The Journal of the Association of Schools and Colleges of Optometry

OPTOMETRIC EDUCATION

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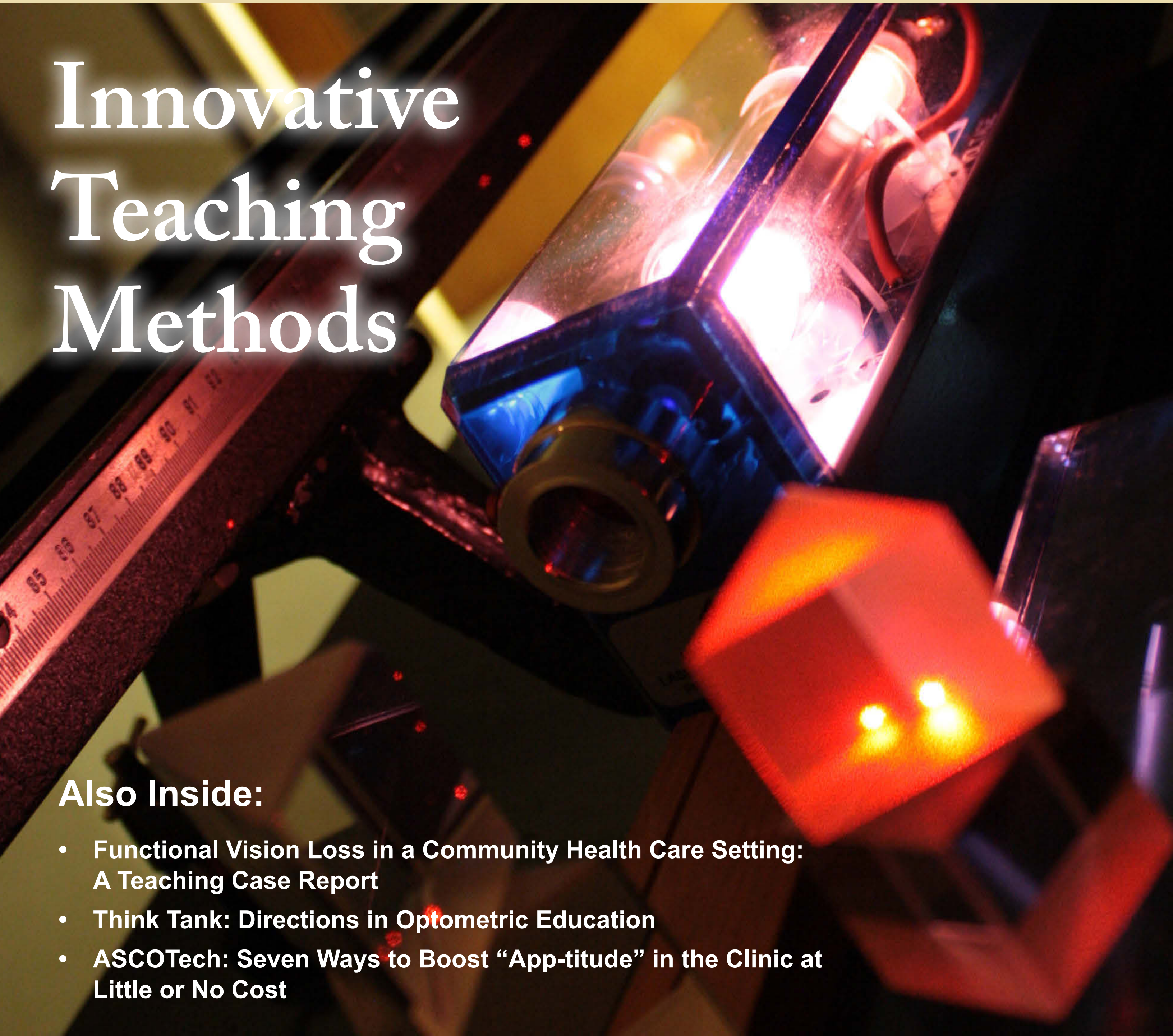

Innovative Teaching Methods

Also Inside:

- Functional Vision Loss in a Community Health Care Setting: A Teaching Case Report
- Think Tank: Directions in Optometric Education
- ASCOTech: Seven Ways to Boost “App-titude” in the Clinic at Little or No Cost

Association of Schools and Colleges of Optometry

The Association of Schools and Colleges of Optometry (ASCO) represents the professional programs of optometric education in the United States. ASCO is a nonprofit, tax-exempt professional educational association with national headquarters in Rockville, MD.

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Past issues of Optometric Education *are available on the ASCO Web site at http://www.opted.org/i4a/pages/index.cfm?pageid=3404. Funding for archiving was generously provided by Transitions Optical.*

ARTICLES

An Innovative Teaching Method for Geometric Optics Using Hands-On Exercises in a Large Classroom Setting to Stimulate Engaged Learning
Faheemah Saeed, OD, FAAO
Conceptualizing the principles taught in geometric optics is difficult for many optometry students. A novel teaching method was developed to address this challenge. Hands-on activities utilizing refractive lenses, mirrors and light sources not only allow learners to visualize the concepts being taught in class but also sustain their interest and attention and result in more engaged learning. 54

Simulating Color Vision Deficiencies on Clinical Tests with a Blue Light
Jeffery K. Hovis, OD, PhD, FAAO
Alex Muntz, MSc
Teaching color vision testing can be challenging when all (or nearly all) of the students in the class have normal color vision. Colored filters or computer simulation can be used to simulate color vision deficiencies, but both have some drawbacks. As an alternative, we used a blue compact fluorescent lamp to illuminate various clinical color vision tests. The results from 20 students showed that the illumination produced typical responses made by individuals with congenital red-green defects on the Ishihara, Standard Pseudoisochromatic Part 1, Standard Pseudoisochromatic Part 2, and Ishihara Compatible color vision plate tests. The results on arrangement tests were more variable with deutan-scotopic defects as the most common patterns. Even though the blue light illumination did not produce responses that are typical of individuals with red-green color vision defects on all color vision tests evaluated, it did provide students a reasonable approximation of their responses and the experience of making decisions based on minimal differences in color. 60

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The Journal of the Association of Schools and Colleges of Optometry

Functional Vision Loss in a Community Health Care Setting: A Teaching Case Report
Amy Roan Moy, OD, FAAO
Brian J. Pietrantonio, OD, MS
Erika Perzan, OD
Functional vision loss is loss of vision that cannot be attributed to a pathological or structural cause and is often associated with psychological issues. This teaching case report will help students in their understanding of the overall role of the primary care optometrist in the diagnosis and multi-disciplinary management of a child with functional vision loss. From this case, students learn how to think critically when their exam results do not match a patient's complaint, coordinate interdisciplinary communication, effectively communicate with children and their parents about sensitive issues, and manage patients with psycho-social issues. **67**

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INDUSTRY NEWS

The following companies support ASCO's national programs and activities benefiting the schools and colleges of optometry in the United States and Puerto Rico.*

Patrons ($50,000 - $90,000)

Alcon Laboratories

Benefactors ($25,000 - $49,999)

Essilor of America
HOYA Free-Form Company
Luxottica / EyeMed Vision Care
Walmart Stores, Inc.

Supporters ($15,000 - $24,999)

Allergan, Inc.
Carl Zeiss Vision / Carl Zeiss Meditec
Pixel Optics
Transitions Optical
Vistakon®, Division of Johnson & Johnson Vision Care

Friends ($10,000 - $14,999)

Abbott Medical Optics
Bausch + Lomb
Compulink Business Systems
Haag-Streit
HEINE
Keeler Instruments
M & S Technologies, Inc.
Marco
Oculus, Inc.
Optos North America
Vision Service Plan
Volk Optical

Contributors ($5,000 – $9,999)

CooperVision
International Vision Expo
LasikPlus / Visium Eye Institute
Review of Optometry
Safilo Group
TLC Vision
Vision Source!

As of January 1, 2013

Scientific Compendium Available Online

The Varilux S Series Compendium, recently posted online by Essilor, provides an in-depth look at the science and research behind the company's S Series of progressive lenses, including Nanoptix, SynchronEyes and 4D Technology. The compendium includes white papers and posters presented at national professional meetings and it details the patented LiveOptics R&D Process. In addition, it encompasses wearers' tests and results obtained with Essilor's virtual reality test platform. The information is available for download from http://sseries.variluxusa.com/TechnicalInformation/Compendium/Pages/WhitePapers.aspx.

New Artificial Tear is Preservative-Free

Allergan expanded its line of OTC products for managing dry eye with the launch of Refresh Optive Advanced Preservative-Free Lubricant Eye Drops. The new drops feature the same formula as Refresh Optive Advanced, without the use of a preservative. The triple-action formula is designed to stabilize the lipid layer to help reduce tear evaporation, hydrate the aqueous layer, and provide a lubricating and protective shield for the mucin layer while further protecting epithelial cells from hypertonic stress.

Refresh Optive Advanced Preservative-Free Lubricant Eye Drops can be used in combination with dry eye prescription therapies and do not require shaking prior to use. For more information, visit www.refreshbrand.com.

Expo Reaching Out to Optometry Alumni

In addition to continuing its student-specific programs, International Vision Expo is looking to work more closely with the schools and colleges of optometry to build programs that cater to the needs of each institution's alumni. The organization plans to work with each school to create alumni-specific benefits such as free exhibit hall registration, receptions, a list exchange, OD referral programs and special invitations. For more information, contact Trade Show Marketing Manager Kristen Reynolds at KReynolds@thevisioncouncil.org or (703) 548-0627.

NSAID Labeled for Once-Daily Use

Alcon recently launched nepafenac ophthalmic suspension 0.3% (Ilevro Suspension), a once-daily non-steroidal anti-inflammatory drug treatment option for pain and inflammation associated with cataract surgery. In two double-masked, randomized clinical trials, patients treated with Ilevro Suspension were less likely to have ocular pain and measurable signs of inflammation (cells and flare) at the end of treatment than those treated with its vehicle. Inflammation resolved at day 14 in 65% of Ilevro patients vs. 32% percent of patients who received vehicle. The pain resolution rate among Ilevro patients was 86% vs. 46% for patients who received vehicle.

For more information and full prescribing information, visit www.alcon.com.

Company Reorganizes Professional Affairs

Vistakon Division of Johnson & Johnson Vision Care Inc. has created a new Professional Development Group, which combines its Professional Affairs, ODLean Consulting Program, and Optometry School educational efforts into one department. In conjunction with the change, Damian May, PharmD, MBA, was named Senior Director, Strategy & Professional Development. Dick Wallingford, OD, was named Senior Director, Professional Affairs. In this expanded role, he will continue to lead the company's professional affairs activities with associations and eyecare practitioners as well as oversee management of its Optometry School programs. W. Lee Ball, OD, FAAO, will continue to work with Dr. Wallingford to support these efforts.

The company also announced that as of Dec. 31, 2013, its Acuvue Brand Contact Lenses Bifocal and Acuvue 2 Colours Brand Contact Lenses will be discontinued. Also, as of July 1, 2013, Acuvue Brand Contact Lenses will no longer be available in select base curves and parameters. Vistakon President Dave Brown noted in a press release that "Contact lens wearers continue to embrace innovative new materials, technologies, and designs ....," and eye doctors can easily upgrade patients from the discontinued older lenses to more popular brands in the company portfolio.

High Magnification Four-Mirror Lens

With magnification of 1.5X, Volk's new G4 four-mirror gonioscopy lens is designed to enable easier visualization of more fine structural details in the anterior segment. The G-4 Four-Mirror Glass High Mag is available in small or large ring options or with a handle that can be angled in two positions. The no-flange design of the lens means an interface solution is not required, allowing quick eye contact and better patient comfort.

For more information or to order the lens, contact your authorized Volk dealer, visit www.volk.com or call (800) 345-8655.

Cultural Diversity Brochures Updated

As part of its ongoing commitment to support eyecare professionals in their efforts to educate culturally diverse patients about their unique eye health needs and risks, Transitions Optical Inc. has refreshed its popular "What to Expect" brochure series with new imagery and updated eye health statistics.

The collection of brochures includes African-American Eyes, Asian Eyes (English and Mandarin), Hispanic Eyes (English and Spanish), Adult Eyes and Kids Eyes. The materials are available for eyecare professionals to display in-office or to use in their community outreach efforts. Printed copies of the brochures are available at no cost through Transitions Optical Customer Service at CService@Transitions.com or (800) 848-1506. Printable PDF versions are available online within the "My Practice" section of MyMulticulturalToolkit.com.

Vision Wellness Programs Expand

EyeMed Vision Care reported that more than 70,000 children and nearly 550,000 patients with diabetes are currently participating in its vision wellness programs. KidsEyes and EyeMed's diabetic eyecare benefits, both launched in 2011, help eyecare providers address the needs of these two key populations. Members are eligible for more frequent services and, in the case of diabetic eye care, coverage for follow-up care when certain criteria are met. According to the company, discounts on retinal imaging have also proven increasingly popular.

The programs are part of EyeMed's mission to help consumers see the importance of vision care and to encourage long-term relationships between patients and their eyecare professionals. The company also reported it plans to expand this focus in 2013.

For more information, visit www.eyemedvisioncare.com, or call (888) 581-3648.

New Web Site for Military Members

In partnership with the Armed Forces Optometric Society, CooperVision Inc. launched a new Web site, www.coopervision.com/armedforces, which reinforces the company's continued commitment to serving the U.S. military community. By logging onto the site, military members and their families can purchase CooperVision contact lenses affordably, with the guarantee they will be delivered wherever they are located around the world.

For every box of CooperVision Biofinity, Avaira and Proclear 1 day contact lenses purchased through the Web site, CooperVision will donate $1 to the Wounded Warrior Project.

EDITORIAL

Educating Educators

Aurora Denial, OD, FAAO

Hardly a day goes by that we as optometric educators aren't reminded in some way just how much our roles and the students we serve have changed over the years. Historically, optometric education was provided in large group lectures with laboratories and clinical experiences. Students were content to listen to lectures, memorize information, regurgitate the information on multiple-choice tests and slowly learn to provide clinical care without the concerns of productivity quotas. Current optometric students, however, part of the Millennial Generation born between 1982 and 2002, prefer to learn through collaboration, use of technology, instant feedback, structure and active learning experiences.[1] The delivery of optometric education has therefore evolved to reflect these student characteristics as well as to address advances in technology and expanded scope of practice. Blended learning, active learning and new technology are now components of the educational process.

Given these accelerating changes, it is incumbent upon us to determine how faculty should be trained in order to provide optimal education. In "Directions in Optometric Education," the Think Tank feature in this issue of the journal, Drs. Ken Seger and Michael Giese explore this important issue. Their commentary is meant to open a national dialogue among faculty members and administrators. I would like to open a similar dialogue via the journal on a closely related question: how optometric faculty grow and develop subsequent to their initial training in regard to teaching, learning and assessment. To start the discussion, I am providing the following reviews of educational conferences I have attended, all of which opened my eyes to new and creative ideas and potential solutions to the challenges faced by all educators.

• ***The Foundation for Critical Thinking: The International Conference on Critical Thinking and Education Reform***. The Foundation for Critical Thinking provides a wealth of information, including books, teaching guides, articles, workshops and professional development programs. Its International Conference on Critical Thinking and Education Reform is held in Berkeley, Calif. This conference is a valuable resource for those who wish to increase their knowledge on critical thinking. The foundation's Web site declares it the longest running annual conference on critical thinking. Drs. Richard Paul, Linda Elder and Gerald Nosich and Mr. Rush Cosgrove are the main lecturers and facilitators. The annual conference is attended by educators involved in elementary education through graduate and professional programs as well as military personnel and business people. I have attended the conference multiple times and felt it provided a framework of knowledge on critical thinking to incorporate into my teaching activities. [www.criticalthinking.org]

• ***National Center for Teaching Thinking: The Summer Institute***. The NCTT is an educational service organization that provides workshops, professional development, lessons and other resources for those who are interested in infusing critical thinking into a curriculum. The center, directed by Dr. Robert Swartz, has been in operation since 1992. The Summer Institute is held annually in the Boston area. It focuses on how to incorporate critical thinking into curricula, lessons and assessment. The conference is appropriate for administrators and faculty. I have attended and felt that although the majority of participants were involved in elementary and secondary education, the concepts were very useful to me in a professional health program. [www.nctt.net]

• ***Magna Publications: The Teaching Professor***. Magna Publications provides extensive resources relevant to all aspects of teaching. It produces publications, online courses, a blog and workshops in addition to other professional development products. It hosts two annual conferences, The Teaching Professor Annual Conference and The Teaching Professor Technology Conference. The organization's Web site describes its purpose as "The Teaching Professor helps you: overcome obstacles to effective teaching, stay on top of the latest pedagogical research, hear what's working for colleagues 'in the trenches,' hone your skills and stay on top of teaching innovations, and truly connect with your students."

I attended this conference last year and am planning to attend again this year. The majority of the presentations are from faculty members who want to share their teaching ideas and experiences. Although the conference provides plenty of useful pedagogy-related ideas, it does not seem to emphasize outcomes assessment for the information presented. [www.teachingprofessor.com]

• ***Lilly Conferences on College & University Teaching***. These symposia are held at various locations across the country at various times throughout the year. The international conference is held in November at Miami University in Ohio. It has been ongoing for 30 years and is considered one of the most prestigious conferences on the scholarship of teaching and learning (SoTL). I attended several years ago. It is a combination of informative keynote speakers, faculty presentations and discussions. I felt it provided a terrific learning experience in creative pedagogy and insights into teaching and learning. The conference participants were diverse and eager to discuss and share information. [www.lillyconferences.com]

• ***International Society for the Scholarship of Teaching and Learning***. This organization has been presenting both national and international conferences since 2004. The national conferences are held multiple times at various locations throughout the country. The emphasis is on SoTL. I attended my first SoTL conference in 2009. The keynote speeches were stimulating, and the faculty presentations contained an assessment piece. [www.issotl.org]

Optometric educators must be receiving continual professional development in clinical specialties as well as optometric education. Share with us your thoughts, information or experiences in achieving professional optometric educational development.

Reference

1. Howe N, Strauss W. Millennials Go to College (2nd edition). Great Falls, Virginia: Life Course Associates, 2007.

☆ Special Announcement ☆

2013 Educational Starter Grants

The Association of Schools and Colleges of Optometry (ASCO) and The Vision Care Institute, LLC, an affiliate of Johnson & Johnson Vision Care Inc., are pleased to announce the availability of the 2013 Educational Starter Grants. The grants have been offered over the past two years and are dedicated to supporting educational research. This is a great opportunity for faculty to get involved in educational research, which can impact teaching, student learning and the profession.

Complete details about the grant program, including a current application, deadlines for proposal submission, selection criteria, and past successful grant proposals, can be found at the ASCO Web site, www.opted.org, under Special Programs and Awards.

Directions in Optometric Education

Ken Seger, OD, MSc, FAAO
Section Chair
AAO Optometric Education Section

Nova Southeastern University
College of Optometry

Michael J. Giese, OD, PhD
Program Chair
AAO Optometric Education Section

Dear Colleagues,

Age has a way of making a person re-evaluate the past and contemplate the future. For the past 30 years or so, both of us have been involved indirectly and directly with optometric education. We continue to think about the future of our educational system. Questions that keep coming up include what kind of faculty members are best-suited to meet the needs of an ever-changing profession, and from where should the schools and colleges get these faculty members. Other questions that beg discussion include whose responsibility it is to train faculty for the future, and what makes a good composite faculty.

We would like to initiate a national discussion on these crucial topics, beginning with what is currently being taught in our schools and colleges. We have previously suggested expanding the definition of vision science to include areas such as molecular biology, microbiology, pharmacology, immunology and any other "ology" relevant to our profession.[1] If we agree this should be done, we must ask whether residency training is adequate for teaching these subjects or whether we need faculty with advanced degrees. Is just having an interest enough, or is having a master's degree or a PhD necessary? Along with this, we need to consider the bigger picture: 1) whether educators with an MS degree or a PhD who are working at optometric institutions need to be ODs, and 2) how many PhDs do optometric institutions need, if any. We should also ask what is in the best interest of the profession. For example, what does a faculty without PhDs say about a profession? Does hiring PhDs add to the prestige of the program and profession? These issues need to be thoroughly and carefully vetted.

Two basic educational models exist. In one, research is emphasized. In the other, clinical teaching is emphasized. For an academic institution that emphasizes research, it seems sufficient to hire non-OD PhDs. However, should these faculty have knowledge of the profession of optometry, and how should they obtain it? It appears that for optometric schools and colleges that are not part of a state-assisted research university, the trend has become to hire newly minted residency-trained ODs as faculty. These faculty members are utilized in various clinics and labs and occasionally lecture courses as the need arises. Currently, most clinical faculty are residency-trained. Additionally, at most schools and colleges, classroom faculty are residency-trained. Is residency training sufficient for producing a well-educated clinical professorate? Typically, residents don't receive training in the ways of academia. By this we mean, ideally, a place where research, clinical or theoretical, is enthusiastically pursued and disseminated; where teaching is important and developed; and where service (administrative or committee level, local or university-wide) is part of the mix. Hopefully, at an optometric institution, respect for service on behalf of the profession, whether it be on the community, Academy or Association level, is also supported. How do traditional academic values become inculcated in the new faculty at institutions that emphasize clinical teaching?

Furthermore, whose responsibility is it to train our faculty-to-be? Should residency programs incorporate training in educational pedagogy and cultivate intellectual curiosity? For the core courses, hiring clinician scientists would be one answer for both models of optometry education, but this requires a big commitment by the institution. It also raises the additional question of whose responsibility it would be to train the clinician scientists. It appears that the model for at least the "ologies" is that it is not optometry's responsibility, but rather the responsibility of medicine/psychology/integrated biology. No matter who educates clinician scientists, we wonder whether our schools and colleges of optometry can afford to risk hiring new investigators without funding, give them adequate facilities and time, provide an environment in which they will grow and, perhaps most importantly, provide potential research collaborators for them. Can our profession afford for them not to? Where are appropriate mentors going to come from? We are not altogether sure that a PhD is not considered a liability at some institutions.

We don't presume to have prescriptive solutions, but we would like to facilitate a conversation regarding these important matters. As Program Chair and Chair of the American Academy of Optometry's Optometric Education Section, we would like to continue this discussion at future Academy meetings as well as through journals such as this. We would love to hear your thoughts.

Reference

1. Giese MJ, Seger KR. A vision science reality check. Optometry. 2010;81:55-56.

Send Us Your Comments

Do you have any thoughts or insights related to the issues in optometric education presented here? Send your comments to Dr. Aurora Denial at deniala@neco.edu, and we will print them in the next edition of the journal.

Seven Ways to Boost "App-titude" in the Clinic at Little or No Cost

James Kundart OD, MEd, FAAO

Dr. Kundart is the Chairman of the Educational Technology Special Interest Group for the Association of Schools and Colleges of Optometry. He is a researcher and author and an Associate Professor at the Pacific University College of Optometry. He can be contacted at (503) 352-2759 or kundart@pacificu.edu.

When it comes to access to information for clinical care, we are living in the golden age of wireless. It sometimes seems the sum total knowledge of humanity is available on the smartphones in our pockets. While this exaggerates reality a bit, no one would deny that the challenge of our age is rapid navigation of the information superhighway. There are certainly some well-known stops on this highway. For instance, our vision science libraries have a rich trove of optometric knowledge, and many of our students can access their class notes electronically wherever they go. These are all highly useful resources when time permits their use. However, when we are under the tight time constraints of clinical care, it is tablet and smartphone applications, or apps, that allow for extremely rapid access to needed information.

Many apps are free, paid for by advertising, and others cost just a few dollars. As a result, my phone is crowded with folders of these apps, many seldom used. On the other hand, a few get such heavy use (or promise such in the future) that I encourage my students to use them in clinic. I'm certain there are some apps I've missed, and many of you have favorites you would rank higher than these seven. Also, not all of these apps work on all platforms. Even so, I'm not going to let that stop me from sharing with you my current favorite apps for clinical optometry.

1. Epocrates

Rhyming with "Socrates," this very useful, free app and Web site (www.epocrates.com) offer a wealth of information concerning systemic disease, medications, and insurance coverage for medications under Medicare and Medicaid.

Drug monographs

Epocrates has an exhaustive database of oral medications, arranged by drug class and categorized from Allergy to Rheumatologic.

You won't find many (if any) topical medications here, but if your patient is on a pill with which you or your interns aren't familiar, you can bring up an entire monograph on the medication. The monographs include indications, contraindications, adverse effects and pictures of the medication if the patient isn't certain of the name.

Interaction check

Here, you can interact with a virtual pharmacist of sorts. By entering the names of the medications a patient is taking, you can see if a potential new medication has any known drug interactions. While not the same as a human pharmacist, the Epocrates interaction check is a potentially lifesaving feature.

Pill ID

Does your patient have an unidentified pill in her pocket? The Pill ID section of Epocrates allows you to search by imprint, shape and color to determine what it is. Try a blue diamond to see a famous example.

Notifications: doc alerts

Epocrates also features periodic "doc alerts." The topics are often timely. One recent alert was titled "What Risks Do Energy Drinks Pose?"

Notifications: picture quiz

The app's picture quizzes can help refresh your knowledge on "mystery diseases," such as skin conditions and ear infections, of interest to primary care providers. In addition, a "Journal Watch" section highlights editors' picks.

Resource centers

This corner of the Epocrates app contains monographs on several common systemic conditions, from bipolar disorder to HIV to schizophrenia. Links lead to clinical news on prescribing meds for the condition as well as scientific abstracts. Even on the smallest screens, the format is readable.

Tables and calculators

Not all of the tools available on Epocrates are commonly used in clinical optometry, but they include the Glasgow Coma Scale for adults and children, and a Body Mass Index calculator.

Systemic diseases

While not technically part of the app, Epocrates online contains a marvelous disease index, including summaries, basics about the disease, diagnosis, treatment, follow-up, references and images.

Registering to use Epocrates on your smartphone, tablet or laptop is simple and free. Make sure you remember your password because with each unsuccessful attempt to log on, you will experience a longer delay.

2. EyeDock

If you want to search contact lenses or topical ophthalmic medications, use a cross-cyl calculator, or find codes for billing, EyeDock is the iPhone app and Web site (www.eyedock.com) for you. EyeDock is not free, but the Web site can be made available at no cost to students, staff and faculty of the schools and colleges of optometry. Here, I've listed what I see as its most useful features.

Contact lens searches

If your patient needs a high-dK toric lens in a high myopic power that costs less than $40 a box, or you want to find the multifocal lens with the steepest base curve available in a six pack or the smallest-diameter plus lens for a young accommodative esotrope, EyeDock can help. It provides a powerful search engine that allows you to use specific parameters to quickly narrow your search. The optometrists who run the site do a good job of keeping new lenses on the list and clearly marking discontinued lenses in red. Even if they are familiar with the latest releases in the contact lens market, your students will find this searchable database invaluable.

Topical medication searches

Unlike Epocrates with its extensive database of oral meds, eyedock.com includes topical ophthalmics. If you're not sure which size bottle Lumigan comes in, or what the cost of Zirgan is, or which combination anti-allergics have gone OTC, it's all there. This part of EyeDock is a fantastic tool for staying on top of the ever-changing TPA marketplace. The estimated retail prices listed are an increasingly vital element for helping to ensure compliance for patients who are uninsured.

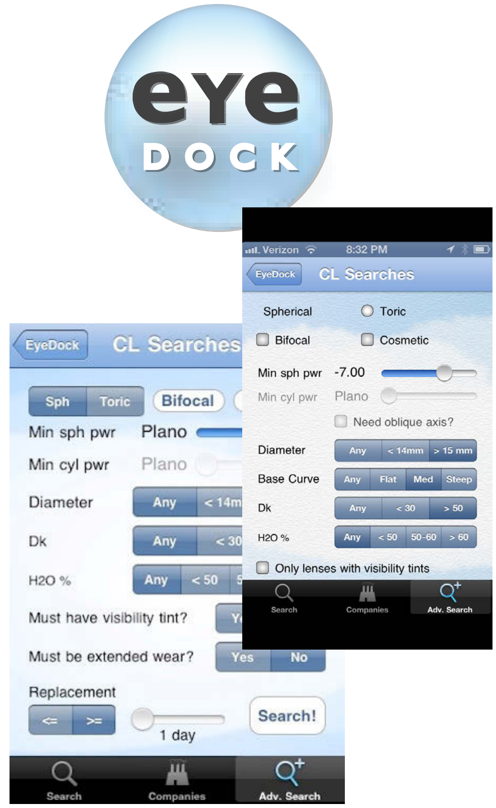
Calculators and tables

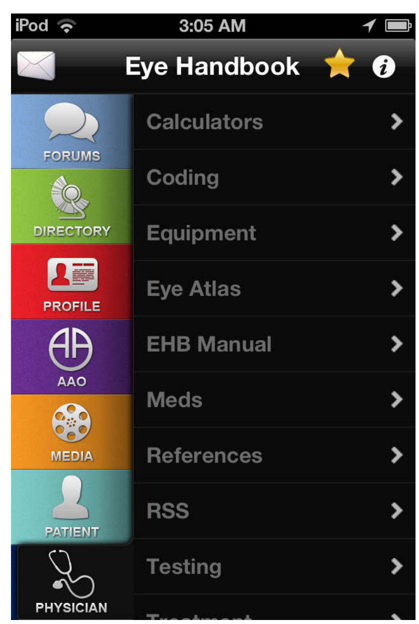
While still in its infancy, EyeDock has the potential to work as an expert system and to recommend a SCL or RGP based on spectacle-plane refraction, keratometry readings, and even fitting philosophy. The contact lens calculator attempts to do this now, though rather imperfectly.

EyeDock's other calculators, such as the one for cross-cylinder, are more straightforward. My students also appreciate the keratometer conversions tool. A Parks Three Step, Plaquenil dosage, CRT Lens Selector, and staff incentive calculator for profit sharing are also available.

3. Eye Handbook

Designed for ophthalmology, this wonderful app goes beyond meds, billing and coding and calculators. It also contains a very solid database of diagnosis and treatment, an estimator for glaucoma risk, a calculator for IOL power for cataract patients, an eye atlas, and RSS feeds to podcasts from various journals. The app is free for Android and iPhone, and the Web site (www.eyehandbook.com) lists it as "exponentially more comprehensive than any other eye re-





lated app." That's a lofty claim, but the Eye Handbook does an admirable job in achieving it. While not a comprehensive list of all the app's functions, the following are some of the most useful located in the "Physician" section.

Eye atlas

Want to see the difference between nodular and episcleritis, optic nerve drusen and edema, map-dot and granular corneal dystrophy, or BRVO and CRAO? All of these are pictured in the eye atlas, and are of considerable usefulness for students and seasoned clinicians alike.

EHB manual

The manual includes definitions, epidemiology, pathology, symptoms and signs, diagnosis, treatment and follow-up for almost every diagnosis you can think of, from acute conjunctivitis to vitreous hemorrhage. Research and references, including web links, are often included.

Testing

The "testing" section of the Eye Handbook is one I have not seen in other apps. Need a portable near card, Amsler grid, color or contrast test, OKN drum, pupil gauge or Worth dot test? All of these and more can be found under this section of the app.

4. Colorblind Vision

Advertised as the "Number 1 medical app in United States, China, Spain, France, Canada, Australia and 80 other countries," this app is subtitled "the color blind simulator at 30 frames per second." In other words, the Colorblind Vision app is a cellphone camera filter that simulates dichromacy (protan, deutan, and tritan) and monochromacy (achromatopsia), compared with normal trichromatic color vision. You can snap a digital picture with it, but you can also see a real-time simulation of how the world appears to a person with color deficiency.

While simple, this app is extremely effective for patient education, particularly for people with a newly diagnosed colorblind family member. Its simplicity is likely the key to its success. It's available for the nominal fee of $2.99. More information is available at www.opcoders.com/colorblind-vision.

5. LetterReflex

We all know that a common chief complaint among our younger patients is trouble in school. It can be frustrating to the optometrist and patient alike when standard interventions such as corrective lenses are not necessary, yet the patient seems to have a vision problem. In places where vision therapy is available, these patients may be further tested for problems with telling left from right. But in many private offices, vision therapy is not available. Enter home vision therapy for laterality, directionality and reversal problems, and the LetterReflex app (www.dexteria.net).

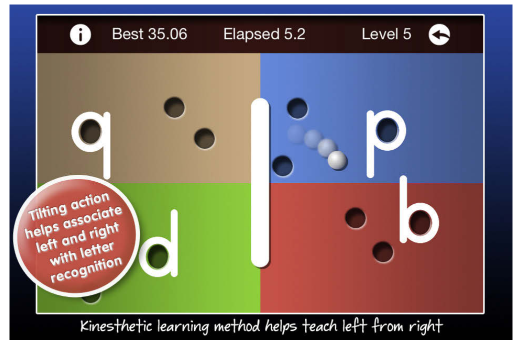
Because there is some correlation between laterality/directionality problems and specific reading disabilities like dyslexia, patients with these problems will continue to report to optometric offices.

My patients who have tried this app find it very motivating and can demonstrate considerable skill after only a few weeks of practice. Listed as part of a family of apps for occupational therapy, LetterReflex is currently on sale for $1.99.

6. Coach's Eye

This camera app has applications outside the optometric office for those who practice sports optometry. While the optometrist must exercise caution not to make recommendations that are better made by coaches, apps like this one allow coaches, teammates, and family to make videos that highlight skills on which the athlete needs to work. So why include this app in a list of the seven best for clinical optometry? The reason is Coach's Eye represents a new generation of software that puts the power of diagnosis in the patient's hands. The player can gather data for teammates, and the coach can apply his or her expertise to showing on the video where the athlete might improve.

So where does the optometrist come in? The Coach's Eye app can help the O.D. to better understand the visual needs of the athlete so as to better prescribe treatment, be it sports specs, contact lenses or vision therapy. You can find more information on this app at www.coachseye.com, or buy it for $4.99 at the iTunes store.

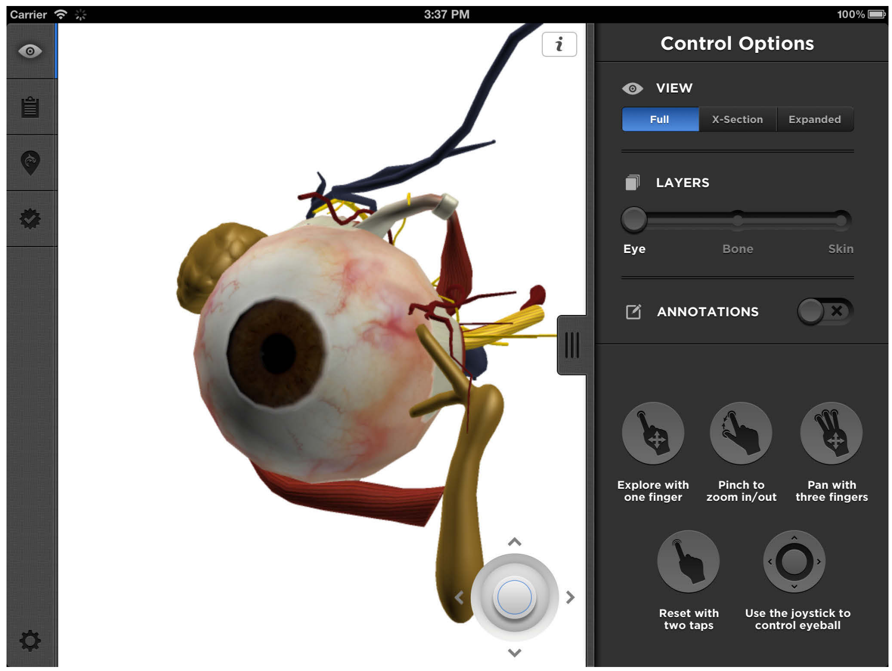


7. EyeDecide

The last of my seven favorite apps for clinical optometry is for students learning ocular anatomy or patients who want to see where their eye muscle problem is. We've come a long way from when I was in optometry school learning the extraocular muscle origins and insertions with a styrofoam eyeball and EOMs made of masking tape.

Now, students and patients can be impressed with 3D renderings of the orbit, including the nerves, vasculature and bones. The app also offers patient education videos illustrating common ocular conditions, such as cataracts and glaucoma. These include video simulations using the smartphone camera to show the visual effects of each disease.

One section of EyeDecide allows patients to find a specialist in their area though, unlike the app, advertising your office here may not be free. EyeDecide is available at no cost through www.orcahealth.com.



Looking Forward to What's Next

The ways in which we access information are changing rapidly, and it's hard to tell which, if any, of these useful clinical apps will be with us in the future. But part of the joy of living in the golden age of wireless is taking advantage of the cutting-edge technologies that make us better educators and clinicians. I eagerly await what I can hardly imagine: what our current students will develop in the future to improve the practice of optometry.

An Innovative Teaching Method for Geometric Optics Using Hands-On Exercises in a Large Classroom Setting to Stimulate Engaged Learning

Faheemah Saeed, OD, FAAO

Abstract

Conceptualizing the principles taught in geometric optics is difficult for many optometry students. A novel teaching method was developed to address this challenge. Hands-on activities utilizing refractive lenses, mirrors and light sources not only allow learners to visualize the concepts being taught in class but also sustain their interest and attention and result in more engaged learning.

Key Words: *geometric optics, engaged learning, visualization, hands-on activities, higher education*

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Introduction

The creation of the National Survey of Student Engagement (NSSE) has elicited curiosity and interest among educators in higher learning regarding their students' engagement in the classroom.[1, 2] Schreiner and Louis have defined engaged learning as positive energy invested in one's own learning, evidenced by meaningful processing, attention to what is happening at the moment and involvement in specific learning activities.[3]

For instructors in the geometric optics series taught in first-year optometry curricula, a primary goal is to stimulate the highest level of student engagement in the classroom and motivate students for deeper learning in a decidedly demanding curriculum. Traditional lecturing can be ineffective in stimulating student engagement. Moreover, it leaves the visualization of important principles to a student's imagination, leaving many with an incomplete grasp of the challenging concepts taught in the course. With the growing emphasis of our profession on conceptual understanding, deeper learning and comprehension are expected of our students, and there is a resulting need to de-emphasize rote memorization of formulae with "plug-and-chug" calculations.

This paper describes a novel teaching approach that allows hands-on learning of optical principles by small groups of students within the large lecture setting. This method was developed in an effort to increase students' engagement in the classroom and allow visualization of optical principles utilizing table-top equipment. Equipment sets consisting of lenses, mirrors, prisms and laser sources were used in different exercises with the intention of supplementing all major topics taught in the geometric optics course series. In the absence of a laboratory for geometric optics at our institution, these hand-on exercises proved to be an invaluable addition to the course.

Workshops

Over the course of two academic quarters, seven workshop sessions were conducted, with each session scheduled at the completion of the traditional lecture component for a major topic.

During these two-hour sessions, the class of 160 students was divided into 20 groups. Ten groups met during the first hour in the lecture center, and the remaining 10 groups met during the second hour. The group assignments were randomly changed to allow students to work with different colleagues. Each group of eight students worked through some hands-on exercises utilizing laser boxes, lenses and mirrors that were designed to present visually the important concepts already presented during lectures. The students were responsible for setting up the optical equipment based on the instructions in their handout, taking measurements, answering multiple-choice questions, and drawing and labeling ray diagrams. One completed handout was turned in by each group, the correctness of which determined the grade earned for the workshop session by each group member. The discussion questions that followed each exercise were specifically written to ensure that students attended to the crucial elements of the exercise setup and engaged in effective group discussions.

Each group activity and interactive discussion was led by an upper classman teaching assistant (TA) to ensure adequate and effective supervision. Prior to each workshop, a one-hour training session was scheduled for the TAs to ensure consistency in their instructions and a clear understanding of the goals and expectations for the workshop sessions. During these sessions, the TAs performed the entire set of exercises that would later be completed by the first-year students. The training sessions allowed the TAs to review the material, ask questions, and gain confidence for leading the activities and discussions. The TAs were equipped with a written answer key to ensure they provided consistent and accurate answers to their first-year student groups during the workshop sessions. Additionally, the TAs were instructed to make a conscious effort to ensure that each student in their group took the lead role in setting up a minimum of one exercise during the session, participated in all the discussions, and contributed to the group activity. During the workshop sessions, the course coordinator observed and supervised all the groups.

The workshop design aimed to impact deeper learning via fact recall, critical-thinking skills, problem-solving, and enjoyment of the learning activity. The exercise questions were designed to be stepping stones toward the more complex exam questions. The purpose of the exercise questions was to prompt the students to start thinking about and discussing concepts that would later be tested in the exams.

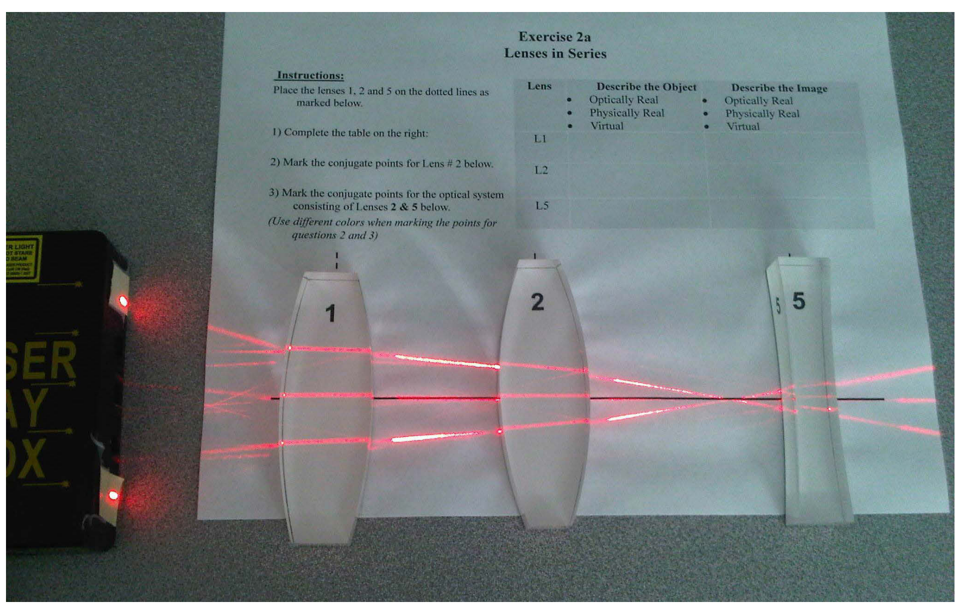
The course was assessed by means of the standard student opinion survey used by the college at the end of each course. The survey did not ask specific questions regarding the workshops. However, unsolicited comments from students and TAs provided useful feedback.

Sample Workshop Exercises

The two exercises described here are among many that were designed to allow the study of optical systems and behavior of light. The first setup **(Figure 1a)**, which utilizes a laser light source, two convergent lenses and one divergent lens arranged in series, facilitates visualization of real and virtual objects and images. Parallel light rays from the laser box are incident on the first lens (L_1). Convergent rays exit L_1 and are incident on the second convergent lens (L_2). The blue dot in **Figure 1b** marks the location where these convergent rays would have intersected with the optic axis if no other lens had intercepted the light rays. In addition to representing the location of the optically real image for L_1, the blue dot marks the location of the virtual object for L_2. In other words, when convergent light rays exit a lens, they represent a real image. However, when the convergent rays are incident on a lens, they represent a virtual object. Next, the light rays pass through L_2, which

Figure 1a

A setup utilizing two convergent lenses and one divergent lens arranged in series allows students to observe a variety of objects and images. Parallel light rays from the laser box are converged by the first lens (L_1). Before L_1 can form a physically real image, the second convergent lens (L_2) intercepts the rays and converges them even more. The convergent rays that exit L_1 represent the optically real image for L_1 and also the virtual object for L_2. The convergent rays that exit L_2 to form a focal point without being intercepted represent the physically real image for L_2. Next, the light rays diverge and continue their travel toward a divergent lens (L_5), last in the series. L_5 adds divergence to its incident light rays and creates a virtual image.



adds more convergence to the already convergent rays. Because the rays that exit L_2 converge to a focal point without being intercepted, the image for L_2 is physically real. Light rays diverge and continue their travel toward a divergent lens (L_5), positioned last in the series. The orange dot in **Figure 1b** represents the location of the image for L_2 and also the real object for L_5. Divergent light rays exit L_5 and form a virtual image. In order to know the exact location of this virtual image, students are instructed to extrapolate the rays that exit L_5. The green dot in **Figure 1b** marks the location where the divergent rays intersect the optic axis after being extrapolated. An optical setup like the one shown in **Figure 1a** not only aids visualization but also provides the framework for more detailed discussions regarding conjugate points and the resulting image parameters such as size, location and orientation.

After setting up the equipment as photographed in **Figure1a**, the students are instructed to identify the type of object and image for each lens, mark the conjugate points for each lens and draw a ray diagram to represent the optical setup, similar to the one shown in **Figure 1b**. Following are some examples of the discussion questions that the students review with their TA upon completion of exercise 1:

1. Are the incident wavefronts for L_2 steeper or flatter than the emergent wavefronts for L_2? To answer this question, students need to recall that the steepness of wavefronts is directly proportional to the vergence. The students are encouraged to sketch the incident and exiting wavefronts on their diagram, as shown in **Figure 1c**, to help them visualize this concept.
2. Do the incident wavefronts become flatter or steeper as they approach L_2? This question, though testing a similar concept as the previous question, is worded differently to place the emphasis on L_1 rather than L_2. Additionally, it challenges students to think about how convergence increases when convergent light travels downstream toward its focal point. To

Figure 1b

A representation of the exercise setup, as drawn by students in the workshop assignment shown in Figure 1a. The blue circle labeled I_1 and O_2 represents the location of the optically real image for L_1 and the virtual object for L_2. The blue dotted rays leading to this location are obtained by extrapolating the exiting rays for L_1. The orange circle labeled I_2 and O_3 marks the location of the physically real image for L_2, which also serves as the physically real object for L_5. The green circle labeled I_3 represents the location of the virtual image for L_5. This location is obtained by extrapolating the divergent rays that exit L_5 (dotted green rays).

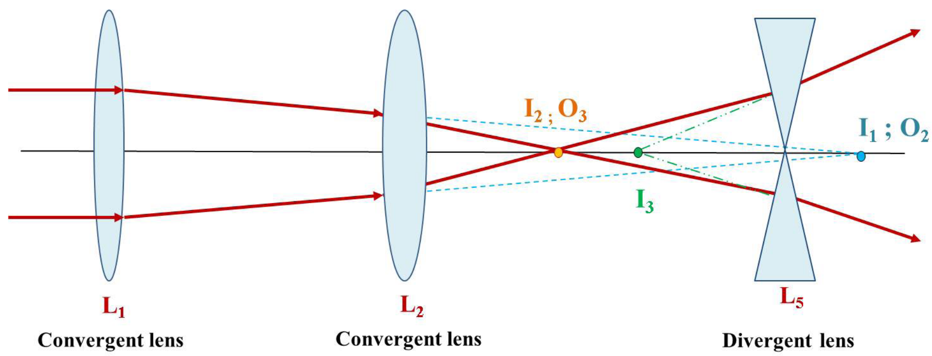
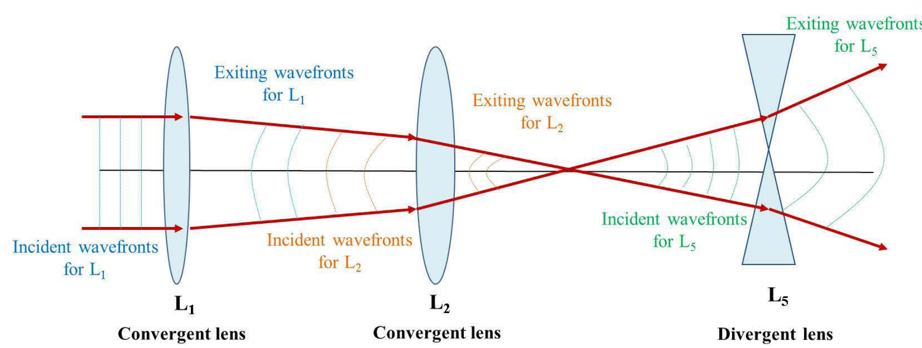


Figure 1c

A diagrammatic representation featuring incident and exiting wavefronts for the exercise setup photographed in Figure 1a. The incident wavefronts for L_1 are flat and perpendicular to the parallel rays originating from infinity. The exiting wavefronts for L_1 are convergent and become steeper as they travel downstream, away from L_1 and approaching their focal point. The exiting wavefronts for L_2 are steeper compared to the incident wavefronts because L_2 adds convergence to the wavefronts. After forming a point focus, the wavefronts that continue to travel downstream toward L_5 are divergent. Divergent wavefronts become weaker and flatter as they travel downstream, away from their point source, and approach L_5. The exiting wavefronts for L_5 are steeper than the incident wavefronts because L_5 adds more divergence to the exiting light rays.



answer this question correctly, the students need to recall that the curvature of wavefronts is inversely proportional to the distance of the wavefront from the focal point.

3. Do the incident wavefronts become flatter or steeper as they approach L_5? This question is designed to initiate a discussion on how divergence decreases as light travels downstream from its point source.

The second exercise, which involves a thick prism and a laser light source, allows students to visualize the passage of a single light ray through a prism. **(Figure 2a)** At the first surface of the prism, the light ray refracts toward the normal as it travels from a rarer to a denser medium. The resulting angle of refraction is smaller than its corresponding incident angle. The light ray then travels through the prism in a straight line to reach the second refracting surface of the prism. At the second surface, the incident angle being larger than the critical angle results in total internal reflection, and the law of reflection governs the behavior of light at this prism surface. The reflected ray creates an incident angle at the third surface (base) of the prism where light travels from a denser to a rarer medium, resulting in a larger angle of refraction than the corresponding incident angle.

The students are instructed to set up the equipment as photographed in **Figure 2a**, measure all angles of incidence, refraction and reflection, draw a ray diagram as shown in **Figure 2b** and label all the angles. Snell's law is applied to aid understanding of the relationship between the incident angle and the angle of refraction at each surface of the prism. Students are asked to calculate the value of the critical angle for the prism and predict which incident angles at the second refracting surface of the prism would yield total internal reflection. This setup also provides the framework for observing the effect of the prism's apical angle and refractive index on the deviation of light by employing different prisms. This workshop provides an effective visual vehicle for observing the set-up for minimum deviation, maximum deviation and normal incidence with thick prisms.

Figure 2a

Utilizing a laser box and thick prism, students can study the relationship between variables, including the angles of incidence and refraction (or reflection) of light, the apical angle of the prism and the index of refraction.

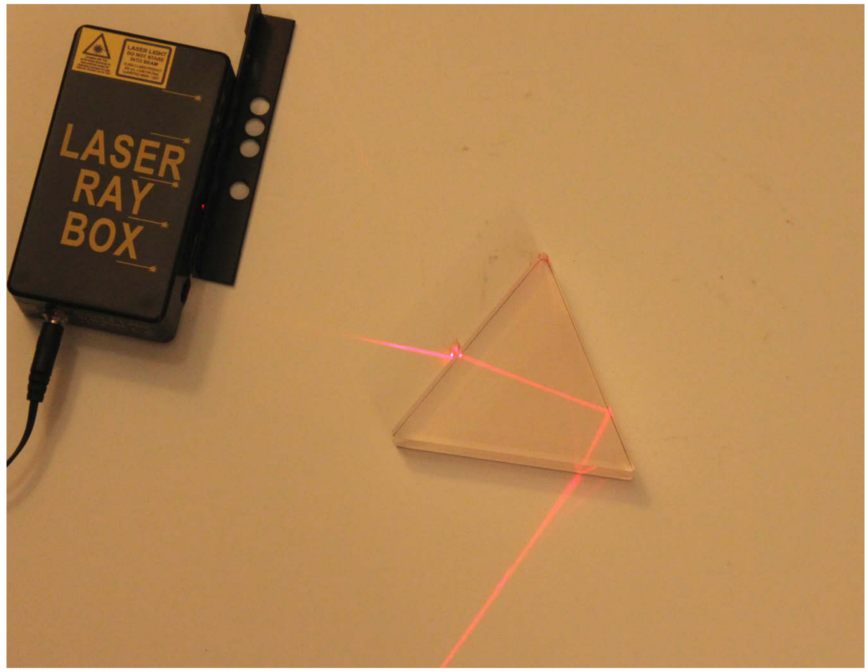
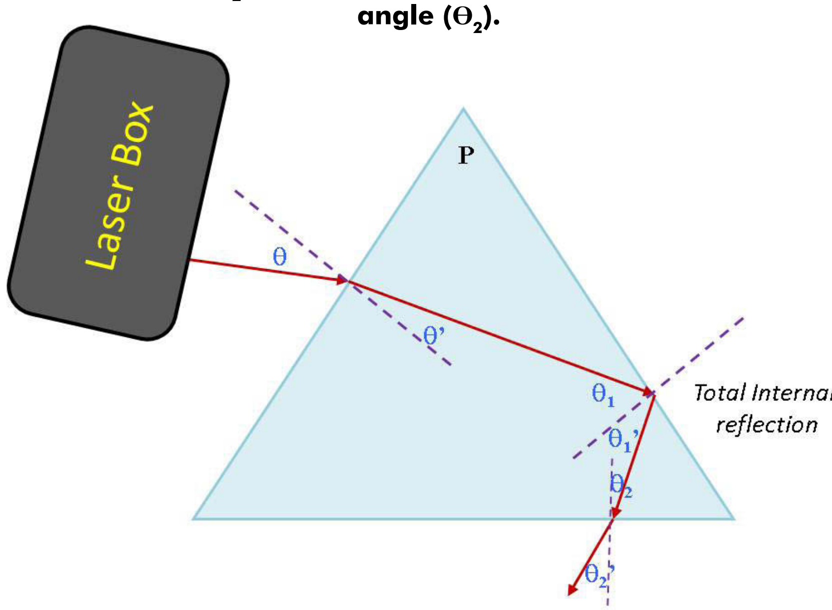


Figure 2b

A diagrammatic representation of the exercise setup, as completed by students in the workshop assignment shown in Figure 2a. Light refracts toward the normal at the first surface of the prism. The resulting angle of refraction (θ') is smaller than the incident angle (θ) at the first surface. Light reflects at the second surface because the incident angle ($θ_1$) is larger than the critical angle for this prism. The corresponding angle of reflection ($θ_1'$) is equal to $θ_1$. Light refracts away from the normal at the third surface of the prism. The resulting angle of refraction ($θ_2$) is greater than the corresponding incident angle ($θ_2$).



Impressions

Informal feedback from students and colleagues indicated that the new hands-on activities were well-received by a majority of the students. Students enjoyed the activities and appreciated being able to observe the behavior of light. A majority of the students commented on enjoying the interaction and discussions with their colleagues. Some students stated that they liked the activities due to the variety that they brought to the course and that the activities kept them engaged and interested. Students also commented that discussing a concept with their colleagues helped them understand it better and prompted them to pay attention to details they may have otherwise overlooked. Higher scores were observed on scheduled mid-quarter and final comprehensive examinations compared to the previous year, possibly reflecting better grasp of concepts. Additionally, the exam performance was improved in spite of a larger proportion of conceptual questions that are generally considered to be more challenging by students.

Many uncontrolled variables can potentially influence exam performance from one year to the next, such as the student body itself and changes in class and exam schedules. Therefore, it is inappropriate to attribute improved exam performance solely to the workshops. A more controlled study in the future, with the use of pre-workshop and post-workshop exams, might better allow determination of the impact of these workshops on students' exam performance. Students also commented on ways to improve the activities, which included suggestions for more time to ensure adequate opportunity for discussions with the group TAs. Students requested better timing of the workshops in the weekly schedule to increase the time between the workshops and exams. Both of these issues can be addressed easily going forward.

Clinical instructors who worked with students who had participated in the optics workshops the previous year and rotated through the Low Vision Service in an observational capacity reported a noticeable difference in students' understanding of the underlying optical principles of low vision devices, particularly fixed-focus magnifiers and the resulting virtual image. Positive comments were also received from the TAs, who reported that the concepts covered during these workshop sessions allowed them to better understand the course material compared to when they had learned it themselves originally, without workshops. Upper classmen have requested a workshop session to help them review the course material for the National Board Examination.

Discussion

Several studies have examined and reported the benefits of group collaboration and engagement. The positive correlation between engagement and deeper learning has been reported by Tagg.[4] Benbunan-Fich and Arbaugh found that students on average achieved better grades in courses where they engaged in collaborative assignments and participated in knowledge construction. In terms of final grades, the absence of both factors (knowledge construction and group collaboration) had a detrimental effect on student performance.[5] McHarg et al. reported a positive relationship between students' performance on knowledge-based assessments and the level of group engagement and collaboration in problem-based learning. Students who engaged most during the problem-based learning process performed markedly better in assessments of knowledge.[6]

Carini et al. studied the association between student engagement and academic performance in 1,058 students at 14 four-year colleges and universities. The authors reported a positive link between student engagement and desirable learning outcomes such as critical thinking and grades. The authors also found student engagement to be more beneficial for college students with the lowest SAT scores. Additionally, student engagement was converted into higher performance on critical-thinking tests more effectively at certain institutions than others.[7]

Pollock et al. compared the effects of different types of face-to-face discussions, including small-group and large-class discussions, on learners.[8] Greater participation and more positive student perceptions were reported in small-group discussions. Previous academic achievements were reported to be less impactful on the level of participation in small groups.[8]

The relationship between faculty practices and student engagement has been explored and reported by Umbach and Wawrzynski. Their findings suggest that students report higher levels of engagement and learning at institutions where faculty members use active and collaborative learning techniques, engage students in experiences and activities in the classroom, and maintain a high level of interaction.[9]

Hands-on exercises where the participating student is responsible for setting up the exercise, explaining the setup to his fellow group members and discussing the results guarantee a more active learning approach. These small group exercises require greater student involvement both mentally and physically compared with a large classroom lecture setting where students are allowed to be passive receivers of information.

Inclusion of these hands-on group exercises in this first-year geometric optics course helped the participating students to grasp concepts more easily by means of greater group interaction and presentation of material from a different perspective. A major advantage of group discussions is that they allow the topic of interest to be discussed in multiple ways, with each participant bringing his/her own perspective to the discussion. Additionally, small group activities create a sense of responsibility and accountability among the participants. In these workshops, each group member was required to take the lead role in at least one exercise, which resulted in observable efforts by the participants to better grasp the concepts so they could effectively contribute to the group activity.

Another important feature of these hands-on exercises that makes them uniquely helpful in learning is that they allow visualization. The students are able to actually observe the diverging and converging light rays, pinpoint the exact location and predict the size and orientation of an object or image. With less reliance on their imagination, students can be uniformly equipped with a solid knowledge base. With the basic and trivial concepts mastered, the entire class can then move on to more complex discussions and problem solving. Hands-on activities can play an instrumental role in learning for all students, but likely are especially important for the visual learners.

Currently, a project is under way to examine the link between student engagement during workshop sessions and academic performance. The study will compare students' performance on exam questions before and after participation in workshop sessions by means of short multiple-choice questions. Additionally, the students will be asked to complete a survey to evaluate the contribution of each workshop session to their understanding of the course material.

Conclusion

Courses in higher education, especially those that lack a laboratory portion, can benefit from course components that allow group interaction, activities that trigger engagement and discussion, and exercises that stimulate interest and allow visualization.

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Simulating Color Vision Deficiencies on Clinical Tests with a Blue Light

Jeffery K. Hovis, OD, PhD, FAAO
Alex Muntz, MSc

Abstract

Teaching color vision testing can be challenging when all (or nearly all) of the students in the class have normal color vision. Colored filters or computer simulation can be used to simulate color vision deficiencies, but both have some drawbacks. As an alternative, we used a blue compact fluorescent lamp to illuminate various clinical color vision tests. The results from 20 students showed that the illumination produced typical responses made by individuals with congenital red-green defects on the Ishihara, Standard Pseudoisochromatic Part 1, Standard Pseudoisochromatic Part 2, and Ishihara Compatible color vision plate tests. Although the majority of errors on the other plate tests were along the red-green axis, some blue-yellow and scotopic errors also occurred. The results on the arrangement tests were more variable with deutan-scotopic defects as the most common patterns. Even though the blue light illumination did not produce responses that are typical of individuals with red-green color vision defects on all color vision tests evaluated, it did provide students a reasonable approximation of their responses and the experience of making decisions based on minimal differences in color.

Key Words: *simulated color vision defects, pseudoisochromatic plate tests, arrangement color vision tests*

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Alex Muntz is enrolled in the vision sciences PhD program at the University of Waterloo. His research interests include corneal physiology and contact lenses.

Introduction

One of the challenges in teaching clinical techniques is exposing students to both normal and abnormal patient encounters so they have a better appreciation of the nuances and hurdles involved in performing the techniques and interpreting the results prior to entering the clinic. Their experience can be enhanced further if they can actually experience abnormality through simulation. A few examples of simulation techniques are using sector Fresnel prisms mounted on spectacles to simulate noncomitant deviations,[1] goggles designed to simulate various low vision conditions in order to teach empathy for patients,[2] and training individuals to simulate various medical conditions as part of a practical assessment.[3] The general consensus of students participating in the low vision and binocular vision simulations was that the simulations provided a greater understanding of the difficulties faced by patients with these conditions.[1,2] In addition to greater empathy, the majority of students in the low vision simulation saw the need to offer more comprehensive care for their low vision patients. Students using the noncomitant simulations believed that the learning experience was more effective than performing the procedures on their healthy classmates. Simulating patients for practical examinations was also judged as effective because only one student was able to distinguish between the simulated and actual patients.

Exposing students to patients who have congenital color vision deficiencies in a preclinic course where the students serve as both patient and clinician is difficult. There may be no one in the class who has a color vision defect, or there may be only one student and he or she may not be willing to serve as a demonstration patient for the others. The deficiencies could be simulated using an image processing algorithm such as VisCheck (www.vischeck.com), but this would require one to scan the pages of a given test booklet. Arrangement tests would require one to scan each cap, alter the color, print and then verify that the printed color matched the color on the computer monitor. This would be tedious if the arrangement test was the Farnsworth-Munsell 100 Hue. It is possible to use a colored filter to alter the appearance of the test in order to simulate congenital defects. This technique has been used to simulate color vision changes with aging.[4,5] Informal conversations with other instructors indicate that they do use filters to simulate color vision defects, but usually restrict the demonstration to one or two tests because both red-green and blue-yellow errors are often produced. We did some preliminary observations with the individual red, blue and green filters from the red/green and red/blue glasses used for binocular vision testing. Although the vanishing test numbers in the Ishihara test did disappear, the transformation numbers were also invisible when viewed through the filters. With other tests, such as the Standard Pseudoisochromatic Part 2 or the Hardy, Rand, Rittler color vision test, it was difficult to see both red-green and blue-yellow test figures, which would result in an indeterminate diagnosis as to the nature of the defect.

Rather than continue to search for a suitable filter, we elected to try a blue light for illuminating the tests in an attempt to find a technique that would simulate primarily red-green defective responses on a variety of tests. This approach was based on Schmidt's report that color-normals make more errors on the pseudoisochromatic plates when the illumination on the test is bluer than the recommended light source.[6] This report summarizes how effective the blue illumination was in rendering the test colors so that the responses matched the results from a person with a red-green color vision defect. We are unaware of any systematic evaluation of any technique to simulate color vision deficiencies across a variety of tests.

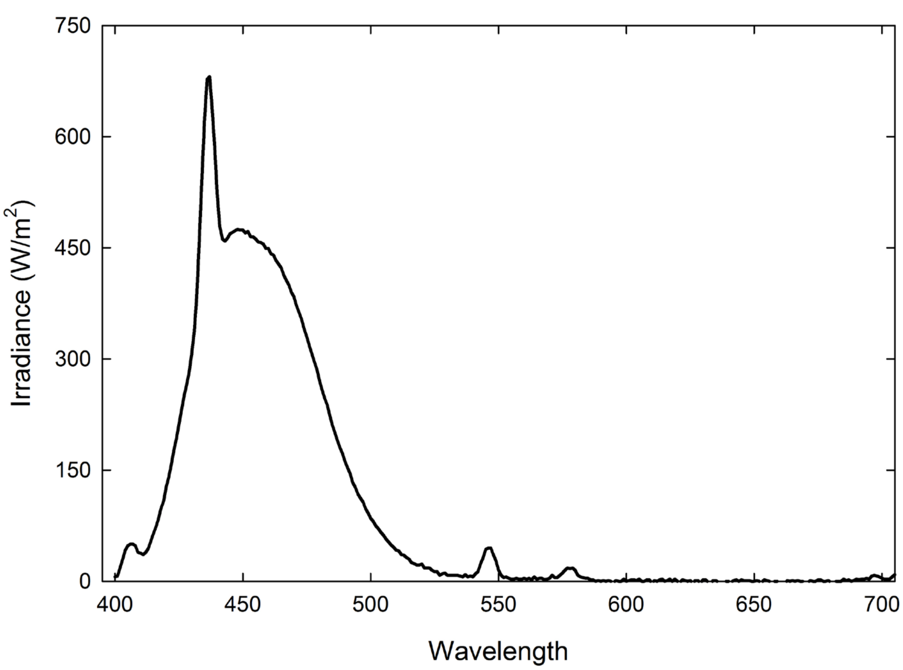
Methods

The criteria for selecting the lamp were that the lamp was readily available in home improvement or hardware stores, relatively inexpensive, could fit into an incandescent lamp desk and did not generate a substantial amount of heat. The latter requirement eliminated the more common filtered incandescent lamps. The bulb selected was a 13-watt blue twisted compact fluorescent light bulb (BPESL 13T/B/CAN, manufactured by Feit Electric, Pico Rivera, Calif.). This lamp is available from a number of suppliers in our area and appears to be easy to obtain in the United States based on a Web search. **Figure 1** shows the spectral irradiance of the lamp in the visible spectrum. The measurements were made using a LI-COR LI-1800 Spectroradiometer (Lincoln NB) with the lamp placed 50 cm straight above the detector. The illumination on the plane 50 cm below the lamp was 36 lux.

The light source was used as part of a teaching laboratory in administering color vision tests. Optometry students administered five different pseudoisochromatic plate tests and three different arrangements tests to each other. The pseudoisochromatic plate tests were the 38-plate edition of the Ishihara test (Kanehara & Co, Tokyo) (the first 21 screening plates and 4 diagnostic plates), Standard Pseudoisochromatic Part 1 (SPP1) and Part 2 (SPP2) (Igaku-Shoin, Tokyo), the 3rd edition of the Hardy, Rand, Rittler Color Vision Test (HRR) (Richmond Products, Albuquerque, N.M.), and the Pseudoisochromatic Plates Ishihara Compatible (PIPC) (T.L. Waggoner, Gulf Breeze, Fla.). The arrangement tests were the Farnsworth-Munsell D-15 (D15), Lanthony Desaturated D-15 (Desat D15), and the Farnsworth-Munsell 100 Hue (FM100).

The tests were administered using both a daylight lamp (Richmond Products, Albuquerque, N.M.) and the blue lamp, with the daylight condition performed first. Results from 20 individuals will be presented for each test; however, the 20 individuals were not the same across the various tests. All subjects had normal color vision.

Figure 1
Spectral Irradiance of the Blue Compact Fluorescent Light Bulb



Results

Figures 2 and 3 show photographs taken with a Sony Digital Camera (DSC-W270, Fluorescent Day white balance and Auto metering settings) of an Ishihara transformation plate and a D15 arrangement under the blue light.

Table 1 summarizes the results of the plate tests performed under the blue light. All subjects passed the tests under daylight illumination. Nearly all the red-green screening figures were missed on all the tests. More importantly, the majority of students gave the expected response of a person with a red-green color vision defect on both the Ishihara and SPP1 tests under the blue light. These responses included the expected red-green defective responses on the transformation and hidden figures. The other error on these tests was that no figure was visible. Two SPP1 demonstration plates can screen for blue-yellow defects,[7] but neither of these figures was missed by any student under the blue illumination. Nevertheless, the SPP2, HRR and PIPC test results show that students did miss other blue-yellow or scotopic test figures under the blue lamp. In all three cases, the average number of blue-yellow errors was small, but nearly everyone missed the same SPP2 figure on plate 4 (the second test plate) and one of the figures on the second HRR blue-yellow screening plate. The blue-yellow figures on the PIPC test were least susceptible to errors. The six (30%) individuals who missed at least one of the HRR blue-yellow diagnostic plates also missed one of the blue-yellow screening figures. The four individuals (25%) who missed one of the SPP2 scotopic figures also made at least one error on the blue-yellow test figures along with numerous errors on the red-green figures.

The Ishihara and SPP1 diagnostic plates were more likely to classify the person as a deutan. Most individuals saw the last SPP2 red-green test figure, which would also be suggestive of a deutan defect.[8] In contrast, the HRR classification was more likely to result in a protan defect if none of the tritan diagnostic plates was missed. Seeing both diagnostic figures was the primary reason for the unclassified results for the Ishihara, SPP1 and PIPC tests, whereas an equal number of protan and deutan

Figure 2
Pictures of an Ishihara Transformation Plate Under the Blue Light and Daylight

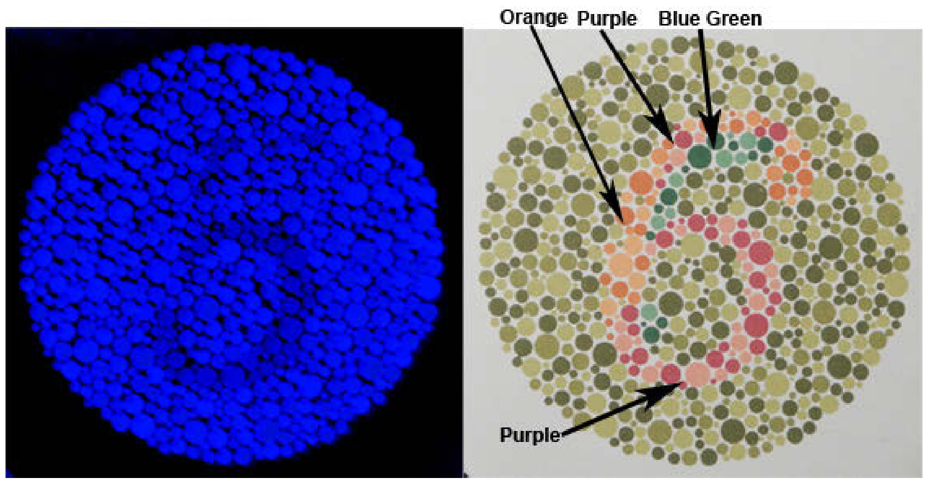


Figure 3
Arrangement of the D15 Under the Blue Light and the Same Arrangement Under Daylight

Table 1
Mean Errors and Classification on the Various Pseudoisochromatic Plate Tests when Performed Under the Blue Light
(The percentages in the parentheses represent the number of students who made at least one of the blue-yellow or scotopic errors. None of the students passed the red-green screening portion of any test.)

Test	Mean Red-Green Screening Errors	Percentage Who Gave the Expected Error on the Majority of Transformation or Hidden Plates	Mean Blue-Yellow Screening Errors	Mean Scotopic Screening Errors	Classification Plates
Ishihara	18/21	75%	NA	NA	40% Deutan 5% Protan 35% Unclassified
SPP1	8.35/10	75%	0/2	NA	85% Deutan 5% Protan 10% Unclassified
SPP2	4.9/6	NA	1.25/10 (85%)	0.3/2 (25%)	NA
HRR	5.4/6	NA	1.5/4 (85%)	NA	15% Deutan 40% Protan 30% Mixed Tritan-Red-Green 15% Unclassified
PIPC	14.5/15	NA	0.05/2 (1%)	NA	40% Deutan 60% Unclassified

figures was missed in the unclassified HRR results.

All subjects passed the D15 without error under daylight illumination, whereas visual inspection of the score sheet for the blue light showed a wide range of results. Errors ranged from one minor transposition to six major crossings with an average of 3.2 crossings. The pattern of crossing errors ranged from protan to tritan, with a deutan-scotopic arrangement as the most common pattern. **Figure 4** shows an example of this last arrangement. In order to analyze the nature of the simulated defects quantitatively, the Color Difference Vector Analysis was performed.[9] The classification of the defect was based on a modification of the red-green dichromats results from Atchison et al.[10] **Figure 5** shows the results and the angles used to classify the arrangement. A minor classification indicated that the number of major crossings was <1, which is typically used as the maximum number of major crossings for a pass. The modification to the Atchison et al. classification was that the range for the deutan angle extended to -20° instead of -15°. The reason for extending the range to -20° was that the distribution of angles is generally continuous between -3° and 20° with a gap in the distribution between -20° and -25°. The ranges for the scotopic and tritan angles were based on breaks in the data distribution, but the values were consistent with preliminary data from Vingrys and King-Smith and values calculated from Sloan's cases.[9,11] The arrangement in Figure 4 is from the subject who had the median angle of the distribution. With the exception of the one result labeled "Other" in Figure 5, the S-indices were similar to values found for red-green color defectives and did not fall within the range associated with random arrangements.[12] The one exception had an equal number of red-green and tritan-oriented crossings.

As with the D15, all subjects passed the Desat D15 without error under the daylight illumination, and their results with the blue lamp illumination varied across subjects. Errors ranged from one minor transposition to eight major crossings with an average of 5.4 crossings. Figure 4 shows the arrangement of the subject who had the median angle of the distribution. The Desat D15 was also analyzed with the Color Difference Vector Program using the same range of angles as the D15 for classification purposes. As expected, based on the higher average number of crossings, both the C- and S- indices were higher than the D15. Figure 5 shows there was also a slight difference in the distribution of the types of defects, with the majority of angles distributed approximately equally between deutan and tritan instead of a scotopic–deutan pattern.

Figure 4
Examples of the Farnsworth and Lanthony D15 Results Under the Blue Light Illumination

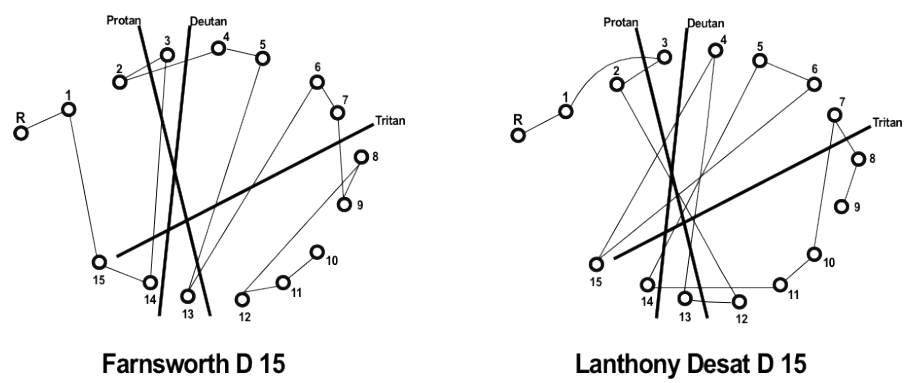


Figure 5
Classification Results for the Farnsworth-Munsell D15 and the Lanthony Desaturated D15 Using the Color Difference Vector Analysis
(The angles in the parentheses are color difference vector values used for the different classifications.)

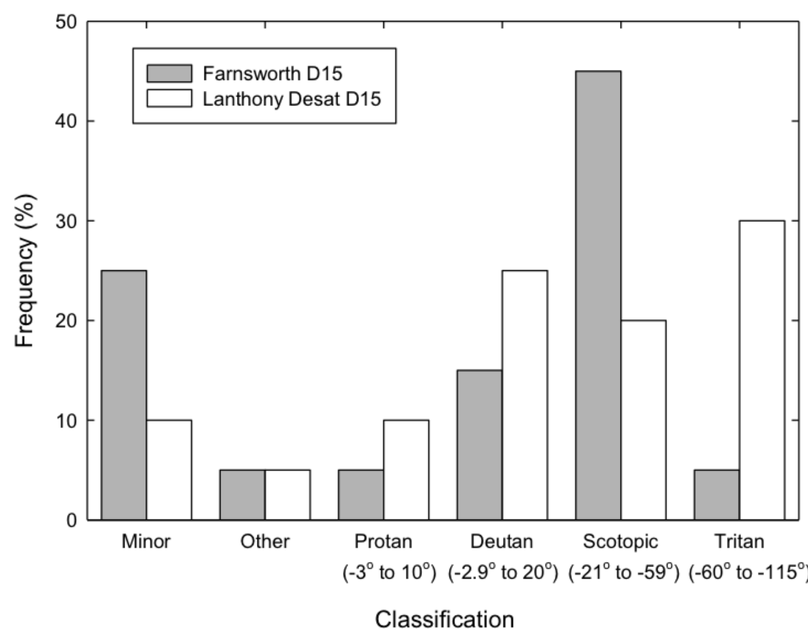
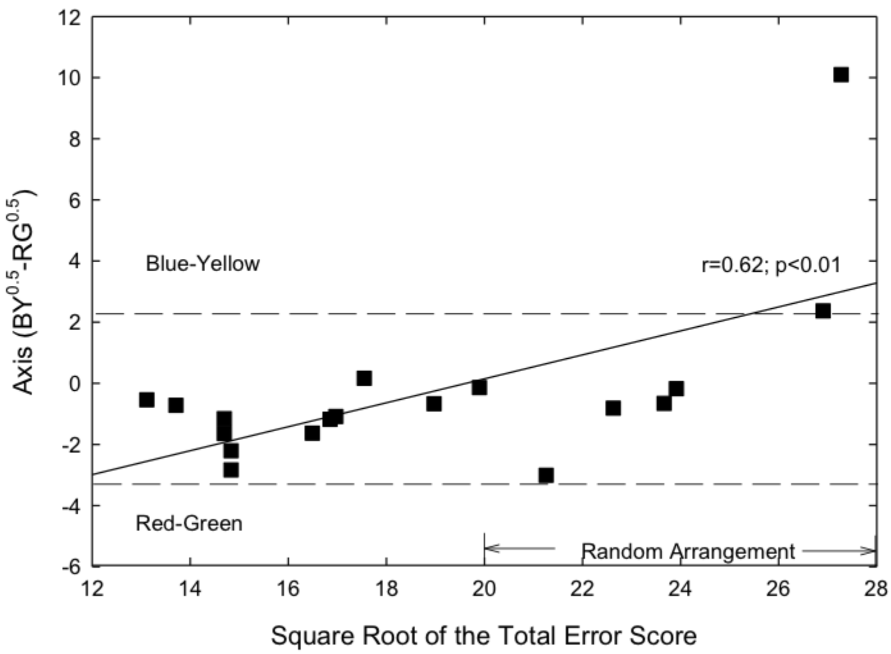


Figure 6 shows the scatter plot of the FM100 square root of the total error score and resulting axis calculated using Smith et al.'s procedure.[13] The figure includes their tentative criteria for a red-green and blue-yellow defect for patients between age 20 and 29. For comparison, the square root of the total error score under daylight was 4.7 and the error axis was 1.10. Under the blue light, there was an obvious increase in the error score and a shift in the axis for most individuals toward the red-green defect boundary. Nevertheless, the level of difficulty under the blue light was high for some individuals, with 28% of the students having error scores typical of random arrangements.[14] The two extreme error scores also had an error axis indicative of a blue-yellow defect, and these two subjects are primarily responsible for the significant correlation between the error score and axis shown in the plot.

Figure 6
Relationship Between Farnsworth-Munsell 100 Hue Error Axis and Square Root of the Total Error Score
(Dashed lines define the color-normal limits for the error axis.)



Discussion

The underlying principle of all clinical color vision tests is to incorporate specific color combinations that are near or below threshold for individuals with impaired color discrimination without introducing brightness differences that could be used as secondary information in performing the test. Instead of having a visual system that is unable to distinguish between two different colors, the lamp renders the color difference on the tests so that the difference is below threshold for individuals with normal color vision. Although the color differences could be calculated for each possible color combination and mapped in the respective dichromatic color spaces if the reflective properties of the pigments were known, we can use Figure 2 to illustrate the effect qualitatively.

The background color of the Figure 2 transformation plate is green with a small area of blue-green adjacent to the test figure. The "6" is a combination of purple and orange. For a person with a red-green defect, the green and orange colors appear identical so that the lower left portion of the 6 of would appear broken.[16] For the color-defective person, the purple and blue-green pigments are nearly identical in appearance, but sufficiently different from the green background so that the "broken 6" would appear as the number 5.[16] Under the blue lamp, the difference in color between the orange and green pigments is below threshold, and the purple and blue-green pigments reflect similar amounts of the light but different from the green and orange pigments so that the number 5 is also perceived by a person with normal color vision.

The primary goal of using the blue light was to simulate how difficult color judgments could be on the various clinical tests if the patient has a red-green color vision defect and, at the same time, simulate the type and pattern of errors typical of a person with a red-green color vision defect. This included rendering the transformation and hidden figures as they would be seen by a person with a color vision defect. The blue light used in this demonstration generally meets this goal for several tests. Most of the students gave the expected red-green responses on the Ishihara and SPP1 tests hidden and transformation plates while nearly all the vanishing plates were missed. Nevertheless, the collection of other results demonstrates that the blue lamp would also produce blue-yellow and scotopic errors depending on the test. Most of the blue-yellow errors occurred on plates where the figure was purple and the background was gray regardless of the test. These types of errors are not surprising because the blue light renders both the gray background and purple test figures nearly the same bluish color because only the short wavelengths are reflected from both pigments. The SPP1 blue-yellow test figures use purple and green as the test and background colors and the Waggoner blue-yellow test plates use a blue-green and green as the test and background colors. Under the blue illumination, the figure colors remained perceptually different from the background for most individuals primarily due to brightness differences so that these plates were rarely missed. The scotopic errors on the SPP2 may reflect individual variability in chromatic discrimination when the color differences are near thresholds for color-normals.

Most of the plate tests classified the defects as deutan, when the classification was possible. This is also expected because the blue light renders the purple figures on the diagnostic plates (missed by deutans) and gray background nearly the same color, whereas the difference between the pink figures (missed by protans) and the gray background under the blue light remains discernible. The result that both deutan and protan figures were missed or both were seen also occurs in individuals with red-green defects.[15] The result that HRR plates were more likely to give a protan classification is likely related to differences in the pigments used in printing the plates. It would be interesting to determine whether the 4th edition of the HRR, which is visibly different from the 3rd edition, produces similar results.

Both D15 arrangement tests showed a tendency for arrangements in the deutan-scotopic direction with the Desat D15 also showing some tritan arrangements. Although these arrangements do not represent the classical red-green error patterns, they do occur in practice if the number of crossings is less than five on both tests.[10] The higher between-subject variability in the Desat D15 arrangements and corresponding angles calculated using the Color Difference Vector Program has also been reported for congenital red-green color defectives who have less than seven major crossings on the Desat D15.[9] The FM100 results suggest that the color differences under the blue light may have been too small for the approximately 30% of the students who arranged the caps randomly. For the rest of the individuals who had FM100 error scores below the random range, there was a shift in the error axis toward the red-green direction, but not completely into the red-green color-defective region. The majority of these patterns were oriented in the deutan-scotopic direction, which is between the deutan and tritan error patterns and consistent with the majority of D15 arrangements.

The Ishihara, SPP1, PICP and the D15 worked best with the blue lamp in simulating the responses of individuals with red-green color vision deficiencies. Obviously, the lamp reduces the color difference between the background and figures for the plate tests and the D15 caps. However, the light provides sufficient output in the mid spectral region so that the color difference between the green, blue-green and reds is discernible, whereas the differences between the green and orange colors are not discriminable. For the D15 caps, the color difference between the blue caps and the purple (cap 15) is reduced more than the color difference with green caps so that the arrangement starts as a deutan pattern for the most individuals. However, the pattern may shift toward a scotopic or tritan arrangement as the student begins to sort the yellow-greens and orange colors. These have a similar hue and brightness to each other under the blue light. This results in a deutan-scotopic arrangement.

Although the blue light does not always give typical red-green results on the D15 tests, the arrangements can be found in practice.[10] The relatively large variability in the patterns was interesting and could arise from at least two factors. The first is the amount of time the students adapted to the blue light illumination. This was not controlled, but it appeared that more than three minutes of adaptation was necessary to minimize the number of blue-yellow errors on the SPP2 and HRR tests and the random arrangements on the FM100. Second, the variability could reflect individual differences in normal color discrimination that become apparent when the color differences are small. Third, it is likely that blue light did produce brightness artifacts and the variability could reflect how the students used this brightness information. This last aspect could also be useful because brightness information is present in everyday tasks for color-defectives and so the testing under the blue light provides students with the experience of performing color-related tasks using brightness information instead of hue. It was interesting to watch the behavior of some of the students as they viewed the tests. Several often tilted the pseudoisochromatic plate booklet back and forth and side to side or held the individual caps close to their eyes in order to help in performing the tests. This type of behavior is sometimes seen with color-defective patients if the testing procedure is not well-controlled.

The demonstration that a blue lamp works reasonably well in simulating red-green defective test results does not preclude using a colored filter instead of a colored light. Figure 1 provides a template for the spectral emittance of a filter-lamp combination that should produce similar results on the color vision tests. However, the blue lamp eliminates the need for any filter holders on the light fixture or for spectacle-mounted filters. Even without the additional holders, the filter is likely to cost more than the lamp.

One of the issues with either the blue light or filter is that everything in the testing area looks bluish. This is obviously an artificial environment and would not be present in a computer-based simulation. However, the computer simulation will render the colors either yellow or blue, and this raises the issue of whether the test colors actually appear that way to individuals with a red-green defect. The blue light also introduces variability within and across color vision tests without any additional image manipulation. This variability could be an advantage or disadvantage depending on one's perspective in teaching color vision testing. Experience in interpreting less common results can be useful in learning how to evaluate a test.

The blue lamp provides a simple, inexpensive method for simulating color vision deficiencies using common clinical tests. Our data provide some guidance to course instructors as to which tests are more compatible with the blue lamp in simulating typical red-green defective responses and which tests result in atypical and more varied results. Although this illumination does not perfectly simulate red-green color vision deficiencies on all tests, it does provide the students with an appreciation of the small color differences perceived by a person with a congenital red-green defect on the various tests and how they may interpret them. The simulation also provides an appreciation of struggling with a color discrimination task that is so easy for a person with normal color vision to perform.

Neither author has any financial arrangement with companies whose products are mentioned in the manuscript or with any competitor company.

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Functional Vision Loss in a Community Health Care Setting: A Teaching Case Report

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Erika Perzan, OD

Abstract

Functional vision loss (FVL) is loss of vision that cannot be attributed to a pathological or structural cause and is often associated with psychological issues. This teaching case report will help students in their understanding of the overall role of the primary care optometrist in the diagnosis and multi-disciplinary management of a child with functional vision loss. From this case, students learn how to think critically when their exam results do not match a patient's complaint, coordinate interdisciplinary communication, effectively communicate with children and their parents about sensitive issues, and manage patients with psychosocial issues.

Key Words: *functional vision loss, non-organic vision loss, multi-disciplinary, community health, visual field, psychological, primary care, optometrist, methylphenidate*

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Background

Functional vision loss (FVL) is vision loss that cannot be attributed to a pathological or structural cause. It is often described as a diagnosis of exclusion because of the need to rule out ocular pathology. This case explains when to suspect this diagnosis, how to differentiate FVL from other potential issues, and the role of the optometrist in ensuring that ocular health is not a factor. Surrounding psychosocial factors, such as home and school environments, that can influence a child's well-being are also discussed. A careful evaluation and comprehensive response by the optometrist can make a difference in the outcome for a young patient.

This case report involves an 11-year-old Hispanic boy who presented with complaints of blurry vision. It is representative of the decision-making process for a diagnosis of exclusion, as well as the role of the optometrist in coordination of care in a multi-disciplinary setting. Third- and fourth-year optometry students and residents can benefit from this case report. The importance of obtaining an extensive case history and involving parents, teachers and health care providers is emphasized.

Student Discussion Guide

Case description

An 11-year-old Hispanic male presented on 1/11/2010 for an eye exam, reporting that he "could not see." His last exam at our clinic in 2008 was unremarkable with documentation of 20/20 visual acuity in each eye. The patient stated that this had been going on for the past year and that he had difficulty seeing the board at school. The patient's family had been unaware of any issues and brought him to the eye clinic for an annual eye exam. His older teenage sister reported that her brother recently liked "to pretend he was blind." He also reported watering and burning in his eyes.

The patient's medical history was positive for Attention Deficit Hyperactivity Disorder (ADHD) and asthma. Additionally, it was noted in his chart that he had been having a worsening series of emotional difficulties both at home and school and he had been seeing a psychiatrist regularly for treatment. Current medications were methylphenidate, clonidine and Prozac. The patient was also followed by the Mental Health department at the health center. He had frequently not shown up for appointments with both the Mental Health department and the eye clinic throughout the previous year. He was allergic to dust, pollen and dander.

Entering uncorrected distance vision was hand motion (unable to count fingers at 1 foot) OD and OS, and the patient was unable to read the near acuity card. Ocular motility was full OU and pupils were equal, round and reactive to light with no afferent pupillary defect. The patient was unable to detect finger motion on confrontation fields OD and OS. The autorefractor showed a minimal refractive error of OD -0.25 -0.50 x 150 and OS -0.25 -0.50 x 031, but there was no improvement in visual acuity. It should be noted that he did not bump into anything as he walked around the clinic, and was able to grasp the near point card and the occluder with no difficulty. When presented with plano trial lenses, his vision did not improve.

Cover test in previous exams had shown an intermittent left esotropia of 8 prism diopters at distance and near with a cycloplegic refraction of plano -0.50 x 158 and plano -0.50 x 031 with 20/20 acuity OD and OS. Near acuities had been 20/20 OD and OS in 2005 and 2008 with no symptoms at near. The patient did not come back for follow-up as advised until now. His near point of convergence was to the nose with a penlight. Further functional testing was not pursued at this time because he was unable to see the near point card.

Examination of the anterior segment was unremarkable. The cornea was clear OU; lenses were clear OU; and angles were open OU. There were no signs of corneal staining observed OU. Intraocular pressures by Goldmann applanation were 16 mmHg and 17 mmHg at 1:45 p.m. Upon dilation, the media was clear; optic nerve margins were distinct; optic nerve rim tissue was healthy; and C/D ratios were 0.3 OD and OS. The maculae were flat and clear with good foveal reflexes OU. The periphery was intact 360 degrees OU.

The optometrist asked the patient if he liked school, and he answered that it was "all right." When the mother was asked how he was doing, she said that he had some learning issues and there would be a team meeting at school to decide how to help him. Upon further questioning, the mother reported that the patient had just started Metadate (methylphenidate) 2 months ago to treat ADHD, and she wondered whether his decreased vision was due to the medication. He had an appointment the same day with his therapist, so a note was written to the therapist, asking her to evaluate the patient's medications for potential side effects causing his vision loss. The therapist discontinued his Metadate and restarted him on Prozac to rule out Metadate as a cause of his vision loss. Given that the medication had changed, we scheduled him back for visual field testing and to follow up on his dry eye in 3 weeks.

The patient was also given preservative-free artificial tears (TheraTears) to use 1 drop t.i.d. OU for subjective reports of dryness. While there were no signs of dryness observed on examination, the patient had been taking medications that can cause decreased tear production. It was hoped that the artificial tears might provide some lubrication, as well as a possible placebo effect if this was functional vision loss. A note was written for his teacher so that she would be aware that he was dealing with significant vision problems and that he was scheduled for follow-up.

Follow-up #1

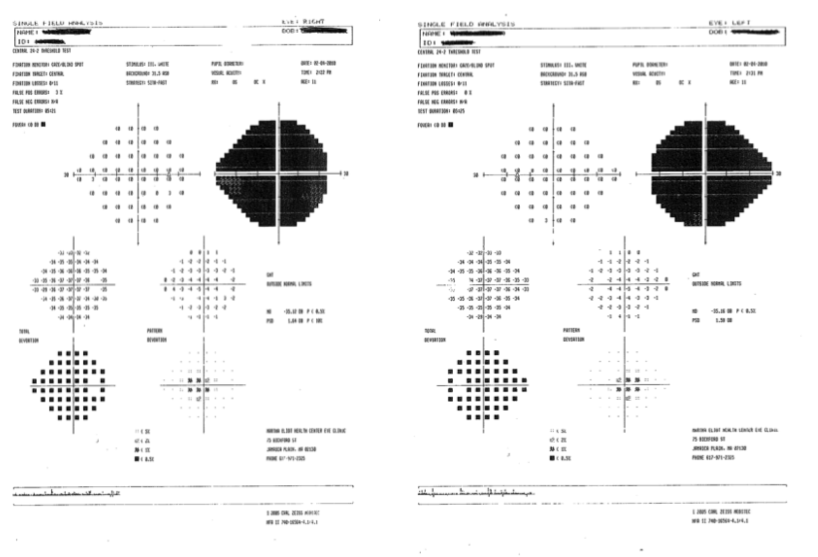
2/4/10

The patient and his mother returned for follow-up and reported no improvement in vision at distance or near. Vision was still hand motion OD and OS, and the patient was still unable to read the acuity card at near. With confrontation fields tested with finger motion, there was severe constriction 360 degrees OD and OS. Humphrey visual field testing (24-2 threshold) showed an absolute defect in both eyes in all quadrants with good reliability **(Figure 1)**. The patient was to come back in 1 month for follow-up. A letter **(Figure 2)** was written to his teacher explaining the situation, including that the patient would need special assistance knowing what was written on the board and doing his homework. Via e-mail we notified his PCP and therapist that his vision status had not improved. In the meantime, the patient continued his therapy visits. However, it had been noted by the therapist that the family had a long history of no-shows.

At this point we deferred referral for OCT, ERG or VER testing for one more follow-up because of the family's history of poor compliance in keeping appointments and not wanting to lose them to follow-up.

Figure 1

Initial Humphrey Visual Field Test Results, 2/4/10



Follow-up #2

3/22/10

The patient missed his 1-month follow-up visit and was called to return. He came 3 weeks later for follow-up. His mom reported that his vision had improved and he was now able to read for fun for 10-15 minutes at a time. Prior to his vision loss, he had good grades in school.

Entering uncorrected distance VA was now 20/50 OD and OS, and 20/30 OU. It was noted at this visit that the patient tended to mix up letters when reading the eye chart. For example, he would reverse his Ds and Bs. The patient was asked to write down the letters as he saw them, and his resulting handwriting size was roughly equivalent to a 20/80 letter size at near. He was also able to read numbers on a piece of paper at 20/80 size. A repeat of visual field testing did not show any significant improvements **(Figure 3)**, and finger-counting fields were still constricted.

The mother was asked if she had noticed him mixing up letters at home, and she said that she had observed this once in a while, but that she was not surprised because dyslexia runs in her family. The mother was strongly encouraged to request testing at school for dyslexia.

Follow-up #3

4/13/10

The patient reported no significant improvement since the last visit. He had suffered a broken leg 3 weeks prior and had to miss school. He was able to read large print with a hand magnifier that his mother had purchased at the pharmacy. The mother reported that she had requested that her son be tested for dyslexia.

Uncorrected distance VA was improved to 20/40 OD and OS, and 20/30 OU. Near VA was 20/70 OU. Loaner glasses of +0.75 sph OU and +1.50 sph OU were available, and it seemed that +0.75 sph OU for near vision helped the patient to magnify reading material so that he could read 20/40 OU. The +0.75 sph glasses were dispensed to him for temporary use, and he was instructed to use them only if they helped to magnify the words at near.

Figure 2

Letter Written to Patient's Teacher, 2/4/10

Dear Teacher:

This letter is concerning Patient X, a 12 y.o. student of yours. He came for his yearly eye exam on 1/11/10 and we found that his vision was severely decreased from the prior year. He cannot see the "big E" on the vision chart, which is worse than 20/400. We were concerned that a new medication he had started on was the cause of his vision loss, but even though he stopped the medication, his vision has not recovered. Upon further testing today, I believe that he has Functional Vision Loss, which is usually a temporary loss of vision due to psychological stress. I understand that he has been going through psychiatric counseling for ADHD, and I am contacting his therapist to suggest that he resume regular therapy.

I am not certain of how long it will take him to regain his vision, but I believe it will probably be at least a couple of months, if not longer. He will probably need special assistance in school so that he can complete his schoolwork (i.e. knowing what is written on the board). I will be seeing the patient once a month to monitor his vision. I am also notifying his primary care doctor so that she can help to request special services if needed.

Please let me know if I can be of any further assistance.

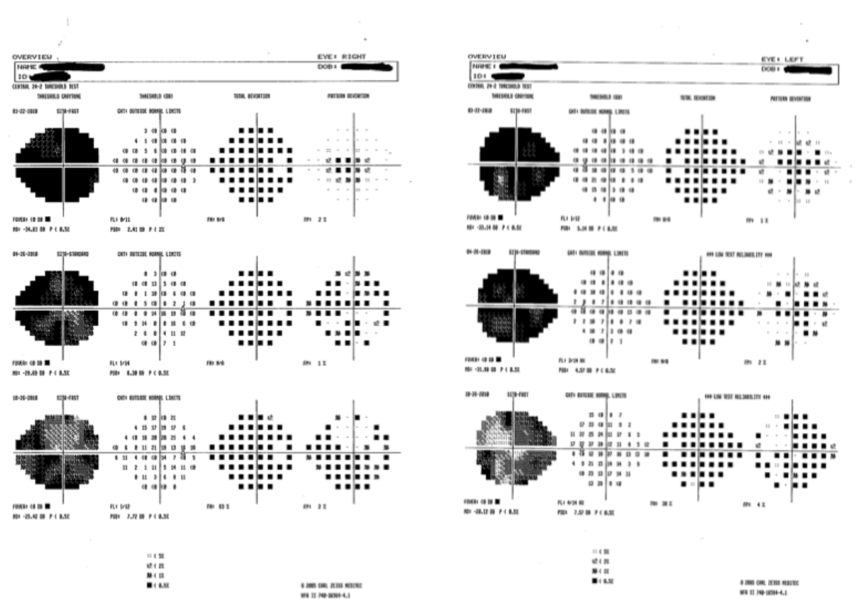
Sincerely,

Optometrist

Figure 3

Visual Field Test Results, 3/22/10

(also shows progression analysis from 3/22/10 to 10/26/10)



The mother deferred a repeat visual field test because of other appointments. The optometrist emphasized the importance of keeping follow-up appointments with the psychiatrist and with the eye clinic.

Follow-up #4

4/26/10

On this visit, the patient said his vision was better, and his mom agreed, stating she had observed an improvement as well. He reported that the +0.75 readers helped him with his near work, and he was now able to see numbers on a cell phone.

Entering uncorrected distance vision was 20/25 OD and OS, and a slow 20/20 OU. Visual field testing continued to show dense defects 360 degrees with some central clearance. **(Figure 4)** The mean deviation, while still high, was improved. The patient was very distracted during testing. He was scheduled to return in 1 month for follow-up, including visual field testing.

Follow-up #5

10/26/10

The patient did not keep his 5/17/10 appointment and was lost to follow-up despite numerous phone calls to his mother from the eye clinic. He finally came on 10/26/10 for a vision check and visual field test. The patient (and his mother) reported doing better in school and being able to read books. His uncorrected vision on this visit was 20/20 OD and OS at distance and near. Visual field testing **(Figure 5)** was consistent with severely constricted fields, but the defects were significantly less dense than on previous tests. His finger-counting fields were now full OD and OS.

The patient's mom reported that they had moved to a new town and her family's stress level in general was much lower. The patient had yet to be tested for dyslexia, but the new school was planning to perform the evaluation. Since this visit on 10/26/10, the patient has not kept multiple routine eye exam appointments.

Figure 4
Visual Field Test Results, 4/26/10

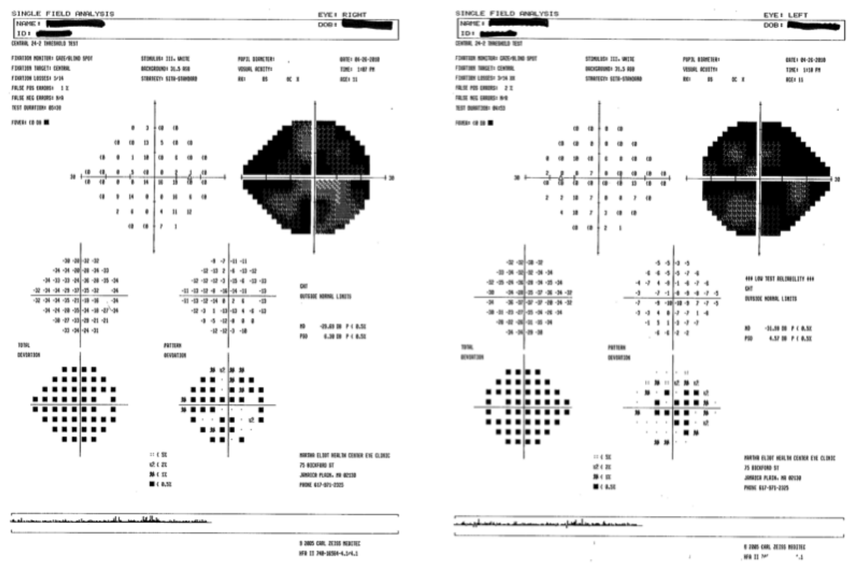
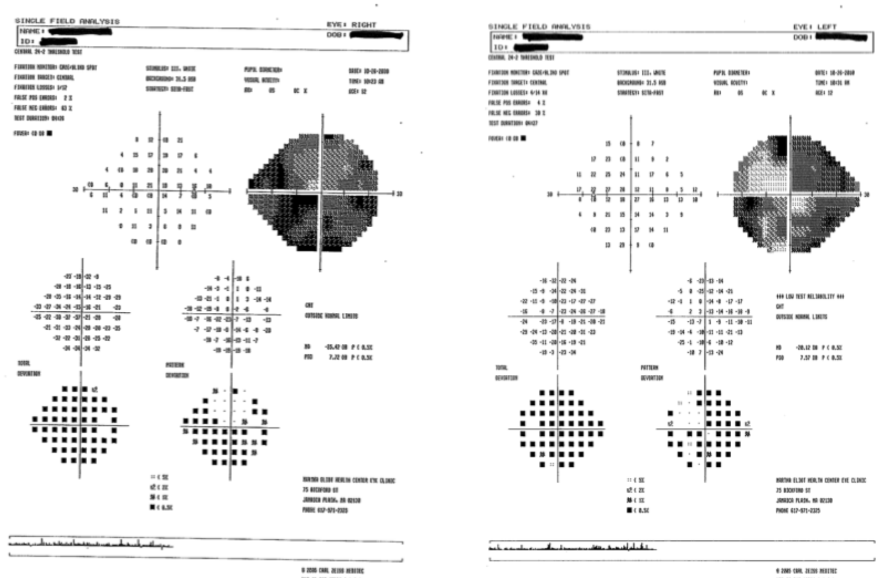


Figure 5
Visual Field Test Results, 10/26/10



Educator's Guide

Key concepts

1. The role of case history in considering FVL
2. The significance of the diagnosis for the well-being of the patient
3. The importance of the optometrist in coordination of care with caretakers and health care providers

Learning objectives

1. Recognize and understand common signs and presentations of FVL
2. Identify potential causes of FVL
3. Understand that a diagnosis of FVL requires ruling out ocular pathology
4. Understand the different types and potential reasons for FVL

5. Effectively be able to communicate with other health care professionals regarding the psychological status of the patient
6. Understand the long-term management and follow-up schedule for the patient

Discussion points

1. What are some conditions that would present as significant decreased vision in both eyes?
2. How do we decide if the vision is refractive vs. pathological vs. non-organic?
3. Describe the differential diagnosis of FVL vs. malingering and other conditions

Generating questions, hypothesis and diagnosis

1. At this time, what are our differential diagnoses?
2. Describe the classic signs of FVL
3. What kinds of questions were asked of the patient to ascertain that there might be a psychosocial cause for the FVL?
4. What diagnostic tests were used to diagnose FVL? What other options are there?
5. Is the diagnosis logical?

Management

1. Discuss whether it would be sufficient to refer the patient to an ophthalmologist
2. How does the optometrist coordinate care with other disciplines in this case?
3. What are the roles of the primary care physician and the psychiatrist in this case?
4. What categories of psychiatric medications can cause visual disturbances?
5. How can the optometrist help to address non-compliance from the patient in keeping appointments?
6. Discuss the different types of FVL

Critically assessing implications, patient management and psychosocial issues

1. What are the implications of only monitoring the patient's vision and not coordinating care with mental health practitioners or the primary care physician?
2. What are the potential consequences if the patient is non-compliant with follow-up care?
3. Discuss how the manner in which the patient was reading letters indicated a potential learning delay
4. Discuss how far an optometrist should go to ensure that a child with FVL is getting proper care at home, at school and in his or her health care facility
5. How might this case be different if it were an adult patient?

Literature review

The prevalence of FVL has been reported as 1.75% in children and 5.25% in adults.[1] FVL includes a variety of visual symptoms that often include ocular discomfort, pain, blurred or decreased vision, color vision loss, ptosis, blepharospasm and light sensitivity.[2] These symptoms, and often lack of symptoms, can present as a result of any number of physical, psychological or emotional stresses or abuse.[3] A diagnosis of FVL first must be differentiated from any type of pathology and then must further be differentiated from a malingering patient, which is often at the top of the clinician's list of differentials, especially in children. Clinically, a variety of testing can be useful in this diagnosis.

FVL becomes a possible diagnosis when a clinician's evaluation of a patient finds no pathology despite a patient's significant visual dysfunction. Griffiths and Eddyshaw suggested that because FVL implies that the cause of the problem has an underlying psychological cause, a less presumptive term might be "medically unexplained visual loss" for the first patient encounter, until more information is gained.[4] In their retrospective chart study of 58 patients with medically unexplained visual loss, there were 39 patients with bilateral visual loss, and 30 of them showed visual field defects of concentric contraction.[4] A classic sign associated with FVL is a tunnel vision or significant tubular constriction of a patient's visual fields. The type of visual field defect should be relatively consistent no matter what type of visual field testing is done, whether it is by confrontation fields, automated fields, tangent screen or Goldmann testing.[2] Other visual field defects associated with functional vision loss have been of a continuous spiral or jagged star pattern, and even a square or cloverleaf pattern in some cases.[5]

There can also be monocular functional vision loss, which can be assessed with tools such as red-green or polarized acuity charts, or by using vertical prism dissociation with a 4 diopter base down prism.[2] One condition that can have a similar presentation to FVL is cancer-associated retinopathy, which presents with positive visual phenomena, peripheral field loss (ring scotoma), decreased vision and color vision and a normal fundus exam that may involve retinal arteriolar narrowing.[2]

A review of the literature shows that children with functional vision loss are often linked with psychiatric issues or stressors from home and/or school. Taich et al. studied 71 children with non-organic vision loss and found that most were connected with psychological or psychiatric illness.[6] The study found that 31% had home or school stress, 26.7% had diagnosed mental health issues such as anxiety, depression and attention deficit disorder, and 22.5% wanted glasses. Girls in this study outnumbered the boys by 3:1 in wanting glasses. There was a higher association of sexual abuse with eye pain and monocular FVL.[6] In a study of 14,000 children, 40 children (1.75%) had psychogenic amblyopia, and 37% of the 40 children recovered their vision within 1 year.[7] Lim et al., in a 5-year retrospective chart study of 140 patients, reported that FVL appeared to be most prevalent in teenagers between 16 and 17 years old, and was three times more common in females.[1] Social problems at home or school were the issue in 45.8% of the FVL cases for the children in this study, and 3.6% had suffered sexual abuse.[1] More than 30% of the adult and pediatric cases reported underlying depression and/or anxiety.[1] Given the strong association of FVL with psychosocial issues, it is important to take a careful history in a sensitive and reassuring manner to assess the etiology of functional vision loss and the need for referral for counseling.

FVL can be broken down into a number of subsets, which should be considered a part of this diagnosis: conversion disorder, somatization, pseudosomatization, factitious disorder and hypochondriasis.[2] Our patient likely suffers specifically from ocular conversion disorder, a subset of conversion disorder. Conversion disorder can include a number of non-pathological neurological and ocular symptoms, often in the second and third decade. Specifically related to vision, findings often include decreased visual acuities, restricted visual fields and ocular pain, among others. The prevalence of conversion disorder has been reported in the range of 11 and 300 out of 100,000, and it is historically associated with poor medical knowledge, lack of concern for one's situation, and low socioeconomic status.[8] However, FVL should be included as the differential for any socioeconomic status due to the possibility of significant stressors in any life stage. The question may arise as to how a patient can perceive themselves as not seeing when anatomically their visual pathways are fine. Current research is pointing to a regulation dysfunction of the modulation pathways within the limbic system, anterior cingulate and orbitofrontal cortex, which may explain the mismatch between what is seen and the patient's perception of what they see.[9]

Somatization (somatoform disorder) is a result of emotional stress that manifests as physical symptoms. It is unintentional and manifests both objective and subjective symptoms.[4] Hypochondriasis essentially is a constant worrying or fear of having an illness, which presents in the form of the patient believing he/she actually has a condition.[2]

Additionally, there are two disorders that are essentially malingering and should be dealt with as such, with the provider's discretion. In pseudosomatization, the individual knowingly attempts to mislead the provider while claiming to suffer from any number of emotional/psychological issues.[2] Essentially, the individual is faking a somatoform disorder. Fictitious disorder (Munchausen's syndrome) is similar to pseudosomatization with the major difference being that the individual will actually harm him/herself or child with the intention of garnering attention from any number of people.[2] Many times, patients who may be experiencing FVL can be mistaken as malingerers. Because of this, it becomes necessary to be able to accurately differentiate malingering from FVL. A study of 973 children with non-organic vision loss revealed 30 cases of malingering or functional vision loss.[10] Six of the 30 cases (20%) were found to be related to psychosocial stressors, and 40% of the 30 cases were malingering because of a desire for glasses.[10] Interestingly, the month with the highest incidence of presentation of non-organic vision loss was September, at 26.7%. The months with the least incidence were July and August.[10] It is important to evaluate the patient's attitude and affect and to use as many objective findings as possible while speaking to the parent/guardian (if applicable).

Medications prescribed for psychiatric conditions often have visual implications. In general, medications for treatment of ADHD are stimulants, such as methylphenidate (Ritalin, Metadate, Concerta, Daytrana), amphetamine (Adderall), lidexamfetamine dimesylate (Vyvanse) and dextroamphetamine (Dexedrine, Dextrostat). The non-stimulant medication (Strattera) is also commonly used.[11] Methylphenidate has been associated with blurred vision and accommodative dysfunction.[12,13] Anticholinergics can also decrease tear production, leading to ocular surface disease.[5]

Some studies have been done to investigate ocular patterns of children with ADHD, as well as the effect of stimulants on the vision of children with ADHD. A 2007 study in Sweden found that 76% of the 46 ADHD children tested had abnormal ophthalmologic findings, such as subnormal VA, strabismus, reduced stereo vision, subnormal near-point of convergence, refractive errors, small optic discs and/or small optic rim areas, increased retinal arterial tortuosity and/or signs of cognitive visual problems.[14] The researchers also found that the addition of treatment with stimulants did not improve visual acuity in these patients. However, a smaller study of 18 children with ADHD in Sweden found that visual acuity and visual field performance improved significantly with methylphenidate and amphetamine.[15]

When FVL is associated with school or home stresssors, research suggests that the prognosis is good for recovery of visual deficit. Lim et al. reported that of their 140 patients, normalization of decreased VA or VF loss occurred in 58.3% of patients, and was more likely in children.[1] Only 10.9% of their patients needed to be referred for counseling; the remainder needed only reassurance that their vision would improve.[1] Taich et al. reported that 80.2% of his 71 pediatric patients improved to the 20/30 visual acuity line.[6]

Discussion

While the diagnosis of FVL is relatively straightforward, the coordination of care for this young patient was complex. The cause of FVL can be an even more difficult diagnosis to arrive at in a child such as the patient in this case. Our patient was a recent immigrant from the Dominican Republic. He was bilingual (Spanish and English), had multiple socioeconomic barriers, had an unstable but improving home life and had psychiatric diagnoses, including ADHD. The patient had all of these stressors as well as frequent school absences due to poorly managed asthma, a recent broken leg and the depth of the functional vision loss he endured for a period of 6-9 months. It was noted both through visual acuities and a series of 24-2 Humphrey visual field test that the child's improvement in vision closely mirrored his improving emotional status. After about 9 months of close optometric and psychiatric monitoring, the child's acuities were restored to 20/20 OD and OS, and visual field testing showed drastic improvements. His school performance improved corresponding to his visual recovery.

FVL in a child can be emotionally traumatic and can impact the child's school life for an extended period of time. A study of 45 children with FVL found 73.3% of them having issues not attending or having frequent absences from school.[16] Optometrists have the opportunity to identify children with visual problems that may interfere with their academic performance, while the family and school are unaware of these potential issues. These visual obstacles can be communicated to the patient's school team to help to support the student's educational goals. Educators may wish to include results from the eye exam in the child's Individualized Educational Plan (IEP) if one is required. In this case, the patient had signs of dyslexia, which also happened to run in the family. The optometrist can play a major role in ensuring appropriate psychological counseling, emotional support for the family, requests for special needs at school, and consistent follow-up for frequent no-shows.

Our patient fortunately showed great improvement over the course of a year while receiving close attention from the co-managing primary care physician and psychologist. He did not present with any type of pathology and showed notable improvements with regard to Humphrey visual field testing, visual acuity, visual symptoms, and parent/psychologist/teacher-reported behavior. Side effects of blurred vision and accommodative dysfunction from the methylphenidate could still have been a factor. Accommodative testing could not be initiated early as a diagnostic tool due to the significance of the patient's visual loss. In the past, he had been noted to have an intermittent left microesotropia, but this would not have caused a bilateral pattern of vision loss. His cycloplegic refractive error had been minimal, and his visual acuities were 20/20 OD and OS. It is worth noting that a Hirschberg or Krimsky test could have been performed even with hand motion vision to determine if the microesotropia had changed in magnitude. If the acuity was truly decreased to hand motion, as opposed to the patient malingering, the magnitude of the microesotropia could possibly increase due to less sensory input for maintaining eye alignment. This would have been another tool for discerning whether vision loss was organic or functional. Given the child's history, we planned to have a consistent follow-up schedule with the child/parent until a full and obvious recovery was made before returning to an annual exam schedule. The optometry student should understand that effective communication and sensitivity to psychosocial issues such as a stressful home environment and difficulty keeping appointments are vital in managing this type of situation.

Had the patient's vision not improved significantly over the first couple of visits, a referral would have been initiated for optical coherence tomography (OCT), electroretinogram (ERG) and visual evoked potential (VEP) tests to search for subclinical findings indicative of retina, optic nerve and visual pathway disorders. An OCT scan could indicate nerve fiber layer, optic nerve or retinal pathology causing vision loss, identifying organic disease such as isolated foveal hypoplasia, which is extremely rare.[17] A military hospital study of 33 FVL patients found that the thinner the retinal nerve fiber layer on OCT, the more likely a patient was to have organic pathology.[18] The absence of pathology on OCT further helps to confirm the FVL diagnosis. A pattern VEP of normal and symmetric amplitude in a patient with severe vision loss would confirm a functional cause for the visual deficit and help rule out optic nerve and visual pathway disease.[5] A normal ERG result would support the lack of severe retinal organic disease.[5] Additionally, it is worthwhile to consider neuroimaging studies such as computed tomography (CT) or magnetic resonance imaging (MRI) to evaluate other potential pathological changes. Some organic conditions that masquerade as FVL include the following: Stargardt's macular dystrophy, Leber's congenital amaurosis, albinism and ocular albinism, isolated foveal hypoplasia, rod monochromatism, retinitis pigmentosa sine pigmento, retrobulbar optic neuritis, neoplasms involving the central nervous system, stroke, multiple sclerosis, Alzheimer's disease and drug toxicity.[5,19] In a retrospective chart study of 140 patients diagnosed with FVL, it was reported that 3 of these patients eventually were diagnosed with some organic cause for their visual loss.[1] Due to bilateral presentation, age, previous healthy exams, and no family history of retinal disease, many of these conditions were ruled out in the first set of visits for this particular case.

FVL is a diagnosis in which the role of the optometrist may be crucial in ruling out malingering, refractive error, functional vision problems and ocular pathology. Below is a list of questions applicable to a clinician who suspects FVL.

1. **Subjective Findings**
   a. CHILDREN
      i. Is the child browsing in the optical prior to examination?
      ii. Does the parent think the child has a visual problem, or suspect an ulterior motive? Does the parent notice the child squinting, covering an eye, sitting close to the television, etc.?
      iii. Is the child performing well in school? If the answer to this question is 'no', then it is possible the child is trying to produce a reason for his/her poor performance.
      iv. Did a sibling, friend or parent recently get a new pair of glasses? The child may be envious of the new pair of glasses and simply want a pair for him/herself.
      v. If the patient previously had no color vision problems, it may be worth retesting this with HRR#4 or Ishihara. A patient with FVL may not recognize any of the plates, while a malingering child will often choose random numbers or, often, one number higher or lower than what is actually being shown.
   b. ADULT
      i. Does the patient seem to have an ulterior motive or a known motive such as a pending lawsuit, disability claim, etc.? Often, this question can be directly asked of the patient.
      ii. Does the person seem legitimately concerned about the change in vision or does he or she really only want a form signed and not seem to care about restoration of vision?
      iii. Did the patient drive to the exam?

iv. Observe for signs of malingering such as careful application of makeup, whether the patient is carefully dressed, etc.

c. CHILDREN and ADULTS

i. If the patient is somewhat unassuming, consider asking a simple question such as "what time it is" if he or she is wearing a watch, or "what color are my eyes?"

ii. Does the problem exist at both distance and near? Clinically, FVL often exists at both distance and near, whereas a patient who is malingering will choose one or the other and focus his or her problems on this.

iii. "The Magic Glasses Test": One of the best and most effective ways to catch a malingerer is to simply put the patient behind a phoropter or use a trial frame with a very low power lens (-0.25, plano, +0.25, etc.) and see if acuities improve. A patient with FVL will not improve, while a malingerer most likely will. This is particularly effective with children who are just looking for a pair of glasses.

iv. Refracting from the 20/10 line: A patient who is malingering, if told that the 20/20 line is "double in size," may be persuaded to read more of the letters.

v. Can the patient sign his or her name with no difficulty? People who are completely blind still have proprioceptive cues and can sign their names or touch their fingers together. A malingerer will pretend to write their names with difficulty.[20]

2. Objective Findings

a. How does the patient act? Is he/she bumping into walls while walking into the exam room, or showing signs of uncertainty when looking around?

b. While a visual field test may be useful, it can also be time-consuming and fruitless because a patient may choose not to recognize any lights, hand motion, etc.

c. Additionally, one seemingly common method of distinguishing a malingerer from a patient experiencing FVL is to have the patient walk up to the chart and compare visual acuities. For example, if a patient can read 20/100 in your chair, and then walks halfway between the chair and the chart, he or she should appreciate the 20/50 line.

d. Pupils: A normal pupil response usually indicates that a person is not blind. An exception would be when there is complete and bilateral destruction of either the optic radiations and/or both occipital cortices.[7]

e. Potential acuity meter (PAM): If told that the test bypasses the eye and measures the brain directly, a malingerer will usually do his best on the test.[7]

In addition to the above methods, in order to confidently diagnose FVL, a student should understand the value of interdisciplinary management in this case, and how to be effective in dealing with so many key players, whether patient, parent, teacher or doctor.

To teach students how to function in a multi-disciplinary environment, the following exercises are suggested:

1. Group discussion: Discuss as a group what potentially sensitive issues might arise when a patient is questioned about potential causes of psychological distress such as home life, work, financial issues, abuse, etc.
2. Role playing: What are the roles of the primary care physician and the psychiatrist in this case? Have students divide up into groups representing the PCP, the psychiatrist, the teacher and the optometrist. What pertinent information would each professional need?
3. Role playing: Discuss how one might speak differently when describing the case to an ophthalmologist vs. a primary care doctor vs. a mental health practitioner (e.g., clinical terms, asking for advice vs. giving advice to another doctor, documentation of conversation)
4. Letter writing: FVL takes time to resolve. How should the optometrist involve the patient's teacher? Students can write a letter to the teacher to convey important information to help school performance.
5. Observation: If students are currently rotating through a multidisciplinary care site such as a community health center, it is beneficial for them to observe the optometrist while he or she is talking with another practitioner about a patient.

Conclusion

The primary care optometrist has the potential to play a pivotal role in the diagnosis and co-management of functional vision loss, especially in children. Had the patient in this case been referred to a specialist outside of the health center, coordination of care would have been more difficult. The optometrist was able to communicate effectively with the parent, the teacher, the primary care physician and the psychiatrist to get the best outcome of visual recovery. This case highlights the importance of interdisciplinary collaboration and communication, as well as an effective patient-doctor relationship.

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