Visual Field and Subjective Improvements in Visual Symptoms Associated with Traumatic Brain Injury Using Optometric Phototherapy Alone: A Case Report

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Abstract:

Background: Traumatic brain injury (TBI) affects many people and is known to have visual sequala, notably light sensitivity. Patients with these visual symptoms have varying degrees of symptoms and exam findings. With the validation of the Brain Injury Symptom Survey (BIVSS), it can be used for diagnostic purposes and monitoring for changes throughout treatment. Additionally, kinetic color visual fields are beneficial in tracking progression of patients through a rehabilitation program.

Case Report: A 31-year-old female presented to the clinic following a concussion during a motor vehicle accident. She initially presented to the clinic and performed vision therapy from 2021 to 2022 for approximately one month before discontinuing therapy. She remained symptomatic and presented to the clinic in February 2024. Her BIVSS was 40, she had symptoms of light sensitivity and exhibited compressed automated Functional Color Field Tester (kinetic color visual fields), enlarged blind spots, and ill-sustained pupillary constriction (i.e., Alpha Omega Pupil). She performed optometric phototherapy (O.P.) using Upsilon Omega, Mu Upsilon, and Delta Omega over five months, improved her BIVSS, improved her blind spot measurements, and expanded her color fields on the automated Functional Color Field Tester.

Conclusion: O.P. clinically improves patients' symptoms and visual deficits, but little research demonstrates these improvements. The present case shows the subjective and objective improvements made with O.P. alone.

Introduction:

According to the Centers for Disease Control (CDC), traumatic brain injury (TBI) affects approximately 1.5 million people annually. Of the 1.5 million sufferers, motor vehicle accidents are the most common cause of TBI.

Test	February 2024	May 2024	June 2024	July 2024
Ill-sustained pupillary constriction (Alpha Omega Pupil)				
Right Eye (in seconds):	4	6	6	6
Left Eye (in seconds):	5	7	6	6
Visual Acuity Distance:				
Right Eye:	20/25	20/20	20/20	20/20
Left Eye	20/25	20/20	20/20-1	20/20-1
Visual Acuity Near:				
Both Eyes:	20/32	20/25	20/20-2	20/20
Brain Injury Vision Symptom Survey				
Total Score:	40*	37	33	26
Light Sensitivity (BIVSS):				
Normal Indoor Lighting is uncomfortable - too much glare:	3**	2	1	0
Outdoor light too bright – have to use sunglasses:	2	3	2	2
Indoor fluorescent lighting is bothersome and annoying:	3	2	2	1

** The total score of the BIVSS is added-up to provide an overall score for all categories: eyesight clarity, visual comfort, doubling, light sensitivity, dry eyes, depth perception, peripheral vision, and reading. The patient responds to a 0-4 questionnaire on each assessment. The answers range from never (0) to always (4), respectively.*

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Table 1: *Objective and subjective measurements showing the changes from the beginning (February 2024) of the O.P. throughout the patient's treatment period up until July 2024.*

Additionally, TBI can be debilitating and lead to hospitalizations and even death.[1] Individuals with TBI can commonly have vision deficits or symptoms.[2]

A common symptom for patients with TBI is photophobia. In a systematic review, Merezhinskaya et al. found that approximately one-third of patients (30.46%) had photophobia. It was statistically significant that the number of patients with photophobia decreased to 13.51% between 1 and 3 months. However, patients can still suffer up to twelve months and beyond.[3] TBI-induced photophobia has been much researched via dynamic pupillometry and its role in photosensitivity; it is common and significant for the TBI population to suffer from photophobia more than visual normal patients.[4-7]

Subjectively, the Brain Injury Symptom Survey (BIVSS) assesses a patient's photophobia symptoms. It is a validated survey that can help predict the visual symptoms associated with TBI. The questions regarding photophobia were significantly worse than those of a visually normal population base.[8]

The current case report is a demonstration of the functional and subjective improvements in a patient who sustained TBI from a motor vehicle accident. Due to an inability to participate in vision rehabilitation, the patient utilized only optometric phototherapy (O.P.).

Case Report:

A 31-year-old female suffered a traumatic brain injury from a motor vehicle accident on September 8, 2019. She subsequently had visual sequela following the accident. She was diagnosed with a traumatic brain injury (ICD-10 code of S06.0X0S) by her physical medicine and rehabilitation physician. She presented to the clinic in December of 2021, and following her testing, she enrolled in vision rehabilitation. However, she only completed four sessions between December 2021 and the end of January 2022. Despite being symptomatic and not noting improvements in her early program, she self-discontinued the program.

In February 2024, she still complained of visual symptoms and noted they had worsened over the approximate-

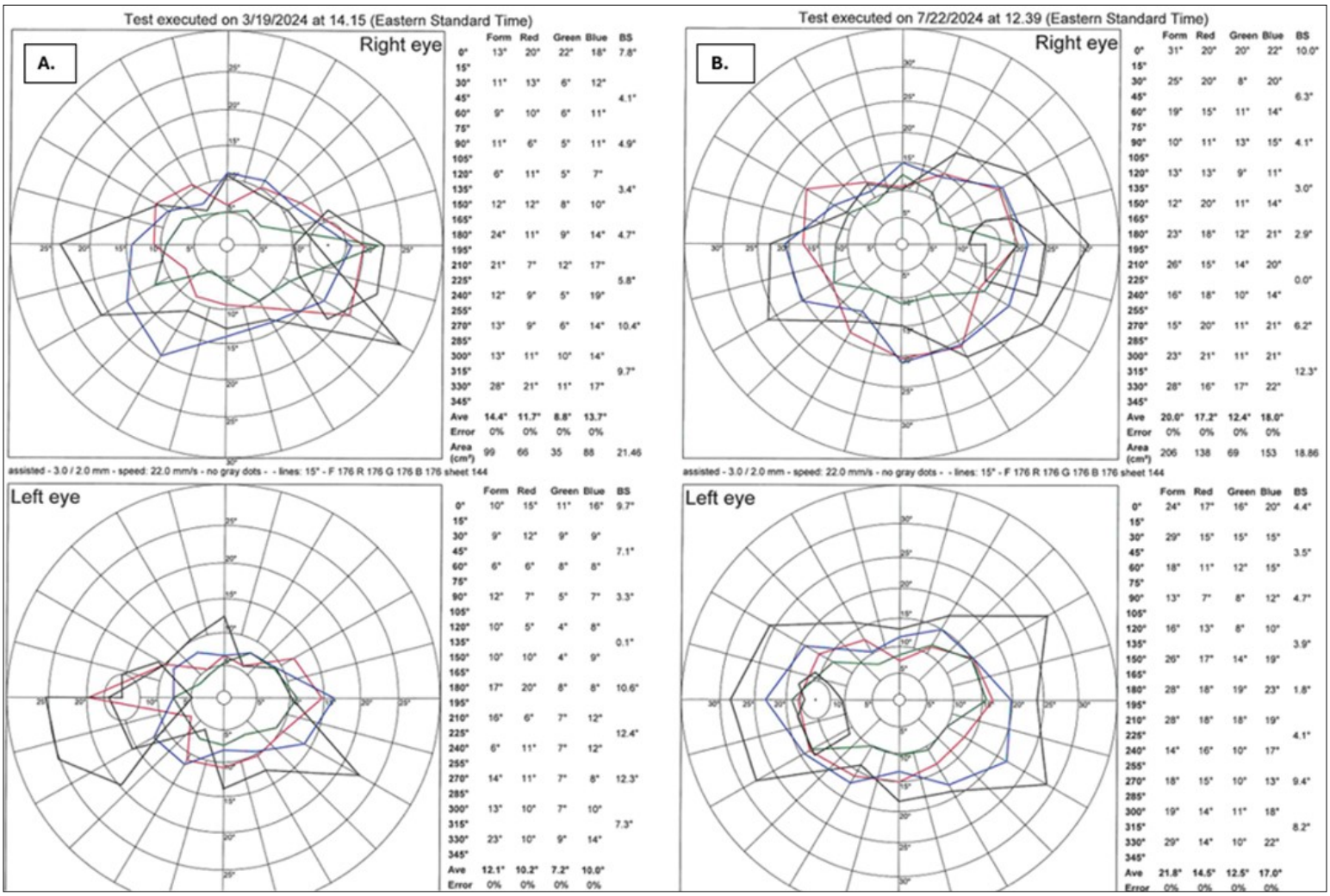

Figure 1: *Automated Functional Field Tester Printouts.* ***A.*** *The initial automated functional field tester was measured on March 19, 2024. The field shows the visual field with the right eye field on the top and the left eye on the bottom. The table on the right of the photo shows the point at which each presentation of the target was identified. The bottom row presents an average (in degrees) of the visual fields for each measured isopter.* ***B.*** *The final visual field measured on July 22, 2024, shows an expansion of the color isopters and a more normalized blind spot (i.e., smaller is better).*

ly two-year period. She had positive symptoms on her Brain Injury Vision Symptom Survey (BIVSS) due to visual comfort and light sensitivity (indoors and outdoors), among other categories. In particular, she noted her indoor photophobia was a 3 (i.e., frequently, on a 0-4 Likert scale).

Her health history was positive for TBI, depression, and anxiety. She was taking Zoloft, Adderall, Wellbutrin, and Rexulti. She reported no history of tobacco, alcohol, or social drug use. Her ocular history and family ocular history were negative for diseases.

She returned to the clinic in late February 2024, with similar complaints from the previous evaluation in 2021. Her pertinent examination findings are in Table 1. The physician ordered an automated functional field tester (FCFTester) and a visual-evoked potential. Her visual fields were compressed or constricted with enlarged blind spots (Figure 1a). Due to her visual deficits and symptoms, the author recommended vision therapy, tinted lenses (e15 blue tint available from Chadwick Optical, Schwenksville, PA, USA), and O.P.. With her schedule, vision therapy was not feasible, and she elected to begin O.P. only. Following her consultation one month later, she began O.P. using Upsilon Omega followed by Mu Upsilon, performing it four to five times weekly for twenty minutes (10 minutes with each filter) per session. Additionally, there were delays with her insurance approving her tinted lenses, and she did not wear the tinted glasses in the initial six weeks.

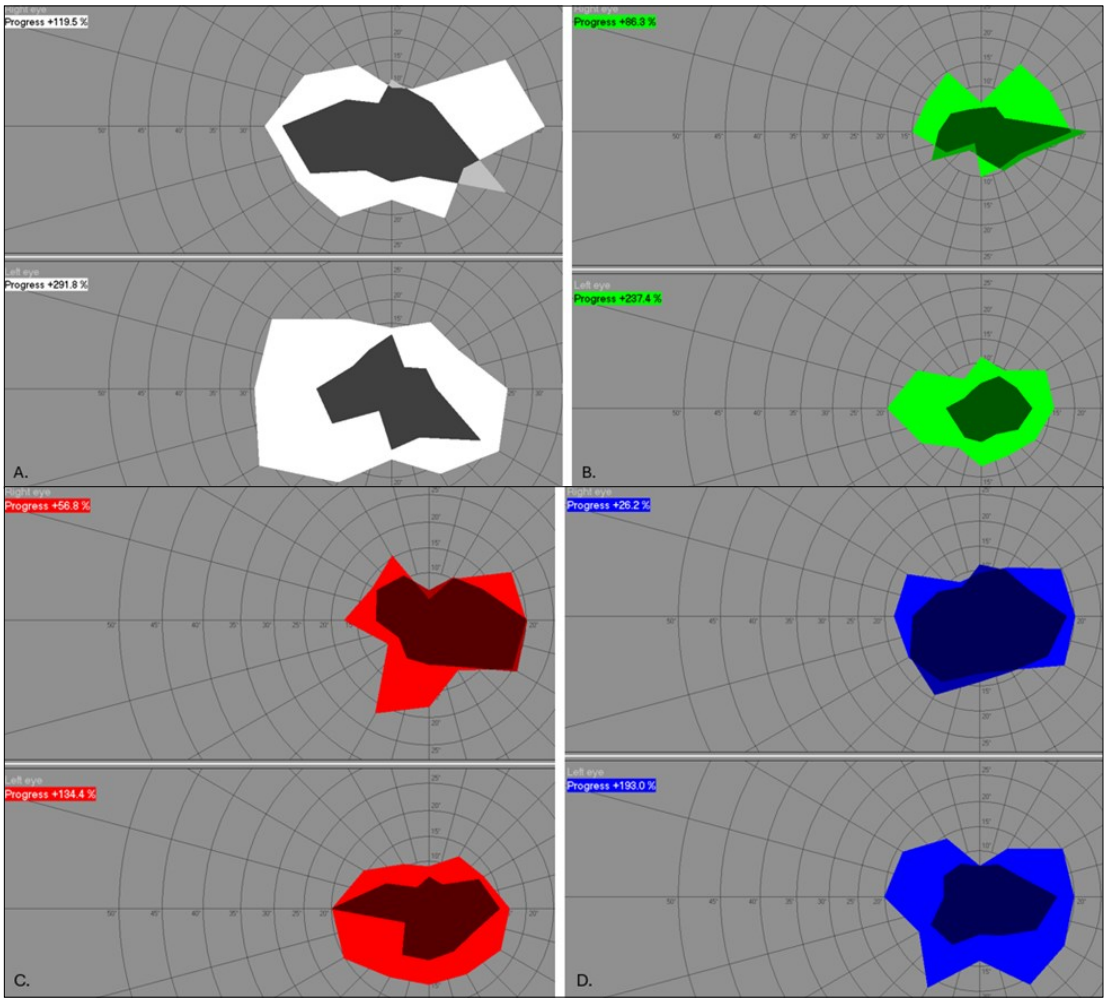

Figure 2: *The comparison of each color isopter for both the right and left eyes while the patient was using Upsilon Omega and Mu Upsilon Filters (February 2024 to June 2024). The visual field shows the expansion of the color isopters in percentage. All the color isopters expanded throughout treatment:* ***A.*** *white isopter (right and left eye percentage change: +119.5 and +291.8, respectively),* ***B.*** *green isopter (right and left eye percentage change: +86.3 and +237.4, respectively),* ***C.*** *red isopter (right and left eye percentage change: +56.8 and +134.4, respectively), and* ***D.*** *blue isopter (right and left eye percentage change: +26.2 and +193.0, respectively).*

She returned in May, with improvements on the FCFTester, and her objective and subjective measures improved (Table 1). Again, there were delays with her insurance approving her tinted lenses; therefore, she did not receive the tinted lenses. However, she noted continued improvements in her BIVSS (Table 1), particularly with light sensitivity. She continued O.P. at home for several weeks using the same filters (i.e., Upsilon Omega and Mu Upsilon). She would call or return if she noted any side effects.

Her visual fields continued to expand at her follow-up in June 2024. She continued to suffer from light sensitivity and noted a lack of energy. Her insurance approved her glasses, and she received her tint clip with her prescription eyeglasses at this visit. However, even though she was continuing to improve, she noticed a decrease in her energy levels (i.e., reduced energy). The doctor replaced Upsilon Omega with Delta Omega, and she continued with home-based O.P. for several weeks, performing four to five times a week for 20 minutes per session.

She returned to the clinic in July 2024, for her first follow-up since changing the filters. She reported that she had not begun to wear her new glasses and continued to wear her old ones. With the new filter, she did not report feeling a difference with the light, but she continued improving. Her BIVSS improved to below the anticipated threshold (≤31), and her (or add visual to above fields) fields showed areas of compression and expansion, depending on the color isopter and eye tested (Figure 3). With her symptomatic improvement and overall expan-

sion of her visual fields (Figure 4), she continued with Delta Omega followed by Mu Upsilon.

Additionally, she showed improvements in her blind spots (i.e., a decrease in the percentage) from the initial visual field to the most recent field. Despite the improvements, she continued to show signs of convergence insufficiency (receded near the point of convergence and moderate exophoria at near greater than four prism diopter difference from distance) and symptoms. If her symptoms do not resolve at the future follow-up schedule at the end of August 2024, she is considering vision therapy or prism glasses for symptom and objective improvements.

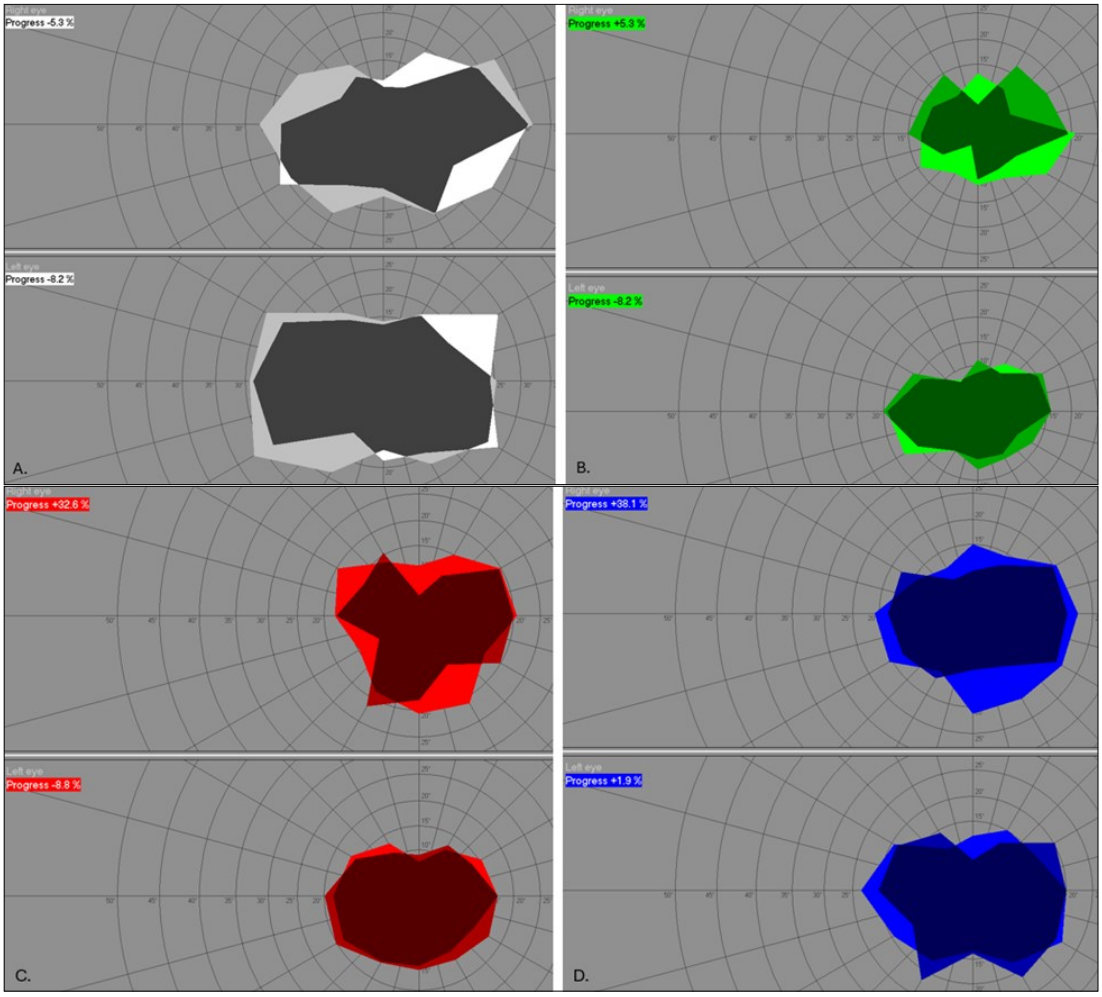

Figure 3: *The Automated FCFTester expansion of the color isopters from June 2024 to July 2024 with the change of the filters from Upsilon Omega to Delta Omega. The patient continued with Mu Upsilon. It can be noted there are some areas of expansion and some areas of compression with the new filter. The different isopters are shown below with their respective changes in percentage:* ***A.*** *white isopter (right and left eye percentage change: -5.3 and –8.2, respectively),* ***B.*** *green isopter (right and left eye percentage change: +5.3 and –8.2, respectively),* ***C.*** *red isopter (right and left eye percentage change: +32.6 and –8.8, respectively), and* ***D.*** *blue isopter (right and left eye percentage change: +38.1 and +1.9, respectively).*

Discussion:

O.P. is another tool for optometrists who provide vision rehabilitation. Currently, no known placebo-controlled or randomized clinical trials have investigated the efficacy of O.P. in the traumatic brain injury population. Without prospective studies, the current case demonstrates that O.P. benefits the TBI population's objective and subjective improvements. Other case reports discuss the use of O.P. in TBI patients and demonstrate functional and subjective improvements. However, other case reports have used vision rehabilitation with O.P.[9,10] Although these cases utilized O.P. to demonstrate a paradigm shift, there is no way to tell the actual effects of O.P. The case above helps advocate for using O.P. as a stand-alone treatment option. The patient yielded improvements; although O.P. did not fully resolve their symptoms or improve all objective measures, this case provides evidence advocating for O.P. and further research in the TBI population.

Automated Functional Field Tester software (FCFT) (available through Bernell Corporation, Mishawaka, IN, USA) is a kinetic visual field. Optometrists use this visual field test to monitor the progression of patients during their rehabilitation. Recently, normative trends were investigated for the FCFT. Although it is not normative data, it can still estimate the visual field measures expected in a healthy normal adult population (e.g., non-TBI). The FCFT of the current patient had a generalized contraction of the color isopters (red, green, and blue) and the form field (white isopter) versus the anticipated results in non-TBI adults.[11] Throughout O.P., the patient expanded their visual field in both eyes (Figures 3 and 4). Additionally, the patient demonstrated enlarged blind spots at the initial evaluation. The patient above showed more normalized blind spots OU (Figure 5) during treatment. Visual field expansion in this case is consistent with an earlier case report of an adult TBI patient who utilized vision rehabilitation and O.P.[9]

O.P. was recently studied in the strabismus and amblyopia population.[12] Although the populations differ between TBI and strabismus and amblyopia, qualitative electroencephalography (qEEG) results demonstrated that O.P. improves the interhemispheric synchronization of patients with visual dysfunctions. Aside from improving synchronization, the expansion of FCFT increases more and is of higher significance than healthy controls. Pa-

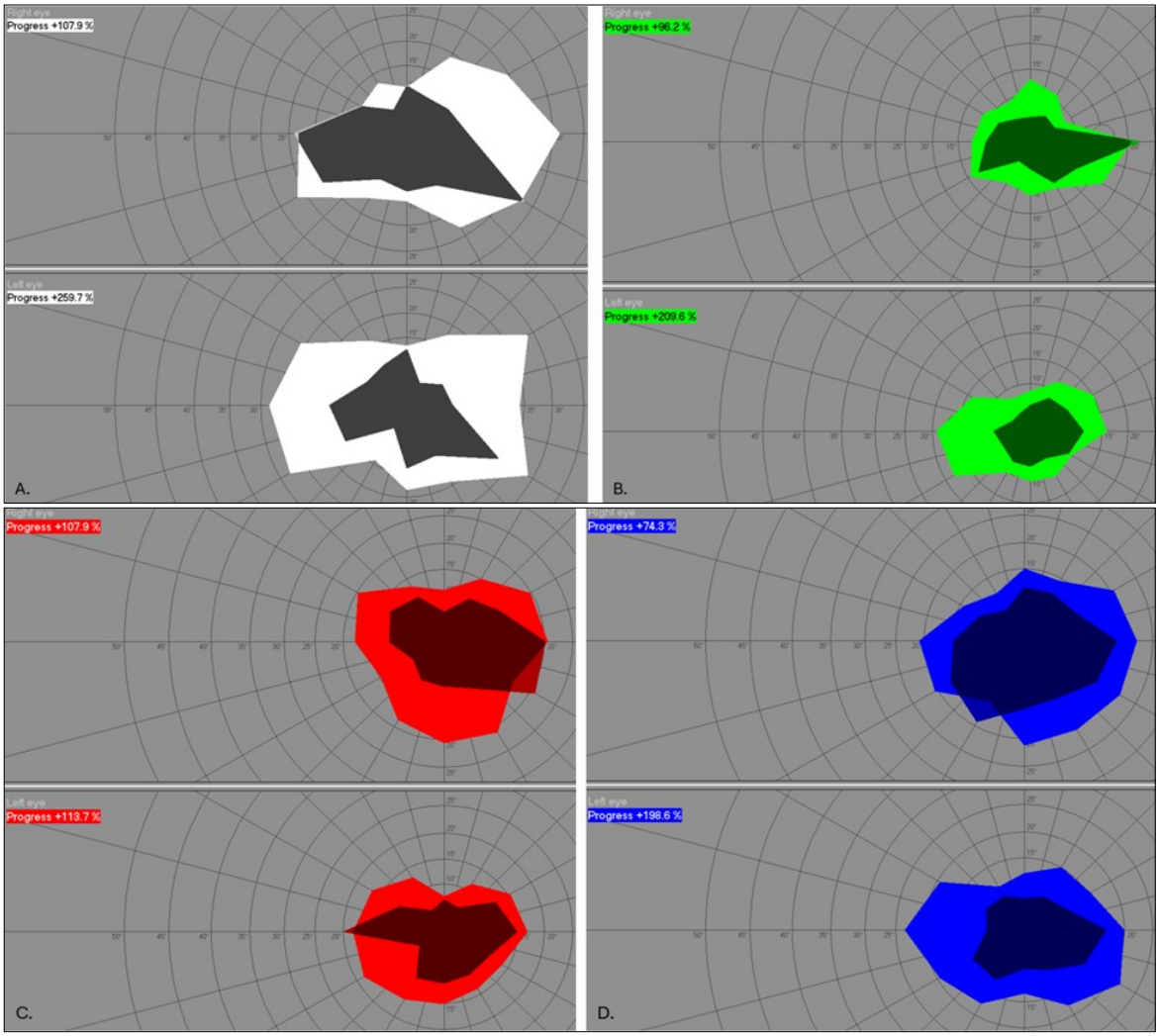

Figure 4: *The changes to the Automated FCFTester from the initial visual field (February 2024) to the visual field measured in July 2024. All of the isopters remained expanded as was found when the patient was using Upsilon Omega. The changes to the color isopters and their respective percentage changes can be found below:* ***A.*** *white isopter (right and left eye percentage change: +107.9 and +259.7, respectively),* ***B.*** *green isopter (right and left eye percentage change: +96.2 and +209.6, respectively),* ***C.*** *red isopter (right and left eye percentage change: +107.9 and +113.7, respectively), and* ***D.*** *blue isopter (right and left eye percentage change: +74.3 and +198.6, respectively).*

tients with visual dysfunctions expand their visual fields more than healthy normals.[12] Future qEEG and investigating the clinical results of the FCFT studies should examine the changes in the visual system with TBI and O.P.

The pupil is used as an objective biomarker for photosensitivity in the TBI population; photosensitivity has been demonstrated in dynamic pupillometry[4-7] and found to be significant versus normal (i.e., non-TBI) patients. However, an ill-sustained pupillary constriction, i.e., Alpha Omega Pupil, is less studied and reported. The College of Syntonic Optometry teaches the measure of an Alpha Omega pupil via a transilluminator and subjective grading. Additionally, the College teaches the correlation between enlarged blind spots and an Alpha Omega pupil. The patient demonstrated an ill-sustained pupillary constriction (i.e., Alpha Omega Pupil) that improved throughout their treatment (Table 1). With the changes to their Alpha Omega pupil and blind spots, this case represents an example of the correlation between improved pupillary responses and blind spot measurements. However, there is sparse data in the literature assessing the Alpha Omega pupil objectively. One case-control study better represents an ill-sustained pupillary constriction in two age-matched patients.[13] With newer technology and the improvement noted in the case above (i.e., long sustained pupillary constriction), further research should investigate the role of an ill-sustained pupillary constriction and light sensitivity in the TBI population while using O.P. Additionally, there is a need to further investigate the correlation between pupillary changes and blind spot measurements in prospective studies.

Conclusion:

In conclusion, O.P. showed subjective and objective changes in a patient with a traumatic brain injury patient. This case report advocates that a more extensive study prospective study or retrospective analysis to assess the efficacy of this treatment for photophobia and subjective deficits in the TBI population is warranted.

All statements are the author's personal opinion and may not reflect the opinions of the College of Syntonic Optometry, or any institution or organization to which the author may be affiliated. Permission to use reprints of this article must be obtained by the editor.

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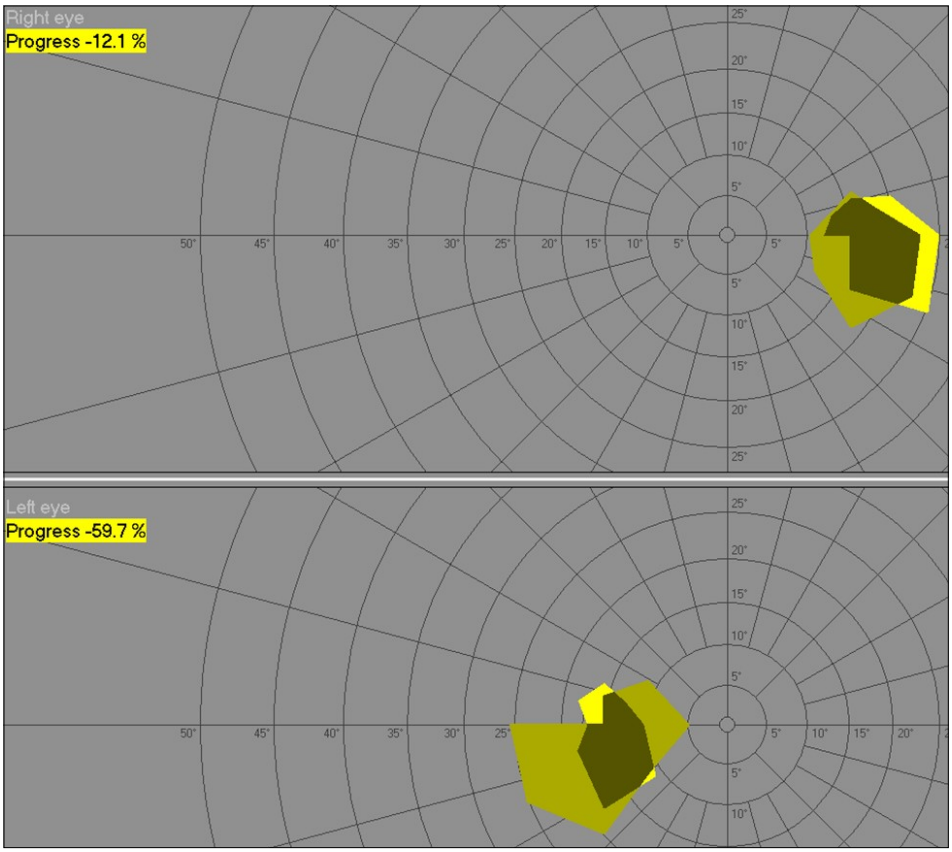

Figure 5: *The blind spot decreased in percentage from the initial visual field in March of 2024 to the final visual field in July 2024. The decreased percentage is the anticipated result.*

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About the Author:

Dr. Nichols has a passion for teaching, lecturing, and research. He has a clinical interest in behavioral optometry, traumatic brain injuries, and optometric phototherapy.

His passion for research has grown since his residency days. He helped create the Optometric Phototherapy Investigator Team (O.P.I.T.). This team of doctors consists of private practice optometrists who have partnered with some of the optometry schools to help provide evidence and promote the use of optometric phototherapy. The team has published their first study in the Vision Development and Rehabilitation Journal and is currently assisting clinical trials at their private practices and at Ohio State University and State University of New York.