAU Junior Olympic Games. These athletes were screened to assess their visual acuity, visual symptoms, refraction, and eye disease. Demographic information including the athlete's age, the primary competitive sport, gender, the highest level of competition, and last complete eye examination was obtained. Pertinent information was collected regarding personal medical history and medications. Each athlete was asked to report on visual symptoms and the type of visual correction used when they participated in their sport. Presenting refractive correction was classified in the following categories: contact lenses, ASTM F803 approved protective eyewear, standard spectacles, or no prescription.

Refractive status, including manifest refraction without correction for each eye, and refractive status through sports correction for each eye, was determined by the use of static retinoscopy.
or autorefration. Entering visual acuity with the athlete's current corrective prescription (if any) for sports for each eye, was measured with the use of a standard Snellen wall chart at a test distance of 20 feet.

Our population consisted of athletes aged 5 to 26 years and was fairly evenly divided between males and females. The percentages of athletes by sport are presented in order of largest to smallest number of participants (Table 1). Over twenty-two different sports were represented with basketball contributing the largest number of athletes. The ages of the participants in each sport varied with baseball and basketball participants being of high school and college age while the participants from the AAU Junior Olympics tended to be younger.

Table 1. Distribution of athletes by sport.

<table>
<thead>
<tr>
<th>Sport</th>
<th>Percent</th>
<th>Average Age (±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>31.1</td>
<td>16.9±2.0</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>12.4</td>
<td>9.9±3.0</td>
</tr>
<tr>
<td>Track</td>
<td>6.8</td>
<td>14.8±2.9</td>
</tr>
<tr>
<td>Football</td>
<td>6.8</td>
<td>18.7±1.5</td>
</tr>
<tr>
<td>Volleyball</td>
<td>6.6</td>
<td>20.2±4.3</td>
</tr>
<tr>
<td>Soccer</td>
<td>6.3</td>
<td>18.3±2.4</td>
</tr>
<tr>
<td>Swimming</td>
<td>5.0</td>
<td>15.9±3.6</td>
</tr>
<tr>
<td>Jump Aerobics</td>
<td>3.9</td>
<td>10.7±2.1</td>
</tr>
<tr>
<td>Tennis</td>
<td>3.7</td>
<td>17.5±3.2</td>
</tr>
<tr>
<td>Baseball</td>
<td>3.6</td>
<td>16.8±2.0</td>
</tr>
<tr>
<td>Softball</td>
<td>3.1</td>
<td>18.7±2.0</td>
</tr>
<tr>
<td>Wrestling</td>
<td>1.7</td>
<td>17.2±4.3</td>
</tr>
<tr>
<td>Golf</td>
<td>1.6</td>
<td>20.0±3.6</td>
</tr>
<tr>
<td>Karate</td>
<td>1.3</td>
<td>11.2±2.7</td>
</tr>
<tr>
<td>Field Hockey</td>
<td>1.1</td>
<td>15.8±1.1</td>
</tr>
<tr>
<td>Power Lifting</td>
<td>1.0</td>
<td>15.8±1.8</td>
</tr>
<tr>
<td>Surfing</td>
<td>1.0</td>
<td>13.0±4.9</td>
</tr>
<tr>
<td>Sailing</td>
<td>0.7</td>
<td>10.1±2.7</td>
</tr>
<tr>
<td>Rifle</td>
<td>0.6</td>
<td>19.7±2.0</td>
</tr>
<tr>
<td>Cheerleading</td>
<td>0.4</td>
<td>18.8±1.0</td>
</tr>
<tr>
<td>Waterpolo</td>
<td>0.4</td>
<td>13.0±2.4</td>
</tr>
<tr>
<td>Other</td>
<td>0.7</td>
<td>21.3±15.1</td>
</tr>
</tbody>
</table>

Table 2. Competition levels of athletes.

<table>
<thead>
<tr>
<th>Competition Level</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade School</td>
<td>12.6</td>
</tr>
<tr>
<td>Jr. High</td>
<td>12.5</td>
</tr>
<tr>
<td>High School</td>
<td>36.8</td>
</tr>
<tr>
<td>Jr. College</td>
<td>22.2</td>
</tr>
<tr>
<td>College NCAA Div. 2/3</td>
<td>3.7</td>
</tr>
<tr>
<td>College NCAA Div. 1</td>
<td>12.2</td>
</tr>
</tbody>
</table>

Table 3 indicates the responses to a questionnaire regarding the prevalence of visual symptoms or perceived difficulties in athletic performance. Thirty-one percent of the athletes tested presented with one or more symptoms. Difficulty seeing and headaches were the most common symptoms.

Table 3. Symptoms experienced by athletes.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty Seeing</td>
<td>12.2</td>
</tr>
<tr>
<td>Lack of Consistency of Play</td>
<td>1.7</td>
</tr>
<tr>
<td>Poor Depth Perception</td>
<td>1.8</td>
</tr>
<tr>
<td>Light Sensitivity</td>
<td>8.8</td>
</tr>
<tr>
<td>Blur after Nearpoint Task</td>
<td>5.3</td>
</tr>
<tr>
<td>Difficulty with Moving Object</td>
<td>1.6</td>
</tr>
<tr>
<td>Decreased Performance with Stress</td>
<td>3.0</td>
</tr>
<tr>
<td>Headaches</td>
<td>12.9</td>
</tr>
<tr>
<td>Easily Distracted from Target</td>
<td>2.8</td>
</tr>
</tbody>
</table>

The use of protective eyewear and other forms of vision correction are presented in Table 4. The use of ASTM approved protective eyewear constitutes less than one percent of the athletes evaluated. Eyewear that has passed the ASTM standards reflect the highest level of protection currently available. The use of standard spectacles during athletics constitutes an unsafe practice and places athletes at visual risk. Approximately 6% of this population wore standard spectacles for athletics.

Table 4. Refractive correction worn by athlete.

<table>
<thead>
<tr>
<th>Correction</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>79.0</td>
</tr>
<tr>
<td>ASTM F803 Prescription</td>
<td>0.4</td>
</tr>
<tr>
<td>Plano Shield</td>
<td>0.1</td>
</tr>
<tr>
<td>Standard Spectacle</td>
<td>5.7</td>
</tr>
<tr>
<td>Contact Lens</td>
<td>14.8</td>
</tr>
</tbody>
</table>

The percentage of athletes wearing contact lenses is close to the reported 19 percent of contact lens wearers under age 17 in the general population. Seventy-three percent of the contact lens wearing athletes demonstrated over one diopter of over refraction through their contacts based on our measurements. Thirty-nine percent had less than 20/20 vision. Table 5 shows the distribution of contact lens design worn by the athletic population. These data demonstrate that many athletic contact lens wearers are not receiving the optimum contact lens designs since a large percentage show residual correction.

Table 5. Contact lens design worn by athlete.

<table>
<thead>
<tr>
<th>Correction</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>79.0</td>
</tr>
<tr>
<td>Over refraction</td>
<td>39.0</td>
</tr>
<tr>
<td>Corrective refraction</td>
<td>61.0</td>
</tr>
<tr>
<td>Power of lens</td>
<td>75.0</td>
</tr>
<tr>
<td>Axis</td>
<td>45.0</td>
</tr>
<tr>
<td>Cylinder</td>
<td>25.0</td>
</tr>
<tr>
<td>Astigmatism</td>
<td>30.0</td>
</tr>
<tr>
<td>Over refractive</td>
<td>65.0</td>
</tr>
<tr>
<td>Center of curvature</td>
<td>40.0</td>
</tr>
<tr>
<td>Edge of curvature</td>
<td>55.0</td>
</tr>
<tr>
<td>Diameter of lens</td>
<td>20.0</td>
</tr>
<tr>
<td>Material of lens</td>
<td>15.0</td>
</tr>
<tr>
<td>Thickness of lens</td>
<td>45.0</td>
</tr>
</tbody>
</table>
Many athletes present to the screenings with no sports prescription and some with vision better than 20/25 still showed clinically significant overrefractions, as shown in Table 6.

### Table 5. Type of contact lens correction used.

<table>
<thead>
<tr>
<th>Contact Lens Type</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Sphere Daily</td>
<td>75.7</td>
</tr>
<tr>
<td>Soft Sphere Extended</td>
<td>12.1</td>
</tr>
<tr>
<td>Rigid Gas Perm</td>
<td>11.2.</td>
</tr>
<tr>
<td>Soft Toric</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Table 6. Sphere power in over-refractions.

The entering visual acuity with prescription for sports for the right eye is presented in Table 7. Twenty-eight percent of the population demonstrated less than 20/25 visual acuity.

### Table 6. Sphere power in over-refractions.

<table>
<thead>
<tr>
<th>Refractive Error</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10.00 / -2.00</td>
<td>3.2</td>
</tr>
<tr>
<td>-1.99 / -0.76</td>
<td>8.8</td>
</tr>
<tr>
<td>+0.75 / -0.75</td>
<td>77.5</td>
</tr>
<tr>
<td>+0.76 / +1.99</td>
<td>9.7</td>
</tr>
<tr>
<td>+2.00 / +10.00</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Table 7. Corrected visual acuity.

The results of our studies were consistent with other researchers when compared to existing literature regarding the prevalence of refractive error, ocular disease and binocular dysfunction in the general population with due consideration to the differing methods and populations for the incidence of myopia and hyperopia. Approximately 3% of this population had possible ocular pathology. This percentage is also comparable to that reported in the general population. But maybe of greatest concern is the incidence of uncorrected refractive errors and athletes wearing correction with less than acceptable acuities.

Unfortunately, the fallacy that athletes inherently have good vision prevents many from seeking necessary eye care. Over 25% of all athletes seen in my experience have never had a complete eye examination in an eye doctor’s office. An additional 14% were more than 3 years overdue for eye care. Contact lenses are the preferred method of correction for many athletes. The fact that a large percentage of the contact lens wearers had less than 20/20 vision with significant over refractions indicates a need for more precise visual corrections and perhaps the application of more sophisticated contact lens designs to optimize acuity for athletics.

Providing vision care services to the athletic population necessitates extra emphasis on issues such as the prevention of ocular injuries. The use of protective eye wear is a compelling issue, since athletes are generally subjected to "higher risk" situations that have the potential to lead to permanent ocular or visual harm. The percentages of athletes wearing appropriate protection, in my experience is very small, and there should be a concerted effort to increase the use of these products.

The results of epidemiological studies and my personal experience from 15 years of sports vision evaluations indicate that the athletic population has a significant need for basic eye care services. In addition, the quality of the vision corrections received by athletes is often not optimal. Many athletes are uncorrected or undercorrected and could benefit from proper visual correction and acuity. It only makes sense to conjecture that athletes who have superior visual skills and acuity would perform better than athletes with inferior visual skills. Sports Vision evaluations are necessary to ensure that problems within the visual system are not interfering with athletic performance. In the future, it will become evident that sports vision is an integral part of a multidisciplinary approach to helping athletes achieve their maximum potential. Whether or not one is athletically inclined, the ocular and visual health of the individual should be assessed routinely, to ensure that proper and efficient ocular and visual skills are maintained to the highest degree possible. With all the publicity on athletics today, sports-minded optometrists have the responsibility to educate patients on the need for these visual services, for the possible loss of athletic performance due to inadequate visual skills, and for the importance of protective eyewear. This is a great opportunity to advance the quality of the athletic performance of our patients as well as to enhance our practices.

### Reference

Abstract
The purpose of this study was to develop norms for heterophoria in primary school children of South Africa with normal binocular vision. Data on the norms for heterophoria are currently not available for this age group (6 to 13 years) in this country.

Nine hundred primary school children of both sexes aged 6 to 13 years with a mean of 10 (±1.6) years were included in the study. The red Maddox rod method and hand-held rotary prisms were used for the detection and measurement of horizontal and vertical heterophorias at far (6m) and near (33 cm). Units for heterophoria measurement were prism diopters (pd). Data were analyzed with a personal computer using statistical package for social sciences (SPSS).

The mean horizontal heterophoria at far was 0.2 (±1.17) pd exophoria. At near, the mean was 2.5 (±2.37) pd exophoria. The means of the vertical heterophorias at far and near were 0.01 (±0.22 and 0.24) pd right hyperphorias, respectively. The distribution curves of both horizontal and vertical heterophorias at far were leptokurtic. However, at near the vertical heterophoria was leptokurtic and horizontal heterophoria was platykurtic.

The findings of this study have great significance for clinicians and optometric education institutions.

Introduction
For human vision to be both clear and single, the eyes’ accommodation and the angle of convergence must both be related correctly to the distance between the observer and the object of regard. This relation is unique to each patient and can only tolerate minor variations of accommodation and/or convergence without the loss of clarity and/or fusion. When fusion is made impossible by some means, the angle of convergence is free to change and does so to a greater or lesser degree in the majority of people, and the eyes assume their physiological position of rest which was called accommodative convergence by Maddox and latter named heterophoria by Stevens. Heterophoria is a condition of ocular motor imbalance, which must be overcome so that the proper alignment of the eyes is maintained.

Clinically, heterophorias are symptomatically manifested as asthenopia (eye strain or eye stress), pain in the eyes, headache, blurred vision, diplopia, decreased stereopsis and poor reading performance. Although there are problems in estimating the presence and strength of such subjective symptoms, the results of an effective diagnostic test for a binocular ocuomotor insufficiency should correlate with them. Clinical measures of heterophorias are important when diagnosing and managing conditions such as convergence excess, convergence insufficiency, divergence excess, and divergence insufficiency.

A number of studies reported the means of horizontal heterophorias at far and near (see Table 1). The mean distance horizontal heterophoria varies around orthophoria, and the near ranged from 0 to 7 pd exophoria.

Figure 1. Histogram of horizontal heterophoria at far. A large proportion of points are between 2 pd esophoria and 4 pd exophoria.
Measurements of heterophorias are influenced by target variation, technique used for dissociation, degree of dissociation, duration of dissociation, level of illumination, accommodative stimulus, proximal effect and the method by which heterophoria is quantified.3,7 Altered levels of attention or interest or fatigue factors on the part of the subject or mistakes by the examiner will also affect heterophoria measurement.8

The purpose of this study was to develop normative data on heterophoria in a South African primary school population. Such data are currently not available for this age group.

Subject selection
The number of subjects examined was 900. Eighteen primary schools in the central region of the Limpopo Province of South Africa were randomly selected. Approximately 20% of the pupils from each school were examined. The University of the North Ethical Committee approved the study. Permission to conduct the study was granted by the Department of Education.

Methods
A cover test was first used to eliminate cases of heterotropia. All subjects were found to be free of ocular pathology, all had 6/6 or better in each eye and all exhibited minimum stereopsis of 100 seconds as measured with the Titmus circles.

Prior to heterophoria measurements all subjects were given preliminary eye examination. The measurements were habitual acuity, interpupillary distance, pupil evaluation, motility testing, confrontation and ophthalmoscopy.

Heterophorias were measured at 6m and 33cm with the red Maddox rod lens on the trial frame in front of the left eye. In order to measure the horizontal heterophoria the Maddox rod lens was aligned horizontally to produce a subjective appearance of a vertical red line. The vertical heterophoria was measured in the same manner having the red Maddox rod lens aligned vertically to produce a horizontal red line. Subjects were asked to report the position of the red line with regard to the white spot of light. Heterophoria was recorded as the amount of prism, using the hand-held rotary prism in front of the left eye, which achieved the alignment of the red line and the white spot of light. If alignment already existed, no prism was required because the subject was orthophoric.

Data were analyzed with a personal computer using the Statistical Package for Social Sciences (SPSS). Three measurements for each horizontal and vertical heterophoria at far and near were taken and the computer generated the means and graphs. Measurements were analyzed by assuming that orthophoria was the reference point.

Table 1: Mean and standard deviation of heterophorias from various studies. Positive values refer to esophorias and negative values refer to exophorias. Standard deviations are given in parentheses. Units are in prism diopters (pd).

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Age of subjects</th>
<th>Methods used</th>
<th>Distance phoria</th>
<th>Near phoria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morgan</td>
<td>1944</td>
<td>Pre-presbyopes</td>
<td>Maddox rod</td>
<td>-1 (2)</td>
<td>-3 (5)</td>
</tr>
<tr>
<td>Shepard</td>
<td>1941</td>
<td>1st grade to adults</td>
<td>von Graefe</td>
<td>-1 (2.5)</td>
<td>-5 (5)</td>
</tr>
<tr>
<td>Haine</td>
<td>1941</td>
<td>Pre-presbyopes</td>
<td>von Graefe</td>
<td>0 (1)</td>
<td>-5 (3)</td>
</tr>
<tr>
<td>Eames</td>
<td>1933</td>
<td>0 to 40 years</td>
<td>Maddox rod</td>
<td>-0.1 (0.1)</td>
<td>-0.2 (0.7)</td>
</tr>
<tr>
<td>Eames</td>
<td>1933</td>
<td>Above 40 years</td>
<td>Maddox rod</td>
<td>-1.5 (0.2)</td>
<td>-7 (0.5)</td>
</tr>
<tr>
<td>Scobee and Gree</td>
<td>1948</td>
<td>Mean age 33.7 years</td>
<td>Maddox rod</td>
<td>1.1 (2.90)</td>
<td>-3.1 (5.4)</td>
</tr>
<tr>
<td>Saladin and Shee</td>
<td>1978</td>
<td>3rd yr Optom students</td>
<td>von Graefe</td>
<td>-1 (3.5)</td>
<td>-0.5 (6)</td>
</tr>
<tr>
<td>Frier and Pickwel</td>
<td>1983</td>
<td>5 to 85 years</td>
<td>Mallett unit</td>
<td>0.3 (2.2)</td>
<td>-2.3 (4.7)</td>
</tr>
<tr>
<td>Betts and Austin</td>
<td>1940</td>
<td>10 to 14 years</td>
<td>von Graefe</td>
<td>0 (2)</td>
<td>-3 (2)</td>
</tr>
<tr>
<td>Jackson and Goss</td>
<td>1991</td>
<td>7 to 16 years</td>
<td>von Graefe</td>
<td>-1 (2)</td>
<td>-3 (4)</td>
</tr>
<tr>
<td>Letourneau and Giroux</td>
<td>1991</td>
<td>6 to 13 years</td>
<td>Maddox rod</td>
<td>0.57 (2.5)</td>
<td>-0.9 (4.5)</td>
</tr>
</tbody>
</table>

Table 2: Summary of the heterophoria measurements. Positive values refer to esophorias and right hyperphorias while negative values refer to exophorias and right hypophorias. Units are in prism diopters (pd).

<table>
<thead>
<tr>
<th>Heterophoria</th>
<th>Range (pd)</th>
<th>Mean (pd)</th>
<th>Std deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>-6 to 4</td>
<td>-0.2</td>
<td>1.17</td>
</tr>
<tr>
<td>Vertical</td>
<td>-1.8 to 2</td>
<td>0.01</td>
<td>0.22</td>
</tr>
<tr>
<td>Near</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>-11.7 to 6</td>
<td>-2.5</td>
<td>2.37</td>
</tr>
<tr>
<td>Vertical</td>
<td>-2 to 2</td>
<td>0.01</td>
<td>0.24</td>
</tr>
</tbody>
</table>
zero point. Esophorias and right hyperphorias were treated as positive numbers while esophorias and right hypophorias were treated as negative numbers.

Results
The number of subjects examined in this study was 900 and included 444 (49.3%) females and 456 (50.7%) males. The ages of the subjects ranged from 6 to 13 years, the mean being 10 years with a standard deviation of 1.6.

The horizontal heterophoria at far ranged from 4 pd esophoria to 6 pd exophoria. The mean was 0.2 (± 1.17) pd exophoria (see Figure 1). The horizontal heterophoria at near ranged from 6 pd esophoria to 11.7 pd exophoria. The mean was 2.5 (± 2.37) pd exophoria (see Figure 2). The range of the vertical heterophoria at far was from 1.8 pd right hypophoria to 2 pd right hyperphoria. The mean was 0.01 (± 0.22) pd right hyperphoria (see Figure 3). At near, the vertical heterophoria ranged from 2 pd right hypophoria to 2 pd right hyperphoria. The mean was 0.01 (± 0.24) pd right hyperphoria (see Figure 4). The standard deviations for the near heterophorias were greater than the standard deviations for the distance (see Figures 1 to 4 and Table 2).

The Kolmogorov-Smirnov goodness of fit test is commonly used for continuous variables. A one-tailed Kolmogorov-Smirnov goodness of fit test showed that the distributions of horizontal heterophoria at far and vertical heterophorias at far and near were leptokurtic, while the horizontal heterophoria at near was platykurtic.

Discussion
The clinical use of the Maddox rod method has been amply demonstrated by widespread clinical use. The Maddox rod lens method is the easiest and simplest method for investigating oculo-motor imbalance.

The mean distance horizontal heterophoria found in the present study is similar to the mean values from other studies (see Table 1). Letourneau and Giroux found a mean value of 0.57 (± 2.54) pd esophoria in a sample of 2035 children aged 6 to 13 years using the Maddox rod method. The distance horizontal heterophoria ranged from 10 pd esophoria to 10 pd exophoria. They reported a leptokurtic distribution. The subjects' age group and method they used are the same with the present study. It seems the Canadian children have a wider distribution of heterophoria and a higher tonic vergence than the South African children. Jackson and Goss examined 244 children ranging in age from 7.9 to 15.9 years. They measured heterophoria using the von Graefe method and found a mean of 1 (± 2) pd exophoria. The heterophoria ranged from 7 pd esophoria to 10 pd exophoria. The mean heterophoria found by Jackson and Goss is the same as the mean found by Morgan. The goodness of fit test shows that the horizontal heterophoria at far is leptokurtic. Apparently, previous studies yielded leptokurtic distribution curves of heterophoria at far among adults. The leptokurtosis of distance heterophoria is sometimes referred to as orthophorization. There is a wider distribution of near horizontal heterophoria than at far. This may be due to accommodation and proximal vergence that play
a role at near, while viewing distance objects requires nearly parallel visual axes of the eyes and little or no accommodation. The mean near horizontal heterophoria found in the present study is about the same as in work done by Morgan9, Scobee and Green13, Frier and Pickwell15, Betts and Austin16 and Jackson and Goss.17 The standard deviations show a high variability. Letourneau and Groux18 found a mean of 0.78 pd exophoria in a sample of 2029 children aged 6 to 13 using the Maddox rod method. The goodness of fit test shows that the distribution of horizontal heterophoria at near is platykurtic. Previous studies also found platykurtic distribution of horizontal heterophoria at near among adults. The basis of the platykurtic distribution of horizontal heterophoria at near is related to the greater standard deviation at near than that found at far.

Previously, there seems to have been little interest in the literature in vertical heterophorias. In this study, the goodness of fit test shows that the distribution curves of vertical heterophorias at far and near are leptokurtic. Letourneau and Groux18 examined 2029 children ranging in age from 6 to 13 years. They measured heterophoria using the Maddox rod method and found means of 0.07 (± 0.69) pd right hypophoria and 0.05 (± 0.68) pd right hypophoria at far and near, respectively. They reported leptokurtic distribution curves of vertical heterophoria at far and near. The leptokurtic distribution of vertical heterophoria at near may be due to the fact that the vertical vergence system is not directly influenced by the accommodative system and accommodative vergence.

Conclusion
A test is worthless unless there is some normal range with which to compare its results. The mean distance horizontal heterophoria, and vertical heterophorias at far and near show orthophoria. The mean near-point horizontal heterophoria is about 3 pd exophoria with a normal range (+/-1 SD) of zero to 5 pd of exophoria. The findings of this study provide normative values for heterophorias in primary school children for clinical interpretation.

Cases falling outside of either range are subject to question as being outside of the known normal range and must be analyzed in relation to all other findings to determine whether or not they are problematic for that particular individual considered.

References
11. Haines HF. Normal values of visual functions and their application in case analysis.
To many optometrists, it is surprising that anyone would doubt that vision could be related to reading performance and academic achievement. First of all, the sensory system through which most information enters the mind is the visual system. Secondly, the experience of many practitioners and available evidence have been sufficient to lead to the development of a position statement and a clinical practice guideline on the relationship of vision and learning. Thirdly, literature reviews and recent textbooks recite large bodies of literature showing a relationship of vision and learning. Nevertheless, there continue to be many reputable researchers and well-meaning practitioners that deny such a relationship. Therefore, new studies that continue to report a correlation of visual function and academic achievement should be noted. Here we review two such recent studies. Both of these studies were conducted at The Ohio State University College of Optometry.


One hundred fifty-five children were administered the Test of Visual Perceptual Skills (TVPS) visual memory subtest to assess visual memory, the Stanford Achievement Test to assess academic achievement, and the Otis-Lennon School Ability Test to assess verbal ability. The TVPS visual memory subtest is commonly used, norm-referenced, and motor-free. The children were from a suburban elementary school near Columbus, Ohio, and ranged in age from 7 years, 0 months to 11 years, 1 month. A vision screening by Modified Clinical Technique was performed to rule out potentially confounding vision problems such as uncorrected refractive errors. There was no statistically significant difference in visual memory scores between those passing and those failing the screening, so all children were included in the analysis.

Academic achievement was classified as below average vs. average/above average, with stanine scores of one to three on the Stanford Achievement Test coded as below average. Achievement areas used as dependent variables based on this test were reading decoding, reading comprehension, total math, and the complete battery. The TVPS visual memory result was expressed as a standard score in the statistical analysis. Odds ratios of having a below average achievement as a function of visual memory standard score were adjusted by age and verbal ability.

The adjusted odds ratios are shown in Table 1. Visual memory was predictive of below average reading decoding with an adjusted odds ratio of 0.816, which was statistically significant at the 0.027 level. This means that a one unit increase in visual memory standard score was associated with an 18.4% decrease in the odds of having a below average achievement level (1.000 - 0.816 = 0.184). Based on the odds ratios in Table 1, each unit increase in visual memory standard score would decrease the odds of below average achievement by 10.9% for reading comprehension, 15.4% for total math, and 21.1% for the complete battery. The statistical significance levels of the odds ratios are given in Table 1.

<table>
<thead>
<tr>
<th>Achievement area</th>
<th>N</th>
<th>Adjusted odds ratio</th>
<th>Stat. sig. (p)</th>
<th>95% confidence interval for odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading decoding</td>
<td>94</td>
<td>0.816</td>
<td>0.027</td>
<td>0.681 to 0.977</td>
</tr>
<tr>
<td>Reading comp</td>
<td>151</td>
<td>0.891</td>
<td>0.093</td>
<td>0.778 to 1.020</td>
</tr>
<tr>
<td>Total math</td>
<td>152</td>
<td>0.846</td>
<td>0.031</td>
<td>0.728 to 0.985</td>
</tr>
<tr>
<td>Complete battery</td>
<td>143</td>
<td>0.789</td>
<td>0.018</td>
<td>0.648 to 0.961</td>
</tr>
</tbody>
</table>

Table 1. Ability of visual memory to predict academic achievement expressed as an odds ratio adjusted for age and verbal ability.

The authors concluded that their study "shows that poor visual memory skill is significantly predictive of below-average performance in reading decoding, total math, and overall academic achievement, while controlling for age and verbal ability. This study suggests that an eye care professional should be part of the..."
multidisciplinary team of a child with academic difficulties to identify and address any untreated vision problems. Further research is needed to explore the effects of visual memory therapy on academic achievement.

This paper has some implications for the primary care optometrist. Although more research concerning the exact nature of the relationship between visual memory and learning is necessary, the results of this study suggest that a visual information processing screening battery may be helpful as part of the optometric evaluation of children, especially those who are experiencing academic difficulties. One component of this screening could be a probe of visual memory.


One hundred seventeen kindergarten to second grade children from a middle class, suburban elementary school were tested in this study. Their mean age was 7.3 years. The purpose of the study was to compare stereoacuity to school performance. Stereoacuity was chosen as a good overall measure of nearpoint visual function because it can be reduced by vision problems such as binocular vision disorders or uncorrected refractive errors. Stereoacuity was measured by the Randot 2 stereotest which was held at 40 cm.

Teachers rated the children in their classrooms in reading, mathematics, and writing on a scale of 1 to 5, with 1 being the highest performance level. Second grade children were also rated by teachers on spelling ability. The Stanford Diagnostic Reading Test was also used to assess reading ability in first graders.

The relationship of Randot stereoacuity and academic performance was examined by correlation analysis, using Spearman coefficients of correlation. The results are shown in Table 2. There are statistically significant correlations of each of the academic variables with stereoacuity.

The authors observed that: "stereoacuity has been found to be a measure of other visual functions and to be reduced in the presence of binocular vision difficulties. Therefore, while correlation does not prove causation, this relationship may or could be attributable to effects of visual difficulties on the efficiency of learning and/or performing academic tasks. It is conceivable that the symptoms (such as asthenopia, headache, blurred vision, intermittent diplopia, fatigue), which are frequently associated with vision anomalies, could result in decreased concentration, distractibility or avoidance behaviors that could decrease the efficiency and/or rapidity of performing academic tasks."

All of the children had stereoacuity of better than 100 seconds of arc, with the median being 25 to 30 seconds of arc. This may be better than many clinicians have considered normal in young children. This paper re-emphasizes the importance of nearpoint testing of children, including stereoacuity, especially in those children who are having problems in school. It would be interesting to explore the causes of reduced stereopsis found in this study. If there were underlying refractive, accommodative, and/or binocular vision anomalies that would account for the results, proper diagnosis of such conditions would help guide the optometric treatment of these patients.

References
4. Simons HD, Grisham JD. Binocular

In addition to the books and materials given above in the reference list, the following are some books and articles on vision and learning that may be of some interest:


The following are web sites with information on vision and learning for practitioners and/or patients and parents:

www.opt.indiana.edu/v782
www.visiontherapy.org
www.children-special-needs.org
www.covd.org
www.pave-eye.com/vision
www.seetolearn.com
www.oep.org
www.visionandlearning.org