

## Eye and Vision Assessment of Children with Special Needs in an Interdisciplinary School Setting

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### ABSTRACT

**Background.** Children with special needs have vision problems that often go unrecognized and therefore, undiagnosed. Many of these children receive interventions, including occupational therapy, through their schools. These therapists can assist in determining which special needs patients require an optometric referral and treatment to help improve their visual function.

**Method:** After an optometric eye clinic was established at the request of occupational therapists in an early childhood center in New York City, a retrospective chart review of all patients examined between the years 2003-2006 was conducted. All of the children were between the 3 to 5 years of age. Data regarding systemic conditions, visual acuity, binocular status and ocular pathology was obtained.

**Results:** During the three year period, 273 children received eye examinations. Approximately 30% of these children were autistic. Vision problems detected in this sample included 3.7% with amblyopia, 6% with strabismus, and 11% with refractive errors requiring correction. Approximately 2.5% were referred for additional care for ocular health problems.

**Conclusion:** Optometrists can work in school settings to examine children with special needs to

ensure eye and vision problems do not go undiagnosed and untreated. Occupational therapists can assist in the testing process and treatment of certain types of vision problems as well.

**Keywords:** amblyopia, Autism, cerebral palsy, children with special needs, Down syndrome, interdisciplinary, occupational therapy, refractive error, strabismus

### Introduction

Children with special needs, particularly those with Cerebral Palsy and Down Syndrome, are at a higher risk of visual and eye health problems than their peers.<sup>1</sup> These children may receive various interventions through their schools systems including occupational, physical and/or speech therapy. However, in most cases, they do not receive a comprehensive eye and vision examination. Frequently, those with special needs who have vision or eye health problems may be asymptomatic or unable to express the presence of symptoms. Because children with special needs often cannot communicate symptoms adequately, it is important for the professionals who treat these children to be aware of the possible ocular and visual disorders that are frequently present. Often, those involved with a child's care may be the first to suspect a problem.

### Background

The Herbert G. Birch Western Queens Early Childhood Center is located in Queens, New York and is one of many Birch centers in New York City. Enrollment at the school is approximately 130-150, 3 to 5 year old students of diverse ethnic backgrounds. The school is staffed by occupational, physical and speech therapists, teachers and psychologists. It operates a traditional September to June schedule with an optional summer program. English is the

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primary language of instruction, with some classes taught in Spanish, Russian and Korean.

Children who are enrolled in the schools have varying degrees of developmental delay. Prior to enrollment, children receive an evaluation by certified professionals, including psychologists, speech and language pathologists, and occupational and physical therapists. If a child is found to have developmental delays and is eligible for early intervention services, he/she can be enrolled at the school. The evaluation and subsequent education at the school are provided at no cost to the family.

In 2002, an affiliation between Birch and The State University of New York State College of Optometry was established at the request of the occupational therapists who felt that many of their students had undiagnosed vision problems. An attending pediatric optometrist, interns and residents from the pediatric program would spend one morning a week at the school. When examined at Birch, children were scheduled for 30 minute exam slots and were accompanied by either their occupational, physical or speech therapist. If the child was not receiving any of these therapies, he/she was assigned to a therapist to accompany him/her to the evaluation. The role of the therapist was to escort the child to and from class, to assist in keeping the child's attention during testing, and to act as a liaison between the parent, doctor and teacher. Therapists were instrumental in communicating any concerns about the child's vision that they, the teacher, or parent noted. After the examination, the therapist would then educate the child's teacher and parents of any problems and work with the optometrist in implementing recommended treatments.

All parents of children receiving an eye examination were sent information regarding the evaluation and dilation, including a HIPAA, consent and history form. Upon receiving the consent, a letter concerning the examination date and time was sent home one to two weeks prior to the exam date so that the parent could be present during the assessment. It was not mandatory that the parent attend, however. If the parents were not present, a letter summarizing the examination results and information on additional testing required was sent home with the child. The letter included information on visual acuity, refractive status, binocular vision status, color vision and ocular health. If a follow up examination or eyeglasses were needed, this was also indicated in the letter.

Testing began with visual acuity assessments at distance and near. Because of the age of the children, a picture chart was used for both tests. The distance 10 foot symbol chart<sup>a</sup> consisted of 3 shapes (umbrella, house and apple) and came with a matching card, so that the child was not required to use a verbal response. If a child was unable to respond to the picture chart at distance, the Cardiff cards<sup>b</sup> were used. The Cardiff test is a forced preferential looking visual acuity test with half the card containing a picture and half the card containing a gray area. Preferential looking is based on the premise that a child would look at the picture, instead of the gray area, if he/she could see it. The card is presented multiple times at each acuity level to rule out the effects of random guessing. If the child was unable to respond to the Cardiff cards, no alternative test was attempted. In most instances visual acuity was assessed monocularly, in some cases however, children who were resistant to having an eye covered could only be assessed binocularly.

Additional tests included the cover test, extraocular motilities, the near point of convergence test, as well as confrontation visual fields, and an assessment of pupil responses, color vision and stereopsis. Color vision testing was conducted using the Waggoner Plates.<sup>c</sup> The Waggoner test consists of pictures of a star, square and circle and has a matching card. Refractive status was measured objectively using retinoscopy. Health was assessed with a direct and/or indirect ophthalmoscope. The dilated fundus examination was performed on children whose parents had given us consent to use eye drops. Because of time constraints, the dilation was scheduled as a separate visit. Additionally, if a child had difficulty responding to testing on the first visit, he/she was rescheduled for a follow up assessment where the tests were repeated. If a child needed eyeglasses, frames were available at the school or the parents could go to any optical establishment of their choice. If a child required additional specialized services than those available at the school clinic, a referral was made to an appropriate provider.

## Methods

A retrospective review of all more than 200 patients seen at the school clinic from 2003-2006 was conducted. Information regarding visual acuity, refractive status, binocular vision, color vision defects, eye health and the need for eyeglasses or specialized treatment was noted. During the time period of the study, all children were examined by the same

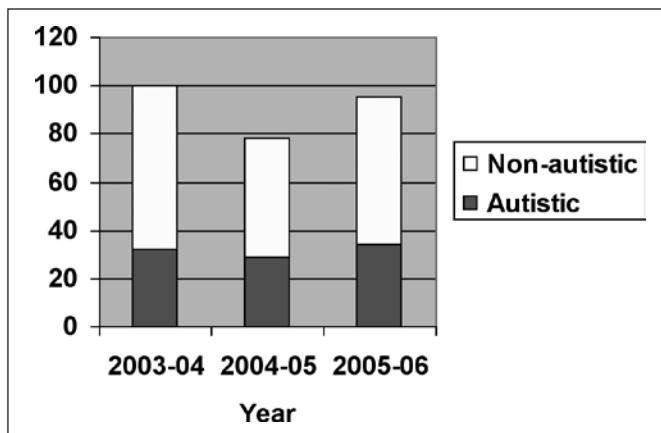


Figure 1: Number of children Examined by Year

Table 1: Visual acuity testing by year

Year	Testable with Picture Chart	Untestable with Picture Chart, Testable with Cardiff Cards	Untestable with either method
2003-04	74%	20%	6%
2004-05	79%	18%	3%
2005-2006	84%	15%	1%

attending optometrist, although the student clinicians and residents evaluating the children varied.

## Results

Overall, 222 individual students were examined during the 3 years. (A breakdown of students examined by year, as well as, the number of children with autism is recorded in Figure 1.) The average number of visits per child was 2, with a range from 1 to 5. In the first year of the program, 100 children out of an enrollment of 146 (69%) were examined. Thirty two children (32%) of those evaluated had been diagnosed with Autism. In the second year, 78 children out of 167 (47%) were examined,\* 38% of these children had been examined at the school in the prior year. Twenty nine (37%) were autistic. In the third year, 95 children out of 127 (75%) were assessed. Twenty four percent of these children had received prior examinations at the school. Thirty four (34%) were diagnosed with Autism.

Visual acuity assessment was performed as described previously. (Results by year are summarized below in Table 1.) The majority of children (74-84%) were able to respond to the picture chart, with only 1-6% of children not being responsive to any test. (Table 2 further looks at the ability to children

\* During the second year of the program, numerous staffing changes created scheduling difficulties so that fewer children were examined.

Table 2: Visual acuity testing monocular versus binocular

Year	Testable Monocularly	Testable Binocularly Only	Percentage of Binocularly assessed children who were autistic
2003-04	72%	28%	39%
2004-05	87%	13%	58%
2005-2006	84%	15%	1%

Table 3: Patients with an Initial Decrease in Acuity

Number of Children	Percentage	Reason for Decrease
8	2.9	Austistic poor responders (All other tests normal)
10	3.7	Amblyopia (Lazy eye)
1	0.4	Nystagmus
12	4.4	Cognitie (Vision improved on subsequent visits)
12	4.4	Refractive Error (Vision improved with glasses)
4	1.5	Lost to follow up (No further information)

without any amblyogenic factors to respond to acuity testing monocularly.)

At the initial visit 47/273 (17%) children did not see 20/40 or better in one or both eyes. However, during follow up, many of these children showed an improvement in acuity. (Possible reasons for the decrease in initial acuity are listed in Table 3.) Ten children (3.7%) were diagnosed with amblyopia.

Glasses were prescribed for 31 (11%) children. Five children (1.8%) received glasses from an outside doctor. With the exception of 1 child who was prescribed prism glasses to compensate for a visual field defect, all glasses were prescribed to correct for refractive errors or accommodative esotropia.

Fifteen children (6%) had strabismus, with the percentage fairly equally distributed between exotropia and esotropia. One child reported a history of prior strabismus surgery. Sixty children (22%) were unable to respond to color vision testing, while 2.9% had a suspected color vision defect. (This includes two siblings who had decreased color vision secondary to a suspected, and later confirmed, cone dystrophy.)

Dilated fundus examinations were conducted on 16% of all children. Ideally with this age group, 100% of children should be dilated in order to better assess the refractive status and ocular health. Reasons that children were not dilated include the following: no consent by parent, child behavior during the examination, or a history of a dilated exam within the

**Table 4: Characteristics of Children with Cerebral Palsy**

Child	Initial VA	Binocular	Refractive	Pathology
1	Picture monocular	No strab		
2	Picture monocular	No strab		
3	Picture monocular	No strab		
4	Picture monocular	No strab	Myopia	Hemianopsia

**Table 5: Characteristics of Children with Down Syndrome**

Child	VA	Binocular	Refractive	Pathology
1	Unable	No strab	High myope - Rx	
2	Cardiff 20/50 OU improved to 20/25 OU	CAXT	Astigmatism- Rx	
3	Cardiff 20/30 OU	Accommodative ET	Hyperopia - Rx	
4	20-25	Alt ET	Emmetropia	
5		No strab	High CHA - Yes	

past year. Percentages for each of these reasons were not recorded.

Approximately 30% of children examined had autism or were considered to be on the spectrum. Two percent of children had a phakomatosis (tuberous sclerosis and neurofibromatosis type 1 (NF1)). Three percent of the children were diagnosed with Cerebral Palsy and Down syndrome. Two percent of children were noted to have low birth weight; however the percentage was probably higher, as 4% of children had a reported history of Retinopathy of Prematurity (ROP).

Of the patients with CP, all were able to respond to the picture chart. Only 1 child was not able to respond monocularly. None of the patients had strabismus. One patient had a right hemianopsia on confrontation visual field testing and was given a prescription for prism glasses. One patient had myopia. No patient had optic atrophy. (See Table 4)

Of the patients with Down syndrome, only one had a low refractive error (<1.00 hyperopia) and was not given glasses. One patient had high myopia, one had high hyperopia and two patients had moderate hyperopia and astigmatism. Three patients had strabismus. (See Table 5)

Other ocular conditions diagnosed included cone dystrophy in 2 siblings, 1 subconjunctival hemorrhage, 2 possible nasolacrimal duct obstructions, 1 nystagmus and 1 child with a ptosis. Allergic conjunctivitis and blepharitis were also frequently encountered.

**Table 6: Reasons Children were Referred**

Number of Children	Reason for Referral	Where Referred
4	Untestable at school	SUNY Pediatrics
3	Amblyopia – parents not present despite requests	SUNY Pediatrics
2	Cone dystrophy (retinal disease)	Retinal specialist
2	Vision therapy for strabismus	Vision Therapy
1	Variable Ptosis (Suspected Myasthenia Gravis)	Neuro-ophthalmologist, Pediatrician
1	Suspected legal blindness; services needed	Low Vision
1	Undiagnosed Nystagmus	Neuro-ophthalmologist, Pediatrician
1	Tearing	Pediatric ophthalmologist,
1	Anomalous eye movements	Neuro-ophthalmologist

Referrals for additional assessments were made for 16% of the children examined. (Reasons for referrals are listed in Table 4.) In some cases referrals were made even though the patient was receiving care at the school, especially if the parents were non-compliant with treatment.

## REVIEW OF SYSTEMIC CONDITIONS

### Cerebral Palsy

Children with CP may have damage to the visual pathways in the brain, resulting in optic neuropathy, cerebral visual impairment or visual fields, specifically scotomas.<sup>2,3</sup> One study found that 60% of children with the most severe form of CP had optic neuropathy, compared to only 10% of children with the mildest form of the disease.<sup>3</sup> Ghasia found that 16% of children with CP had cerebral visual impairment defined as “bilateral, subnormal, best corrected visual acuity for the age not attributed to oculomotor deficit or a structural deficit of the afferent visual pathway.”<sup>3</sup> He also noted that many children with normal, or mildly subnormal visual acuity had been labeled as having cortical blindness by other practitioners. In many cases these children were found to have saccadic, smooth pursuit or fixation disorders which made them appear as if they could not see. The use of the visual acuity optotype can also affect results. Schenk-Roetleib found that almost 70% of patients with CP have a reduction in visual acuity without an organic etiology and may show an improvement in acuity on subsequent testing.<sup>6</sup>

Many children with CP have hyperopia or myopia greater than expected for their age.<sup>2,4,5</sup> Hyperopia has been found three times more frequently than myopia. Studies have found that 40-70% of these patients have strabismus.<sup>3,5</sup> Both exotropia and esotropia have been reported as being frequently encountered.<sup>3,5</sup> Vertical strabismus is often reported in this population.<sup>2,3</sup> Between 42-58% of children with CP, especially those with more severe motor impairments, have accommodative difficulties as well and the optometrist should consider prescribing multi-focal lenses for these focusing disorders.<sup>1,2,7</sup>

## Down Syndrome

When using electrophysiological tests, children with Down Syndrome were found to have decreased visual acuity and contrast sensitivity, even in the absence of ocular disease, when compared to a control group.<sup>8</sup> Another study found that 7% of children with Down Syndrome had reduced acuity in the absence of any organic disease, and that 22% had reduced acuity secondary to amblyopia.<sup>9</sup>

Some studies report that most children with Down Syndrome have a normal refractive error, but moderate to high amounts of hyperopia and myopia are seen more frequently than expected.<sup>9</sup> Astigmatism has been reported to be present in 9-53% of patients.<sup>9,10</sup> Reasons for the large difference in percentage of patients with astigmatism include: patient ages and amount of astigmatism included in the study (e.g. 1 diopter or 1.75 diopter), as well as, the distribution of refractive error vary with age. Studies have found no significant difference between the refractive error of infants with Down syndrome when compared to a typical population. However 51% of preschool and 55% of school age children were found to have a significant refractive error, particularly hyperopia.<sup>11</sup>

Approximately 42% of children with Down syndrome have strabismus. Esotropia has been noted to be present in 29-88% of patients, while exotropia has been reported in 4-16%.<sup>9,10,12</sup> One study found that the onset of esotropia occurred between 3 and 6 years of age.<sup>12</sup> Between 55-68% of these children have been found to have accommodative dysfunctions.<sup>10,12</sup> Stewart et al found that bifocals for these children resulted in improved accommodation, even when looking through the distance portion of the glasses.<sup>13</sup> The authors hypothesized that the bifocal lenses act as an active treatment for the accommodative system.



Figure 2: Eye chart cover

## Autism

Patients with autism have been found to exhibit hypersensitivity to one or more sensory modalities, most commonly auditory, visual and tactile. This behavior can interfere with the assessment process.

One study found that 44% of autistic children had >1 diopter of refractive error and 21% had intermittent strabismus.<sup>26</sup> Another study found that children with autism performed well on psychophysical tasks of motion but not pattern detection.<sup>14</sup> Children with visual hypersensitivity often have difficulties with psychophysical vision tests, particularly those requiring processing of high spatial frequency information. As a result of these findings, the authors recommended that children with Autism receive an evaluation of psychophysical performance.<sup>14</sup>

## Discussion

Children with special needs, especially Cerebral Palsy and Down syndrome, are at a greater risk of having vision problems than their peers. In many cases, these children may not be able to respond to traditional measurements of visual acuity. Additionally, children within the Autism Spectrum may manifest sensory integration issues such as sensitivity to light, or aversion to new surroundings, and therefore can be considered difficult to examine and treat. Perhaps because of these perceived difficulties and for reasons yet investigated, many of these children with special needs do not receive an adequate assessment of visual function. Having a vision clinic in a school setting facilitates examination and, in some cases, treatment of these children.

Through the course of the program, the percentage of children testable with the visual acuity chart increased from 74 to 84% and those that were testable monocularly increased from 72 to 87%. One possible reason for these improvements was an aid developed by the occupational therapists to facilitate acuity testing. The visual acuity chart used was a wall chart with many figures. Children would get easily distracted and would not attend to a single line or figure, in spite of efforts to use paper or other objects to isolate figures. The therapists designed a "flip" screen to be placed on the chart that enabled the isolation of a single shape. (See Figure 2).

Another possible explanation for the improvements in the ability to test children with the picture chart is increased experience on the part of the interns and therapists involved in patient care. In the first year of the program, student clinicians rotated through the clinic on a weekly basis, but in subsequent years, they rotated through the clinic for a six week session, enabling better continuity of care. Additionally, the therapists became more familiar with the examination techniques and comfortable in assisting during the examination and in preparing children to work with the matching card, as well as, informing the doctor if they felt the child was not responding appropriately for the individual's abilities (i.e. "The child is having a bad day.") The fact that many of the therapists worked directly with the children they escorted to the assessment was especially helpful as it provided the children with a familiar presence so they would feel more at ease.

The ability to reexamine children also helped them to become more comfortable with the testing and better able to respond. Overall, 17% of children were not able to identify a 20/40 picture with one or both eyes at the initial visit. (See Table 3) A 20/40 level of acuity was chosen because it is accepted by the Maternal and Child Health Bureau and National Eye Institute Task Force on Vision Screening in the Preschool Child as passing acuity for a vision screening in preschool children less than 48 months of age.<sup>15</sup> Most children had their initial visit during this time, although some were initially examined at 49 months and older. As table 3 reflects, 20 children (7%) showed an initial decrease in acuity without refractive error or disease. Twelve of these children (4.4%) improved on subsequent testing without any treatment. This finding is noteworthy as children who are not able to be tested monocularly at a school screening are often referred for further care because amblyopia can be present in one eye.

Similarly, 3% of children examined were not able to identify a 20/40 shape or respond to Cardiff cards in the absence of an amblyogenic factor or ocular pathology. These results are lower than those found by Tsiaras who noted that 7% of children with Down syndrome had decreased acuity of worse than 20/50 without any etiology being obviously present.<sup>12</sup> Significant differences are found between that study and the current one. Tsiaras' results were based on Snellen acuity, older patients, a lower acuity cutoff value, and only 1 visit per child. Many studies

have found that children with Down syndrome and Cerebral Palsy could not be tested with traditional letter, or picture acuity charts, so researchers used preferential looking tests as an alternative.<sup>13,14</sup>

In this study, approximately 4% of all children examined were diagnosed with amblyopia. In those cases where patching was prescribed, the occupational therapists were instrumental in ensuring that children wore the patch appropriately and would often work with these children during therapy sessions. Many children with amblyopia, particularly secondary to strabismus, have poor speed and dexterity during fine motor tasks, for which they receive occupational therapy.<sup>17</sup> Therefore, it is important for occupational therapists to be aware of the presence of amblyopia when treating these children.

All therapists, as well as eye care professionals, should be aware that children with cerebral palsy typically exhibit a decreased visual acuity when compared to those individuals with Down syndrome. This is usually because of a greater incidence of cortical and ocular impairment.<sup>17,18,19</sup> Individuals with cerebral palsy and Down syndrome also appear to perform better for near tasks and reading when multifocal/bifocal lenses and/or when vision therapy is utilized as a part of their treatment program as well.<sup>20,21,22</sup>

Not only do we not know the true etiology of Autism, but those with Autism tend to process information in yet undiscovered and novel ways.<sup>23,24</sup> We must adapt our examination techniques so that optometrists can better serve those we suspect to be on the spectrum and to diagnose and treat the eye and vision problems associated with Autism so that all with Autism can perform at their highest level.<sup>25,26,27</sup>

## Disadvantages of Program

The primary disadvantage of the program was the lack of parental involvement, especially when the child required additional testing or referrals. In some cases, it is possible that the parents did take the child for follow up with another provider who did not return a report to the eye clinic. Unfortunately follow up by another health care provider could not easily be confirmed.

Furthermore, if a parent was not present during the examination, they were not aware of what testing was done. Upon receiving the examination report indicating the need for glasses, some parents took their child for another eye examination and received different treatment. In other cases, although glasses and/or patching were prescribed by us, the child was

not complaint with the treatment (as reported by the therapists). It is possible that some parents, especially those who did not speak English, did not understand the purpose of the therapy recommended, especially if they were not present at the examination.

Another disadvantage of the program was that the case history questionnaire was not always completed. Because of this, some systemic disorders may have been underreported. Parents might not have reported this information because of language barriers, or the fact that they might have been unaware of the potential vision and eye health sequelae of certain systemic conditions.

## Benefits of Program

One benefit of having an eye clinic in a school is that follow up of children is facilitated. Those children who are unresponsive to testing can be rescheduled for another visit without a great deal of inconvenience for the parents. Another benefit of the program is that therapists involved with the child's care develop a better understanding of the child's visual functioning and how to assist him/her. Working with the children on a regular basis allows the therapists and teachers to see the benefits of vision intervention. Another advantage is that because the research on vision screenings has been so poor that we do not know if they are effective or not, full, comprehensive eye and vision examinations provided within the school environment should allow outcomes to be much more readily accessed.<sup>28</sup>

## Conclusion

The program developed at Birch is unique in that it is truly interdisciplinary with the therapists, teachers and optometrists becoming involved with the care of the children, particularly if the child needed glasses or patching. Occupational therapists are in a unique position in that they work closely with children and are able to observe their visual behaviors and can recognize those who need further treatment. Because of their working relationship with students, they can serve as an additional resource in the treatment of certain visual disorders, particularly amblyopia.

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Steve, Mike and Maria. Portions of this paper were presented originally as a research presentation at the 36th Annual Meeting of the College of Optometrists in Vision Development in 2006.

## References

- Note:** URLs and underlined text are functional hyperlinks to Internet addresses.
- a Symbol visual acuity charts are available from <https://www.bernell.com/> and <http://www.good-lite.com>
  - b Cardiff cards are available from <http://www.good-lite.com>
  - c Waggoner Plates available from <http://www.good-lite.com>
  1. Woodhouse, JM Investigating and managing the child with special needs *Ophthal Physiol Opt* 1999; 18: 147-52.
  2. Leat SJ Reduced accommodation in children with cerebral palsy. *Ophthal Physiol Opt* 1995; 16: 385-390.
  3. Ghasia F, Brunstrom J, Gordon M, Tychsen L. Frequency and severity of visual sensory and motor deficits in children with cerebral palsy: gross motor function classification scale. *Invest Ophthal Vis Sci* 2008;49: 572-80.
  4. Sobrado P, Suarez J, Garcia-Sanchez, FA, Uson, E. Refractive errors in children with cerebral palsy, psychomotor retardation, and other non-cerebral palsy neuromotor disabilities. *Dev Med Child Neurol* 1999; 41: 396-403.
  5. Scheiman MS. Optometric findings in children with cerebral palsy. *Am J Opt Physiol Opt* 1984; 61:321-23.
  6. Schenk-Rooteib AJF, van Nieuwenhuizen O, van der Graaf Y, et al. The prevalence of cerebral visual disturbance in children with cerebral palsy. *Dev Med Child Neurol* 1992; 34: 473-80.
  7. McClelland JF, Parkes J, Hill N, Jackson AJ, Saunders, KJ. Accommodative dysfunction in children with cerebral palsy: a population based study. *Invest Ophthal Vis Sci* 2006; 47: 1824-30.
  8. John FM, Bromhan NR, Woodhouse JM, Candy, TR. Spatial vision deficits in infants and children with Down syndrome. *Invest Ophthal Vis Sci* 2004; 45: 1566-72.
  9. Haugen OH, Hovding G, Lundstrom I. Refractive development in children with Down syndrome: a population based, longitudinal study. *Br J Ophthal* 1999; 85: 714-19.
  10. Tsiaras WG, Pueschel S, Keller C, et al. Amblyopia and visual acuity in children with Down syndrome. *Br J Ophthal* 2001; 83: 1112-14.
  11. Woodhouse JM, Pakema VH, Clegg M, et al. Refractive errors in young children with Down syndrome. *Optom Vis Sci* 1997;74:844-51.
  12. Haugen OH, Hovding G. Strabismus and binocular function in children with Down syndrome. A population-based, longitudinal study. *Acta Ophthalmol Scand* 2001; 79: 133-39.
  13. Stewart RE, Woodhouse J.M, Trojanowska, LD In focus: the use of bifocal spectacles in children with Down syndrome. *Ophthal Physiol Opt* 2005; 25: 514-22.
  14. Davis RA, Bockbrader MA, Murphy RR, Hetrick WP, O'Donnell BF. Subjective perceptual disorders and visual dysfunction in children with autism. *J Autism Dev Disord* 2006;36:199-210.
  15. Maternal and Child Health Bureau and National Eye Institute Task Force on Vision Screening in the Preschool Child. Preschool vision screening. *Optom Vis Sci* 2001;78: 122-26.
  16. Webber AL, Wood JM, Gole GA, Brown B. The effect of amblyopia on fine motor skills in children. *Invest Ophthal Vis Sci* 2008: 49: 594-603.
  17. Wesson M, Maino D. Oculo-visual findings in Down syndrome, cerebral palsy, and mental retardation with non-specific etiology. In Maino D (ed). *Diagnosis and Management of Special Populations*. Mosby-Yearbook, Inc. St. Louis, MO. 1995:17-54.
  18. Maino DM, Maino JH, Cibis GW, Hecht F. Ocular health anomalies in patients with developmental disabilities. In Maino D (ed) *Diagnosis and Management of Special Populations* Mosby-Yearbook, Inc., St. Louis, MO. 1995:189-206.

19. Maino D. Overview of special populations. In Scheiman M, Rouse M. (eds) Optometric management of learning related vision problems. St. Louis, MO: Mosby Inc. 2006;85-106.
20. Duckman RH. Accommodation in cerebral palsy: function and remediation. *J Am Optom Assoc*. 1984 Apr;55(4):281-3.
21. Ross LM, Heron G, Mackie R, McWilliam R, Dutton GN. Reduced accommodative function in dyskinetic cerebral palsy: a novel management strategy. *Dev Med Child Neurol*. 2000; 42(10): 701-3.
22. Nandakumar K, Evans MA, Briand K, Leat SJ. Bifocals in Down syndrome study (BiDS): analysis of video recorded sessions of literacy and visual perceptual skills. *Clin Exp Optom*. 2011;94(6):575-85. doi: 10.1111/j.1444-0938.2011.00650.x. Epub 2011 Sep 21.
23. Maino DM, Viola, SG, Donati R. The Etiology of Autism. *Opt Vis Dev* 2009;(40)3:150-156.
24. Viola SG, Maino DM. Brain anatomy, electrophysiology and visual function/perception in children within the autism spectrum disorder. *Opt Vis Dev* 2009;40(3):157-163.
25. Coulter RA. Serving the needs of the patient with autism. *Optom Vis Dev* 2009;40(3):136-140.
26. Scharre JE, Creedon MP. Assessment of visual function in autistic children. *Optom Vis Sci*. 1992 Jun;69(6):433-9.
27. Press LJ, Richman J. The role of optometry in early identification of autism spectrum disorders. *Optom Vis Dev* 2009;40(3):141-149.
28. Powell C, Hatt SR, Powell C, Hatt SR. Vision screening for amblyopia in childhood. Cochrane Summaries available from <http://summaries.cochrane.org/CD005020/vision-screening-programmes-for-amblyopia-lazy-eye> last accessed 11-11.