Prepared for the Nebraska Occupational Therapy Association Conference

October 9, 2004, Lincoln, NE

Photon Induced Visual Abnormalities (PIVA) and Visual Dyslexia

Michael C. Parker[1], P.E.

[1]Bureau of Nuclear Facility Safety
1035 Outer Park Drive
Springfield, Illinois 62704
Email: mclparker@insightbb.com

Abstract

This paper presents a unique fundamental causal theory for some forms of visual dyslexia. This work posits that photon energies, specific to hypersensitive individuals, induce within the eye's *photopic* photoreceptors the conditions that create dyslexic-type visual abnormalities, and that those photon energies can be effectively suppressed before they reach the visual system of susceptible individuals. Dyslexic individuals often experience symptomatic relief when treated with specific colored transparent overlays. This work is an outcome arising from a rigorous mathematical analysis of therapeutically successful colored transparency performance (see Henson-Parker reference) and electromagnetic spectrum physics.

The theory proposed here differs from prevailing theories suggesting that dyslexic effects are primarily caused by brain cognition failures, magnocellular visual neurological pathway deficiencies, "deep-brain timing problems", and other causes within or by the human brain.

The term "dyslexia", as used here, is intended to include an array of abnormal visual effects including blurry, vibrating, pulsating, wavy, disappearing, and shifting images, light sensitivity, reversal and transposition of visual images, etc. Figure 6 illustrates some examples of those effects.

Background

From the extensive work of Henson-Parker (see references), and other educational professionals, the use of colored transparent overlays has historically demonstrated dramatic therapeutic results in some individuals who suffer from dyslexia and other visual abnormalities. The theory proposed here was an outcome of collaboration with Henson-Parker to determine the physics underlying the success of patient-specific color transparencies in mitigating the effects of various visual abnormalities, including, some forms of visual dyslexia. In selecting the research approach for this work, we began at the premise that the successful outcomes observed by educational professionals are axiomatic.

To date, there has not been a physical theory that explains why or how patient-specific color transparencies mitigate dyslexic effects. The author believes that absence of such a theory has been central to failures in achieving therapeutic and research consensus within the medical and educational research communities.

This work was undertaken in the sincere hope that it will benefit educational, medical, and other technical professionals and will prompt further research into development of testing and corrective strategies for children and adults with visual learning disabilities arising from what is termed here as the PIVA Effect.

PIVA Effect

The Electromagnetic (EM) Spectrum is a term used to classify radiation with the property of traveling waves comprised of an electrical and a magnetic field component.

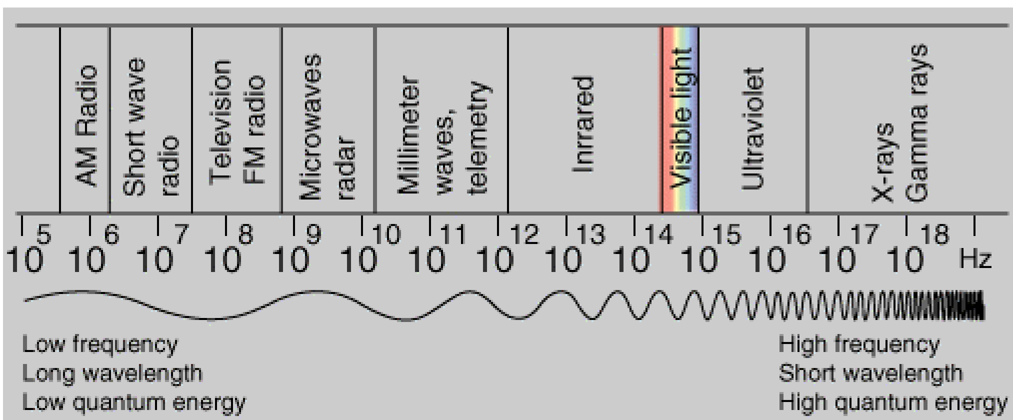


Figure 1
Electromagnetic Spectrum

Observe that Figure 1 rather arbitrarily begins on the left with AM Radio frequencies and ends on the right with Gamma Rays. In fact, the physical EM spectrum is continuous over a much larger range of frequencies. Here, however, our interest is in that portion of the spectrum known as "***Visible Light***".

From Figure 1, visible light is depicted within the range of 10^{14} to 10^{15} Hertz (Hz). The human visual system is generally classified to be sensitive in the range sub-set of 385 to 790 Tera Hertz (THz), although some individuals may be able to "perceive" visible light slightly above or below that estimate. EM radiation is generally accepted to be comprised of ***photons***. A photon can be visualized as a particle of EM radiation, or, for our purpose here, particles of visible light comprised of different colors. Photons have important properties for our discussion. The ***PIVA Effect***, introduced by this work, posits that specific photon energies induce, within the eye's photoreceptors, the conditions that create the visual abnormalities experienced by dyslexic patients.

In the author's view, progress in developing corrective strategies for the PIVA effect have, among other causes, been stifled by thinking of visible light in terms of its ***wavelength***. Wavelength is not a true *fundamental* property of visible light. Wavelength is a derivative property of light, which is to say, that wavelength is derived from explicit knowledge of the speed of light in the medium in which it is traveling (e.g., vacuum, air, cornea, vitreous humor, etc.) and the associated refractive index of that medium. For instance, 600nm wavelength light entering the eye (perceived as *orange* in air) becomes approximately 436nm wavelength light (perceived as *indigo* in air) at the Fovea due to refractive index effects within the eye. What *are* inherent properties of EM radiation (including visible light) is ***frequency*** and that light is comprised of quantum particles known as photons. The specific photon energy associated with light's quantum particles is the product of the photon frequency and a universal constant known as "Planck's Constant".

Humans perceive light through a combination of electro-chemical actions occurring within the eye itself. The outcome of those electro-chemical actions is transmitted to the brain via the optic nerve bundle in the form of complex electronic ***frequency variant waveforms.*** Fourier power analysis of a simulated spectrum, and of Lewine's data (see Figure 11 and references), confirms this. An example of frequency variant waveforms is common FM radio signals.

From Figure 2, light enters the eye, and travels through the cornea, aqueous humor, iris, lens, and vitreous humor where it is reasonably well (although not always) focused on the quite important Fovea Centralis. *In light's journey through the eye, the wavelengths of the incident spectrum change, however their constituent frequencies, and therefore energy, remain constant.*

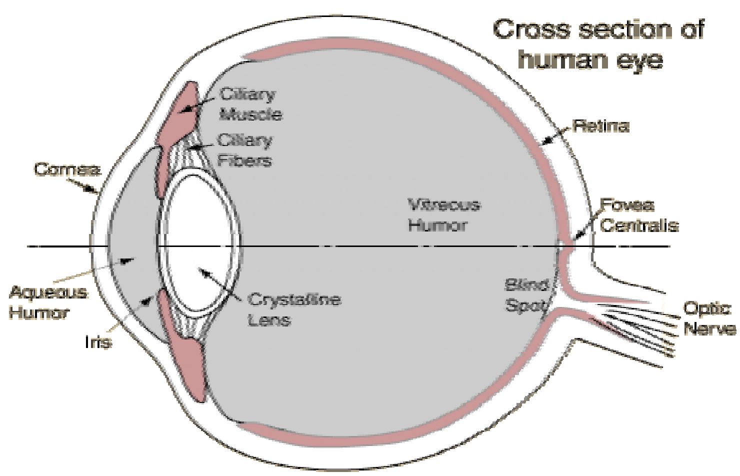


Figure 2
Cross-Section Human Eye

From Figure 3, the Fovea Centralis is where long, medium, and short wavelength high-density photoreceptor cones reside. These photoreceptors transform light's

photon energy into electronic signals. To date, there has been little success in attempting to electronically model the interactions of each individual component of the human visual system. The human visual system does, however, mathematically behave predictably, and reproducibly, between photon input to the visual system and electronic output to the optic nerve bundle. This work will use that characteristic to electronically model the human eye as a single mathematical transfer function.

The number and distribution of cones within the Fovea Centralis varies, and are not only unique to each individual, but also change with age. Cones contain a pigment known as rhodopsin, which, it is believed, is broken down and bleached by the energy transferred from the incident photons. This breaking down process sets off a series of electronic charges that transmit the color light information to the brain, by way of the optic nerve bundle, in the form of frequency-variant electronic waveforms where they are cognitively converted into "visual perceptions". In other words the brain is processing, unaltered, the exact information contained in the electronic waveforms from the optic nerve bundle, and comparing that exact waveform information to past experience according to some as yet unknown algorithms.

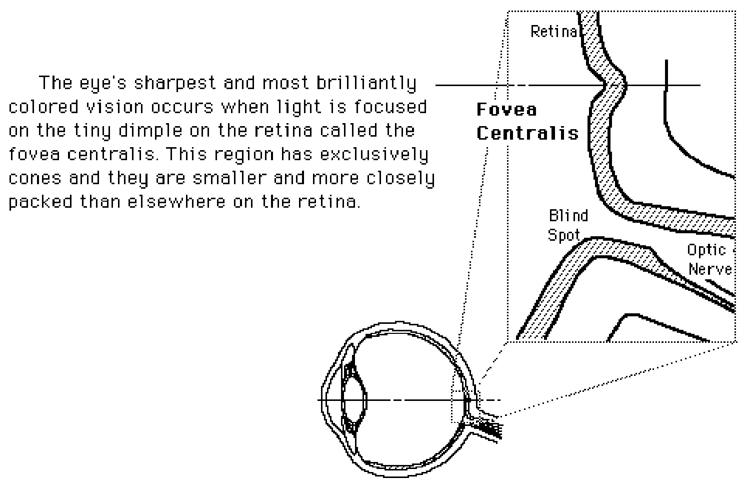


Figure 3
Fovea Centralis

Figure 4 is the commonly used format to graphically represent spectroscopic performance of color transparencies. Figure 4 is from an actual transparency that has been extensively and successfully used in correcting visual abnormalities in children suffering from reading disorders. Spectroscopic data for this transparency was obtained by Henson-Parker from a commercial laboratory. Spectroscopic performance of any individual transparency is extremely dependent on its materials constituency and fabrication methodology. This particular transparency is perceived as *blue* by the normal human eye in ambient light conditions.

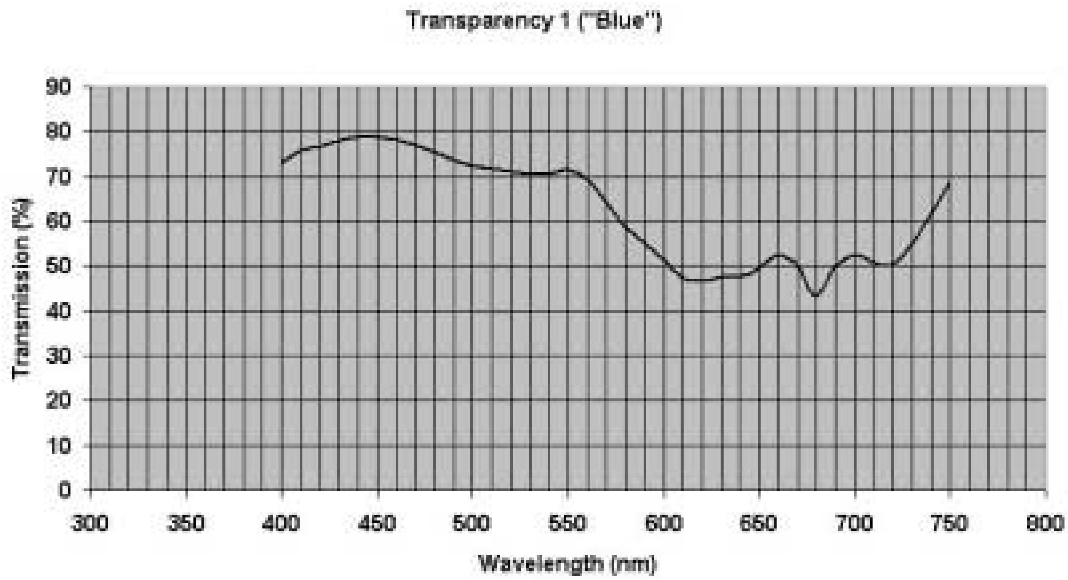


Figure 4
(Graph taken from the work of Henson-Parker)

Figure 5 was developed using the same raw spectroscopic data from Figure 4, but analyzed using various data mining techniques, and presenting the outcome on different scales.

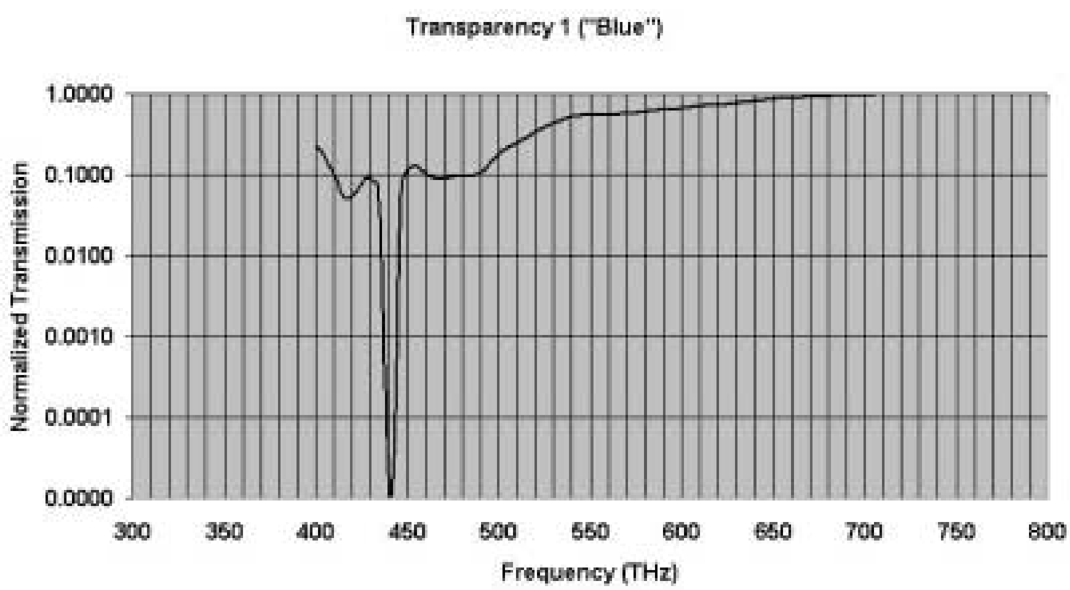
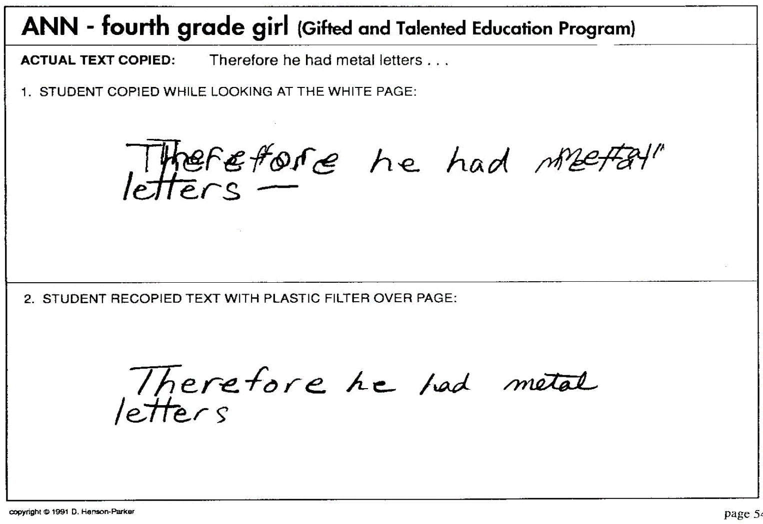


Figure 5
Color Transparency 1 Spectroscopic Data Analysis

When viewing the spectroscopic data as depicted in Figure 5, the physics of transparency operation becomes evident. Transparency 1 is acting to suppress incident photon energies to the eye from the near band on either side of the 441 THz color component of ambient light frequencies. As a point of reference, this EM frequency, in air, would be perceived as “Ultra Red”.

The examples in Figure 6 demonstrate comparisons between what two different children “see” without and with the use of various color transparencies unique to each child. Other students report seeing, among other distortions, upside down and backwards letters and whole words, added or missing letters in words, very irregular spacing or no spacing at all, etc.


ANN - fourth grade girl (Gifted and Talented Education Program)

ACTUAL TEXT COPIED: Therefore he had metal letters . . .

1. STUDENT COPIED WHILE LOOKING AT THE WHITE PAGE:

Therefore he had metal letters —

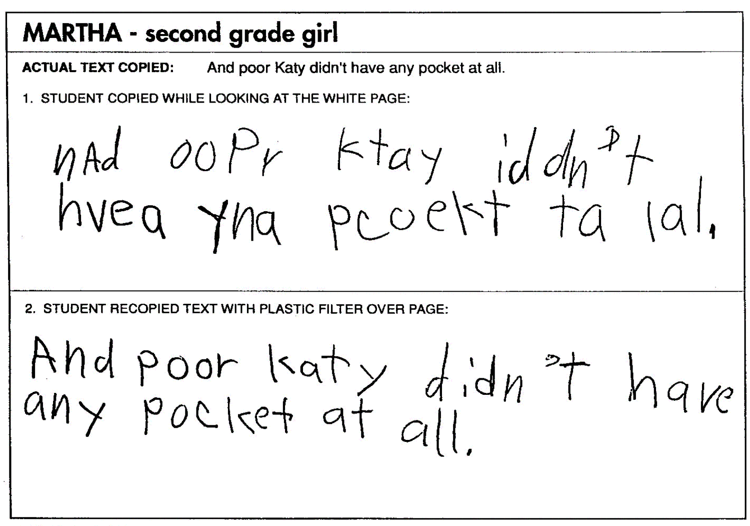
2. STUDENT RECOPIED TEXT WITH PLASTIC FILTER OVER PAGE:

Therefore he had metal letters

copyright © 1991 D. Henson-Parker

page 54

Figure 6a
Henson-Parker Distortion Effect Example


MARTHA - second grade girl

ACTUAL TEXT COPIED: And poor Katy didn't have any pocket at all.

1. STUDENT COPIED WHILE LOOKING AT THE WHITE PAGE:

nAd ooPr ktay iddn't hvea yna pcoekt ta lal,

2. STUDENT RECOPIED TEXT WITH PLASTIC FILTER OVER PAGE:

And poor katy didn't have any pocket at all.

copyright © 1991 D. Henson-Parker

page 50

Figure 6b
Henson-Parker Distortion Effect Example

Mathematically, the human eye performs very much like an electronic circuit. Various simulation models were created in an effort to investigate whether any specific correlations exist between color transparency physics, ordinary electronic circuits, and various electronic models of the human eye.

Figure 7 is the graphical representation of the gain from a simplified electronic "notch filter" circuit designed to simulate Transparency 1. Figure 8 is the schematic of the mathematically simulated circuit that produced Figure 7.

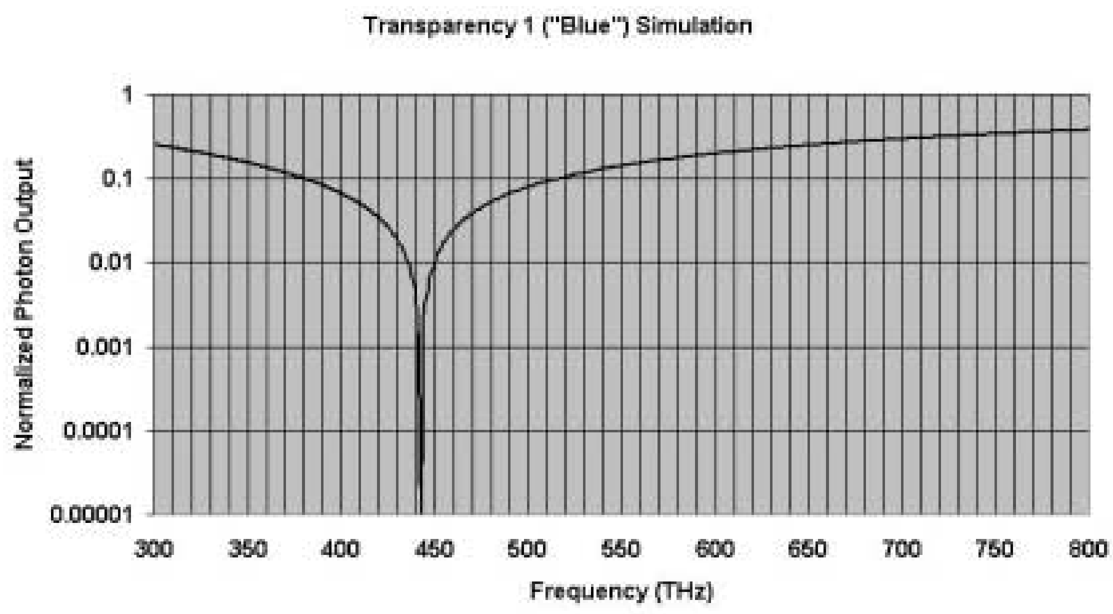


Figure 7
Simulation of Transparency 1 Operation

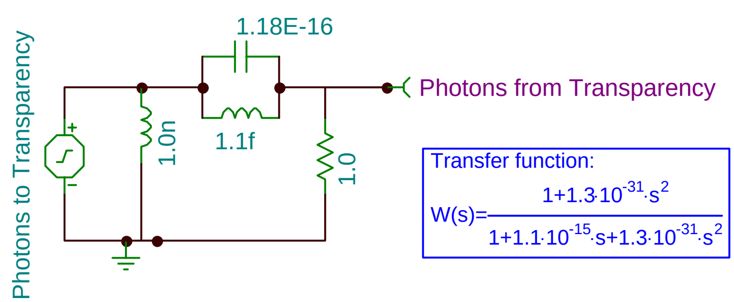


Figure 8
Electronic Circuit Transparency 1 Simulation

Observe the similarities between Figures 5 and 7. A transparency with significant historical success in mitigating visual abnormalities, and a simulated electronic "notch filter" have similar performance at, in this case, the 441 THz frequency.

The mathematical performance of other color transparencies has been examined, and in each case the result is the same, i.e., each successful transparency significantly depresses *specific* photon energy bands. The theoretical implication is that the physics of the transparency and the human visual system behave very much like an electronic circuit that can be modeled and analyzed mathematically, and that *uncorrected incident photon energies can be mathematically correlated to visual abnormalities*.

If, as proposed here, depressing specific photon energies is indeed the underlying physics behind successful transparencies, then it is also reasonable to deduce that the uncorrected eye is transmitting ***distorted*** high gain, high energy, electronic signals when the Fovea Centralis photoreceptors encounter photon energies to which they are hypersensitive. The simulation below is a simplified theoretical optic nerve distortion effect due to an uncorrected visual system hypersensitive to the photon energy associated with the 441 THz frequency.

This distortion effect is similar to "feedback" from conference room speakers. When a microphone is placed too close to the speakers, sound amplifier circuits become overdriven, resulting in the distorted high pitch, high energy, feedback squeal we hear. Similarly, when symptomatic photon energies enter the human eye, the dyslexic's photoreceptors are posited to produce distorted high energy electronic waveforms delivered to the brain via the optic nerve bundle, e.g., electronic "chaff". Figure 9 is a partial simulation of the effect. The mathematically simulated electronic circuit depicted in Figure 10 produced the effect graphed in Figure 9.

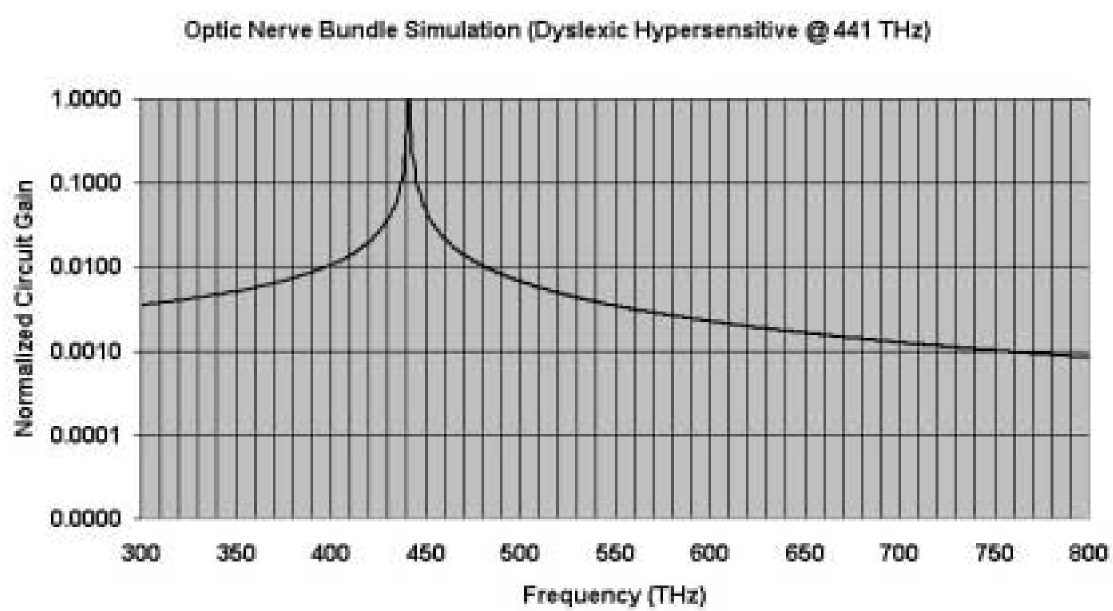
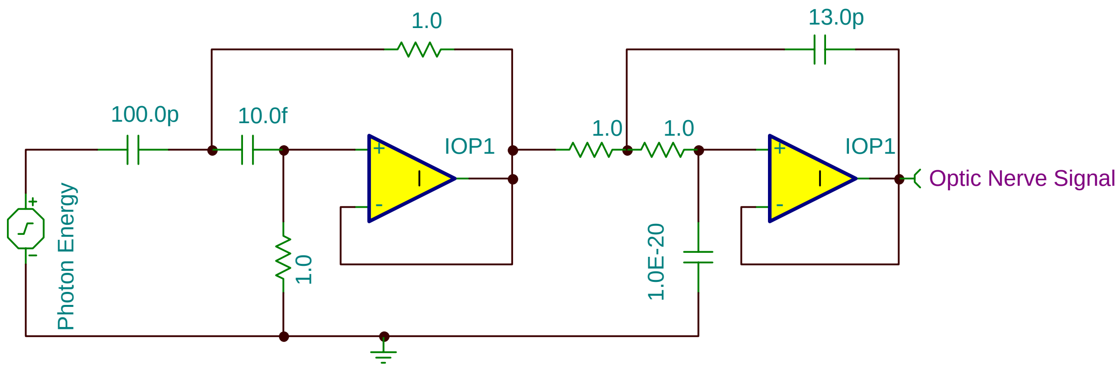


Figure 9
High Gain Optic Nerve Distortion Simulation

Observe in the Figure 9 simulation that the 441 THz signal has a circuit gain over 100 times higher than the gain at 300 THz and nearly 1000 times higher than the gain at 700 THz. Another important physical property of the distortion simulation is that its power spectrum energy content is higher than a non-distorted signal. This is analogous to the real-life effects observed in Figure12. Borrowing from geometry's similarity theorems, our theory posits that for those individuals whose photoreceptor circuits are hypersensitive in the "ultra red" range, the presence of this photon energy in ambient light produces a distorted high gain, high energy content, signal to the brain causing, at least in part, the visual perception effects depicted in Figure 6. It is noteworthy and relevant, from Lewine's work shown in the reference section, and consistent with the theory here, that otherwise visually "normal" individuals can be ***induced*** to experience dyslexic dysfunction conditions by selectively altering photon energies to the eye.



$$W(s)=1\cdot10^{-24}\cdot\frac{s^2}{1+1\cdot10^{-10}\cdot s+1\cdot10^{-24}\cdot s^2+1.3\cdot10^{-41}\cdot s^3+1.3\cdot10^{-55}\cdot s^4}$$

Figure 10
Electronic Circuit Simulation of 441 THz Distortion Effect to the Brain

Figures 11 and 12 graphically represent the optic nerve time series data taken from the Lewine study (see references) and the author's time series Fast Fourier Transform (FFT) power spectrum analysis of that data. In that study, Lewine captured and compared optic nerve electronic signal data from a dyslexic subject with uncorrected and corrected (*with color glasses*) vision. The Lewine data were taken from the work of James Irvine (see references). When the Lewine time series power spectrum data are compared (Figure 12), the energy content of the uncorrected vision is higher than the energy content of the corrected vision. This correlates with the theory presented here that the circuits of the dyslexic's visual system are overdriven by incident high photon energies to which they are hypersensitive.

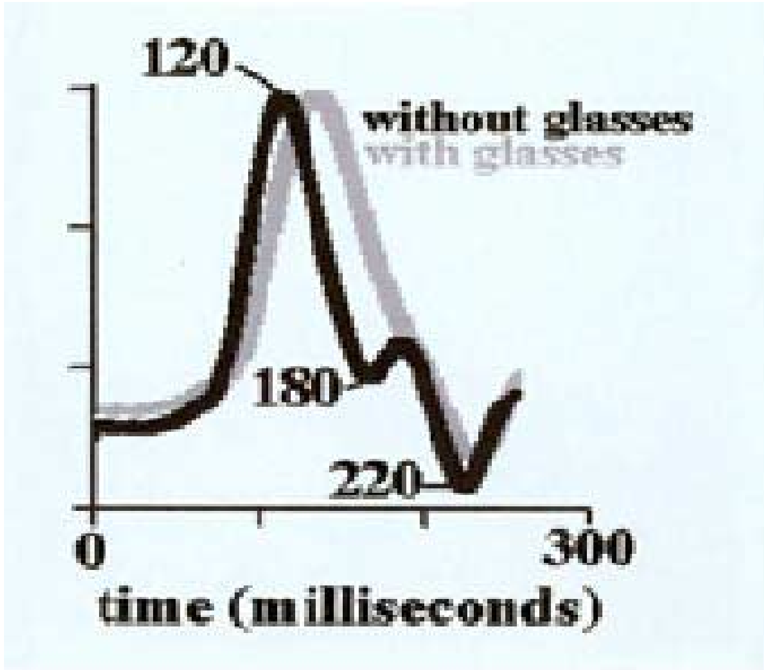


Figure 11
Lewine Optic Nerve Signal (graph taken from the work of Jim Irvine)

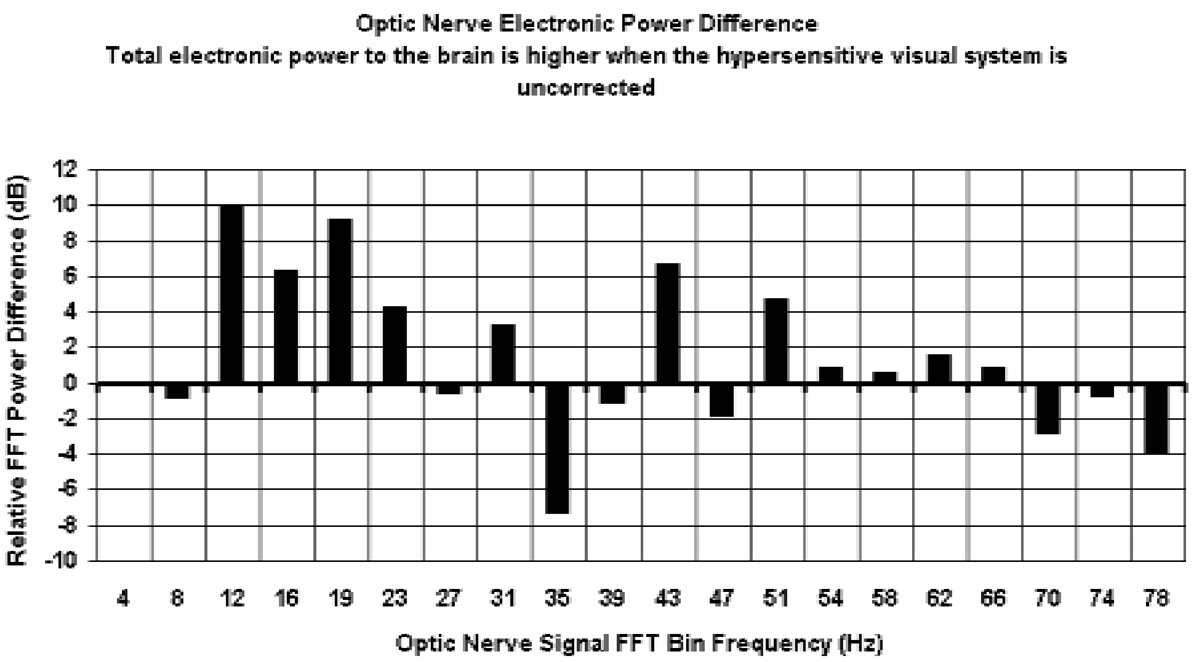


Figure 12
Lewine Optic Nerve Electronic Power Spectrum Comparison
(uncorrected power minus corrected power)

Conclusions

This work proposes a unique causal theory of visual dyslexia. It was an outcome of a collaborative effort with Henson-Parker to determine the physics underlying the success of color transparencies in mitigating the effects of visual dyslexic symptoms.

The theory proposed here differs from prevailing theories suggesting that dyslexic effects are primarily caused by brain cognition failures, magnocellular visual neurological pathway deficiencies, “deep-brain timing problems”, and other causes within or by the human brain. Although these various theories all correlate well with observed dyslexic conditions, our analysis indicates that they are not fundamentally causal. We can only speculate that perhaps the observed conditions from other theories are outcomes, rather than causal, of the brain’s natural adaptation process.

The PIVA theory proposes instead that symptoms of visual dyslexia and other related visual abnormalities are *induced* by specific photon energies that cause electro-chemical abnormalities within the eye’s photoreceptors, that those photoreceptor abnormalities process a distorted high energy content frequency-variant electronic waveform to the brain via the optic nerve bundle, and that many visual abnormalities can indeed be corrected by selectively depressing specific photon energies incident to the visual system of hypersensitive individuals. The proposed theory is not only consistent with the observed performance of subject-specific color transparencies, e.g., see Figure 6 and references, but is derived from knowledge of their successes.

This theory also deduces, from photon energy analysis, that the dyslexic effect is predominately photopic, and not scotopic, in its underlying cause.

Henson-Parker’s extensive studies with both regular and dyslexic students and color transparencies provided the statistical basis from which PIVA was derived.

James Irvine of the Naval Air Warfare Center conducted a study into the basis for successful operation of color transparencies in correcting dyslexic effects. Irvine’s approach, applied to a dyslexic subject, involved the use of colored transparencies and sophisticated mathematical and statistical techniques empirically applied to different theoretical models of the human visual system. The color transparencies were used to reduce the ambient energy of the EM spectrum to the test subject. Among other discoveries, Irvine’s analysis found that it is indeed possible to mathematically simulate the output of the human vision system, and that, to a significant degree of correlation, empirical data from his experiments fit major elements of the Receptor Field Theory of Human Vision. The Receptor Field Theory posits that the eye’s photoreceptors combine their electro-chemical outputs in systematic and unique ways such that an electronic waveform, uniquely representative of given photon energy spectral input to the eye, is processed to the brain via the optic nerve bundle.

Dr. Jeffrey Lewine of the University of Utah conducted studies on human subjects using Magnetoencephalographic techniques. In simplified form, these techniques involve electromagnetic coupling and data logging of electronic signal information from the optic nerve and in the brain. Lewine's data verifies correlations between uncorrected and photon energy corrected (with the use of colored glasses) optic nerve electronic waveforms in subjects who suffer dyslexic type symptoms. Fourier analysis of the Lewine time series data shows that the power spectrum content for uncorrected vision in a dyslexic is higher than the power spectrum for corrected vision in the same subject. This is consistent with the PIVA Effect described here.

The real-life test of any theory is that the theory correlates with experience, whether empirical or derived from first principles or both. The extensive and pioneering work of Henson-Parker, Irvine, Lewine, and others fit within, and are consistent with, the parameters of the theoretical conclusions presented here.

References

Henson-Parker D, 1994 "*See it Right*! Assessment System", Rancho Cucamonga, CA.

Irvine JH, 1997 "Scotopic Sensitivity Syndrome in a Single Individual (Case Study)", NAWCWPNS TS 97-14, Naval Air Warfare Center Weapons Division, China Lake, CA.

Irvine JH, "The Cause of Irlen Syndrome", Naval Air Warfare Center Weapons Division, China Lake, CA.

Lewine JD, Davis JT, Provencal S, Edgar JC, Orrision WW, 2001 "A Magnetoencephalographic Investigation Of Visual Information Processing In Irlen's Scotopic Sensitivity Syndrome", *Perception.*