Article ▸ Visual Impediments to Learning

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ABSTRACT

Cognition and learning are dependent upon accurate encoding of stimuli from the environment. If there is an error in, or an impediment to, sensory perception, higher cognitive functions, such as reading, memory, emotional awareness, and impulse control can be affected.

In schools, functional defects of the visual process impair reading acquisition and learning and influence other behavior. Children are affected by different types of impairments to eyesight and visual function. The degree to which children are impacted varies according to the depth and nature of the impediments present, and to some degree to ethnicity. Some children are at a greater disadvantage simply because of the greater visual demands of the neo-traditional classroom.

These visual impediments to learning (VIL) are rarely detected in common sight screenings and are associated with limited socioeconomic success and increased criminality. Significant VIL limit academic and life outcomes, with some ethnicities affected by a greater prevalence of reading-impairing impediments. This presents difficulties for various public agencies at all levels of government. To complicate matters further, children who are affected by vision difficulties will most often not report the problem.

VIL are described in brief, as is how they alter children's academic outcomes, health, and behavior. A model of sufficient vision care in the prevention of vision-related learning and behavioral difficulties is proposed. The position is advanced that ensuring adequate vision management for children entering the 12-year academic cycle is a matter of fundamental human rights.

Keywords: ADHD, ethnicity, human rights, learning disability, public health policy, vision, visual impediments to learning

Educational Context

When a child's perceptual abilities are evaluated in psychology, the goal is typically to identify deficits in the learning process that may be impeding the encoding and processing of information in order to remediate. These interfere with the child's ability to receive, to organize, to memorize, or to express information. Before a child can begin to process information, the visual signals triggering memory must be gleaned from the environment and organized into meaningful constructs. This discovery requires not only a sound medical state of the entire visual system, but that the biomechanical mechanisms for perception be properly integrated at a neurobiological level, operate unimpeded, and remain optimally functional for the duration of the day. Significant deficits in either the acquisition, processing, or integration of information can and will impact learning processes and have adverse effects on a child's ability to function in the classroom.[1-3]

There are seven channels or sensory modalities through which information from the environment is gathered for the purpose of active learning: auditory, visual, tactile, kinesthetic, gustatory, vestibular, and olfactory. As information is taken in through these modalities, the percepts are integrated, given meaning, organized in some fashion in memory, and then reflected through a variety of responses to stimuli at different times. Vision, as a dynamic multi-sensory process, is the pinnacle of human sensory evolution, and serves as the paramount sense for discovery in the neo-traditional classroom, which emphasizes text-based learning through print and electronic media. Mature vision arises as a function of the progressive integration of the developing sensory modalities, and with advancing memory and evolving executive functions. Vision also has a feed-forward relationship with motor and cognitive planning and execution, where each one supports and advances the development of the other.[4]

Instruction in technologically advanced nations places primary emphasis on visual and auditory input, as opposed to multi-sensory experiential learning. Furthermore, the instructional strategy shifts from an auditory to a visual bias with advancing age as children are expected to learn more on their own through reading. By mid-elementary, most learning occurs through acquisition and processing of visual percepts in text. Modern education also imposes greater visual stresses on students through increased use of text-based electronic media and smaller screens at reduced viewing distances.[5-14] It follows that existing visual perceptual deficits (eyesight, motor control and alignment, cortical and sub-cortical visual information processing) will put a student at a relative disadvantage compared to his peers when trying to acquire information for processing.

There is a consensus among researchers that text is read in a sequential order, that the eyes are moved to attentional units, and that saccades are triggered most often by a cognitive event.[1] Because visuomotor control is driven by lower level sensorimotor and reflex functions, the student's ability to move the eyes in a rapid, automated, accurate, and predictable manner provides insight into the relative readiness for reading,[15] as well as the child's general developmental status. Research interest in this area is growing, especially in Europe,[1] though there is a long tradition of developmental optometry in the United States. Nonetheless, there is little evidence to suggest that visual processing or visual-motor subtests typically found in standard neuropsychological visual batteries can identify visual functional disorders.

Germane to this paper is the concept of visual impediments to learning. These mechanical neurosensory impairments, that is, visual developmental and functional deficits, adversely affect a child's ability to acquire relevant visual information from the environment. This limits a child's educational performance and well being.

The Role of Vision in Learning

Visual perception (the acquiring and processing of visual information to find meaning and for thinking) is considered to be one of the most important specific ability areas in early assessment due to the relationship between visual perception deficits, reading performance, behavior,[16,17] and other disabilities that affect learning and the classroom.[18] Vision and audition are both involved in learning to read.[19] There appears to be more emphasis on auditory proficiency from birth, whereas higher visual processes do not arise until much later. The later maturation of visual development is due to its multisensory nature; specifically, the fact that it arises out of the parallel evolution of equilibrium and balance, kinesthesis, touch, and audition. Phonological awareness, the ability to manipulate in an abstract form the sound constituents of oral language, is also strongly related to expected reading skill.[19] When combined, matured vision and phonological awareness provide the platform for written language development. It is not surprising that phonological awareness and visual functional status[20] remain powerful predictors of reading outcomes.

In a maturing child, vision becomes sensory shorthand for the oral and tactile environmental investigation of the first months of life. Strong and effortless vision relies on a sound neurosensory and neuromuscular foundation. As with any human behavior and capacity, visual function lies along a spectrum of ability, with each child uniquely endowed with their own visual functional profile that can facilitate or hinder the intensive vision-based work in school. The component elements of visual function are all subject to less than optimal condition and performance. These deficits can be rooted in developmental concerns due to genetics, disease, and congenital factors, or in a functional disparity between what a child can manage physiologically and what a given task demands. Visual input transcribed from the environment can be impaired in its quantity, quality, and sequencing, especially with respect to text.

Some have suggested that low-level visual deficits, such as visual acuity, are not major causes of poor reading performance.[21,22] It seems intuitively obvious, however, that if a child is struggling with the clarity of detailed visual information, for example, he will also struggle with information gathering through text-based instruction. Likewise, if the child struggles with visual function, this diversion of energy will detract from learning, and so facility of vision is also critical.

Indeed, clinical and epidemiological studies will show that reduced distance acuity is not associated with reading delays, and this is consistent with other findings. It is also clear that low to moderate levels of myopia present as a relative advantage in the classroom compared to hyperopia, even though hyperopia is much less likely to be detected in rarified vision checks.[23] Children with astigmatism, hyperopia, and other non-myopic visual difficulties, and who can still read distance eye charts, can and do struggle with reading.[5,24-26] Consider that children who cannot see clearly at a distance are much more likely to be myopic than hyperopic. For example, a child who is farsighted by two dioptors will pass a distance acuity check, while a two-diopter myope will see blurred lines. However, the hyperopic child is much more likely to struggle academically.[25] Amblyopia alone affects some 5% of children in the general population and has been shown to be a cause of reading impairment.[27] Very low levels of astigmatism have also been shown to have measurable impact on reading performance,[28] even though these levels may not be immediately apparent on distance acuity assessments conducted by laypeople or untrained professionals.

There are conflicting reports concerning the involvement of high-level visuomotor difficulties in reading. A strong relationship does exist between deficient visuomotor skills and reading disability,[29,30] though there is some question whether motility problems are causal or rather a parallel outcome of neurodevelopmental anomalies that also affect reading and learning.[31,32] While some writers have attempted to disprove the relation between oculomotor control and reading by using unique exceptions,[33] it is clear that restrictive ocular motility[17,34] and poor visuomotor control are associated with limited academic outcomes.[2,18,20,35-43] Children who suffer with ocular motility concern such as convergence insufficiency can exhibit behaviors that can be misinterpreted as other developmental or medical concerns,[44-46] and see reduced outcomes and more disruptions in the classroom.[16,17,45,47,48]

Beyond visuomotor control, low level visual tasks such as visual motion, contrast sensitivity, visual tracking, and temporal processing[37,39,49,50] have all been shown to correlate with reading and, at least in some studies, used to differentiate between groups of good and poor readers.[51-55] In spite of this, visuomotor control and other concerns of visual information

acquisition are rarely considered in psychometric and pediatric assessments despite the critical role they play in reading and the consistent finding of visual perceptual difficulties among children with reading disabilities.[30,31,35,40,41,53]

Early identification of such impediments allows for appropriate treatment, leading to maximal benefit over the school cycle and the child's lifetime. Once refractive error has been accounted for, visual neurorehabilitative efforts tend to focus on remediation of visual spatial and visuomotor concerns, from a low level working upwards, leaving fine reading-type motor training to the latter stages of therapy. For example, a practitioner might begin by addressing shortcomings in retained primitive reflexes, balance, coordination, bilateral integration, and laterality awareness, and then move on to visual motor integration, visually-guided behaviors, spatial awareness, and saccadic control.[56] Because of this, treatment addressing visuomotor skills[57] can sometimes have significant impact on other behavioral concerns, and this is widely reported anecdotally as well as in emerging reports in developmental optometric research.[58,59] There is also evidence that addressing ocular motility problems directly can also provide some measurable benefits to reading behavior.[60]

Visual Impediments to Learning and the Need For Early Detection

Children who are not blind but still suffer from other 'invisible' challenges in vision have always been, and always will be, at a disadvantage in a learning environment that emphasizes the use of detailed visual stimuli at near distances and for extended periods of time. Common visual conditions such as moderate to high astigmatism and hyperopia, limitations in fine or gross muscle control, accommodative dysfunction, and amblyopia are surprisingly common, as high as 35% in some populations.[61] These are associated with pain around the eyes, headache, discomfort, difficulty attending to tasks, emotional lability, agitated behavior, and inattentiveness, especially when combined with protracted nearpoint visual strain.[5,7,23,25,26,28,62-71] Visual functional impairments also present as reading anomalies such as general intolerance of reading, reversals of letters and words, skipping and repeating lines, and reports of wavy or moving images (Table 1 & Table 2).

To complicate matters, even in moderate and severe cases, VIL-affected children will most often not report visual problems because to them "what is known is what is normal."[72] It does little good to ask a child "can you see that?" as the answer will almost certainly be in the affirmative and because it offers next to no clinical value. Myopic children, for example, for whom near work is often more comfortable, tend to self-identify during simple screenings. As a consequence, parents and teachers alike will only rarely know any problem exists, even when they ask, except in many cases of myopia or extremes of other conditions. Furthermore, vision's complexity and the anatomical, physiologic, and intellectual variability between individuals imply a great range of operational tolerances. Thus, the suitability of a person's visual profile is a direct function of the nature of the tasks assigned and of that individual's capacity to mitigate the impediments with which he is burdened. In the neo-traditional classroom, the especially high demand on extended near tasks, the ubiquitous use of backlit displays, the reliance on text, the proliferation of low contrast projection systems, and the emergence of 3-D viewing systems are all potentially more challenging and noxious to some children.[73]

Vision 'feels' different from one person to another and cannot be shared as an experience, not as well as in the case of touch or hearing. Children's unique egocentricity permits them to think that everyone else has exactly the same sensory experiences they are having and can cause them to rationalize difficult vision in many ways. This can include internalization of failure when they struggle with what others seem to do with ease. Given the physiologic load of difficult vision and the intense near vision requirements in school, affected children can exhibit other academic, behavioral, and even medical concerns that can often respond well to early detection and treatment.[5,59,74]

To the extent that restrictive ocular motility control, range of motion, and undetected refractive errors can pose obstacles to reading, learning, and health, the American Academy of Pediatrics recommends that any child referred for reading problems should be assessed for visual functional anomalies by pediatric vision specialists, clinically available through developmental optometry or pediatric ophthalmology.[1,75,76] The authors agree with this imperative given the potential impact of visual impediments to the child's health and achievement in the classroom environment, but also because of the common reliance on vision-based assessment tasks, such as are common with current psychoeducational testing protocols. It is also conceivable, if not obvious, that testing with uncorrected visual impediments could lead to erroneous metrics and conclusions, especially with respect to measures of visual perception, reading, and executive function where there is a heavy reliance upon visual test elements.

Diagnostic Signs of Visual Impediments

The impact of vision on reading and learning results in part from the manner in which children use their vision in and out of the classroom. Children spend a large percentage of their day involved in near visual tasks, including academic time, homework, and typical recreational time such as computers, texting, and reading.[77] All of these activities require efficient, effortless, and sustained near visual skills, and this becomes increasingly critical once the child has acquired basic reading proficiency and reading is used increasingly to extract and to learn information on a daily basis. After the third grade, children are expected to be largely independent learners, and they will be limited by the degree to which vision

is impaired. A child's behavior will often point to significant visual impediments, but not always.

Numerous skill areas are associated with visual perception, and these can be broadly categorized in terms of either visual information processing (VIP), relating to the sub-conscious mental processing of visual information, or visual signal acquisition (VSA), the optical and motor-mechanical aspect of visual perception. VIP skills relate to how visual information is deconstructed and reconstructed cortically in order to glean meaning from the visual signal. Examples of VSA skills include eye alignment and resting posture, coordination of muscle movement and focusing, and eyesight. While fine visual and perceptual acuity is critical for success in the modern classroom, it is also necessary that visual control be unimpeded and fluid, accurate, and free of discomfort. A child's visual status can vary significantly within each of these functional domains, with deficits in one or more area potentially resulting in significant visual impediments.[78]

Impaired visual function can impact negatively upon academic performance in a vision-based education, and it can also affect a child's behavior due to associated physiologic strain. VIL are often felt physically and sensed by the child, varying in intensity and frequency depending upon the nature and depth of the impediments. Children burdened even with moderate and heavy VIL have difficulty expressing this feeling. Parents and professionals will not see the VIL, but the child will exhibit other behavioral concerns. These can vary from a gentle or moderate irritated feeling when faced with near tasks, to complex head pain and reading anomalies. This nearpoint stress phenomenon has been a focus of clinical and experimental interest in developmental optometry for some decades.[6] These problems are not often attributed to vision, and are almost never detected during vision screenings. The excess visual strain of even moderate hyperopia alone can lead to medical and academic concerns. This has been documented for well over 150 years as asthenopia, a condition that affects farsighted people especially, and more so during near work.[5,70,71,79,80] This is exacerbated when viewing video display terminals, and indeed, computer vision syndrome has been well documented for over 40 years.[7-13,62,77,81,82] The effects of VIL are compounded by the extended hours of reading and nearpoint stress required in modern classrooms and the ubiquity of electronic displays.[8,77,81-83] Recent research describes the differences in the added visual strain of handheld electronic devices compared to print.[84]

Several behavioral indicators can guide educators and parents to seek testing to determine if a child has particular visual perceptual difficulties, either problems of information acquisition (neuromuscular), or information processing (neurocognitive). Many of these behaviors are observable (Table 1), whereas others are discovered through medical, psychoeducational, or optometric testing.

Children with significant visual impediments to learning also show atypical visual behaviors that are signs of possible trouble (Table 2). Medically, visual impediments such as restrictive muscle movement, poor ocular alignment, and refractive conditions like farsightedness and astigmatism can also lead to concerns of diplopia, headache, dizziness, fatigue, and inattentive or disruptive behavior.

Table 1: General visual perceptual difficulties*

The child/student:
• Exhibits poor motor coordination
• Uncoordinated–frequent tripping, stumbling, bumping into things, having trouble skipping and jumping
• Communicates infrequently with gestures or through physical "acting"
• Does not enjoy books or pictures, perhaps does not enjoy video games
• Demonstrates restlessness, short attention span, perseveration
• Plays games poorly; cannot imitate children in games
• Exhibits poor handwriting, artwork, drawing
• Exhibits reversals of the letters b, d, p, q, u, n when writing [beyond age 7]
• Inverts numbers or reverses numbers
• Requires auditory cues
• Gives correct answers when teacher reads test but cannot put answer on paper
• Fails to understand what is read
• Exhibits poor performance on group achievement tests
• Appears brighter than test scores indicate
• Has poor perception of time and space

**Adapted from: Pierangelo R & Giuliani G[85]*

Table 2: Example Behavioral Indicators of Visual Impediments to Learning*

Reduced Reading Comprehension
• Holding materials very close to face
• Rapidly tires when reading
• Poor attention span
Tracking Problems
• Moving head back and forth while reading
• Rereading or skipping lines while reading
• Losing place when copying from board
• Must use a marker to keep place
Near-Point Convergence Problems
• Complaining of double vision
• Covering one eye during near work
Focusing Problems
• Transient blur at near or distance
• Headaches
• Burning and/or itchy eyes

**Modified from "The Effects on Vision on Learning and School Performance." Oregon Optometric Physicians Association, 2000, Milwaukee, OR.*

Select studies have shown improvements in some measures of behavior in some children with attention and behavior concerns treated by means of pharmacologic agents.[86] Still, such medications do come with a significant risk profile, and the academic benefits are not always clear.[87] Because visual impediments to learning do manifest as behaviors homologous to those of other behavioral concerns, it is recommended that visual functional assessment be considered prior to, or concurrently with, trials with pharmacologic agents.

Extending the discussion, there is strong evidence showing great variability in diagnostic stability in school-aged children identified with learning disabilities.[88] Given the potential impact of visual impediments, especially in later grades, and the prevalence of undetected and un-managed VIL, it is possible that some of this variability is due to changing performance based on a child's ability to manage increasingly difficult visual tasks. More research is required to determine the impact of VIL on clinical diagnosis and diagnostic stability over time.

Socioeconomic Implications of Visual Impediments to Learning

Research shows that visual impediments to learning are determined by genetics,89 but other concerns such as muscle control deficiencies and amblyopia can be due at least in part to environmental factors. For many decades, the optometric literature has described the high prevalence of visual problems among incarcerated juvenile delinquents.90-98 In a submission to the Canadian National Strategy for Early Literacy, the Canadian Association of Optometrists reports independent studies of juvenile delinquents showing a much higher rate of undetected vision problems—as many 58% of the study population in one case, and 70% in another.[99] In particular, these visual concerns consist of saccadic fine motor control and high refractive errors.[92-94,96-98,100-103] In a comparison study at Children's Hospital Medical Center in Boston, a group of delinquents were compared to a matched group of nondelinquent senior high school students using a neuropsychological protocol that assessed six areas of function. There was no significant difference in the prevalence of minor neurologic signs (P=0.37). Eighteen percent of the children in the delinquent group were deficient in two or more areas, while the same was true for only 4% of the comparison group. There was also a clear difference in gross motor function anomalies (P=0.02) and problems with temporal sequential organization (P=0.04), both of which reflect upon visual developmental status. Indeed, the most significant differences were in visual processing (P=0.0002) and auditory-language function (P=0.0001).[93]

Visual impediments are linked to socioeconomic disadvantages including reports of lower intelligence, limited academic and professional success, and limited access to the benefits of an enriched childhood environment.[104-109] Some have suggested that a pleiotropic link between intelligence and myopia is in part responsible for this relationship,[110,111] but evidence of the physiological impact of VIL on reading, behavior, health, and attention points to other more obvious causes, especially when considering generational effects of intolerance to reading. Modestly nearsighted children with strong visuomotor control are naturally suited to sustained periods of near work, while others are at a relative disadvantage depending on the nature and severity of the refractive error and the presence of visuomotor control difficulties.[5,6,24-26] Furthermore, there may be a bias in epidemiological research towards observing myopia while disregarding other conditions because sight-based screening methods emphasize distance acuity measures and frequently test little else.

Studies have also demonstrated significant differences and patterns in visual biometrics and refractive errors between ethnicities.[112-114] With prevalence greater than 30% in some populations, visual impediments to learning affect some groups of children more than others.[61,63,115,116] While there are notable differences in the visual developmental profile between ethnicities, there is little evidence showing the same variability between boys and girls.[117] Within any population, there will be some proportion of children affected by visual impairments. Still, only 15-20% of elementary school children in the general population are ever properly assessed, and often as few as 5% or less in remote and isolated communities.[27,63,118-120] Anecdotal clinical evidence suggests a decrease in prevalence in significant VIL with grade level, suggesting VIL alone account for a significant portion of attrition as grade achievement advances. This observation requires much more attention in research.

Bias in Current Standards of Vision Assessment

Maples concluded that although race and socioeconomic status are significant factors in academic performance on the Illinois Test of Basic Skills (ITBS), visual functional status plays a greater role.[20] Nonetheless, in spite of its role in determining academic outcomes, visual functional assessment is largely ignored in early childhood school readiness evaluation and learning disability/reading disability prevention protocols. This means that some students are excluded from the benefits of formal education, to a lesser or greater degree.

Most current screening protocols are predicated on the notion that blurred vision in the distance is undesirable because it impedes reading from the front of class, and that this constitutes sufficient grounds for intervention. Paradoxically, a myopic child, who must squint to see in the distance, has much easier and more comfortable vision at near where most school activities occur, compared to non-myopic classmates. The concern is that vision in the classroom relies on a complex system of neurosensory and neuromuscular processes interacting with the near environment within

Table 3: Comparison of Comprehensive Vision Assessment and Vision Screening Methods

COMPREHENSIVE VISUAL HEALTH AND FUNCTION EXAMINATION			VISION SCREENING		
	AOA(1)	AAO(2)	MCT(3)	School/Community Nurse	AAP(4)
Detailed Visual Health and Developmental History	X	X		Observation	
Visual Acuity (D-distance, N-near, ()-intermittent)	DN	D(N)	D	D(N)	D
Refractive Error	X	X	X	Plus Lens Test (infrequently)	
Cover Test	X	X	X	X	X
Near Point of Convergence	X				
Stereopsis	X			X	X
Fusional Vergences	X				
Versions	X	X		Tracking (Pursuits)	

Adapted from "Pediatric Eye And Vision Examination: Reference Guide for Clinicians", American Optometric Association, 2002 (2nd Edition). (1) American Optometric Association. (2) American Academy of Ophthalmology. (3) Modified Clinical Technique. (4) American Academy of Pediatrics.

relatively narrow operating parameters. A simple check of acuity at distance provides very little helpful information.

In practice, most screening protocols have a high capture rate for myopes because of the heavy reliance on distance visual acuity. Ironically, glasses for nearsightedness reduce this benefit by increasing the accommodative (focusing) demand of near tasks. Because screenings almost never take into account actual refractive error, visual strain, or assessment of visuomotor readiness for reading, most significant VIL slip through and continue to work against students over the years until identified and managed.[121]

The Need For More Robust Standards

This "serious issue with devastating long-term consequences,"[122] that is, the need for equitable vision management in early childhood, has been well documented for over a half-century.[25,123-127] There is an abundance of evidence that early detection and treatment of visual impediments results in improved visual strength and behavior, despite what some detractors have posited.[35,36,128-132] Still, evidence shows how the majority of children who are struggling with visual impediments to learning have not been diagnosed or treated.[25,63] This is due in part to an insufficient standard of assessment and the emphasis on distance visual acuity as the sole measure of VIL, both of which contribute to a false sense of security through low sensitivity and specificity.1 The problem also lies in the inadequate coverage of principles of visual function in the curriculum for professional schools of education, medicine, and psychology.

Research in optometry and ophthalmology has shown that for vision to be adequately assessed, specific elements of visual health and function that represent potential obstacles to reading, and by extension, learning, must be measured. The Orinda study of 1959123 was the progenitor of the Modified Clinical Technique (MCT), which is much more sensitive and specific for VIL due to the inclusion of refractive error determination and detection of strabismus. Some have questioned the value of current school screening methodology, and with good reason.121,133 The MCT remains a very high standard134 in comparison and represents economy in efficiency. Still, the MCT also falls short on some counts; it does not require assessment of rapid motor skills, phoric posture, pursuits, or vergence, all of which provide valuable insight into a child's reading readiness and developmental status.

Table 3 is a general summary of some approaches to vision assessment in early elementary.

Attempted measures of distance visual acuity by untrained personnel are ineffective in determining the visual functional status of a child.[135] Use of distance visual acuity alone as the main determinant of visual dysfunction is perhaps no better than 27% sensitive to the most significant visual impediments to learning. Of the VIL detected through such sight tests, the majority consists of myopia, which ironically confers a relative physiological advantage in the classroom in low to moderate levels by making near work more comfortable, even though distance vision is blurred.[5,23-26,65-69,71,79,136-138]

Evidence shows that too many children struggle with school in some part due to visual impairments because there is no general mandate for comprehensive assessment. Screenings are generally viewed as a cost-effective means of early detection of potential problems, though there is some disagreement as to which elements should be considered compulsory in early vision assessment.[139] Methods recommended by some reports,[139] such as visual acuity screening or photo screening, are no more than 27% and 37% sensitive, respectively, revealing a strong need for more robust standards.[15,140] The Modified Clinical Technique, by comparison, is 96% sensitive and 98% specific for most VIL.[134]

In order to ensure that children are properly assessed for potential significant visual impediments to learning, it is proposed that all children be assessed for early learning readiness and adequate visual health following specific guidelines (Table 4), beginning shortly before grade 1, then occasionally

Table 4: Recommended Elements in Assessing Visual Readiness for Early Elementary.

Examination Component	Purpose
Visual Health	Ensure health and good function of the eyes and the visual nervous system.
Refraction >Retinoscopy or Autorefraction (more recent technology w/ trained personnel)	Determination of the degree of nearsightedness, farsightedness, and astigmatism.
Cycloplegia – borderline or clinically significant cases.	Pharmacologic agents are administered as drops to silence the accommodative response in order to determine more accurately the eye's refractive error. Detects latent hyperopes and cases of accommodative spasm.
Visual acuity at distance (min 3m)	Distance acuity reveals myopes who will struggle to see the board. These children will fare better in class compared to hyperopes who will often pass this test. Near visual acuity testing will reveal some degree of facial muscular strain in hyperopes, if not observable decreases in acuity.
Ocular Motility >Ocular range of motion and comitancy >Binocular alignment and posture (including cover testing) >Pursuit movements and fixations >Saccades	>Ocular range of motion: Looking for neurological concerns, disease, strabismus, diplopia. >Binocular alignment and posture: Determination of restrictions on targeting and target maintenance. >Pursuit movements and fixations: Insight into neurodevelopmental status. >Saccades: Looking for potential impediments to rapid automated sequential targeted movements required for reading.
Color	Not critically important in visual function, though color vision deficiencies will require some activity modifications. There are some limitations in career options depending upon color deficiencies.
Stereopsis	Provides measure of depth perception, but a better indicator of relative visual development and alignment status. Measured as seconds of arc of image disparity detectable between the two eyes. May not be required if refractive error and alignment are known.

afterwards following more abbreviated protocols.[121,125,133,141,142] The elements of the comprehensive examination are practical for on-site assessments of large groups, and sufficiently detailed data regarding refractive error, visuomotor skills, and visual neurosensory and neuromuscular function can be obtained in a relatively brief time. It is reasonable, then, that such a protocol should be considered compulsory. Refraction using more recent autorefractor technology is an effective means of increasing reliability of referrals to tertiary care, and of reducing overall long-term costs.[135,143] Occupational therapists and nurses are ideally suited for training for the purpose of meeting the assessment needs of larger groups, such as schools, with instructions for referral to trained vision professionals when children are borderline or do not meet standards.[144,145] This approach significantly increases rates of detection of affected children and reduces costs of vision assessment for health and education authorities. School-based solutions where the examiner attends the school to assess students are agreeable for parents with work and home scheduling needs.

Comprehensive assessment programs, as compared to current screening methods, are prudent fiscally and with respect to health and education outcomes.[120,146] The appearance of an initial cost might dissuade some from supporting policy for compulsory examination, but data does not support costs as a sufficient reason to deter school authorities or state or provincial governments from implementing mandated comprehensive visual assessments.[146-149] Research does support the efficacy of early visual assessment and management as a means of improving outcomes and reducing future costs for treatment of conditions such as amblyopia,[74] all of which offset the initial cost of detection. Furthermore, it has been shown that regimented visual assessment and intervention leads to greater academic standings overall.[146] Still, tightening school and health budgets encroach upon school nursing and monitoring programs, and more effort is now spent on making vision screening faster and more efficient, but with decreased accuracy.[140,150,151] This reduction in service level leads to increased false negatives, and, it would seem, higher costs for intervention for academic, behavioral, and health concerns resulting from unchecked VIL over the child's lifetime. Abbreviated screening protocols may well represent false economy while providing little to no benefit to those who need the help most.[15]

Summary

Because robust visual input is critical in the development of perception and in reading acquisition, VIL present a threat to learning processes and behavior in the visually demanding neo-traditional classroom. Many children struggle against vision difficulties, and yet most VIL are ignored in pediatric visual screenings. The lifetime cost of these is significant to the individual and to society.

Current models of visual screening allow most significant problems to pass through as false negatives. Moderate and severe visual functional impairments spur a variety of behavioral adaptations and responses, depending on the nature and depth of the impediments, and on the child's capacity to manage the additional strain, especially during nearpoint learning. Even mild visual impediments can interfere with reading behavior and cause discomfort. Moderate to profound VIL are also associated with criminality, limited socioeconomic and academic achievement, reading and learning disabilities, and other behavioral concerns.

There is a need for a more comprehensive, and compulsory, early childhood functional vision assessment protocol. This protocol must detect a wider range of learning related vision

problems than is provided through the current institutional standard of simple distance acuity measurement, or no measurement at all. When vision is adequately managed from an early age, academic and health outcomes are improved, leading to reduced long-term costs in each area. The current lack of attention to vision means that many children struggle needlessly and are misdiagnosed due to behavior homologous to other developmental concerns. Indeed, psychoeducational testing may prove wasteful and meaningless in the presence of uncorrected VIL.

Finally, this lack of appropriate VIL detection and management, combined with compulsory participation in a visually taxing education model for 12 years or more, may well constitute an implicit neglect of children's health and basic human rights. This important area requires much more urgent exploration in education, psychology, and ethics. It also underlines the need for improved training regarding vision in professional schools interested in child education, psychology, health, and development.

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