CASE REPORT

Assessment and Use of Therapeutic Reading Glasses to Guide Visual-Spatial and Binocular Development in Patients with Autism Spectrum Disorder

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ABSTRACT

Given their growing incidences, patients with autism spectrum disorders (ASD) are important populations to be serviced by the optometric community. This case report will underline the importance of using refractive tools and a functional vision assessment to effectively manage this population and both improve and guide visual-spatial development. Further, this case report will review the visual sequelae and co-morbidities of autism spectrum disorders and how to appropriately manage these patients inter-professionally.

Correspondence regarding this article should be emailed to Allie D. Decker, OD, at **adecker.od@gmail.com.** *All statements are the author's 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.* *VDR is indexed in the Directory of Open Access Journals. Online access is available at* **covd.org.** **doi.org/10.31707/VDR2023.9.4.p231.**

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INTRODUCTION

Autism spectrum disorders (ASD) have an increased incidence globally nearing 1 in 36 children and it is important for optometrists to effectively care for this special population.[1] The spectrum of neurodevelopmental disabilities that encompasses ASD is pathognomonic for repetitive behaviors, delays in communication and limitations in social interaction with the degree of severity of these behavioral patterns varied by patient.[2] Given the widespread differences in brain function that characterize ASD, variations in the visual system are likely.[2] It has been well documented that patients with ASD have difficulties with sensory processing affecting their ability to attend to tasks and result in learning difficulties.[1,2] The visual system provides significant sensory input and difficulty processing that information results in the characteristics seen in this population including poor eye contact, limited fixation ability, poor coordination of eye movements and reduced visual-spatial awareness.[2] Further, there is higher prevalence of near point and oculomotor dysfunctions in the ASD population.[2] Given the significant impact that appropriate visual development has on learning, it is important to help guide proper vision development, particularly with a therapeutic lens and prism correction. Multisensory-based visual rehabilitation should be considered for ASD patients to develop the visual skills necessary for optimal functioning.

CASE REPORT

Initial Comprehensive Eye Examination and Functional Vision Assessment

A seven-year-old Caucasian male accompanied by his mother presented for an initial functional and comprehensive vision assessment. The mother reported concerns with his fine and gross motor skills, in addition to concerns regarding his social and cognitive development. Signs and symptoms of visual dysfunction noted by the mother included the following: rubbing his eyes, head turning, quickly flicking and/or spinning objects near his eyes, limited visual attention, difficulty coordinating tasks, difficulties writing and poor handwriting. She additionally noted that he is often in constant motion

and is a very active child. He had no avoidance of reading, despite his difficulty attending to tasks.

The patient had a history of a full-term birth with no pre-natal, post-natal or peri-natal complications. Upon assessment of developmental milestones, it was noted the patient began crawling on all fours at 12 months and promptly began walking at 13 months. Speech development was significantly below age-expected norms and the patient had been diagnosed with a non-verbal learning disability with a subsequent diagnosis of childhood autism at age 22 months. The patient's mother additionally reported poor sleep, impulsivity and limited speech. The patient was currently repeating Kindergarten with significant in-school support and he was receiving bi-weekly private occupational therapy. He had no prior ocular health assessments and was not taking any medications.

Due to his limited attention, poor fixation and limited speech, a visual acuity assessment was unattainable at distance or near. At distance and near, matching Allen Symbols to obtain a visual acuity measurement was attempted and unsuccessful. No forced choice preferential looking or grating acuity methods were attempted. Pupillary testing revealed equal, round and responsive to light, with no afferent pupillary defect in either eye. Upon assessment of his pupillary release, there was evidence of an ill-sustained pupil response in both eyes, graded as a 3+ out of 4 in each eye. Extraocular muscle testing revealed full motilities without restrictions in either eye. See Table 1 for functional examination clinical findings. The patient was unable to perform accommodative amplitude, further binocular testing, stereoacuity, color vision or confrontational visual field testing. Stereofly

Table 1: Cross-comparison of pertinent functional examination clinical findings from both patient encounters.

Clinical Assessment	Clinical Findings from Patient Encounter #1	Clinical Findings from Patient Encounter #2
Visual Acuity	Unable	Distance: 20/20 OU Near: 20/30 OU
Near Cover Test	14pd XP	4pd XP
Near Point of Convergence	8" break, 10" recover (Wolf Wand)	3" break, 5" recover (Wolf Wand)
Accommodative Amplitudes	Unable	1" OD, 2" OS (Push-in method)
Bell's Near Retinoscopy (sc)	14" OU	17" OD, 14" OS
Oculomotor Skills	Fixations: Minimal ability to fixate, inaccurate Pursuits: Inaccurate, significant loss of fixation Saccades: Very limited ability to perform, briefly touching target in horizontal/vertical gazes only	Fixations: Inaccurate, but improved to last Pursuits: Overall jerky, inaccurate, comitant Saccades: Able to complete task and shift fixation on command, 1-2+ undershoots in all gazes
Vergences	Distance BO: x/8/2 Distance BI: x/12/4 Near BO: x/12/0 Near BI: x/14/8	Distance BO: x/20/18 Distance BI: x/20/14 Near BO: x/35/20 Near BI: x/16/12
Autorefraction	OD +1.25 – 2.50 x 007 OS +100 – 1.75 x 175	OD +0.25 – 0.50 x 172 OS +0.50 – 1.00 x 180
Dry Retinoscopy	OD +1.00 – 1.50 x 180 OS +1.00 – 1.50 x 180	OD +0.50 – 0.50 x 180 OS +0.50 – 1.00 x 180
Visual-motor Integration and Behavioral Assessment	Limited engagement, poor visual-spatial awareness, poor bilateral integration	Improved engagement during testing, improved visual-spatial awareness

was attempted to assess global stereoacuity and Color Vision Made Easy plates for the color vision assessment, however, the patient did not respond.

An undilated ocular health assessment with Optos fundus imaging revealed optic nerves that were healthy, perfused, and distinct, graded as a 0.1/0.1 cup to disc ratio in both eyes and unremarkable retinal health. Slit lamp examination revealed normal anterior segment findings in both eyes. Manual intraocular pressure assessment was noted as soft and equal in pressure in both eyes.

Based on the patient's case history and examination findings, the differential diagnoses considered included the following:

1. Convergence insufficiency secondary to high exophoria at near
2. Oculomotor dysfunction
3. Mild accommodative insufficiency
4. Reduced visual attention

The patient was diagnosed with convergence insufficiency, oculomotor dysfunction, and mild accommodative insufficiency. The patient's reduced compensatory base-out vergence ranges, receded break and recovery on near point of convergence testing, in addition to his high exophoric posture at near upon objective cover testing were indicative of convergence insufficiency. Objective testing of the patient's accommodative status using Bell near retinoscopy revealed a mild accommodative lag in both eyes, indicative of a mild accommodative insufficiency. Limited attention, poor visual accuracy, observed as hypometric saccades and pursuits with Northeastern State University College of Optometry (NSUCO) oculomotor testing, and difficulty performing the oculomotor testing was indicative of oculomotor dysfunction. Given the patient's engagement, performance on testing and his history of ASD, the patient was diagnosed with reduced visual attention.

Additional differential diagnoses considered included a visual information processing dysfunction and reduced visual-spatial awareness. Given that these were not formally tested in the functional examination sequence, the author can not definitively conclude that the patient's visual difficulties are attributed to these diagnoses. Limited visual perceptual skills and visual-spatial awareness are likely contributing to the patient's visual difficulties; literature suggests these skills are often reduced in ASD patients.[2]

An objective assessment of the patient's tracking, bilateral integration, visual motor as well as visual-spatial awareness was performed using the Marsden Ball in the vision therapy room with and without the final prescription. Without the prescription, limited visual-spatial awareness, poor visual information processing and significant difficulty engaging with the Marsden Ball was observed — the patient avoided fixation, proprioceptive feedback and exhibited poor visual-motor integration. An avoidance of bilateral integration was noted as the patient had difficulty coordinating both hands simultaneously to touch the ball as it moved in space. With addition of a therapeutic prescription of +0.50 sphere 1 prism-diopter base-in prism OU, it was observed that the patient exhibited improved tracking, spatial awareness and visual-motor integration. Addition of yoked prism was not trialed given the observed improvement with base-in prism. While yoked prisms are often adopted in this patient population to improve visual-spatial awareness, base-in prisms have also been effective in our clinical practice. Further, base-in prism was selected as a result of Sutton and Kraskin's spatial model of the characteristics of lenses and prisms.[2,24] Wearing base-in prism induces an outward shift of visual space, reduces muscle tonicity and expansion of visual space volume.[2,24] These objective observational assessments were indicative of the suspected differential diagnoses of reduced visual-information processing and limited visual-spatial awareness. This diagnosis was not quantified clinically with a visual-perceptual processing battery of testing yet it was clinically observed. Re-assessment of the clinical findings through the therapeutic prescription was not completed due to the limited visual attention and engagement observed throughout the examination.

The therapeutic reading prescription of +0.50 sphere 1 prism-diopter base-in OU was prescribed, with the recommendation to be worn for all pro-

longed near work. A low plus prescription was indicated given the mild accommodative lag that was found on near retinoscopy. No astigmatic correction was indicated due to the poor fixation observed during testing and the patients high exophoria, likely ensuing limited reliability. The patient revealed moderate isoametropic astigmatism in both eyes, which was inconsistent between autorefraction and dry retinoscopy findings. The degree of astigmatism in both eyes was asymmetric, although not amblyogenic in nature on autorefraction. The refractive error observed on dry retinoscopy revealed a symmetric prescription in both eyes that also was not amblyogenic. This inconsistency in refractive findings was indicative of poor fixation and visual attention, deferring a cylindrical refractive correction. There was low concern that the patient was susceptible to poor sensory fusion given the inconsistent automated and objective astigmatic refractive findings. Additionally, Sutton and Kraskin's research on the postural and spatial characteristics of lenses and prisms was considered, as they recorded increased tonicity of posture musculature and reduced visual space volume from minus lenses.[2,24] The finalized prescription included prism in order to encourage stability of the visual-spatial and binocular systems. Re-assessment of the patient's refractive status and acuity measures at a follow-up visit in three months was encouraged to assess the stability and/or accuracy of the cylindrical refractive error, need for cylindrical refractive correction, in addition to determining if in-office visual therapy is indicated. If stable autorefraction findings indicate uncorrected high hyperopia, a cycloplegic refraction will be considered for diagnostic accuracy. To continue improving upon his visual-spatial awareness, the patient was encouraged to continue with his structured occupational therapy program twice weekly.

Comprehensive Eye Examination and Functional Vision Assessment 1 Year Later

The patient did not return at the requested follow-up interval after his initial assessment, instead returning for his annual exam approximately 1.5 years later. At this examination, the mother reported good compliance with the glasses; he did not avoid or resist spectacle wear. With spectacle wear, she noted that her son demonstrated improved engagement in visual tasks. She returned wanting to acquire another pair of spectacles, as his glasses had recently broken and his team of therapists reported improved attention with glasses wear. The patient was actively receiving occupational therapy three times a week and speech support from his specialized education program. The patient now was minimally verbal rather than nonverbal. His mother reported improvement in all areas of development and stated there were no signs of visual dysfunction that were previously noted at his last assessment. The only remarkable finding was the patient had difficulties incorporating his sight words into a sentence, despite knowing them individually. Additionally, the patient's occupational therapist had some concerns regarding his visual tracking skills. The patient's medical history was stable and he was not taking any medications.

The patient exhibited improved visual attention at his follow-up comprehensive vision assessment. He was able to sustain visual attention and match Allen Symbols on the visual acuity assessment with both eyes. Using single symbols to avoid the crowding phenomenon, the patient was able to read the 20/20 symbol at distance uncorrected. His visual attention was much more limited at near; he briefly attended to the 20/30 single Allen symbol target presented to him with both eyes, uncorrected. Pupillary testing revealed equal, round and responsive to light, with no afferent pupillary defect in either eye. Assessment of his pupillary release revealed a stable ill-sustained pupil response, graded as a 3+ in each eye. Extraocular muscle testing revealed full motilities without any restrictions in either eye. See Table 1 for functional examination clinical findings. The patient was unable to reliably respond to stereoacuity, color vision or confrontational visual field testing. The testing methods were stable from the previous examination. Overall, the patient was much more engaged, demonstrating improved expressive and receptive language skills in the examination.

Ocular health assessment at this examination was performed using slit lamp examination and direct ophthalmoscopy only, as the mother deferred fundus imaging and dilation. Retinal health to the extent seen was unremarkable in both eyes. Optic nerves were healthy, perfused, and distinct, graded as a 0.15/0.15 cup to disc ratio in both eyes. Slit lamp examination revealed normal anterior segment findings in both eyes. Intraocular pressure assessment was completed manually, with both eyes noted as soft and equal in pressure.

Based on the examination findings and NSUCO oculomotor testing, the patient remained diagnosed with, albeit improved, oculomotor dysfunction. Very mild signs of accommodative insufficiency remained, exhibited by the mild lag of accommodation on Bell retinoscopy in the right eye only. The patient no longer presented with clinical signs of convergence insufficiency. The astigmatism noted at his previous examination had reduced significantly and entering uncorrected visual acuity was 20/20 at distance. This was attributable to the patient's improved visual attention, engagement and fixation. Based on the visual acuity, an accurate acquisition of the patient's refractive status, lack of amblyogenic hyperopic astigmatism and improved functional examination findings, a cycloplegic refraction was not indicated. The finalized therapeutic prescription remained stable to the last examination, of +0.50 sphere 1 prism diopter base-in OU. It was encouraged that the patient continue to wear the glasses for prolonged near work and all supportive therapies. Discussion with the patient's mother underlined the importance of continuing with his active occupational therapy program. Collaboration with the patient's occupational therapist was recommended to incorporate more visual-motor integration, tracking, visual-spatial and visual-processing activities into his therapy. Discussion of visually based recommendations with the patient's occupational therapist via telephone communication was conducted. Recommendation to pursue activities with a focus on sensory integration, tracking exercises, near and far shifting, spinning in different positions, jumping/swinging, visual-perceptual/processing skills with an emphasis on multisensory system integration was encouraged. A functional vision re-evaluation was recommended in six months. If there is minimal improvement in the oculomotor findings and visual attention at the next examination, in-office visual therapy and/or an alteration to the patient's therapeutic prescription will be considered. Dilated fundus assessment and Optos fundus imaging will be attempted at the patient's follow-up to assess peripheral retinal health in both eyes.

DISCUSSION

Defining and Classifying Autism Spectrum Disorders

Autism spectrum disorders (ASD) are a complex range of neurodevelopmental dysfunctions with a diverse impact on behavioral, social, emotional, and cognitive function.[1] Patients diagnosed with autism manifest poor sensory processing, in addition to difficulties attending to tasks.[2] It is a spectrum of disorders as those affected present with various degrees of severity, ranging from cognitively gifted to having significant developmental challenges, highly responsive to non-verbal communicators, and very independent to needing notable support.[2] The spectrum of autism disorders prior to 2013 had previously been grouped into autistic disorder, Asperger's syndrome, childhood disintegrative disorder, and pervasive developmental disorder, combining the criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM) fourth and fifth editions.[3] More recently, the condition has been identified with the blanketed diagnosis of ASD, rather than through subtypes, categorizing the condition based on severity: Level 1, Level 2, and Level 3 autism (Table 2). Grading patients within this updated classification system is predominantly based on two criteria: "social communication impairment and restricted interests/repetitive behaviors."[4] Patients typically present with symptoms of ASD prior to 3 years old; some authorities note manifestations in the first 12 months of life.[2,4] Incidence is more prevalent in males than females, noted as a 4:1 ratio.[2,4] There is no greater incidence in any racial ethnicity or from any socioeconomic background.[2,4] The prevalence of

Table 2: Updated classification of autism spectrum disorders (ASD) based on Level of Severity.[5,6] Adapted from American Psychiatric Association, with further background attainable from the DSM-5.[5]

Level of Severity Classification	Restricted Interests/Repetitive Behaviors	Social Communication Impairment
Level 1: Requiring support	Desire for organization Behaviorally inflexible Varying levels of attention Reduced adaptability and difficulty with transitions, ensuing stress Poor tolerance of frustration	Poor social skills Difficulties initiating or disinterest in social interactions Limited eye contact Varying emotional or sensory dysregulation Difficulty understanding or adhering to normative social conventions
Level 2: Requiring substantial support	Very engaged and fixated on specific areas of interest Easily distracted by stimuli Distressed when exposed to change or disruptions in routine Self-harming when anxious Requiring stimulation behaviors	Notable speech variations; less regulated expressive/receptive language, varying nonverbal disability Unable to register nonverbal cues Atypical social behavior; poorly responsive
Level 3: Requiring very substantial support	Significant repetition and fixation on behaviors (i.e., spinning, blinking, rocking) Extreme distress when altering focus or changing tasks Inability to complete daily tasks, often with reduced cognition	May be nonspeaking or demonstrate echolalia Preference for solitude with very limited interest in social interactions or friendships Interactions to service an immediate need

ASD diagnoses is rapidly increasing, with the most recent estimate from the National Health Center for Health Statistics projecting it to be as high as 1 in every 36 children.[1,4]

Preparing for the Visual Assessment with an ASD Patient

It is important that optometric clinicians are aware of the various behaviors that may present during the visual assessment of a patient diagnosed with ASD. Such behaviors include gaze aversion, abnormal social interaction, a desire for solidarity, repetitive behaviors, fixation on specific interests, and resistance to change and/or new environments.[7] Understanding these behaviors builds a strong foundation of trust with the patient, thereby enabling a successful examination experience. There are no standardized optometric diagnostic criteria for assessing the ASD population.[7,8] Clinicians must be able to work creatively and efficiently, recognizing that repeat interactions may have variable results, and/or that their testing sequence will often vary between examinations.[7,8] Additionally, an examiner may consider separating the visual examination into multiple parts, particularly in the setting of a functional vision assessment with suspect refractive, or oculomotor or binocular dysfunctions, and/or allow more evaluation time to meet the needs of the patient.[7,9] Prior to the patient's arrival, best practice is to desensitize them to the clinical setting by providing information about the practice in advance. Posting pictures of the practice exterior, interior, and the equipment used in the examination on the practice website is useful for preparing patients in this population. This approach is known as utilizing a "Social Story," a short description of an event, activity or situation with information about what to expect in that situation and why.[7,25] In children and adolescents with ASD, research has shown that social stories improve numerous behaviors, including: social engagement, prosocial behavior, social communication, conversational skills, on-task behavior, out-of-seat behavior, reciprocal interactions, adaptive behavior, reduced problem behaviors, self-regulation and generalized improvement in social skills.[7,25] If the patient presented in this case was shown a social story of the practice environment and vision examination

experience, it is possible more baseline clinical testing could have been completed. It is imperative to be sensitive to the patient's sensory processing dysfunction.[7,10] Due to the range of expressive and receptive communication previously discussed, it is important to minimize commands into simple pronouns.[10,11] When assessing visual acuity, it is best to use single letters/symbols to avoid the crowding phenomenon.[7,10] For non-verbal patients, the use of matching techniques or grating visual acuity testing (i.e. Lea paddles, Teller cards, Cardiff cards) yields best results.[7,10] Employing objective testing wherever possible to acquire refractive and binocularity status, using engaging visual targets allows for maximum success.[7] If there is resistance to testing, demonstrating on a family member first prepares the patient.[10] As noted in the case presented, a visual acuity assessment was unable to be attained due to limited fixation during the first vision assessment. At his next evaluation, the patient's baseline visual acuity with both eyes was obtained, in addition to a much-reduced refractive error in both eyes. Each assessment can offer varying depths and degrees of reliability to the testing, with the primary goal of acquiring appropriate data to ensure that the patient is progressing and improving based on clinical outcomes.

Prevalent Visual Sequelae in ASD Patients

In addition to acquiring a thorough developmental history, it is important to assess for visual concerns that may be indicative of a neurodevelopmental disorder in patients.[10] This was outlined by optometrists Press and Richman, who described the following behaviors which may raise suspicion of ASD: avoiding eye contact, gaze aversion, gaze following, insensitivity to prolonged visual attention with another individual, difficulties integrating peripheral vision with central vision, and persevering on one item of interest.[12] This list has expanded to include additional visual signs of ASD: light sensitivity, toe walking, distaste/preference for a particular color, significant surface touching in unfamiliar environments, and poor postural control.[2] The patient described in the case demonstrated flicking/spinning objects around his face, poor coordination, and limited attention – all behaviors that have been linked to ASD.

When a patient has been diagnosed with ASD, their symptoms may often remain throughout their life.[2] There are various visual sequelae associated with ASD that developmental optometrists are aware of and actively screen for in their assessments. Refractive error in ASD populations ranges from normative to amblyogenic, with high astigmatism being the most prevalent.[9] There are varying degrees of accommodative responses in ASD patients with some studies revealing a more prominent accommodative lag in comparison to typically developing children.[13,14] Literature reveals that children with ASD have a greater prevalence of accommodative deficits, even while wearing habitual correction.[13,14] Instability of binocularity has been widely shown in ASD patients, ranging from 20-50%.[2,9,13] Additionally, the prevalence of strabismus in this population ranges from 10-60%.[2,9,13] A study conducted by Milne et al. in 2009 noted increased prevalence of convergence insufficiency in ASD patients.[2,9,11,13] The convergence difficulty is indicative of limited neurological control and/or control of the extraocular muscles themselves for coordinated vergence movements on a proximal target.[9] This may be secondary to poor binocular rivalry and/or reduced cortical inhibition, as patients require adequate fixation stability to have controlled convergence.[9] Ocular motilities within the ASD population are often atypical.[7,15,16] Optokinetic reflexes, fixation stability, and saccadic function are most typically affected.[2,7,15] The case presented, upon initial evaluation, exhibited significant losses of fixation with poor eye contact and hypometric saccades, consisting of undershooting of the eyes and an inability to meet the amplitude of the target. Additionally, contrast sensitivity with pattern targets is often limited in the ASD population, often resulting in difficulties transitioning into an environment with altered flooring/stairways.[2]

ASD patients may encounter visual hyper- and hypo-sensitivities.[2,15] These are often secondary to a sensory processing dysfunction, with concurrent visual stimuli processing difficulties often exhibited.[2,15] Generalized photosensitivity is often

encountered with ASD patients; fluorescent lighting hypersensitivities have been documented, exacerbating repetitive behaviors.[2] ASD patients may have acute or longstanding hypersensitivities to bold visual colors.[2] Visual hypersensitivities are attributed to a heightened visual scanning ability, theorized to be from a lack of visual information inhibition.[2] Over-stimulation of the senses may also present as a hyposensitivity, where patients are overloaded with stimuli and are unable to successfully process visual information.[2] The degree of hyper- and hypo- sensitivities in ASD patients varies widely.[2] Underlying developmental visual efficiency and perceptual/processing issues may also be heightened in these patients.[2] Additionally, enlarged pupil size is often noted in these patients in bright and dim conditions.[2,9,18] Ill-sustained pupils, also called Alpha-Omega pupils, were noted during the examinations presented, secondary to autonomic nervous system imbalance.[2,9,18]

Use of Lenses and Prisms for Treatment of Visual Dysfunction in ASD Patients

As a result of their limited visual-attention, ASD patients often use significant tactile and proprioceptive feedback from their environment to provide input.[2] The reliance on proprioception can result in reduced visual-spatial awareness and negatively impacts their localization of space of self and others, resulting in inadequate postural stability.[2,18] Compensatory mechanisms to improve body awareness such as toe walking and hand flicking/flapping near faces are prevalent and frequently manifested by ASD patients.[18] The case presentation indicated a similar compensatory behavior, where the patient's mother reported symptoms of flicking and/or spinning objects proximally to his face at the initial evaluation. Improvement of postural stability using lenses and prisms therapeutically has been a longstanding tool used by behavioral and developmental optometrists. It is therefore appropriate to consider a prismatic therapeutic correction for these patients.[19,20] Prisms can shift the light input and cause the eyes to move in a particular direction creating a change in spatial perception.[19,20] Yoked prisms cause a spatial shift secondary to the movement of the perceived image toward the prism apex, triggering an altered center of gravity, altered gait, postural change, and a shift and/or rotation in the pelvis.[19,20] When used appropriately, these lenses can therapeutically alter behavior and visual attention. Press and Richman noted that ASD individuals have a greater perception of local processing versus global processing, where they will often process fine detail rather than the "big picture." This is evident in the well-established literature review of poor peripheral awareness in ASD patients.[2,10] Yoked prisms can also improve peripheral awareness.[20] Kaplan's yoked vertical prism techniques, specifically using the Kaplan Nonverbal Battery, have shown notable improvements in posture, visual-motor skills, and global processing among individuals with autism.[2,20,21] Other clinicians have noted improved balance, behavior, spatial awareness, and language development with the use of yoked prism.[2]

It is important to consider the developmental history, visual efficiency, and binocular status prior to prescribing therapeutic prism. Low plus lenses (+0.25 to +0.75) with low amounts of prism ranging from 0.5 to 3.00 prism diopters should be considered in combination, but with a solid rationale for prescribing those lenses.[10] Higher plus prescriptions in patients demonstrating more limited accommodative skills (i.e., accommodative insufficiency, high lag on near retinoscopy) are warranted.[10] Prism is best prescribed using the lowest amount of prism that enables a positive change in visual-spatial awareness.[20] If the patient has limited peripheral awareness, poor divergence and gait disturbances (i.e., toe walking),base-down prism can be useful.[10,20,22] Base-up yoked prisms may be prescribed in isolated or combined cases of hypotonicity, hyperactivity, a reduced near point of convergence, and low base out ranges are exhibited, in addition to when more peripheral processing is present.[10,22] Yoked horizontal prism application has been successful in the treatment of a head tilt, asymmetric accommodative reflexes, preferential looking, and/or very limited visual-spatial awareness.[10,20,22]

The patient in this case first exhibited a high exophoria at near with a clinically significant convergence insufficiency. Low base-in horizontal prism was prescribed in both eyes in a low plus prescription to aid in convergence, reduce visual stress, and expand visual space/peripheral awareness.[10,22] In our high-volume clinical practice, children, adolescents and adults alike respond positively to low magnitude (typically less than 3 diopters) base-in prism for convergence insufficiency. Similarly to Bowan, 1 base-in prism is frequently prescribed in both eyes to decrease visual stress, as it is theorized to reduce the visual aliasing phenomenon.[25] Newer research has shown that 0.75 prism diopters of base-in prism can be used in patients with Sensory Processing Disorder; after 2 months of continual spectacle wear, improvements in behavior, posture and visual skills was reported.[26] The low amount of plus prescription was indicated to maintain fixation and accommodation. Based on the patient's progress and improvement in testing, he was encouraged to continue with his current prescription. Given the asymmetric accommodative response at his follow-up, the low plus reading prescription continued to promote accommodative stability. At the recommended follow-up, if examination findings remain stable or worsen, a trial of yoked vertical prism may be introduced to assess for improvement in visual-spatial awareness. There is no standardized method of prescribing yoked prism; evaluation of the patient's attention and performance with low yoked base-up and base-down prism should be trialed in-office while engaging in a visual-motor task (i.e., bunting a Marsden Ball at mid-torso height)10. Altering the prescription will be considered if there is a notable positive change in engagement. The goal of behavioral optometrists is to improve visual engagement, so that visual processing improves and develops effectively.[19]

Use of Vision Therapy for Treatment of Visual Dysfunction in ASD Patients

In addition to therapeutic lenses and prisms to treat the visual sequelae often encountered in ASD patients, visual therapy is an important tool to consider for these patients. Although there is limited evidence in the literature supporting the efficacy of visual therapy in special needs populations, there is substantial evidence of using vision therapy to treat the visual conditions often manifested in these patients.[23] Multisensory visual therapy for these patients is of great importance, as neurological pathways are connected via top-down and bottom-up processing, in addition to feedback mechanisms.[24] These pathways are strengthened when signals are both multimodal and synchronous.[24] Using a multisensory inventory assessment (see Appendix) helps to determine difficulties in other sensory systems. As a result, a more comprehensive understanding of the visual dysfunction is achieved, as well as the ability to appropriately support concurrent interdisciplinary therapies. There is a higher prevalence of near point and oculomotor dysfunctions exhibited in ASD patients.[13,14] In ASD patients, there is a 12.5% greater risk of accommodative insufficiency, nearly 3 prism diopters more of near exophoria and a reduced near point of convergence break and recovery of 7.0 cm and 8.02 cm respectively (in comparison to 2.19 cm and 3.99 cm in control subjects). NSUCO saccades reveal reduced fixation and accuracy, poor stamina/ability to complete testing and motor overflow, observed as head and body movements in ASD patients.[13,14] These visual dysfunctions cause difficulties with near work and task avoidance.[23] Vision rehabilitation can enhance visual efficiency, attention, and thereby the ability to perform near tasks.[23] This translates into improved patient outcomes, although results may be more qualified rather than quantified upon assessment.[10,23] For instance, the greatest indication of visual improvement with these patients is often when assessing their ability to engage in the vision therapy room, particularly with the Marsden Ball. For the patient presented in this report, an assessment of his interaction with the Marsden Ball at his next progress evaluation will be used to help assess visual attention, visual-motor integration, and visual tracking progress. If there is minimal improvement in objective and observational findings of visual

skills, in-office vision therapy, and/or altering the therapeutic lenses will be indicated. Observational and/or qualifiable findings are often more indicative of visual skill progress than clinical findings in this patient population. It is important to discuss with the patient's caregiver and/or interprofessional team that the cause of the patient's visual dysfunction is due to neurodevelopmental delays and the functional results of multisensory visual therapy, if prescribed, are difficult to predict.[13] Optometrists play an important role in addressing visual concerns through individualized vision therapy programs with a predominant motor-based, multisensory approach to develop oculomotor, binocular, accommodative, visual-spatial, and visual information processing skills.

Considering the Comorbidities and the Importance of Integrative Care

Comorbid conditions in those with ASD include numerous psychological disorders, such as: major depressive disorder, attention-deficit/hyperactivity disorder, anxiety disorders, bipolar disorders, schizophrenia, post-traumatic stress disorder, and various personality disorders.[4,7,8] These diagnoses often require support in the fields of behavioral therapy and psychiatric care.[8,18] Cognitive impairment in the form of Intellectual disability has recently been noted as high as 31% in ASD patients from the Centers for Disease Control and Prevention.[3] Other systemic comorbidities to consider are a higher prevalence of epilepsy, obesity, gastro-intestinal disorders/sensitivities, and poor sleep patterns.[3] To acquire the support needed to effectively function on a day-to-day basis, it is recommended that patients have an established ASD diagnosis based on the severity of impairment.[2,18] This enables a more streamlined referral process to the appropriate inter-professional provider. It is important to remember the underlying social, communication, and behavioral dysfunctions manifested by ASD patients that require inter-professional assistance in the form of speech, occupational, and physical therapies.[18]

Assessment from a multisensory approach as outlined in Appendix can help the provider make the appropriate referral to a member of the multi-disciplinary team, when indicated. It is important to complete a Multisensory Inventory Assessment at the baseline functional vision evaluation. Based on the patient history, observation, clinical examination findings and the completed inventory, a decision can be made on whether solely visual rehabilitation or concurrent therapies are indicated. Sensory systems with a high prevalence of 3 and 4 grading should be considered for external referrals. It is important to repeat the inventory at consecutive visits as a way of monitoring treatment. A patient may be considered borderline in a system if they are predominantly scoring 3's. Implementation of multisensory vision therapy is important as it increases the salience of stimuli, unifying the perception from different senses and increasing their signal for improvements in sensory and motor responses. Should this system not improve with multisensory-based visual therapy, an external referral may be indicated.[23] Primary external providers to consider include audiologists, speech-language pathologists, occupational therapists and physical therapists. Research is currently being conducted to develop a specific scoring system to make the appropriate referral using the Multisensory Inventory Assessment.

Integrating a structured vision therapy program can provide improvements in visual information processing, visual-motor integration, and visual-spatial organization, while supporting adjunctive therapies.[18] The patient in this case received extensive in-school support in addition to a highly structured occupational therapy program. His structured therapy regimen undoubtedly contributed to the improvement in examination findings and improved visual engagement at the second assessment post-application of therapeutic lenses and prisms. Based on our understanding of autism, practitioners must acknowledge the importance of multi-disciplinary supportive care to guide development and improve the quality of life of the patient. Inter-professional care strengthens the foundational movement, emotional, and social skills necessary for functional vision.[18] With the addition of visual rehabilitation

through lenses, prisms, and/or vision therapy, ASD patients can develop the skills necessary to use their visual system comfortably and efficiently.

CONCLUSION

No individual presenting with autism spectrum disorder will present the same. Testing these patients requires various skill sets: forward-thinking to have a comfortable clinical environment, flexibility, creativity, variability during the visual examinations, and having the humility to co-manage the patient with other professionals. There is profound research demonstrating the visual sequelae that co-exists with this neuro-developmental disorder. Refractive error, binocular dysfunction, strabismus, oculomotor dysfunction, hyper- and hypo-sensitivities, gaze aversion, reduced peripheral awareness, poor spatial awareness, and visual perceptual dysfunctions are those most frequently encountered.[2] Optometrists have an integral role in assessing, diagnosing, and managing these patients. Behavioral optometrists can treat these patients with therapeutic lenses and optometric vision therapy, helping to improve their quality of life. Although these patients may not reach age-equivalent normative values, visual skills can be enhanced with the appropriate rehabilitative care, translating into more engagement in their activities of daily living.[23] Further, use of a multisensory assessment supports and/or helps decide the appropriate adjunctive care for ASD patients. This report outlines a multi-dimensional case of non-verbal autism, where compliant use of therapeutic glasses, in addition to the appropriate adjunctive interprofessional care, demonstrated significant progress in visual-spatial development.

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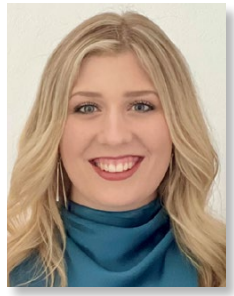

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Dr. Allie Decker was born and raised in the province of Newfoundland and Labrador, Canada. She completed her Bachelor of Science degree in Cell and Molecular Biology with minors in Business Administration and Biochemistry at Memorial University of Newfoundland. She completed her Doctor of Optometry degree with Advanced Studies in Contact Lenses from the Pennsylvania College of Optometry at Salus University. Pursuing her passion for pediatrics and rehabilitative care, Dr. Decker completed a residency in Vision Therapy and Rehabilitation at EyeCare Associates, PC in Connecticut. Dr. Decker continues to practice at EyeCare Associates, with an emphasis on rehabilitative, behavioral and developmental optometry. She has a special interest in multisensory integration, management of neurodevelopmental disorders, pediatrics and interdisciplinary care in her practice.

APPENDIX

Multisensory Inventory Assessment

Designed by Celia Hinrichs, OD, FCOVD & Randy Schulman, MS, OD, FCOVD

PROPRIOCEPTIVE/KINESTHETIC	0	1	2	3	4
Responds differently to touch either very sensitive or needs deep pressure or touches everything					
Has difficulty maintaining posture, spreads legs/uses arms to support core or unusually still					
Has difficulty performing gross and fine motor tasks such as writing, ball catching, skipping					
Clumsy or awkward, Falls over and loses balance easily or uses momentum to maintain balance					
Total Proprioceptive/Kinesthetic					

VESTIBULAR	0	1	2	3	4
Dizziness					
Disorientation, feeling off-balance, as if floating or the world is spinning					
Nausea/Lightheadedness or feeling faint					
Resists moving					
Total Vestibular					

BALANCE	0	1	2	3	4
Falling or stumbling					
Unstable gait, Unsteadiness or inconsistencies in balance					
Total Balance					

AUDITORY	0	1	2	3	4
Seems distracted/unable to sustain attention when receiving verbal messages, Needs to hear instructions/directions more than once					
Differently sensitive to sound, Appears overwhelmed with excess auditory activity or background sounds					
Has problems with receptive and expressive language					
Total Auditory					

INTEROCEPTION	0	1	2	3	4
Has palpable fears and anxiety, easily startled, particularly sensitive to or unaware of environment					
Has difficulty regulating emotions, Becomes frustrated, overwhelmed or irritated easily, experiences socialization difficulties					
Has trouble falling or staying asleep or staying awake					
Has eating or bowel difficulties					
Total Interoception					

(continued on next page)

Multisensory Inventory Assessment

Designed by Celia Hinrichs, OD, FCOVD & Randy Schulman, MS, OD, FCOVD

VISION	0	1	2	3	4
Double vision or eye turn, Squinting or closing an eye					
Light sensitivity					
Difficulty with eye contact					
Burning, tearing, watering eyes					
Headaches					
Moves head or uses a finger while reading, Loses place, misreads or has poor reading comprehension					
Reverses words or numbers					
Makes errors in copying					
Has ***no interest*** or is obsessed by reading					
Gets frustrated by or avoids near tasks					
Total Vision					

ATTENTION	0	1	2	3	4
Loses train of thought, Extensive off task time, distracted easily					
Difficulty following directions					
Difficulty organizing tasks, Forgets to complete tasks					
Difficulty remembering steps in a multi-step process					
Total Attention					

AUTOMATICITY/COGNITIVE LOADING	0	1	2	3	4
Does the task, but requires full attention					
Cannot repeat the task, fatigues quickly					
Requires ***motor overflow,*** subvocalization to complete the task					
Reduced efficiency					
Total Automaticity					