Article • Treating Convergence Insufficiency Using Fast-Track Vision Therapy

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ABSTRACT

Background: Convergence insufficiency is the most common binocular vision issue encountered by optometrists. Traditional vision therapy is performed once per week for 12-25 weeks in most offices around the world. For some patients, this program is too lengthy and inconvenient. This case report will highlight a "fast-track" vision therapy, in which treatment takes place in a two-week time frame.

Case Report: MS attended my office for a vision assessment as she was experiencing significant difficulties with near work. She had previously been seen by a major UK optical chain and given spectacles with plano with 1.00$^{\Delta}$ base-in each eye, which failed to address her issues. After this, she was referred for ophthalmological investigation, and was identified with convergence insufficiency. As a result, she was prescribed pencil-to-nose exercises. Neither treatment was found to be beneficial. During the CITT studies carried out by Scheiman, both base-in prism treatment and pencil-to-nose exercises were found to be ineffective and no better than placebo.

Prior to her vision assessment, MS completed a COVD questionnaire, with a significant score of 79. During her vision assessment, she was diagnosed with convergence insufficiency (inability of the left eye to converge) and related visual processing issues. The tests we carried out, and in particular, the functional visual field tests, helped her and her parents to understand the "why" of the difficulties she was experiencing in the school environment. As a result of her symptoms, history, and vision assessment, she was recommended to attend an office-based "fast-track" vision therapy program to relieve her symptoms as quickly as possible to allow her to be able to concentrate on her school studies and her upcoming examinations in a comfortable, stress-free manner.

Conclusion: This case study has been provided to demonstrate that conditions such as convergence insufficiency (CI) can not only be treated in an office environment successfully, as identified within the Convergence Insufficiency Treatment Trial (CITT) study, but they can be dealt with in a speedy, stress-free manner within a practice/office providing optometric vision therapy combined with optometric phototherapy (syntonics), later referred to as "Fast-Track" Vision Therapy.

Keywords: accommodative flexibility, convergence insufficiency, "fast-track" vision therapy, Okimo eye tracking, optometric phototherapy (syntonics), vision therapy

Introduction

Convergence insufficiency (CI) is a binocular vision disorder characterized by difficulty maintaining fusion while looking at a near target due to insufficient positive fusional vergences, a reduction of near point of convergence, and exophoria at near greater than at distance. Commonly associated symptoms of CI include asthenopia (eye strain), diplopia, headaches, blurred vision, movement of print while reading, and difficulty with reading comprehension. Other notable symptoms exhibited after short periods of reading or prolonged near work include sleepiness and the inability to concentrate.[1] CI is associated with many other aspects of deficient near visual processing. The most common "medical" treatment provided for this condition is "pencil-to-nose exercises," which were shown to be no better than placebo in the Convergence Insufficiency Treatment Trial (CITT study).[2] The CITT study[3] indicated that "in-house" vision therapy was the most successful form of therapy.[4]

In the mid to late '90s, the author was introduced to Syntonic Phototherapy by the late Dr. Wayne Pharr, OD, who practiced in Okechobee, Florida. His concept was to work intensively with his patients combining various modalities including syntonics and OVT.

Optometric Phototherapy (Syntonics)

Syntonics was developed in the early part of the 20th century, with the conclusive results of studying many patients being published by H. Riley Spitler in 1942 in his book *The Syntonic Principle*.[5] Dr. Spitler was instrumental in setting up the (US) College of Syntonic Optometry, still operating today with regular conferences and providing educational programs. A number of studies are frequently quoted indicating the benefits of syntonics.[6-9] A more recent study showed the benefits of syntonics in treating amblyopia.[10]

Syntonics, or optometric phototherapy, is the branch of ocular science dealing with the application of selected light frequencies through the eyes. It has been used clinically for over 70 years in the field of optometry, with continued success in the treatment of visual dysfunctions, including strabismus (eye turns), amblyopia (lazy eye), focusing and convergence problems, learning disorders, and the aftereffects of stress and trauma. In recent years, syntonics has been shown to be effective in the treatment of brain injuries and emotional disorders.

Syntonic phototherapy may be today's most advanced clinical science in light therapy. Since the 1920s, it has been used effectively by optometrists to treat patients who have inefficient visual function. Since eighty percent of learning occurs by way of the eyes, inefficient visual function can adversely affect all aspects of one's life, including academic achievement, athletic performance, proficiency at work, and homemaking.

Syntonics is increasingly being used as either the primary treatment or to support other therapies to aid in the remediation of strabismus, amblyopia, accommodative/convergence problems, asthenopia, ametropia, visual attention deficit, vision-related learning and behaviour problems, and visual field constrictions associated with visual stress, brain injury, degenerative ocular disorders, and emotional trauma.[11] The College of Syntonic Optometry organises regular conferences and educational training programs in the US, as do other organisations throughout the world.

A recent study by Sanaa Ahmed Mohamed et al. identified that amblyopia treatment is successful even after age 8–10 years if the predisposing cause of amblyopia is treated and amblyopia therapy is performed. They identified that syntonic phototherapy was an effective treatment modality for refractive amblyopia and was superior to part-time occlusion in the treatment of refractive amblyopia.[10]

Typically, CI takes several months to treat with OVT. Over the past 30 years, we used his concept to help many patients, both children and adults, in as little as two weeks. This case study combined "fast-track" optometric vision therapy (OVT), as developed by the late Dr. Wayne Pharr, OD, combined with optometric phototherapy (syntonics). Patients are seen for a one-hour session twice per day for 2 weeks (20 sessions in total), using a range of activities to treat the Five "F"s of vision: **F**ields, **F**ixations, **F**ocus, **F**usion, and **F**lexibility.

A brief description of the Five "F" concept of vision (Wayne Pharr)

Fields: peripheral awareness, this is a functional/dynamic measure, as opposed to more typical threshold fields to assess pathology. Functional field issues can easily be identified from basic confrontation to detailed campimetry.

Fixations: eye movements, availability, fluidity, pursuits, saccades, convergence

Focus: ability to accommodate, range of clear near focus (accommodative flexibility, AF), speed of focus change (accommodative facility), etc.

Fusion: ability of the brain to integrate the information from the two eyes to produce a (perceived) single, clear, non-diplopic, binocular image at all distances

Flexibility: all the above need to work in a comprehensive manner to allow the brain to integrate conscious and unconscious visual information to provide the individual safe, speedy, and efficient access to their space world and to be able to take appropriate action for the future.

Over the years, we have developed his program to produce a fast, successful OVT program that is less stressful for patients, parents, and therapists. We have treated most of our VT patients successfully using this concept (presenting this at the CSO conference in Santa Fe, 2015). This case study shows the effectiveness of the "fast-track" concept.

Published accounts of "fast-track" efficiency

A past published case involved a lady in her 20s, who, following a car accident (with an air bag hitting her face), had intermittent diplopia (esotropia) with associated symptoms, including headaches, eye strain, stress, and depression. After five years, three hospitals, including the renowned Moorfields Eye Hospital in the UK, failed to improve the situation in any way. After two weeks of "fast-track" therapy, diplopia and symptoms resolved, and, as a bonus, amblyopia improved two lines down the Snellen chart.[12]

Another unusual case was a professional "eventer" who was successfully treated with 30 sessions over two months, allowing him to represent the UK at the Rio Olympics after he had suffered a fall from his horse. He suffered typical visual issues associated with mTBI, including right eye temporal field loss and oculomotor dysfunction, with a defect of the left lateral rectus, which impacted his ability to walk, ride his horse, and read and caused severe postural issues[13,14]

Campimetry: assessing functional visual fields (Wayne Pharr)

The author does not measure campimetry in the manner taught by the US College of Syntonic Optometry (CSO), but instead uses the CSO campimeter with targets made by Rex Cross. This technique was taught by Wayne Pharr, OD and has been enhanced by the author.[15]

White targets, which are inset into a black ring (Figure 1), are used in a four-stage approach:[16]-

i) Awareness of the white spot: this is the field that is currently "wired up" and available for use.

Figure 1. Campimeter set-up

ii) Awareness of the "black edge" to the white spot: this is the area in which you are aware of some degree of detail, i.e., when walking, your awareness of steps, people around you, etc.

iii) Awareness of the "complete edge (circle)" around the white spot: this is the area that you have available for fine detail viewing such as reading (with very small level 1 field, level 3 may not be measurable).

iv) Investigation of the "blind spot": using the small white target.

- when the level (ii) and (iii) fields are reduced, experience has indicated that the blind spot will always be enlarged. The blind spot can also be displaced or rotated, referred to as dural torque,[17] often seen in patients with spatial issues such as visual midline shift syndrome.

In addition, when the functional fields are reduced, there is often a corresponding reduction in acuity.[17]

This concept is more easily understood by patients or their parents, rather than the standard CSO colour fields.[18] Whilst the colour fields give the optometrist additional information, it is more difficult to convey that detailed analysis to the patient/parent, as opposed to the Pharr concept. These functional visual fields (Figure 2) are very different from those obtained by "automated visual field" analysis used in regular optometry/ophthalmology to identify and monitor diseases such as glaucoma. These reduced fields may, in some cases, be associated with functional neurological disorder (FND, Figure 3).[19]

Case Report

History

MS was a 17-year-old student, who, despite struggling with close work, wanted to attend University. She completed the COVD questionnaire,[20] with a significant symptom score of 79.

The COVD-QOL questionnaire is a cost-effective, quick, and easy tool that may be used in school screening to identify possible visual symptoms that are correlated to academic performance. This questionnaire shows the extreme problems she was experiencing that we can identify from her visual examination were due to having significant visual processing issues, inducing symptoms of debilitating frontal headaches as well as lower back, shoulder, and neck pain from leaning in towards the PC[21] due to her limited accommodative flexibility (Figure 4).

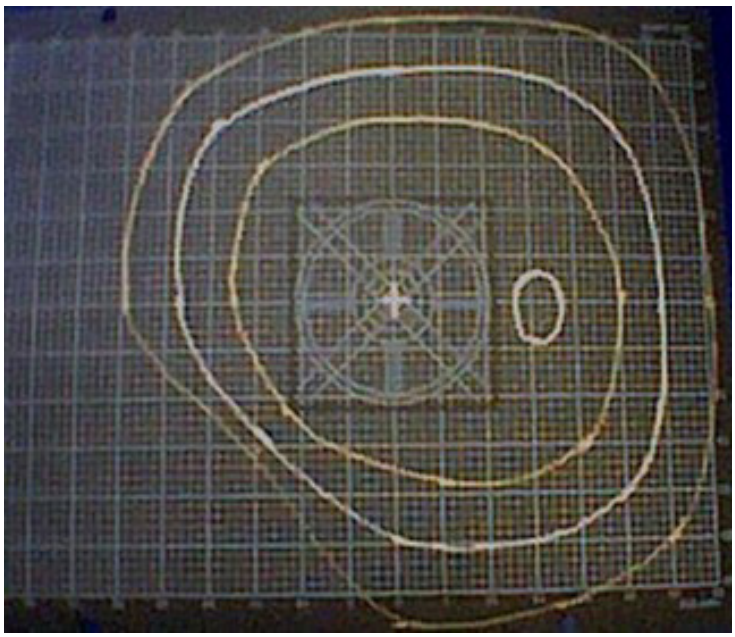


Figure 2. Normal campimetry field

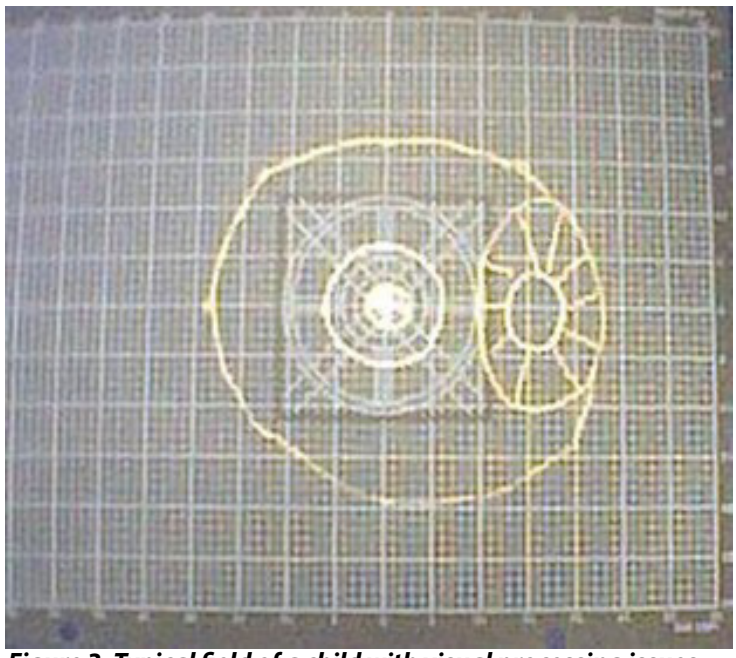


Figure 3. Typical field of a child with visual processing issues

She had previously been seen by a major UK optical chain and been given plano with 1.00$^{\Delta}$ base-in each eye, which Scheiman identified as an "ineffective treatment."[22] After this, she was referred for ophthalmological investigation. The ophthalmologist at the local hospital prescribed pencil-to-nose exercises and discharged her.

NOTE 1: Scheiman identified in 2008 that pencil-to-nose was an ineffective treatment, no better than placebo.[22]

NOTE 2: The ophthalmologist had no intention of reviewing or monitoring her visual function following his provision of pencil-to-nose activity, as he had simply recommended the exercises and discharged her.

During the Covid-19 pandemic, she was home schooling and spending around 10 hours per day on computer, as well as several hours using her iPhone.

From the COVD symptom score, it is obvious that the two main treatments that would be routinely provided in both ophthalmology and optometry had proved ineffective.

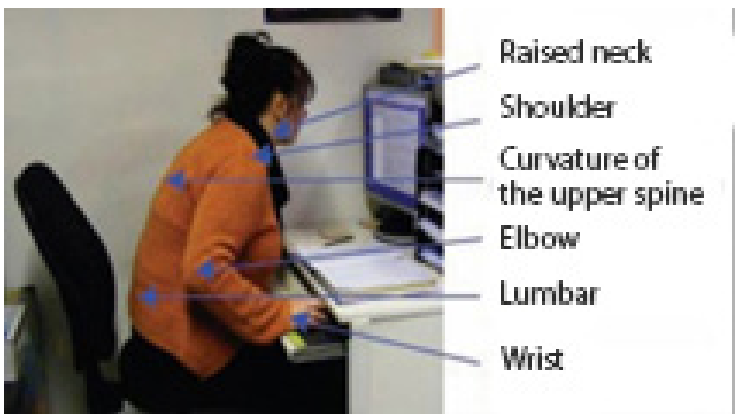


Figure 4. Demonstration of the patient's postural issues

Visual Assessment

Motility: Full

Pursuits: Smooth – no head movements

Saccades, x axis: Fairly good, tended to undershoot, left eye would occasionally diverge

Saccades, y axis: Left eye wanders out to the side

Saccades, z axis: Unable to maintain fixation on far target and can only briefly align on near target before left eye deviates

Convergence: She could only converge for very brief moments. Even at 40 cm, she could not maintain convergence, with the left eye diverging.

Oculomotor balance with Howell chart[23] at 10 feet (3m): 14 exophoria

Oculomotor balance with Howell (near) chart at 1 foot (30cm): 31 exophoria

Peripheral processing assessment using a laser pointer at 3 feet (1m): 30 degrees

Awareness of practitioner (AOP) test[24,25] was carried out at 10 feet (3m): Whilst looking at my nose, she was aware of my body down to my knees (25 deg)

Previously supplied specs: R&L plano with 1.00$^{\Delta}$ base-in each eye

Refraction: R plano/-0.25x180=20/40 (6/12), L plano/-0.25x180=20/40 (6/12)

Accommodative flexibility[26,27] is the difference between the near and far measures that an individual can read N7 text (on Howell chart) before blurring. She could only clear the print from 17-42 cm, so AF = 42-17 = 25 cm, and she could only maintain clarity

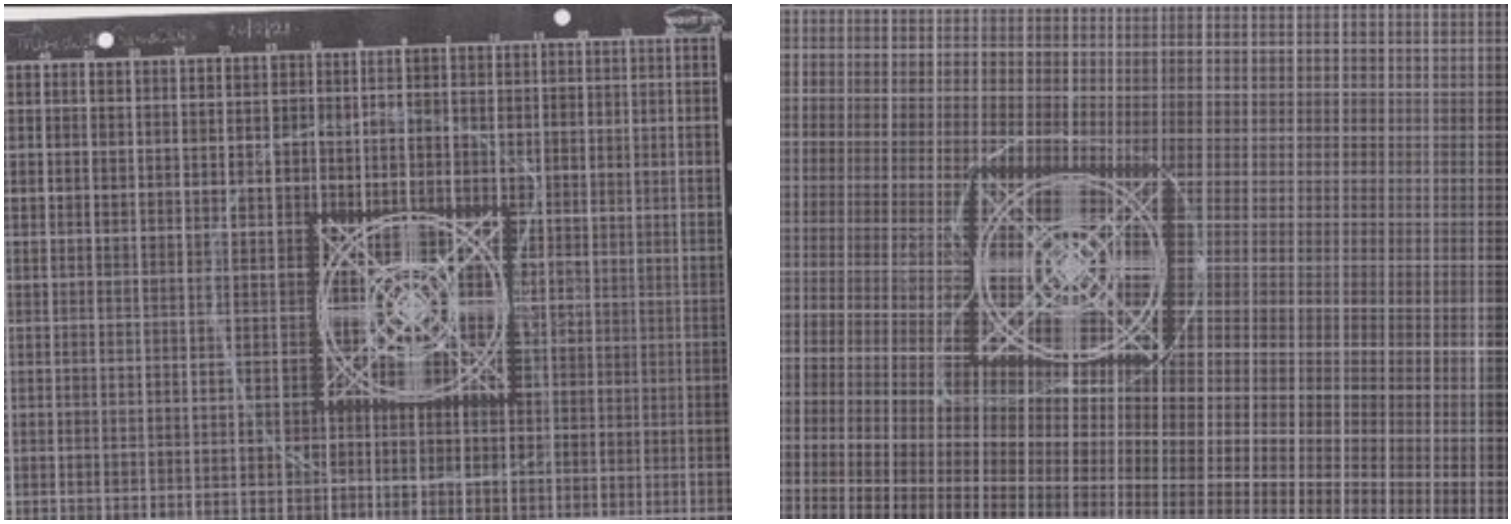


Figure 5. Initial assessment campimetry plot right eye (left), left eye (right)

for a limited time. Her fp/np ratio was 42/17=2.47 (at her age, normal average would be 3.5[28]). Neither low-plus add, prism base-in, yoked base-up, or yoked base-down provided any meaningful benefit.

All aspects of the visual fields were constricted, and they were too small to measure the extent of the physiological blind spot (Figure 5).

Assessment of Van Orden Star indicated a strong exophoric pattern, with tight closure on the right and a more open pattern on the left.[29] Typically, we have identified that an "open" VO star on the left is frequently associated with enlarged blind spot or small field. In her case, the fields were too small to measure the full blind spot (Figure 6).

Pursuit eye tracking assessments were carried out with Okimo software.[12,30] Okimo was a software program designed to assess visual tracking that is unfortunately no longer available, but similar programs are. Once tests for eye alignment have been carried out, the patient observes (tracks) a ball that moves to the right, to the left, to the right, and to the left of the screen, and plots this like a sine wave, the yellow spots indicating the ball position. Looking to her right, graph goes up; looking to her left, graph goes down. The blue and green plots are for the right and left eye, respectively (Figure 7).

Figure 6. Pre-treatment Van Orden star

This graphically showed how the eyes were primarily dissociated and thus indicated how her considerable problems of eye tracking will have impacted on her reading ability. In addition, whilst the patient was reading text on the computer screen, the Okimo™ software monitored the respective eye position and saccades during reading. This indicated extensive disorganisation of binocular function, with each eye very much "doing their own thing" (Figure 8).

As a result of her symptoms and vision assessments, we recommended that she attend a program of "fast-track" optometric vision therapy.

Optometric Vision Therapy

Typically, OVT is carried out with patients attending office visits on a weekly or fortnightly basis, where, at each visit, they are taught a number of activities, which they have to repeat on a daily basis until their return to the office for the next group of activities to be prescribed/taught. According to data obtained from parents (in the US) who are members of facebook/visiontherapyparentsunite, this process typically takes 6–14 months to complete. In some offices, syntonics is added to the program, but for many VTODs, it would appear to be an either/or situation.

Why do most patients require OVT?

OVT is typically used to treat a visual processing issue that impacts an individual's wellbeing. In many cases, it may be because something has occurred to put their visual system under stress, causing conditions such as convergence insufficiency, other

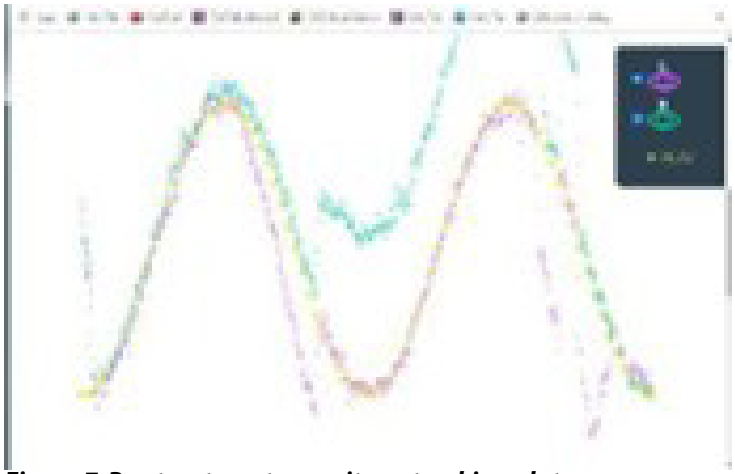


Figure 7. Pre-treatment pursuit eye tracking plot

visual processing issues, strabismus, amblyopia, visual issues associated with mild traumatic brain injury (mTBI), etc.

<u>What is the impact of home-based vision therapy on the child?</u>

- Forced to do 20-30 minutes of VT 5 days/week
- Attend weekly/fortnightly/monthly office visits, which can mean frequent long-distance drives for some
- Reduction in pleasure time after school
- Increased nagging by parents to do VT, which together can add to the stress the child is already experiencing and can potentially inhibit their progress.

<u>What is the impact of home-based vision therapy for the parents/family?</u>

- Parents get home from work tired, have to prepare dinner, argue with their children to get school-based homework done, and then try to find time to sit quietly to assist their child with their vision training
- Possible jealousy from siblings as parents spending more time on VT child
- Reduction of money available for family pursuits/ holidays, etc.

<u>What is the impact of home-based vision therapy for the therapist?</u>

- Activities are explained and demonstrated in the practice, verbal and written explanations given, and yet, when checked on their return to the practice at their next visit, the activity has been carried out in a totally different way, which has failed to produce expected gains.

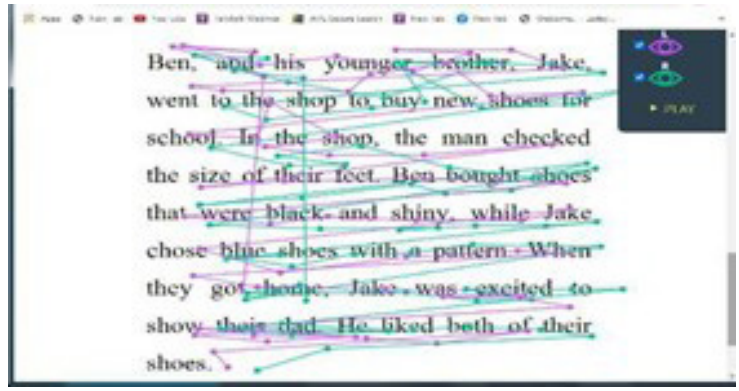


Figure 8. Pre-treatment eye tracking while reading plot

What is the result? The child has failed again, reinforcing their low self-esteem and again increasing their stress.

"Fast-Track" Vision Therapy

Dr. Pharr's concept was to consider and treat, concurrently, the five "F"s of vision—Fields, Fixations, Focus, Fusion, and Flexibility—and, within each therapy session, provide activities that deal with each of these areas.

On arrival for their VT session, patients spend:

- 3 – 6 minutes TBI (translid binocular interactor[31]) to break down suppression
- 3 minutes nascentisation[32] (binocularity), observing the white light in the syntoniser whilst wearing red/blue or red/green anaglyph specs. (Note: Gottlieb recorded that nascentisation is not as commonly prescribed during a syntonic treatment as in the past)
- 10 + 10 mins* appropriate syntonic filters (according to accepted syntonic protocols); this helps to relax and balance the autonomic nervous system, allowing the field to expand and putting the brain into a receptive mode for learning. *These times are guidelines and may need to be adapted dependent on the individual patient, symptoms, and dignosis
- 5 minutes activities for each of the five "F"s

At each session, as far as possible, we use different activities. The brain loves "novel" experiences, so instead of repeating the same activity for a week or two, we challenge the brain to sort itself out by giving it different tasks that have, for us (the therapists), the same ultimate aim. In other words, rather than learning a "splinter skill", they develop ways of resolving different visual tasks that are provided in therapy. Because my therapist was experienced, should a prescribed activity be too easy or too hard,

she would modify or change it for another activity within the same "F" category that would be more suitable at that time.

Consider for example how the simple Hart chart, can be used in different ways that affect the five "F"s in different ways

a) Sit and read chart
b) Stand and read chart
c) Reading rows or columns
d) Reading every 3rd letter
e) Split Hart chart
f) Walking forward and backward to just blur
g) Near/far Hart chart
h) Tromboning near Hart chart
i) Walking rail forward and backward whilst reading chart
j) Infinity walk with Hart chart, (in the case study of the eventer, quoted above, he carried out this activity on horseback[33])
k) Balance board whilst reading chart
l) Anaglyph, anti-suppression, Hart chart
m) Many more variations that simplify or intensify such an apparently basic activity

Over just one week (10 sessions) of fast-track, your patient could experience, and learn from, 10 different Hart chart activities. With conventional home therapy, this would take 10 weeks (weekly office visits) or 20 weeks (fortnightly office visits).

Patients are seen for one hour in the morning, have a three-hour gap, and then another one hour in the afternoon, five days per week for two weeks, totalling 20 sessions (hours). Optometric reviews take place at around session 10 and 18. Fields and VO star are checked at session four to confirm improvements are progressing as expected. VT reviews are carried out at every session by the therapist, and any issues are reported to the optometrist. Following discussion with the optometrist following the session 18 review, the therapist provides, at session 20, a list of activities and the Vision Builder computer software[34] downloads, with an individually designed home-

Table 1. Pre- and Post-Treatment Examination Results

Test	Pre-VT	Post-VT
Motility	Full	Full
Pursuit tracking	Fairly good, but LE wanders	Can follow a clover leaf pattern with ease
Saccades x direction	Left eye difficulty fixating	Accurate
Saccades y direction	Left eye wanders	Accurate
Saccades z direction	Unable to align LE on either target	Accurate
Convergence stress point	Unable to maintain convergence even at 40 cm	11 cm
Convergence diplopia	Can converge close only for very brief periods	4 cm
Cover test DV	10 exo, sluggish recovery	Quick recovery on CT in all angles of gaze
Cover test NV	20+ exo, unable to recover binocular alignment	Quick recovery on CT in all angles of gaze
DV Howell	14 exo	5 exo
NV Howell	31 exo	7 exo (11 exo when looking up or down)
Campimetry level 1 (Horiz diameter)	24 deg	70 deg
Campimetry level 2 (Horiz diameter)	9 deg	63 deg
Campimetry level 3 (Horiz diameter)	2 deg	50 deg
Physiological blind spot	Fields too small to measure	Normal size and position
AOP field test	Nose to knees	Full (maximum possible)
Laser pointer field test	30 deg	Full (maximum possible)
VA's	20/40 (6/12)	20/20 (6/6)
Refraction	R plano/-0.25x180, L plano/-0.25x180	R +0.25 DS, L +0.25 DS
Accommodative flexibility	17 - 42cm	9 - 67 cm
Near VA (binoc)	N7	N4
Reading speed on Okimo	141 wpm	180 wpm
Static (form) coherence threshold	24.23 (normal static 16.73 stan dev 4.22)	15.81
Motion coherence threshold	45.62 (normal motion 24.51 stan dev 6.731)	23.84

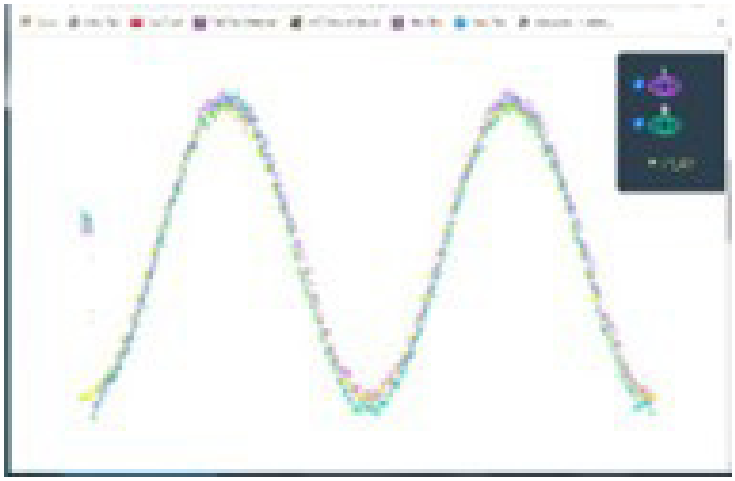


Figure 9. Post-treatment pursuit eye tracking plot

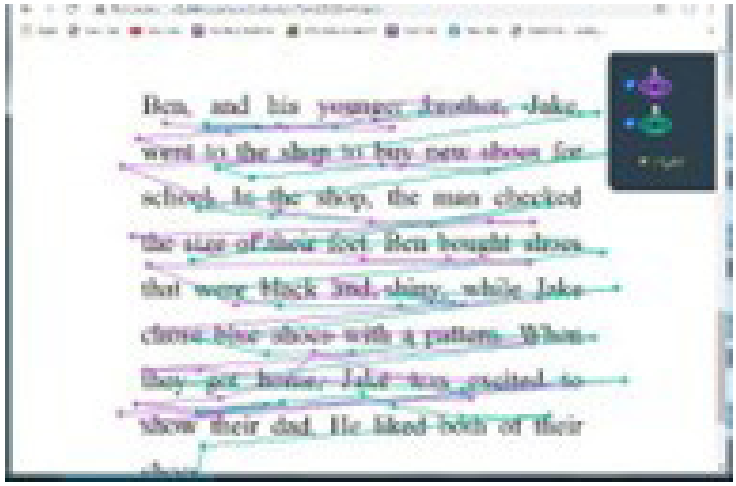
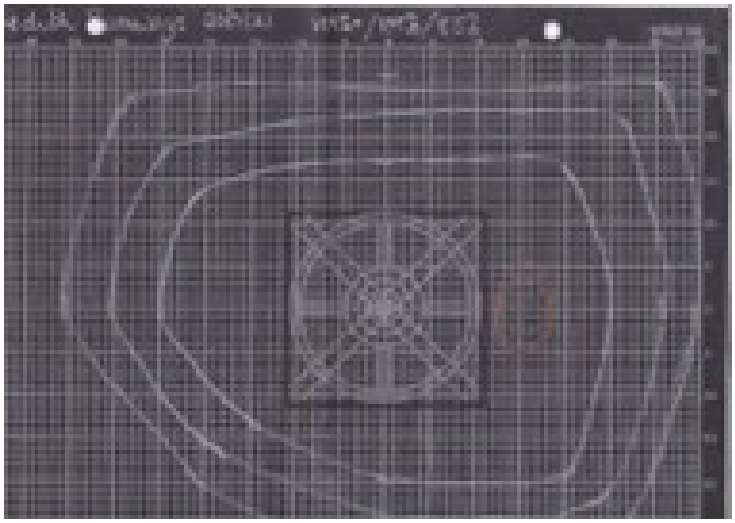


Figure 10. Post-treatment eye tracking while reading plot



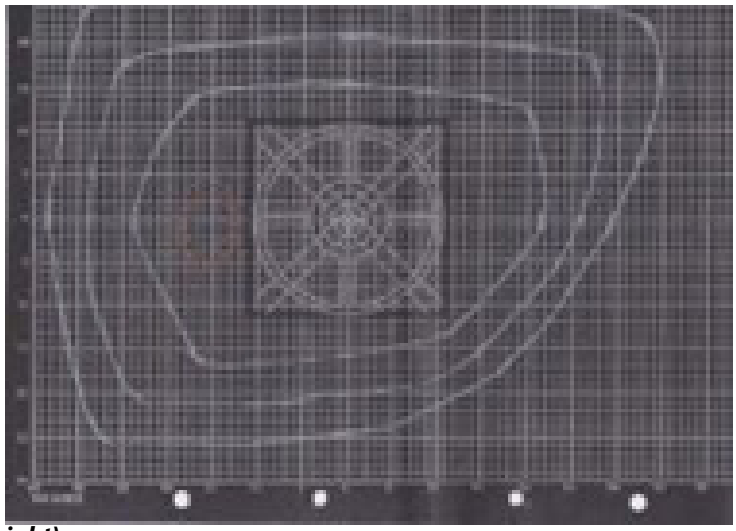


Figure 11. Post-treatment campimetry plot right eye (left), left eye (right)

based, four-week VT program to provide a variety of activities that reinforce and establish the visual changes that have taken place during office VT. Further optometric reviews are carried out after 1-, 3-, and 6-month intervals.

She was re-examined at the one-month post-VT review. Table 1 shows the results of that assessment, with pre-assessment results for comparison. Figures 9-12 show post-VT results for several tests. While the results were still not ideal, they were a significant improvement.

Static (form) coherence and motion coherence thresholds

These are assessed using a computer-based program, "the ball in the grass", that was originally designed to assess dorsal stream vulnerability,[35] developed by Atkinson, Braddick, and Wattam-Bell at UCL and Oxford Universities to analyse related visual function. In a very simplistic concept, we can consider that static (form) coherence provides a guide to parvocellular efficiency, and motion coherence gives a guide to magnocellular efficiency. The lower the figure, the more efficiently the brain is performing.[36] This test demonstrated normalisation of these measures post-therapy and confirmed their maintenance six months later.

Comments by MS

I would always find it difficult to read off of white paper or off the board at college. Now I can read off of white paper and off the boards, which helped me achieve the best grades in my class. Prior to therapy, I was also not allowed to drive because I did not have

Figure 12. Post-treatment Van Orden star

adequate peripheral vision, but in May, I managed to pass my driving test. Since I was 13 years old, I have been having really bad migraines, but after the two weeks of therapy, I have not had any migraines or headaches.

Conclusion

For MS, she was happy that she could immediately see that that her hard work during her "fast-track" vision therapy program resulted in not only marked changes in her visual performance (functional (dynamic) visual fields, convergence, accommodation, accommodative flexibility, eye tracking, etc.) had occurred, but specifically for her, she experienced significant reduction in all her visual symptoms and improved educational performance and ease of reading, allowing her to perform to her full potential in her school exams.

Our experience has shown that convergence insufficiency is easily treated successfully, and speedily, by combining syntonics with OVT (fast-track protocol) and is less stressful, both for the patient and their parents. They no longer have to suffer months of home therapy, and when patients have to travel long distances to their optometrist or optometric vision therapist, with fast-track, they can stay in local accommodations and make a holiday out of it, further relaxing the situation and reducing overall costs.

Eye tracker software (Okimo no longer available, but Thompson eye tracker and others are available) and measuring static (form) coherence and motion coherence thresholds gives us demonstrable and independent verification of the success in treating this "common" condition that impacts so many children's (and adults') lives!

The considerable change in symptoms recorded, using the QOL questionnaire, demonstrates the personal impact of "fast-track" vision therapy on the quality of life for the individual who has undergone therapy.

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