Remediation of Visual Snow (VS) and Related Phenomena in a Neuro-Optometric Practice: A Retrospective Analysis

Barry Tannen, OD, FCOVD, FAAO

Jacob Brown, OD

Kenneth J. Ciuffreda, OD, PhD, FCOVD, FAAO, FARVO

Noah M. Tannen, OD, FCOVD, FAAO

ABSTRACT

INTRODUCTION

Visual Snow (VS) and the Visual Snow Syndrome (VSS) represent relatively new and important medical and neuro-optometric diagnoses. While there is much information dealing with their defining characteristics and diagnosis, there is a relative paucity of information dealing with therapeutic intervention. Methods: In the present investigation, a retrospective analysis of 27 patients (ages 9-55 years, mean of 28 years) with documented VSS was performed with respect to treatment of the visual snow, palinopsia, and the newly-discovered versional oculomotor dysfunctions in a private, optometric practice setting. Patients were provided a comprehensive neurooptometric and binocular vision examination, as well as completed the VSS Symptom Survey. Treatment: they were given a selection of 5 BPI and FL-41 chromatic tints to assess using a simple clinical comparison protocol for the VS; they were provided a range of saccadic tests to remediate the common finding of palinopsia; and they were given optometric vision therapy to remediate the common, versional oculomotor problems. Results: Chromatic filters were prescribed in 24 of the 27 patients for their VS, with symptom reduction of at least 50%. Reduction of the palinopsia by 50-65% was found in all 23 patients who had palinopsia following the saccadic therapy. 23 of the 27 were given oculomotor-based vision therapy for their versional deficits (i.e., OMD), and marked symptom reduction was reported in all. Conclusion: This is the first study to demonstrate that neuro-optometric rehabilitation (NOR) provided successful remediation of the problems of VS, palinopsia, and OMD in symptomatic, clinical patients with VSS.

Correspondence regarding this article should be emailed to Barry Tannen, OD, FCOVD, FAAO, at drt@eyecareprofessionals.com. *All statements are the authors' personal opinions and may not reflect the opinions of the College of Optometrists in Vision Development, Vision Development & Rehabilitation or any institution or organization to which the authors may be affiliated. Permission to use reprints of this article must be obtained from the editor.* *VDR is indexed in the Directory of Open Access Journals. Online access is available at* covd.org. https://doi.org/10.31707/VDR2022.8.2.p105.

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INTRODUCTION

The phenomenon of "visual snow" (VS) was likely first reported in 1944 as a side effect of the drug digitalis used for heart problems.[1] The topic lay relatively dormant until 1995,[2] and over the past decade or so has experienced a revival of interest, primarily with respect to the development of specific diagnostic criteria and consideration of it as a "syndrome", namely the "visual snow syndrome" (VSS).[3-5] The primary visual symptom reported in those with VSS is VS, that is they see a pixelated overlay of "snow" encompassing the entire visual field, which could be either monochromatic or chromatic, and also either transient or constant, in nature[4,6,7] (Figure 1).

As indicated above, this condition represents as a syndrome. In addition to the perception of VS, the diagnosis must include at least two of the following four primary visual symptoms: palinopsia, photosensitivity/photophobia, enhanced entoptic phenomenon, and visual difficulty at night ("nyctalopia").[3,4] Furthermore, those with VSS frequently report one or more of the following secondary visual and non-visual symptoms:photopsia, migraine, phonophobia, hyperacusis, cutaneous allodynia, tinnitus, balance problems, and tremor.[3,4]

Figure 1. Patient Drawing of Visual Snow

Until recently, the treatment aspect has received relatively little attention. This has included the prescription of medications which has been unsuccessful,[8] simple discussion to allay the fears of such patients,[3] and recent case reports/case series involving neuro-optometric rehabilitation which has been successful.[6,7,9,10]

In the present paper, we report the results of a retrospective, clinical study in 27 patients diagnosed with VSS. It includes the use of specialized tints to reduce the perception of VS and related abnormal visual phenomena, and specific oculomotor-based paradigms to reduce the intensity of the palinopsia as well as to remediate the newly-uncovered versional eye movement deficits.

METHODS

A retrospective analysis of 27 patients diagnosed with VSS between the years 2017 and 2021 that presented at a private optometric practice was performed. The cohort included 21 adults and 6 pediatric patients, ages 9-55 years with a mean of 28 years. There were 15 females and 12 males. Clinical queries included: relevant case history, presenting symptoms, clinical findings, treatments, and outcomes. In addition, the VSS Symptom Survey[6] was completed to list formally and categorize their symptoms and related aspects.

Table 1: The neuro-optometric evaluation

Best Corrected Visual Acuity
Refractive Status
Distance Phoria (Von Graefe)
Near Phoria (Von Graefe)
Nearpoint of Convergence (accommodative target)
Near Convergence Range
Distance Convergence Range
Distance Convergence Recovery
Distance Divergence Range
Distance Divergence Recovery
Distance Fusional Facility (4pd BO/2pd BI)
Near Convergence Recovery
Near Divergence Range
Near Divergence Recovery
Near Vergence Facility (12pd B0/3pd BI)
Accommodative Facility (+/-2.00 D)
Accommodative Amplitude (minus lens D)
Smooth Pursuit Eye Movements
Saccadic Eye Movements
Stereopsis (global)
Stereopsis (local)
Developmental Eye Movement Test (DEM)
Visagraph Reading Eye Movement Test
Simultaneous Visual Memory: Tachistoscope
Sequential Visual Memory: Visual Span

Protocols

A complete neuro-optometric evaluation was performed, which included pupil, visual field, tonometry, biomicroscopy, and fundus examination. The results of these specific tests were unremarkable for all of the patients in this study. A summary of the other diagnostic tests which were performed is included in Table1.

Saccadic Training for Palinopsia

A variety of traditional, optometric-based saccadic vision therapy procedures were employed[11] with the goal of presumably restoring/recalibrating the patient's normal saccadic suppression.[10] These included procedures that emphasized small saccades (1-2 degrees) up to large saccades (20 degrees and greater), with both self-generated and stimulus generated (horizontal, vertical, and oblique), at various tempos and levels of tracking complexity. In

general, larger more isolated targets were used first, progressing to smaller and more visually crowded targets, as the patient's proficiency increased.

Instruments and procedures included:

- Four Corner Fixations/Saccades
- Visual Scan-Computer Orthoptics
- Michigan Tracking
- Hart Chart Saccades
- Neuro-Visual Trainer (Fast Match)
- Post-It Saccades
- Handheld Pencil Saccades with Background Distractors
- Sanet Visual Trainer- Eye Hand Proactive and/or Reactive
- Wayne Saccadic Fixator

The following is an example of one procedure progressing from relatively simple to complex, that is, "task loading":

Hart Chart Saccades (Figure 2)

Figure 2. Hart chart used for saccadic training.

Equipment

- 4 Single letters cut from the Hart Chart
- 4 4-letter quadrants cut from the Hart Chart
- a whole Hart Chart (Figure 3)

Figure 3. Four corner Hart chart

Procedure

The patient stands 10 feet from the wall with the Hart Chart and follows the procedures outlined below. Accuracy of the saccades is monitored by the therapist by observing the patient's eye movements and responses. The patient proceeds to the next level once accuracy is achieved.

1. Single letters from the Hart Chart are taped to the wall arranged in a 1-foot x 1-foot square. To start, two letters are approximately six inches apart are placed on one line with a second line of two letters approximately six inches below the first line. As the patient's proficiency increases, additional letters are added to each line, as well as additional lines of letters being added. With one eye occluded, the patient makes saccades from one letter to another letter, which the therapist calls out. The therapist first calls the letters in order (clockwise and counter-clockwise), and then randomly.
2. Four Hart Chart quadrants are taped to the wall in a 1-foot x 1-foot square. The patient is to read aloud one letter from

each quadrant. Two clockwise rotations are made, one only using the first letter of every quadrant, and the second only using the 2nd letter of every quadrant. Then two counter-clockwise rotations are made using the 3rd and 4th letter of every quadrant, respectively.

3. Again, using the quadrants, the patient reads aloud: the 1st letter in quadrant #1, the 2nd letter of quadrant #2, the 3rd letter of quadrant #3, and so forth. The patient is to complete 2 clockwise rotations and 2 counter-clockwise rotations.
4. Using the whole Hart Chart, the patient reads aloud the first and last letter of every line.
5. Using the whole Hart Chart, the patient now reads aloud the first and last letter of the first line, the 2nd letter and 2nd to last letter of the 2nd line, and so forth.
6. The above is repeated with the fellow eye, and then binocularly.

Figure 4. FL-41 filter (top) and BPI-Omega filter (bottom) chromatic lenses used in study

Tint Selection

For the tint determination, patients selected from six possible BPI tints covering much of the visible spectrum: FL-41, Omega, Signal Blue, Deep Blue Zee, Sahara, and Signal Yellow; these specific selections were based on two years of experience with such lenses in patients with VSS. The individual would fixate upon a reduced

Table 2: Patient demographics

Age Range: 9-55 yrs, average age: 27.6 yrs
Gender: 15 Female and 12 Male
Frequency: 14 Constant, 13 Transient
Appearance: 22 Monochromatic, 5 Chromatic

Table 3: Possible etiologies of VS

Concussion/mTBI	15	55.5%
Idiopathic/Migraine	6	22.2%
Post-Surgery with Anesthesia	3	11.1%
Idiopathic/Non-Migraine	1	3.7%
Mixed	1	3.7%
Other	1	3.7%

Table 4: Primary VS/VSS visual symptoms

Palinopsia	23	85.2%
Photophobia/photosensitivity	20	74.1%
Enhanced Entoptic Imagery	14	51.2%
Nyctalopia	9	33.3%

Table 5: Secondary VS/VSS visual/non-visual symptoms

Migraine	15	55.5%
Tinnitus	13	48.1%
Photopsia	8	29.6%
Phonophobia	7	25.9%
Balance problems	7	25.9%
Hyperacusis	4	14.8%
Cutaneous allodynia	2	7.4%
Tremor	1	3.7%

Table 6: Co-morbid binocular abnormalities

Oculomotor Dysfunction (OMD)	16	59.3%
Convergence Insufficiency	14	51.9%
Accommodative Insufficiency (n= 22 patients under the age of 40)	12	54.5%
Convergence Excess	9	33.3%
Fusion with Defective Stereopsis	6	22.2%
Strabismus	1	3.7%

Hart Chart, try the various tints in random order, and indicate if the print looked clearer and/or more comfortable with the tint versus no tint. Then they would compare the tints they preferred to each other, and eventually come up with a tentative single preferred selection. With that preferred tint, the patient was then instructed to look around the room, focus upon a computer screen, and look from far to near

several times, etc., to confirm that this tint was better than their second choice. If not certain, the individual would try the first and second selections again in the same test conditions, until the single best lens was determined for that specific condition. In general, we attempted to trial tints in the most visually provocative environment we could create in office for each individual patient (Figure 4).

RESULTS

The compiled demographic and diagnostic information is presented in Tables 2-6. The patients presented to the clinic with the main symptom of VS, with it being constant in just over 50% and in the majority being monochromatic in nature. Concussion either precipitated or exacerbated the symptoms of VSS in fifteen of the patients; of these fifteen, seven had a history of co-morbid migraine. In addition, three patients began experiencing VSS shortly after undergoing surgery with anesthesia, with Propofol being used in two of the three cases, and furthermore two of these patients experienced migraines before their surgeries. Six of the nine patients reported migraine-associated VSS and reported having these symptoms all/much of their lifetime. Of the primary visual symptoms in VSS, palinopsia was reported in twenty-three, photophobia/photosensitivity in twenty, enhanced entoptic imagery in fourteen, and nyctalopia (i.e., reduced vision at night) in nine. Migraine and tinnitus were the most prevalent non-visual symptoms/conditions, being reported in fifteen and thirteen patients, respectively. Lastly, photopsia was reported in eight, whereas phonophobia and balance problems were found in seven.

All but one (96%) were diagnosed with either a single or multiple, co-morbid binocular vision problem/condition (Table 6). Fifty-nine percent were diagnosed with a basic versional oculomotor dysfunction (OMD; i.e., a deficit of fixation, saccades, and/or pursuit),[11] fifty-three percent with convergence insufficiency, fifty-four percent of patients under age forty years with accommodative insufficiency, and approximately thirty-three percent with convergence excess. Conventional oculomotor-based, neuro-optometric rehabilitation was initiated in twenty-three of the patients (~85%), which included versional, vergence, and accommodative components.[11] Symptom reduction (e.g., skipping words during reading, intermittent blur) was reported in all patients.

Table 7: Patient filter selection

Vision Therapy and Filter	22	81.5%
FL-41 Filter	12	44.4%
BPI-Omega Filter	9	33.3%
Both Filters (Separate Tasks)	3	11.1%
No Filter	3	11.1%

Treatment for the VS and palinopsia was also provided (Table 7). Chromatic filters were prescribed in all but three patients. The FL-41 filter was selected by twelve patients, whereas the BPI-Omega filter was selected by nine. In general, patients who had a concussion history were more likely to select the Omega tint. An additional three patients selected both filters for use in separate spectacles for different tasks, such a computer use versus general wear. All patients who had a filter preference reported symptom reduction of the VSS of at least 50%. There was a reduction in intensity as well as frequency. Reduction of the palinopsia was rarely noted with the filter alone, but always occurred to some degree (50-65%) following a program of a specific oculomotor-based saccadic therapy as described earlier. The reduction of palinopsia following vision therapy occurred in both frequency and intensity.

CASE PRESENTATIONS

Case 1: VSS Onset Post-Mild Traumatic Brain Injuries/Concussions:

The patient was a 37-year-old male with a long history of migraines. He presented after sustaining three concussions over the previous three months. His first concussion was followed by a significant headache later in the day. He experienced eyestrain, visual motion sensitivity,

and visual snow over the next few days, as well as general fatigue. He described the VS as transient, monochromatic visual distortions that appeared around the images he was fixating. This was his first occurrence of VS, and it was also accompanied by an increased awareness of his ocular floaters (i.e., enhanced entoptic imagery). Additionally, he often now perceived palinopsia, which he described as trailing ripples when he shifted gaze between objects. He was instructed by his primary care physician to spend the next month resting in a light-controlled environment and to avoid any computer screen time. He followed this advice, but the symptoms did not reduce. The continued presence of the VSS symptoms produced considerable anxiety, as he now doubted his chances for recovery. During a subsequent neurological consultation, it was recommended that he commence both physical and vestibular therapy. With these therapies, his symptoms began to reduce. However, he then sustained the second and third concussions, which caused his original symptoms to recur. He was prescribed Buspirone for his anxiety, and he was then referred by his neurologist to seek a neuro-optometric assessment at our practice.

This optometric assessment revealed convergence insufficiency (CI), with greater exophoria at near as compared to distance, and a receded near point of convergence. In addition, he was diagnosed with fusional instability and general accommodative/oculomotor dysfunction. The peripheral OKN test revealed a high degree of visual motion sensitivity (16/40),[12] which confirmed the presence of this frequent visual symptom in concussion.[13] He was prescribed an updated spectacle prescription which included a 20% FL-41 filter to reduce the VS, as well as a low degree of base-in prism (1pd/eye) for the exophoria. In addition, neuro-optometric, oculomotor-based vision therapy was suggested to reduce his near symptoms (e.g., intermittent diplopia) due to the CI, but he could not do so at that time. When he returned six months later, the eyestrain and visual distortions were reduced with the FL-41 spectacles. However, he still had headaches following near work. He then was prescribed 16 session of in-office, oculomotor-based vision therapy, with emphasis on saccadic tracking and vergence, which resulted in major reduction of his related near symptoms; it also reduced the VS and palinopsia by approximately 75%.

Case 2: Post-Surgical Onset of VSS:

The patient was a 50-year-old male who began experiencing ophthalmic migraines several days following surgery for a heart mitral valve repair. They occurred four to five times per day, and each lasted for 15-20 minutes. Prior to the surgery, he had a history of migraines that occurred only 1-2 times per year over the previous 10 years. The ophthalmic migraines were described as an arc-like distortion in his visual field beginning near the blind spot. Following the surgery, he also began noticing the VS.This appeared as a constant, monochromatic, pixelated snow effect throughout the visual field and distinct from his migraine visualizations. He noticed the VS more prominently in dark environments and reported his night vision to be worse (i.e., nyctalopia). The migraines reduced in their frequency over the subsequent several months, but the VS did not. Additional VSS-associated symptoms included photosensitivity, palinopsia, enhanced entoptic imagery, and photopsia.

The neuro-optometric evaluation at our office revealed convergence excess and fusional instability. He was prescribed an updated spectacle correction that incorporated a 20% FL-41 filter to reduce the VS/VSS-related symptoms. With the new spectacles, the migraines completely resolved. He was also prescribed twelve sessions of oculomotor-based vision therapy to remediate the vergence dysfunctions, as well as to reduce the perception of the VS and palinopsia. While the vergence deficits were fully remediated, the VSS-related ones were only partially reduced. But the patient was now

not much bothered by them, perhaps due to attentional processes and/or neural habituation.

DISCUSSION

This is the first paper to demonstrate successful neuro-optometric rehabilitation (NOR) in a clinical population diagnosed with VSS and its wide array of unique visual symptoms. It included the use of: (1) chromatic tints/filters to reduce the perceived intensity and frequency of the VS and many of the other abnormal visual phenomena (e.g., palinopsia)reported in those with VSS; these filters reduce the overall illumination of the visual field, more so in the specific "offensive" spectral band, which typically appears to be in the blue region of the visible spectrum.[14] (2) Saccadic tracking to reduce the perceived intensity and frequency of the palinopsia, which has been speculated to occur due to a disinhibition/hypersensitivity phenomenon related to saccadic suppression;[6,7] the training appears to re-establish/reset a more normal level of saccadic suppression, such that its smeared, afterimage perception during a saccade is inhibited once again. In addition, and somewhat serendipitously, this is the first study to detect, diagnose, and treat the multitude of versional oculomotor deficits (i.e., OMD) that appear to be present with a very high frequency of occurrence in our sample (~60%), and likely present more generally.[15,16] This is fruitful territory for future investigations (see later Discussion). We have found that common optometric diagnostic tests (DEM, Visagraph, and direct observation of eye movements) combine to allow for the diagnosis of oculomotor dysfunction.

The new neuro-optometric treatment approaches presented here show considerable promise in remediating, at least in part, the range of sensory, motor, and perceptual problems encountered in the VSS population. The chromatic tints can be helpful in many respects: they reduce the luminous intensity of the offensive visual snow, as well as the palinopsia, photopsia, photosensitivity, and enhanced entoptic imagery. Similarly, the saccadic tracking paradigm appears to be beneficial in reducing the intensity and frequency of the palinopsia. And, the broader, traditional oculomotor approach was assistive in remediating the wide range and prevalence of eye movement abnormalities in the present cohort, which is a new finding. For example, nearly 60% were diagnosed with general versional, oculomotor dysfunction (OMD), which is far greater than predicted for similarly-aged individuals (~20 percent).[17] Related to this, nearly 85% (23/27) were referred for its remediation using general oculomotor-based vision therapy for their versional, vergence, and accommodative deficits. This new finding of a very high rate of oculomotor abnormalities in the VSS population is consistent with two recent laboratory investigations suggesting possible attentionally-based, saccadic eye movement differences as compared to normals.[15,16] Abnormal neural gain has also been postulated.[18] And, these new oculomotor findings are consistent with more general motor abnormalities frequently found in this population, namely tremor and balance difficulties. Further research is needed to determine if there is a link.

The diagnosis of VSS can provide a measure of peace-of-mind for patients afflicted with VSS. Additionally, it can serve as a "unifying diagnosis" for other health care providers who may be consulted by patients with VSS and a range of seemingly unrelated symptoms. For example, one of the patients consulted our referring neurologist for migraine headaches along with persistent "static" in her vision. The neurologist's case history stated that, "...the patient initially consulted an ophthalmologist for large 'floaters' that occurred in either eye at different times and also bright-colored lights which occurred intermittently." The patient also consulted an otolaryngologist for "persistent tinnitus". Both the ophthalmologist and otolaryngologist found no medical reason(s) for her symptoms after performing numerous diagnostic tests within their respective disciplines. Knowledge of the typical symptoms in those with VSS would have been critical to

the proper diagnosis in this case. That is, in a patient with the following symptoms, namely visual snow, tinnitus, floaters, and migraine, the correct diagnosis of VSS becomes apparent.

There were four possible study limitations. First, sample size was relatively small. Second, testing was not conducted in the context of a controlled clinical trial but rather by convenience sampling within a clinical optometric practice. Third, the selection of chromatic filters was relatively small. And, fourth, objective measures were not employed, such as brain imaging and eye movements.

There are several possible future directions[19] to expand in this important, and emerging, research area. First, a clinical trial should be conducted to ascertain treatment efficacy in a larger cohort of individuals with VSS, perhaps with respect to different subsets of symptoms, treatment "dose" levels, long-term follow-up, and other relevant issues. This would include a wider range of chromatic tint possibilities, such as available with the Intuitive Colorimeter,[9] for VS and related symptom reduction; development of saccadic tracking paradigms specifically for the palinopsia; and more targeted, oculomotor-based vision therapy protocols specifically to address the versional deficits (i.e., OMD) that now appear to be commonly found in this population. In addition, new methodologies should be developed centering around computer- and cellphone/app-based technologies,[9] perhaps exploring augmented/virtual reality environments with their unique sense of total immersion and ability to control stimulus conditions. Second, more psychophysical testing should be performed to assess behavioral and performance metrics, which would provide insight into the related brain mechanisms. Lastly, and related to the above, more brain imaging is critical to understand better this complex condition of VSS and its related sensory, motor, and perceptual components. For example, such testing before and after a visual intervention would yield new and important information for both the clinician and basic researcher regarding the involved brains sites and their underlying plasticity.

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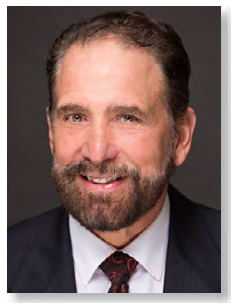

CORRESPONDING AUTHOR BIOGRAPHY:
Barry Tannen, OD • Hamilton, New Jersey

Dr. Tannen is in private group optometric practice at EyeCare Professionals, PC in Hamilton, New Jersey, where his clinical and research emphases are visual deficits related to concussion, acquired brain injury, strabismus, amblyopia, and learning-related vision problems. Dr. Tannen is the program supervisor for a private practice-based, Residency in Vision Therapy and Neuro-Optometric Rehabilitation at EyeCare Professionals.

Dr. Tannen received the A.M. Skeffington award for excellence in Optometric Writing from the College of Optometrists in Vision Development in 2016, the Ludlam Education Award by the Neuro-Optometric Rehabilitation Association in 2014, and the Scientific Achievement Award by the New Jersey Society of Optometric Physicians in 2002. He is a Fellow in the American Academy of Optometry, and the College of Optometrists in Vision Development (COVD), Past President of COVD, and an Associate Clinical Professor Emeritus of the SUNY/State College of Optometry in New York. Dr. Tannen lectures internationally and has co-authored over 60 journal articles, as well as a clinical textbook on Eye Movements.