Vision Therapy For A Patient With Developmental Delay Literature Review & Case Report

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Abstract

Individuals with developmental delay (DD) have a higher incidence of visual problems including visual efficiency disorders. Ocular motor dysfunction (OMD) is one such disorder that can negatively impact an individual's quality of life. Gross motor control and coordination are the foundations for fine motor control, especially for eye movements. Individuals with DD tend to have poorly developed gross motor skills.It follows that they frequently will have delayed fine motor skills including ocular motor performance. A 10-year-old white male presented with developmental delay and very poor oculomotor control. He was treated with 20 sessions of vision therapy (VT) resulting in significant improvements in visual efficiency skills. VT is very effective in the treatment of OMD in the general population. This case demonstrates that individuals with DD can benefit from VT as well. Often bilateral coordination and body awareness are critical building blocks for accurate eye movements. Such activities should be integrated into the VT program.

Key Words

bilateral integration, body awareness, developmental delay, eye movements, oculomotor dysfunction, pursuits, quality of life, saccades, special populations, vision therapy

Dudley LM, Vasché T. Vision therapy for a patient with developmental delay: Literature review and case report. J Behav Optom 2010;21:39-45..

INTRODUCTION

Developmental Delay

Developmental delay (DD) is characterized by a late onset of motor, speech, behavioral and/or cognitive skills.[1] There are many causes of DD including, but not limited to: genetic syndromes, acquired brain injury, cerebral palsy, autism, seizures, central nervous system malformations, low birth weight, hypoxic-ischemic encephalopathy, abnormal movement pattern and abnormal muscle tone.[2] The prevalence of DD in the general population varies depending on the criteria used. Studies based on parent surveys vary from 3.3% to 17%.[3,4] A more objective study by Rosenberg et al was based on a sample of young children, representative of the entire United States, eligible for Part C early intervention services.[1] Part C service is an interagency program for coordinating early intervention through speech and occupational therapy for children ages nine months to three years and identified as having DD. Determination of DD is based on testing cognitive and motor skills, or the presence of diagnosed conditions that confer high risk for developmental delay. Almost 14% of all children were qualified as DD, although only 10% of the 14% received Part C services.

The prevalence of visual conditions found in the DD population is not well reported but seems to vary depending on the etiology of the delay. Although some studies describe an increased incidence of high refractive error and reduced visual acuity in these populations[5-7] few have considered visual efficiency disorders such as oculomotor dysfunction (OMD), accommodative insufficiency and binocular coordination. Some visual efficiency disorders have been documented in subgroups of DD, including cerebral palsy, Down's syndrome, low birth weight children and genetic anomalies. Individuals with cerebral palsy have a markedly higher incidence of visual efficiency disorders such as accommodative insufficiency (42%-100%) and oculomotor dysfunction (100%).[8,9] Down's Syndrome patients also have a high occurrence of accommodative insufficiency (80-92%), although the incidence of OMD has not been reported.[10,11] Children born prematurely have difficulty with voluntary control of saccades as infants.[12] Aside from these reports, there is little evidence in the literature that gives an accurate picture of the visual function of children with DD. Regardless of the patient's individual level of function, visual efficiency conditions such as OMD and accommodative insufficiency can have a significant negative impact on daily life and learning capabilities of the patient.

Oculomotor dysfunction

As toddlers, children are primarily motor-driven.[13] Normal oculomotor control develops as a result of using vision to replace motor exploration of the environment. This process can only occur once gross motor coordination develops appropriately. Gross motor control includes bilateral coordination, visual motor integration and body awareness. Bilateral coordination allows the child to differentiate right from left and gain an inherent knowledge of midline and laterality. Visual motor integration enables the child to transition from motor to vision as the primary learning modality. The child must also be aware of where their body is in space before they can accurately localize targets.[14] These gross motor elements are critical for the development of fine motor control. Eye movements are the pinnacle of fine motor control given the high demand for accurate, coordinated movements. Consequently, deficits in gross motor coordination can lead to OMD. The same types of gross motor deficits can cause problems with laterality, directionality, and visual spatial skills resulting in delays of visual perception. For this reason it is common to find OMD concurrently with visual perceptual dysfunctions.[15,16]

The clinical definition of OMD is the delay or inability to control the eyes while making pursuits, saccades or maintaining fixation. This results in a decrease in visual efficiency that can affect reading and learning significantly.[17] A list of typical symptoms of OMD can be found in Table 1.

Many children will not actively offer complaints since they may not be aware of the problem. In the absence of pathology, OMD is typically found in school-age children and is the result of 'incomplete development of the internal spatial map' and is 'thought to be a problem within the higher levels of neurologic function.'[15(p.246-262)]

The prevalence of OMD in the general population has not been established, although most clinicians would agree it is not uncommon to find the condition in children and some adults. Studies have found that good readers tend to have good eye movements and a low prevalence of OMD. Preliminary reports by Maples and Ficklin indicate that the incidence of OMD in good readers ranges from 6-19%. Conversely, individuals with learning disability were found to have OMD in 24-40% of the population.[18] Some specific populations have increased prevalence of this condition, as well as other visual efficiency disorders. OMD is found more often in individuals with traumatic brain injury,[19] learning disabilities,[20-22] cerebral palsy, premature births[12] and other special populations.[5]

There are a number of subjective and objective tests to diagnose OMD.[18] The Northeastern State University College of Optometry's (NSUCO)[a] oculomotor test and the Developmental Eye Movement Test (DEM are two such tests.[24,25,b] Using a scaling system of 1-5, eye movements can be quantified and compared to norms based on age. (Appendix) Low scores, especially in the categories of head and body movement, indicate OMD. Reading-related eye movements can be assessed using the DEM,[24,25] a well established, reliable scoring system. Once OMD has been identified, vision therapy (VT) is the traditional treatment approach.[26,27]

Table 1. Symptoms associated with OMD

General signs and symptoms	Signs and symptoms while reading
• Poor fixation, locating or tracking objects	• Loss of place
• Head or body movement while tracking	• Skipping words or skipping lines
• Difficulty copying from far to near	• Excessive head movement
• Short attention span	• Eyestrain or headache
• Poor performance in sports	• Slow reader
• Motion sickness or dizziness	• Uses finger to keep place
• Poor visually-guided coordination	• Poor comprehension

Adapted from Scheiman M, Wick B. Eye Movement Disorders. In: Scheiman M, Wick B, eds. Clinical Management of Binocular Vision,[15] and Applied concepts in Vision Therapy.[16]

CASE REPORT

A 10-year-old white male of Eastern European descent presented for a comprehensive eye exam at Silver Falls Eyecare in March of 2007. The chief complaints from his mother included poor visual attention, trouble seeing the computer, losing his place often and poor eye contact. His teacher was concerned that he had not made any progress recently and suspected a visual problem. Delays in gross and fine motor coordination were also reported. His mother revealed concern at some of these unusual behaviors she observed.

The patient was adopted at age 7 and consequently much of his medical history was unknown. A recent neurological and physical examination revealed overall developmental delays including mental retardation, poor gross motor development and speech delays. The cause of the overall DD was suspected to be a hypoxic event prior to or during birth and/or an alcohol related neurodevelopmental disorder. However, the facial features of the patient were not characteristic of fetal alcohol syndrome. At one month prior to his initial visit to clinic he was diagnosed with Attention Deficit Disorder for which he was prescribed Atomoxetine HCl (Straterra®) for one month. He was enrolled in grade 3 at a public school special education program. Speech therapy was provided by the public school, but neither occupational therapy nor physical therapy had been initiated.

The pertinent examination findings are summarized in Table 2 under 'pre-VT.' The refraction revealed emmetropia with 20/20 visual acuity at distance OD, OS and OU. Monocular near visual acuity was reduced to 20/40 OD, 20/30 OS, but was 20/20 OU. Pupils were round and reactive to light without afferent pupillary defect. Anterior segment ocular health was unremarkable. Posterior segment health was evaluated with dilated fundus exam and was also unremarkable.

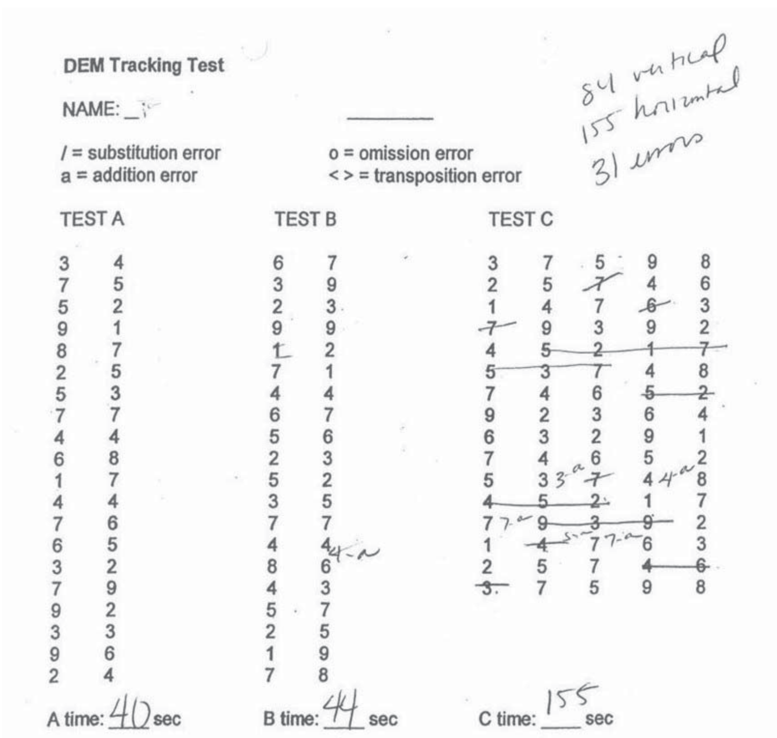
While ocular motilites were full, pursuit movements were severely deficient resulting in NSUCO score age equivalent of less than 5 years of age. Pursuits were characterized by significant head and torso movement, profound inaccuracy and inability to complete a single rotation. Saccadic eye movements were also very poor resulting in NSUCO score age equivalent of less than 5 years old. Saccades required head and torso movement to initiate the saccade and were grossly inaccurate with very poor ability to complete a single cycle between targets. A complete description of the NSUCO procedures, scoring criterion and age norms are listed in the Appendix. Fixation was of very short duration (<2 seconds) with significant latency of initiation, frequent large saccadic intrusions and large fixation errors up to 15 degrees. The patient had little ability to control his eye movements and often could not move his eyes to the desired target, even with concentration and effort. Binocular findings including phoria and vergence ranges were borderline. Stereoacuity at near was reduced to 70 seconds of arc with Wirt circles. Negative relative accommodation (NRA) was +0.50 and positive relative accommodation (PRA) was -0.25, both very reduced. The DEM was very poor with many errors resulting in an age equivalent below test norms. The DEM recording form in Figure 1 illustrates the difficulties the patient had with horizontal eye movements.

Tests of visual perception were administered to assess the patient's ability to

Table 2. Clinical Findings Pre- and Post-Vision Therapy

Diagnostic Test	Pre-Vision Therapy (6/07)			Post-Vision Therapy (12/07)		
Near Visual Acuity	20/40 OD, 20/30 OS, 20/20 OU			20/20 OD,OS, OU		
NSUCO Pursuits[15]	Ability	2	Age	Ability	5	Age
	Accuracy	2	<5 yr	Accuracy	2	8 yr
	Head Movm	1	equiv	Head Movm	3	equiv
	Body Movm	1		Body Movm	4	
NSUCO Saccades[15]	Ability	2	Age	Ability	5	Age
	Accuracy	1	<5 yr	Accuracy	3	8 yr
	Head Movm	1	equiv	Head Movm	3	equiv
	Body Movm	1		Body Movm	4	
Fixation	Duration <2 sec, significant latency of initiation, frequent large saccadic intrusions, large fixation errors			Duration 7-8 sec, no latency of initiation, 1-2 small saccadic intrusions, good accuracy		
Stereo Vision	70 sec of arc			20 sec of arc		
NRA/PRA	+0.50/-0.25			+2.75/-2.50		
DEM[24,25]	Vert	84s	Age	Vert	81s	Age <6 yr
	Horiz	155s	<6 yr	Horiz	87s	Age 7 yr
	Err	31	equiv	Err	16	Age 7 yr
	Ratio	1.84		Ratio	1.07	Age >14 yr
Piaget L/R [28]	Age 6 equivalent			Age 11 equivalent		
Jordan L/R Reversal[29]	Part 1&2: 23 errors Below age 5 equivalent			Part 1&2: 2 errors Age 10 equivalent		
Beery VMI[30]	Age 5.3 equivalent			Age 5.7 equivalent		
Monroe Visual Three[31]	Age 4 equivalent			Age 9 equivalent		
Visual Manipulation[32]	Age 4 equivalent			Age 4 equivalent		
MVPT[33]	Age 6.8 equivalent			Age 6.11 equivalent		

See Appendix A for NSUCO scoring criterion and age norms


DEM Tracking Test

NAME: ____ ____

/ = substitution error o = omission error
a = addition error < > = transposition error

84 vertical
155 horizontal
31 errors

TEST A		TEST B		TEST C				
3	4	6	7	3	7	5	9	8
7	5	3	9	2	5	7	4	6
5	2	2	3	1	4	7	6	3
9	1	9	9	7	9	3	9	2
8	7	1	2	4	5	2	1	7
2	5	7	1	5	3	7	4	8
5	3	4	4	7	4	6	5	2
7	7	6	7	9	2	3	6	4
4	4	5	6	6	3	2	9	1
6	8	2	3	7	4	6	5	2
1	7	5	2	5	3	7	4	8
4	4	3	5	4	5	2	1	7
7	6	7	7	7	9	3	9	2
6	5	4	4	1	4	7	6	3
3	2	8	6	2	5	7	4	6
7	9	4	3	3	7	5	9	8
9	2	5	7					
3	3	2	5					
9	6	1	9					
2	4	7	8					

A time: 40 sec B time: 44 sec C time: 155 sec

Figure 1.

process visual information. The following tests were administered to assess the corresponding visual skills: Piaget Left/Right Awareness[28] (laterality/directionality), Jordan Left/Right Reversal[29] (directionality), Beery Developmental Test of Visual Motor Integration (VMI)[30] (visual motor integration), Monroe Visual Three[31] (visual memory), Visual Manipulation Test by Getman-Henderson-Marcus[32] (visual spatial skills), and the Motor-Free Visual Perception Test (MVPT)[33] (overall visual perceptual skills). Severe deficiencies were noted in all areas of visual processing. The patient's average performance on tests of visual perception was at a 5 year age equivalent. Moderate speech delay was observed but the patient could adequately express himself and follow instructions. Attention was often poor but the patient responded well to verbal redirection. The following diagnoses were made: profound oculomotor dysfunction, severe accommodative insufficiency and overall visual processing deficits.

VT was recommended with an estimate of 20 sessions consisting of weekly 45 minute in-office sessions combined with daily home activities. The VT components are listed in Table 3. The goal for therapy was improvement of oculomotor control and gross motor coordination. The patient was not a visually guided learner; he was still relying heavily on reinforcement from auditory and motor input. An occupational therapy evaluation was also recommended but due to the family's financial limitations it was not presently affordable. VT was initiated in June 2007 and the recommended 20 sessions were completed over a period of six months. There was good attendance to office sessions and moderate compliance with home therapy activities. Emphasis was placed on bilateral integration, body awareness, laterality, visual motor integration, pursuit and saccadic eye movements, accommodation and vergence. Visual perception skills were addressed, but given a more guarded prognosis.

At the conclusion of therapy, the patient showed progress in many areas and his parents were both thrilled with the dramatic transformation at the end of therapy. Increased ability to make eye contact was observed as well as improvement in his behavior and attention. He no longer had problems seeing the computer and had better visual attention. His mother expressed that he seemed like a different child altogether; he was more observant, independent and aware of his surroundings. The clinical findings after completion of VT are summarized in Table 2. Marked improvements in ocular motility control were seen at the end of therapy, showing an overall developmental gain of three years. Near visual acuity improved to 20/20 OD, OS and OU. Pursuit eye movements showed profound improvement with NSUCO score age equivalent of roughly eight years. The full pursuit rotations were able to be completed with moderate accuracy with very few head movements and no torso movements. Saccadic eye movements also improved with NSUCO score age equivalent of approximately eight years. The patient was able to complete the NSUCO cycles with moderate accuracy, minimal head movements and no torso involvement. The DEM test was significantly better; although the vertical time component did not change, the horizontal component and the number of errors made was reduced by almost half. This gives evidence that while the ocularmotor skills were improved, the automaticity problem remained. The resulting age equivalent on the DEM was age six to seven years. Fixation duration increased to seven to eight seconds and initiation latency was no longer seen. Fixation accuracy was very good with minimal small saccadic intrusions. Stereoacuity reached 20 seconds of arc. The NRA and PRA normalized to +2.75 and -2.50 respectively.

While some of the tests of visual perception improved, others did not. The tests that improved were: Piaget Left/Right Awareness (age 11 equivalent), Jordan Left/Right Reversal (age 10 equivalent) and the Monroe Visual Three (age nine equivalent). For all of these tests he improved to near age equivalent. There were no significant improvements with the Beery VMI, Visual Manipulation and the MVPT. Moderate progress was observed in bilateral coordination and arm/leg coordination during therapy, although this area will need continuing rehabilitation. These results correlate well with the behavioral and functional changes reported by his parents at the conclusion of therapy. Attention, visual awareness, tracking and visual perception improved dramatically both subjectively and objectively.

DISCUSSION

VT for the treatment of OMD has been shown to be an effective form of rehabilitation in children and often improves reading skills.[26,34,35] Overall, VT has been shown to be quite effective for a number of visual dysfunctions.[36,37] However, the efficacy of VT in the DD population is not well established. Consequently, many practitioners may not consider individuals with moderate to significant DD as candidates for VT.[38] This case demonstrates the error of that assumption.

There are very few reports in the literature regarding the efficacy of VT in special populations. Duckman documented improvement in nine patients with cerebral palsy after VT for OMD, accommodative insufficiency, and visual perceptual skills.[39] All patients showed improved eye movements and most showed improvement in other visual skills. Aside from this study, there is little evidence in the literature that represents the potential for improvement in patients with DD.

Some practitioners think that individuals may simply outgrow their poor visual skills and catch up with their peers; this is not the case. Tassinari conducted a retrospective study showing that OMD did not improve if left untreated.[40] Woodhouse et al showed that in young Down's syndrome patients, accommodative skills do not improve with age.[10] The search of the literature indicates that the best method to address these visual problems in the general population is through VT. There is no evidence that patients with DD would not benefit from VT as well. If the patient is not a good candidate for VT because of physical or mental limitations, lens prescriptions (e.g. bifocal for accommodative insufficiency) should be considered to provide them the best vision for their daily activities.[5] Treatment of these visual conditions can make a significant impact on the quality of life of the individual and their learning potential.[41,42]

Motor Control in Visual Development

Many optometrists recognize the importance of motor development in vision.[14,43-45] Often, in order to treat the fine motor component, poor gross motor coordination must first be addressed. Ideally this is done through co-management with an occupational therapist, but visual motor activities can also be incorporated into the VT program.[46]

Taub et al indicates the relationship between motor development and eye movements as follows.[47] Motor coordination starts as the child learns to stabilize his body in space with basic muscle control. Then balance and centration is learned to counteract gravity and maintain stability. The visual-motor experiences that are acquired will then enable the child to accurately localize targets. Bilateral integration and coordination are essential parts of this process and enable a child to sense right from left and fluidly move through space. Once the child can use vision to guide their movements, when the body is centered and stabilized, fixation and accurate eye movement can develop. If the child has not adequately progressed through these stages, they will have difficulty remediating poor eye movements.

Since DD typically includes delays in motor development, these patients frequently benefit from gross motor activities integrated into the VT program. The patient was observed to have poor coordination and balance, especially during eye movements. If he was standing and asked to make a slow pursuit, he would recruit his whole body such that he almost fell over. After it was recognized that this patient had severely deficient gross motor coordination and body awareness, these skills were addressed as a foundation for rehabilitation of his oculomotor system. A list of gross motor and oculomotor activities utilized to encourage bilateral integration, body awareness and visual motor integration can be found in Table 3.

Vision Therapy for Individuals with Developmental Delay

In general, VT has been shown to be effective for a variety of conditions in a wide range of different populations.[27,36,37] VT has also been shown to improve quality of life.[41,42] There is no reason to believe that patients with DD cannot derive the same benefits from VT as other patients. Modifications to accommodate the patient's specific needs are often necessary. Also, progress in therapy may be slower depending on the physical limitations (motor and cognitive) of the patient in question.

Treatment of OMD and other visual dysfunctions in a patient with DD may require some slight modifications to traditional therapy methods. Each patient is unique in their disability and often creativity is employed to alter activities or invent new ones. OMD activities should focus on accuracy, eye-hand-body coordination, rhythm and automaticity. Starting therapy with monocular activities often results in better control with gradual transition to binocular therapy. Age appropriate elimination of head and body movements

Table 3. Vision Therapy Activities for OMD and Developmental Delay

Activity	Description
Body awareness and bilateral integration	
Angels in the snow	Lying on ground – tap limb and patient has to move only that limb. Start homologous (ex both arms), then monolateral (one arm) then ipsilateral (ex R arm and R leg) then contra-lateral (ex R arm and L leg). Progress to standing angels in the snow.
Pointer dog	On hands and knees, balance with one arm or leg elevated at a time, progress to balance with opposite arm and leg elevated.
Swimming in place	Lying on stomach, move arms and legs in swimming motion including head turning to side. Start with arms or legs only, then move ipsilateral limbs forward, then move contralateral limbs forward (Alexander has excellent description).
Walking rail	Start walking straight line on the ground, then walking rail with aid, and progress to walking heel-toe on walking rail.
Hopscotch	Encourage good balance on one foot and alternate hopping.
Chalkboard circles	Chalk in each hand, child draws circles with arms moving symmetrically then reciprocally.
Windshield wipers	Draw lines between two targets, first symmetrical motion then reciprocal motion.
Balloon, ball or ring toss	Catch with both hands, then catch with one hand, then catch with R or L hand.
Jumping jacks	First arms or legs only, then arms and legs.
Soldier crawl	Crawl on elbows and knees.
Pursuits	
Marble in pan	Roll marble in pie pan slowly while patient tracks marble.
Marsden Ball	Start by lying on the floor, bean bags around head to eliminate head movements. Progress to sitting, then standing, then balance board. Use sticker to make target interesting, ask questions about sticker.
Marble roll	Roll marble across table, patient catches it in cup.
Rotating Pegboard	Follow hole with peg for one full rotation before putting peg into hole
Saccades	
Penlights saccades	Use small light or toy on penlight, patient has to look at lighted target. Verbal feedback on accuracy of eye movements is helpful.
Sticker saccades	Column of simple stickers 5-8" apart, patient has to fixate each sticker across row and identify name or color of sticker
Groffman tracing	Start with easy lines that do not cross, allow patient to draw on top of lines at first. Progress to more difficult designs.
Hart chart	-Start with 2 columns of letters, patient reads across. Add number of columns, progress to using whole hart chart. -Near/Far Hart chart rock, start using small section of chart
Pegboard	Copy pattern from another pegboard, then from pattern.
Tracking worksheets	Michigan tracking, number tracking, hidden pictures, connect-the-dots, etc

Adapted from reference 15 and 45.

during oculomotor activities is of primary concern to gain fine motor control, emphasizing tracking with the eyes and not the body.

Unfortunately, patients with DD tend to be underserved when it comes to health care, including vision care.[5,6] The reason for this lack of care may be due to a variety of reasons including access to care, transportation, and locating a practitioner who is willing and able to accommodate patients with DD. Optometrists who have a developmental or behavioral approach are the best trained providers to treat these types of patients.[5,48,49] Given that the prevalence of DD in the general population may be as high as 13.8%, it is likely that optometrists will routinely encounter patients with DD and consequent visual efficiency problems.

A survey of the literature and lectures from 2001-2007 by Sands et al revealed that only 0.3% of lectures at the American Academy of Optometry addressed special populations.[49] Lectures in the same time frame at the American Optometric Association devoted only 0.9% of lectures to this subject. The College of Optometrists in Vision Development had a greater proportion of lectures with 16% of lectures devoted to special populations. The disparity between the prevalence of DD and the amount of optometric education dedicated to this population is striking.

CONCLUSION

The patient presented with deficient motor and visual efficiency skills. He was not visually guided, and instead was 'stuck' in the motor development stage. Without a structured learning environment for visual-motor development, it is likely that very little improvement would have been possible without intervention. The visual motor and bilateral integration activities provided in VT gave him the gross motor foundation upon which to develop appropriate eye movements. Creative modification of traditional VT techniques allowed this patient to excel in his visual efficiency and visual perception skills to age appropriate level.

Given the infrequency of these reports in the literature, the prevailing thought is that individuals with DD have a reduced potential to improve their visual skills, therefore extra effort should not be expended to increase their abilities. On the contrary, this case demonstrates the good success that can be seen with special populations through VT. Patients with delays may not reach an age equivalent levels in their visual efficiency skills and visual perception abilities and should not be compared to age norms. They can, however, make significant improvements, often gaining years of developmental skills that greatly improve their capability for activities of daily living. The parents of individuals with DD are appreciative for any advancement that can be made in the lives of their children.

Patients with DD have an increased need for health care and are often overlooked by eyecare professionals. Optometrists with a developmental perspective are the ideal vision care providers to evaluate and treat these types of patients. VT with a motor-based developmental approach is often best when treating these patients. Unfortunately, there is a lack of literature that adequately demonstrates the success that VT can provide with special populations. Although not all patients are ideal candidates for VT due to cognitive and motor limitations, the developmental optometrist should give each individual consideration for any services that may improve their quality of life. Published literature on the prognosis and efficacy of VT in special populations is critical to increase awareness in the optometric community. As optometrists, we are obligated to provide each patient with all treatment options that would benefit them and refer to the appropriate provider when necessary. The potential positive impact of VT on a child's life is immense and highly rewarding for the child, the parents and the practitioner.

Acknowledgments

Special thanks to Drs. Esther Han, Rochelle Mozlin, Deborah Lee, Diane Adamczyk, and Paul Hulse for their guidance on this publication.

Sources

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Date accepted for publication:
March 24, 2010

APPENDIX
North State University College of Optometry (NSUCO) Oculomotor norms

NSUCO PURSUITS

Procedure
Instruct the patient to follow the target. Move the target in a circle of 20cm diameter at a distance of 40cm from the patient. Do 2 rotations clockwise and 2 rotations counterclockwise.

Scoring criterion
Ability
1. Cannot complete ½ rotation
2. Completes ½ rotation but not 1 full rotation
3. Completes 1 rotation but not 2 rotations
4. Completes 2 rotations in one direction but not the other
5. Completes 2 rotations in each direction

Accuracy
1. No attempt to follow the target to 10 refixations
2. Refixations 4-10 times
3. Refixations 2-4 times
4. Refixations 2 or less times
5. No refixations

Head and Body Movement
1. Gross movement of head/body
2. Large to moderate movement of the head/body
3. Consistent slight movement of the head/body
4. Intermittent slight movement of the head/body
5. No movement of the head/body

Normal pursuit eye movement criterion by age and gender

	Ability		Accuracy		Head Mvmt		BodyMvmt	
Age	M	F	M	F	M	F	M	F
5	4	5	2	3	2	3	3	4
6	4	5	2	3	2	3	3	4
7	5	5	3	3	3	3	3	4
8	5	5	3	3	3	3	4	4
9	5	5	3	4	3	3	4	4
10	5	5	4	4	4	4	4	5
11	5	5	4	4	4	4	4	5
12	5	5	4	4	4	4	5	5
13	5	5	4	4	4	4	5	5
>14	5	5	5	4	4	4	5	5

NSUCO SACCADES

Procedure
Instruct the patient to look at the indicated target. Hold two targets 20cm apart at a distance of 40cm from the patient. Ask the patient to look from one to the other for 5 complete cycles.

Scoring Criterion
Ability
1. No attempt is made to perform the task to 1 cycle
2. Completes 2 cycles
3. Completes 3 cycles
4. Completes 4 cycles
5. Completes 5 cycles

Accuracy
1. Gross over or undershooting is noted
2. Large to moderate over or undershooting is noted
3. Constant slight over or undershooting noted
4. Intermittent or slight over or undershooting noted
5. No over or undershooting noted

Head and Body Movement
1. Gross movement of head/body
2. Large to moderate movement of the head/body
3. Consistent slight movement of the head/body
4. Intermittent slight movement of the head/body
5. No movement of the head/body

Normal saccadic eye movement criterion by age and gender

	Ability		Accuracy		Head Mvmt		BodyMvmt	
Age	M	F	M	F	M	F	M	F
5	5	5	3	3	2	2	3	4
6	5	5	3	3	2	3	3	4
7	5	5	3	3	3	3	3	4
8	5	5	3	3	3	3	4	4
9	5	5	3	3	3	3	4	4
10	5	5	3	3	3	3	4	5
11	5	5	3	3	3	4	4	5
12	5	5	3	3	3	4	4	5
13	5	5	3	3	3	4	5	5
>14	5	5	4	3	3	4	5	5