The Efficacy of Vision Therapy in Reading and Literacy Skills

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ABSTRACT

This research review investigates the effects of vision therapy on reading and literacy skills, with an emphasis on reading fluency, speed, and comprehension in students with visual processing deficiencies or learning disabilities. This literature review was written after a detailed analysis of 15 articles, consisting of both qualitative and quantitative data. A systematic search of databases such as PubMed, Google Scholar, and Cochrane Library was conducted using predefined keywords.

As a result of this review, it can be determined that there appears to be a lot of data supporting the efficacy of vision therapy in reading and learning difficulties. However, there is not enough data or research to be obtained that suggests any improvement in reading abilities for those with specific learning disabilities, such as Dyslexia or Dysgraphia, unless it is a vision related problem such as a binocular dysfunction or a refractive error. Vision therapy is found most useful in correcting visual defects such as convergence insufficiency, accommodative problems, oculomotor and visual processing defects, binocular problems, particularly, amblyopia and visual impairments caused by traumatic brain injury. Key findings have determined notable connections between visual deficits and educational difficulties. More research needs to be done on this topic at a larger scale and with more diversity. Research emphasizes the need of interdisciplinary teams in developing individual therapeutic solutions that address an individual's specific requirement as collaborative efforts can lead to improved academic outcomes.

Keywords: *vision therapy, reading skills, students, specific learning disabilities, reading comprehension, reading fluency, visual processing deficits*.

INTRODUCTION

An Overview of Vision Therapy

Vision Therapy aims to improve visual function and affect the way eyes and brain work together, by devising individual programs that can involve eye exercises, occlusion and prisms. It differs from conventional optometry, that uses corrective lenses, which treats visual problems caused by nearsightedness and farsightedness. Vision therapy is frequently used to correct defects caused by binocular vision problems, such as strabismus and amblyopia, convergence problems, accommodative dysfunctions, and visual processing defects. It is an individualized treatment program that involves specific exercises designed to correct or improve specific visual dysfunctions by affecting how the eyes and brain coordinate. These exercises aim to improve the visual system's ability to focus, track, and process visual information effectively. Vision therapy interventions can be used to train the visual system to function more optimally, thereby, improving overall visual performance crucial in activities such as reading, writing and learning.

Vision therapy caters to and targets the individual needs of a patient by suggesting a form of treatment that involves both in-office sessions and exercises at home. Following a detailed optometric assessment, which often includes but is not limited to-or problems with focusing, coordination skills, or visual processing that cannot be fixed using contact lenses or spectacles. Devices like lenses, prisms, computers, and other instruments are incorporated in the common practice of treating patients to enhance vision and brain coordination.

A certain percentage of children with learning difficulties often present visual processing disorders features centralized around deficits in visual-motor skills required for reading or writing, where vision therapy is sought to enhance facilities such as visual memory, eye movement control, and visual attention processing as a way of improving academic activities. There is a vast array of cognitive and visual functions that Vision therapy can be able to support which are key for effective learning, movement and even everyday activities.

Binocular vision requires that both eyes encompass a particular area to create a single image located on similar points on the retina. It is also responsible for judging distance and how well the two eyes work together. Binocular Vision therapy, for instance, may involve exercises to enhance the control of the eye muscles as a way of managing strabismus and convergence deficits.

Visual perception therapy addresses issues involved in the process of taking in visual input, recognizing and categorizing them. Oculomotor skills, such as, saccades, pursuits and fixation, are eye movements that can be trained to improve eye tracking, focusing and following moving objects.

Spatial and directional awareness is a cognitive skill that enables a person to understand distance, location and direction of objects in relation to oneself. In order to reduce confusion in physical environments, therapy may focus in improving the spatial orientation. As visual memory is important for reading and recognizing objects, therapy may aim to strengthen memory retention of visual information. To maintain concentration on visual tasks for a time, attention and focus are vital. Vision therapy can help to address deficits in this area to

maintain concentration levels on visual tasks, which is helpful with learning.

Visual cognition requires a higher level of processing visual information which allows for problem-solving, reasoning and understanding complex visual inputs. Visual analysis skills involve analyzing and differentiating between visual stimuli, such as discrimination, closure, and figure-ground. Therapy for visual analysis skills might focus on improving recognition of patterns, shapes, or object details, which are essential for reading, math, and other cognitive tasks.

Visuomotor skills are crucial for coordination between the visual input and motor actions, which guide physical movements. Therapy to help visuomotor skills aim to improve activities that require coordination, such as doing sports, writing or drawing.

Neurological disorders can disrupt visual perception, oculomotor control, and other visual-cognitive processes. Vision therapy may help patients recover or compensate for visual deficits related to these disorders (Scheiman et al., 2006).

An overview of reading and literacy skills

Effective reading and comprehension are fundamental competencies necessary for performing well in any educational system and for the existence of every individual. In its broader sense, reading involves other skills the likes of phonemic awareness, vocabulary development, and reading fluency, among others. It is vital that one learns about these skills because studies indicate that there is a correlation between our perception and reading. As research conducted by Stein (2001) shows, the ability to read is affected in both individuals with Dyslexia and those without, by some impairment within the magnocellular system.

An additional investigation led by Cancer et al. (2020) stated that music when added to appropriate learning conditions can enhance any reading abilities. This suggests that it is indeed possible to train the senses simultaneously in order to develop more advanced pre-reading activities. Knowledge of how the visual and auditory systems function can be applied in certain therapies, for example, vision therapy aimed at correcting a problem that is likely to occur in the future such as poor academic performance.

When one thinks of reading, vision features prominently. However, vision is more than just the ability to sight well. It encompasses a complex range of functions such as eye-hand coordination, visual tracking and focusing as well as visual information processing. Any deficits in these areas do ray deformity further exacerbating the problem and hence the child's ability to cope with reading fluency, comprehension, and even overall academic performance may be impaired.

The treatment involving vision therapy is aimed to improve not just one single visual skill but various visual skills which are necessary for effective reading and learning like control of eye movements (saccades), focusing (accommodation), and eye coordination (binocularity) (Scheiman, 2018). There are positive clinical reports which claim that children receiving the vision therapy reported increase in their reading speed and visual processing which greatly influence their literary performance.

Mastery of literacy acquisition necessitates an integration of several neural processes and visual skills. It has also been demonstrated that multiple brain regions are recruited when a person reads written words. Especially in the left hemisphere are engaged many areas

including the angular gyrus and the inferior frontal gyrus which play important roles in phonological and semantic processing respectively. These different areas in the brain collaborate with the visual regions of the brain, which help a person understand and break down symbols. The more reading one does, neural plasticity allows for the synaptic connections to be able to become stronger and this in turn leads to the enhancement of recognition of specific patterns of letters and organization of languages which in turn increases cognition. It is indicated that reading text influences cognitive development, enhances meta-awareness, and encourages the appropriate use of higher-order thinking (Overmann et al., 2019). In a similar vein, Ostrogska et al. (2013) state that skill development and practice help in reinforcing these neural pathways which contributes to the basics of high-level literacy.

OBJECTIVES

The theories and practices of educational psychology and rehabilitation sciences have developed recently, leading to a growing understanding of how vision therapy may enhance reading ability and comprehension. A number of other studies, for example, those of Borsting et al. (2006), O'Connor et al. (2017), and others, show that reading skills are compromised due to impairments in visual processing especially among children with learning disabilities. The objective of this review is to review the existing literature on the vision therapy including the various ways used to measure improvement in reading within the aspects of fluency, speed, and comprehension in patients with learning disabilities, visual processing disorder or Dyslexia. Furthermore, the use of case studies shows how such therapy may help solve specific visual processing problems resulting in improved performance. This review aims to explore how the qualitative and quantitative information presented can

advance the debate and discussion on the use of vision therapy as a major strategy in educational intervention for improving reading skills and literacy with regard to individuals who have learning disability.

Loss of vision in children can result in the interference of visual processing, tracking, and maintaining focus which are key activities in reading. Visual deficits such as convergence insufficiency, tracking disorders, or uncorrected refractive errors affect a child's ability to fixate on the text while scanning the words on the page and processing the information on a visual level. These can more manifestly result in poor reading understanding, reading speed, and retention of information, which are major components of literacy (American Optometric Association, 2020).

Several specific learning disorders such as dyslexia have been linked to problems in visual processing. Usually, dyslexia affects the person's ability to link the symbols, letters and words depicted by images in their brain, thus causing a communication disability. Although vision therapy cannot cure dyslexia, it can help enhance more efficiency of eye movements, focusing, and other visual skills which allows to lower the cognitive load during reading tasks. The development of functional visual deficits in pre-school children has been shown to have deleterious effects on their educational attainment, social and occupational prospects, and quality of life. Limited reading abilities may cause underperformance in schools, increased dropping out rates, and problems with self-acceptance. Poor eyesight

even more denied ocular health may lead to cycles of poverty and underemployment. Combatting these problems rather than fostering them is essential since there is the possibility of intervention at such a young age which can spare one a lifetime of academic failure.

Although it is quite difficult to cite proper global statistics about how many children go uncorrected for visual defects, many insight research show that it is a large percentage of children that have learning disabilities and have either visual problems that remain undiagnosed or under-treated. By estimates presented in a publication by the World Health Organization (WHO) in 2021, it was stated that around 12 million children all over the world suffer from correctable vision impairment.

There is a considerable treatment gap, especially in low income and developing countries also known as low vision countries, where vertical vision care inequities are common and are prone to exposure. Many children with learning disabilities such as dyslexia or attention deficit hyperactivity disorder (ADHD) are often found to have vision defects that go unrecognized thereby deepening their reading and learning issues.

METHODS AND MATERIALS

This section describes the methods that were used to carry out the literature review. The focus of the review is on assessing the effect of vision therapy in the case of reading and literacy skills, learning disabilities, treatments of vision therapy, and any associated clinical trials. This guarantees that only the best, most rigorous, peer-reviewed journals and clinical research evidence available are incorporated.

The search of the literature was performed on several databases such as PubMed, Google scholar, Scopus, and Cochrane Library with the aim of collecting literature on vision therapy such as clinical and medical studies, interdisciplinary studies, peer-reviewed articles and systematic reviews and clinical trials**.**

Keywords include “vision therapy”, “reading skills,” “reading fluency,” “reading comprehension,” “visual processing deficits,” “students” and “specific learning disabilities”.

The inclusion and exclusion criteria were established to ensure the relevance and quality of the chosen studies. The inclusion criteria were relevant papers published in English from 2000 till 2024 that focused on pupils identified with visual processing deficiencies or learning disorders, as well as meta-analyses, and systematic reviews. Exclusion criteria included studies that focused primarily on reading therapies and did not incorporate vision therapy.

RESULTS

Definition and Overview of Specific Learning Disabilities

In many instances, learning processes are affected by a spectrum of conditions and specific learning disabilities (SLD) such as dyslexia, dysgraphia, and dyscalculia. These disabilities tend to present with challenges in some distinct areas like reading, writing, and mathematics, which require that academic success be achieved through individualized intervention strategies. Visual processing disorders and non-verbal learning disabilities include those educational impediments that make it necessary for people to have specific

learning approaches owing to their cognitive profile. In addition, there are attention deficits like those observed in students with ADHD and learning difficulties that are developed from Autism and these disorders call for other management strategies. Eye movement dysfunctions and binocular vision disorders are other types of disorders that can lead to SLDs since these children suffer visually and cannot read very well. The importance of these factors in SLDs is paramount especially when working on vision therapy treatments aimed at reducing such symptoms and enhancing educational performance.

Types of Specific Learning Disabilities

In order to appreciate the intervention and support strategies, there is need to appreciate the nature of specific learning disabilities (SLD). One of the most common SLD and probably the most well-known is dyslexia. This is a kind of reading disorder where a born reader may have difficulties in decoding words as well as word recognition diction. Similarly, but related to this is dysgraphia which also comes as a writing disorder. In this case, the individual experiences difficulties in the formation of letters while writing, spelling correct words, as well as putting the ideas into writing in a logical flow. Another primary learning disability is dyscalculia, which interferes with one's ability to reasoning in mathematics even the easiest tasks like counting. Moreover, some of the non-verbal learning disabilities interfere with skills essential in understanding non-verbal communication and oriented distances leading to social problems. Learning also becomes problematic in this respect because of visual processing problems, oculomotor dysfunctions, and binocular vision anomaly which affects the ability to correctly process visual information often requiring remedial vision therapy. As cited in (Dennis et al., 1999) stresses the importance of understanding these differences in disabilities for the utilization of educational and occupational interventions to be individualized.

Dyslexia and Its Impact on Reading Skills

Dyslexia is a type of learning impairment in which a person finds it difficult to read, write or spell even if he has an average intelligence and an adequate educational opportunity. It is due to a deficit in the language processing system of which phonological awareness is one component. It is neurobiological in nature and manifests itself in impairment in the ability to accurately and/or fluency in word recognition, spelling and word decoding. There are several categories of dyslexia each relating to specific challenges in processing language. 1) Developmental Phonological Dyslexia is studied the most "classic" phonological dyslexia. Individuals with phonological dyslexia find problems in categorizing a word into its sound units called phonemes. Therefore, such individuals experience problems in decoding unfamiliar words and associating different sounds with their respective letter. 2) Surface dyslexia refers to an impairment in recognizing a whole word. They may be able to decode words written phonetically but struggle to recognize words that do not follow standard phonetic spelling, for example "yacht" or "colonel". 3) Rapid Naming Dyslexia (Double Deficit Dyslexia): a type of Dyslexia wherein individuals have trouble with rapidly naming of letters, figures or colors when they see them. This limitation also impairs reading fluency, causing reading speed and accuracy to be low. 4) Visual Dyslexia: a condition that

impairs visual processes that result in difficulty to recognize and recall shapes like letters words etc. It may also lead to read at a slow speed, to lose track of or skip text, and to reverse letters. 5) Deep Dyslexia: deep dyslexia is a more severe form and is usually secondary that may result from a brain injury. It is often the case that the patients with deep dyslexia would swap meanings of words with those that are relevant to the context, but different in meaning, like reading 'forest' instead of 'trees' and have challenges in word meaning such as 'if' and 'but'. 6)Developmental dyslexia is present from birth and is not caused by brain injuries. It encompasses various other types of dyslexia and is diagnosed during the developmental stages of childhood.

The issue of dyslexia is, more often than not, connected to language rather than an ocular problem and therefore a lot of arguments exist to oppose that vision therapy can assist in alleviating dyslexia. Chronic dyslexia has in research been viewed as a neurobiological disorder due to its excessive impairment of phonological processing. Overall, according to many researchers and institutions including the International Dyslexia Association (IDA), "dyslexia is not caused by a disturbance of the visual system, oculomotor control or fixation, but rather a disorder of the brain's language centers" (Shaywitz & Shaywitz, 2007). As a result, it has become common to frown upon the use of vision therapy to address dyslexia since the scientific literature does not support its efficacy of improving reading. Also, most of the existing studies have demonstrated that no evidence exists supporting any link between dyslexia and vision problems, and both health and education practitioners discourage the application of vision therapy interventions in managing dyslexia.

The American Academy of Pediatrics (AAP), the American Academy of Ophthalmology (AAO), and the American Association for Pediatric Ophthalmology and Strabismus (AAPOS) decisively disagree with the assertion that treatment for dyslexia can include vision therapy. They claim that, although some children may have visual problems, these are not the same as dyslexia, and treatment for them should be offered independently. Statement of AAPOS, "To date, there is no evidence that vision therapy allows dyslexic children to read fluently and makes any long-term difference in their ability to decode written language." Nevertheless, a considerable number of parents and patients alike seek out vision therapy, although the evidence is scant and does not support it. Stories and reports show that some children improve in the course of vision therapy, however, these improvements are not necessarily relevant to their primary diagnosis of dyslexia. For example, vision therapy may improve the condition of those children who have a genuine vision problem such as convergence insufficiency, but this does not target the phonological processing impairment which dyslexia revolves around. Most professionals conduct studies for vision therapy and aim to improve reading difficulties with exercises designed for the eyes. On the contrary, current science proves that the underlying issue in dyslexia is not vision but language processing. Health care and educational bodies of relevance do not recommend the use of vision therapy as a treatment of choice for children with dyslexia and instead promote clinically effective methods including phonics oriented reading approaches and multisensory strategies which have existed with years of research.

Dysgraphia and its Effects on Writing Abilities

A variety of learning disabilities can greatly affect writing skills, the most noticeable one being dysgraphia. It is a learning disorder that affects different levels of functioning in writing, spelling, and creating written texts. This kind of disability makes it almost impossible to express thoughts on paper, which is discouraging and hampers one's education. Studies show that this particular learning impairment involves not only the mechanics of writing but mental skills such as organizing and formulating ideas, which compounds the problem of the individuals affected. The hard evidence to prove that vision therapy is able to affect the defect in writing performance dysgraphia is not sufficient. This is parallel to what pertains to dyslexia; it suffices to say that, to a great extent, the condition of dysgraphia is not influenced by the visual aspects of it but the neural- motor aspects. It is not the vision that is affected but motor coordination itself and the way the brain controls the necessary muscle movements for the process of writing (Phillips & Clark, 2008). Consequently, treatment options addressing children with dysgraphia, are focused on occupational therapy, motor skills training and multisensory techniques are more appropriate compared to the vision therapy treatment. Vision therapy can be beneficial for some patients who have trouble with visual motor integration or visual perception. These enhancements, however, should not be mistaken for the enhancements in the fundamental writing deficits associated with dysgraphia.

Vision-Related Issues in Learning Disabilities

There is a wide spectrum of learning disabilities such as dyslexia, dysgraphia, and dyscalculia which may at some point, be aggravated by a problem of vision, hence impeding the educational process of the individual. Where a child has a visual processing disorder or oculomotor dysfunction reading comprehension and rate may also be affected. Binocular vision dysfunction, on the other hand, predisposes the child to difficulty in scanning a line of printed text. Such effects are not confined to certain disabilities but can be experienced in conditions such as ADHD and Autism that rely heavily on visual ideas for learning. It is debatable whether vision therapy is effective in treating vision problems that co-occur with autism or attention deficit hyperactivity disorder, and scientific justification for practice is sparse. While some of the exercises of vision therapy may help in treating convergence insufficiency in children with ADHD or eye tracking deficiency in children with ASD, the concept of vision therapy does not treat the primary neurological pathology of these conditions (Granet et al., 2005). Most of the visual problems in ASD are not so much because of poor vision and therefore, vision therapy is not a treatment modality offered for autism. Instead, there are other interventions that are deemed fit such as occupational therapy and sensory integration devises (DeWitt & Whitman, 2011).

Vision therapy can help children with specific learning disabilities when they have accompanying visual problems, such as convergence insufficiency, tracking difficulties, or visual perception deficits. It can improve visual efficiency, visual-motor integration, and visual processing, which

may enhance reading and writing skills. However, it is important to recognize that vision therapy is not a cure for the learning disability itself and should be used in conjunction with other targeted educational and behavioral interventions.

Visual Processing Disorders and Their Role in Learning

Visual processing disorders and learning have a complex interrelation which makes the use of specific strategies within the classrooms imperative. Many children with learning disabilities, including dyslexia and dysgraphia, can also have problems that result from difficulties with sensory integration, which subsequently affects how they process any visual information. For example, visual processing weakness can limit a student's ability to read and pronounce letters, hence contributing to the reading disorders, dyslexia, or to the arrangement of text in a written form, as seen in individuals with dysgraphia. In addition, MSEs are touted as research-based therapeutic options for children with issues such as autism who also face visual processing challenges (Atari et al., 2014). In particular, MSEs create sensory stimulation that is useful in lessening anxiety and promoting active learning in autistic children. Some vision therapy techniques help in reducing educational problems resulting from Learning Difficulties and facilitate cognitive development enhancing better educational outcomes.

Oculomotor Deficits and Their Influence on Academic Performance

Numerous learning disabilities can create academic disruptions, especially those associated with visual processing and oculomotor function. For example, children with oculomotor deficits often struggle with tracking, focusing, and shifting their gaze, which interferes with the visual attention needed to process what is going on efficiently in the classroom. This may be one of the reasons certain reading related learning disabilities like dyslexia and dysgraphia are pervasive, making reading and writing a particularly painful task. Also, the effect of hyperactivity and attention deficit disorder (ADHD) on academic performance is further aggravated by the presence of visual memory impairment often associated with the above disorders. While children like these are not able to integrate what they see with what they are trying to do cognitively, their academic performance may decline. Hence it is important to concentrate on their performance and may require oculomotor dysfunction correction through vision therapy in order to ensure any improvement in their learning process and academic performance.

Binocular Vision Disorders and Reading Difficulties

Disorders of binocular vision (DBV) such as convergence insufficiency and accommodative insufficiency are associated with problems during reading and developing literacy. Higher percentages of binocular vision anomalies have been recorded in dyslexic children than in their non-dyslexic counterparts which can further complicate issues related to the acquisition of literacy. These visual dysfunctions quite often present themselves as an inability to keep proper eye alignment which leads to poor reading and slow literacy development.

BVD induced visual dysfunctions such as heterophoria may cause an increase in a person's perceptive field, it therefore causes increase in crowding effects hence requiring

more energy to read. Such individuals may struggle to process the letters and words in a quick manner which may impair the level of fluency adequate for acquisition of literacy skills (Palomo-Álvarez & Puell, 2009).

Moreover, it is quite noticeable to aim at BVDs through corrective interventions like vision therapy not only helps in restoring the visual function but also helps in enhancement of performance in academics, especially in subjects like reading and mathematics. It has been reported that school-based vision therapy programs aiding in the treatment of binocular vision disorder have led to an increase in the mean scores of standardized tests administered after the intervention. These treatments indicate that when the visual difficulties related to BVD are lessened, the children may develop better literacy engravings and learning progress overall.

A study by Hussaindeen et al. (2018) titled Efficacy of vision therapy in children with learning disability and associated binocular vision anomalies, gave the following results: of the 94 children assessed, 59 (62.8%) exhibited BV anomalies, with 46 children (78%) diagnosed with NSBVA and 13 children (22%) with strabismus. The most common NSBVA was accommodative infacility (68%), followed by convergence insufficiency (25%). Among strabismic cases, exotropia was the most frequent (10 children). Significant differences were found between normal BV and NSBVA groups in near point of convergence (NPC) break and recovery values, positive fusional vergence (PFV) break and recovery values for near vision, and monocular and binocular accommodative facility. Children with NSBVA also showed prolonged vertical DEM times, indicating automaticity difficulties, but no significant difference was observed in horizontal DEM times. The correlation between reading rates and horizontal DEM scores was statistically significant, suggesting that poorer oculomotor performance was associated with lower reading rates. Post-vision therapy, significant improvements were observed in NPC break and recovery values, near PFV break and recovery values, and monocular and binocular accommodative facility in the intervention group. These improvements were not observed in the control group, indicating the efficacy of vision therapy. However, no significant differences were found in DEM times or reading rates pre- and post-therapy. This study highlights the high prevalence of NSBVA (63%) among children with SLD, with accommodative infacility (68%) and convergence insufficiency (25%) being the most common anomalies. Vision therapy significantly improved key binocular vision parameters in children with NSBVA, particularly in convergence and accommodative facility, supporting its role in enhancing visual function in this population. However, improvements in reading rates and DEM times were not statistically significant, potentially due to sample size limitations. The study emphasizes the importance of including comprehensive binocular vision assessments in the management of children with learning disabilities. Vision therapy is recommended for children with NSBVA to improve visual parameters, which may contribute to better academic performance. Further research with larger sample sizes and randomized controlled trials is needed to assess the long-term benefits of vision therapy in this population.

Children with specific learning disabilities have a high frequency of NSBVA, particularly accommodative infacility and convergence insufficiency. Vision therapy plays a crucial role in improving binocular

vision parameters in this population and should be included in their vision care management.

Clinical Studies and Research on Vision Therapy

Convergence Insufficiency Treatment Trial (CITT)

The Convergence Insufficiency Treatment Trial (CITT) led by Mitchell Scheiman focused on evaluating various therapies for treating convergence insufficiency (CI) in children and adults, a common binocular vision disorder that can result in eye strain, headaches, and difficulties with reading. Vision therapy was shown to be more effective than pencil push-ups or placebo treatments in reducing symptoms and improving signs of convergence insufficiency. In children aged 9 to 18 years, vision therapy led to statistically significant improvements in near point of convergence (NPC) and positive fusional vergence (PFV). Importantly, neither pencil push-ups nor placebo therapy were as effective. Vision therapy demonstrated the most robust clinical improvement, particularly in terms of NPC and PFV. After treatment, approximately 42% of patients achieved symptom elimination criteria. A significant percentage of patients remained symptomatic after treatment, emphasizing the need for individualized care. Successful treatment of convergence insufficiency in children resulted in a reduction in adverse academic behaviors, such as difficulty concentrating and reading, as measured by the Academic Behavior Survey scores. The findings support that improvements in binocular vision positively impact attention and academic performance. Office-based vergence/accommodative therapy (OBVAT) was the most effective in improving both clinical signs (NPC and PFV) and reducing symptoms, compared to home-based treatments. The treatment kinetics revealed that clinical improvements preceded symptomatic relief, with OBVAT showing the most rapid improvements. Over 25 years of research into vision therapy led by Scheiman et al. (2020) has established a solid evidence-based literature that supports the efficacy of office-based vision therapy. More recent studies have highlighted meaningful improvements in disparity vergence peak velocity and response amplitude, further substantiating the success of office-based therapy.

Accommodative Dysfunction in Children

A randomized clinical trial was conducted with 221 children, aged 9 to 17 years, all of whom had symptomatic CI. The primary objective was to assess the impact of vision therapy on accommodative amplitude and accommodative facility. Of these children; 164 (74%) were found to have accommodative dysfunction. A total of 63 children (29%) had decreased accommodative amplitude (the ability to focus close). There were 43 children (19%) who had decreased accommodative facility (the speed of switching focus). A total of 58 children (26%) had both types of dysfunctions. These children were randomized into four treatment groups: Office-based vergence/accommodative therapy with home reinforcement, home-based computer vergence/accommodative therapy, home-based pencil push-up therapy and office-based placebo therapy (control group). The goal was to compare how effective each treatment was at improving the children's ability to accommodate (focus) over a 12-week period. Accommodative

amplitude and facility were measured at 4, 8, and 12 weeks using standardized tests (Scheiman et al., 2011). After 12 weeks of therapy, the improvements in accommodative amplitude (measured in diopters, D) varied significantly between groups. The largest improvement in accommodative amplitude was observed in the OBVAT group, with an average increase of 9.9 D. The home-based computer therapy group showed an average increase of 6.7 D. The home-based pencil push-up therapy group had a smaller but still significant improvement of 5.8 D. The placebo group showed the least improvement, with an increase of only 2.2 D. The differences between the active treatment groups and the placebo group were statistically significant, with p-values $\leq$ 0.010, showing that the therapies, particularly OBVAT, were effective in improving accommodative amplitude. Similarly, improvements in accommodative facility, measured in cycles per minute (cpm), were observed across all groups. The results after 12 weeks were; the greatest improvement in accommodative facility was seen in the OBVAT group, with an increase of 9 cpm. The home-based computer therapy group showed an improvement of 7 cpm. The home-based pencil push-up therapy group improved by 5 cpm. The placebo group had a modest improvement of 5.5 cpm. The OBVAT group showed a significantly greater improvement in accommodative facility compared to the placebo group ($p = 0.016$). One year after the completion of therapy, researchers assessed whether the improvements in accommodative function were sustained. The results were promising, only 12.5% of children experienced a reoccurrence of decreased accommodative amplitude. Similarly, only 11% had a recurrence of decreased accommodative facility. These long-term outcomes indicate that vision therapy, especially OBVAT, provides lasting benefits for children with CI and accommodative dysfunction. This clinical trial demonstrates that vision therapy, particularly OBVAT, is an effective and lasting treatment for improving accommodative function in school-aged children with symptomatic CI and accommodative dysfunction. The significant gains in both amplitude and facility, as well as the low recurrence of symptoms after one year, suggest that structured, office-based therapy combined with home reinforcement offers the best outcomes. For children unable to access office-based care, home-based treatments still offer substantial benefits, though results may be less pronounced. As convergence insufficiency and accommodative dysfunction can impact a child's ability to read, learn, and function comfortably in school, vision therapy is a crucial intervention that should be considered in pediatric eye care.

Vision Therapy in the Rehabilitation of Traumatic Brain Injury

The link between visual processing and the brain functions has come under the spotlight, especially with regard to traumatic brain injury (TBI). People who suffer from TBI often have several challenges in terms of visual functioning such as eye tracking, visual acuity, and depth perception worsening one’s ability to perform daily activities and damaging their quality of life. Vision therapy is one such rehabilitative approach which devices practicing and working on visual cognitive abilities in a holistic manner to overcome visual complaints. Vision therapy helps in retraining the patient for effective potpourri of eye hand coordination objects and

enhancing assimilative power practicably by increasing the patient's neuroplasticity to the treatment. Vision therapy more frequently is given to patients with cognitive visual perceptual problems due to injuries to their heads. Many of these deficits have a direct effect on reading and literacy. TBI can affect one's ability to fixate both eyes on one point, making it extremely hard to read, skip, or zoom in on any text. Vision therapy seeks to assist with the synchronization of eyes while reading in order to facilitate comfort whilst reading (Smaakjær et al., 2021).

Brain trauma injury patients can experience cognitive deficits related to the visual system including such factors as visual memory, perception, and spatial awareness. Vision therapy makes use of these skills to train the brain to assimilate visual information which is an important aspect of reading concerning comprehension and fluency. Traumatic brain injury, more so that regulates lower brain functioning also, is associated with head and eye-related complaints such as headaches, blurred vision, as well as strain when attempting to read. Vision therapy is aimed at enhancing these focus-factors and hence, patients are enabled to read extensive volumes of literature without getting tired too quickly. Many patients with TBI may find it hard to control eye movement when reading lines of text or jumping from text to text. The purpose of the vision therapy is also to facilitate saccades and efficient tracking, which are very important skills in fluent reading.

A study by Smaakjær et al. (2021) improves binocular visual dysfunction in patients with mild traumatic brain injury: The study evaluated vision therapy for mTBI patients aged 25 to 61 with oculomotor dysfunctions. A 10-week vision therapy program was implemented to improve convergence, saccades, and visual tracking, with weekly sessions and daily home exercises. Tests used to assess improvements included the Groffman Visual Tracing Test, King-Devick Test, Reading Speed Test, MFI-20, and a modified COPM. Significant improvement was found across all metrics post-therapy, including visual tracing, reading speed, and reduced fatigue. Improvements in visual attention and stability were also observed, enhancing patients' safety in everyday activities like traffic. The study suggests vision therapy not only improves visual parameters but also has functional benefits in daily performance and satisfaction. Fixation stability and endurance increased, reducing the visual fatigue commonly reported by mTBI patients. The reading speed test showed marked improvement, reflecting enhanced ocular motility and reading efficiency. The therapeutic approach was multidisciplinary, involving both neurooptometric and speech therapy techniques for comprehensive care. The home-based component of the training helped reinforce gains made during therapy, emphasizing the importance of consistent practice.

Vision therapy for traumatic brain injury (TBI) is a comprehensive term that outlines a range of treatment practices aimed at the recovery of visual functions like eye movement, eye coordination, and eye perception. In this regard, vision therapy includes oculomotor therapy, convergence and divergence training, accommodation therapy, visual perception therapy, balance and visual motor integration training, prism therapy, syntonic, and neuro-optometric rehabilitation. Rehabilitation therapy after traumatic brain injury includes borrowed forms of therapy which focus on physical condition of the eyes and processing of the information by the brain. These methods and

materials are premised within the TBI impairments and are aimed at improving eye movement control, visual perception and visual cognitive integration. The therapy process is highly personalized and usually incorporates adjunct home-based exercises without professional supervision.

Vision therapy, particularly when integrated with other rehabilitative treatments, can play a critical role in helping TBI patients recover not only visual function but also reading, writing, and daily life activities.

Johansson et al. (2020) explores the role of vision therapy (VT) in improving visual and functional outcomes for patients with visual impairments due to acquired brain injuries (ABI), such as stroke or traumatic brain injury. The study, conducted in an outpatient setting, found that VT improved visual acuity, daily functioning, and quality of life for many participants. Key strengths of the study include its personalized, multidisciplinary approach and its focus on quality of life improvements. However, limitations such as the small sample size, lack of a control group, and reliance on subjective outcomes reduce the strength of its conclusions. The findings support the inclusion of VT in neurorehabilitation, but the authors call for further research with larger, more controlled studies to confirm the therapy's effectiveness. Overall, the study emphasizes the importance of addressing visual impairments in ABI rehabilitation programs.

Magnocellular System and Reading

The magnocellular system (M-system) is an important component of the visual system, which also makes reading and literacy possible. It processes mainly movement, contrast sensitivity, and low resolution (Livingstone & Hubel, 1988). The magnocellular cells can be found in the thalamic lateral geniculate nucleus (LGN) that feeds the primary visual cortex (PVC). In contrast, the parvocellular system, which emphasizes color and fine details, the magnocellular system has been built for quick detection of changes in stimuli as in motion or flicker. This system is crucial for the coherent motion of an object across a person's visual field without jerky movements, which is the most used when reading (Stein, 2001). Reading involves scanning a sequence of letters as the eyes move from one point to another in a written content. More so, it coordinates the saccadic eye movement that occurs when reading; that is, a fast movement of the eyes between information in different parts of the text. In children, it helps them focus their attention on the words and schemas of sentences quickly, separating words from one another and understanding the general structure of the given information. Such system dysfunctions have been associated with specific learning difficulties such as dyslexia. Rayner et al. (2001) explain that individuals with dyslexia are usually unable to track rapid sequences of alphabets or a word, and this occurs due to impaired smooth eye movement and word recognition. Some researchers have supported the notion that there is a relationship between dyslexia and magnocellular impairment (Stein, 2001).

A common feature of dyslexia is the subnormal activation of the magnocellular system, sluggish saccadic movement, and inadequate processing of the temporal constituents of the stimuli. This hampers flow in which they process words and sentences thus they read slower and comprehend lesser from the texts. Reading difficulties can be specifically addressed with vision therapy in significant ways for children who have a

weak or poorly developed magnocellular system. This therapy consist of a set of activities meant to improve eye movement coordination, control of focus and the speed in which the brain can filter visual information. These then are skills that directly affect the actual processing of the signals in the magnocellular system to enhance its efficiency. Specific vision therapy could consist of prisms, lenses and eye-tracking work that targets the magnocellular system. Magnocellular is an important aspect of our visual system, especially in tasks inclusive of reading and literacy. Both its ability to assess motion or contrast and its ability to analyze spatial data means that the eyes move efficiently and that words are correctly identified, crucial when reading. The results observed in the current experiments suggest that the specific combined deficit in this system leads to reading problems when the magnocellular system is suboptimal, which is characteristic of dyslexic individuals. Nonetheless, vision therapy can be seen as the way out. Since the vision of patients with dyslexia may reflect the malfunctions of the magnocellular system, vision training gives prospective for the improvement of the reading difficulties. It can help to enhance M-cell processing, correct eye movements, and lead up to enhanced literacy levels.

The article "M-cell deficit and reading disability: In “a preliminary study of the effects of temporal vision-processing therapy” Solan et al. (2004) where the authors strive to establish a link between M-cell pathway and dyslexia, or more generally, reading disability. This research proposal seeks to determine whether poor functioning of M-cell pathway which is involved in the processing of visual motion as well as timing has poor impact on reading abilities. It also aims to determine whether temporal vision-processing therapy will enhance the reading ability of children having these dysfunctions. In the present research, the authors identified that the children struggling to read experienced extensive deficiencies in M-cell processing in comparison with the average selectors. Students who underwent temporal vision-processing therapy also demonstrated enhanced temporal vision processing initially and later also improved reading efficiency and reading comprehension. Limitations of this study include a small sample size and no control group and thus results of this study can only be considered preliminary. More studies involving larger samples of patients and better control samples are required before establishing that the therapy is effective, as well as before concluding that M-cell deficits are involved in reading disabilities. A deficit of M-cells in early development was established in this work using reading disabilities, making it possible to propose poor visual motion and timing as factors to low reading. Temporal vision-processing therapy was successful in correcting these visual processing abnormalities and, consequently, reading deficits; the generalization of these findings to clinical practice requires further investigation.

DISCUSSION

The present review of the literature has reviewed the effectiveness of vision therapy in the management of learning problems with a varying degree of success substantiating the appropriateness of the intervention and its application. It has been established that visual processing deficit is correlated with educational performance especially in children suffering from convergence insufficiency, dyslexia among others. It has

been demonstrated that there are successful intervention strategies such as structured vision therapy that have been very effective in treating visual impairments and enhancing performance in academic work especially when used with behavioral approaches and family involvement. On the other hand, the review shows that these studies also have their shortcomings, particularly that there should be more studies that include larger populations and diverse methodologies to better assessment of long-term efficacy.

The importance of these findings is seen with the impact they will have on educational practices and therapeutic measures for intervention for persons who suffer from learning disabilities. As the research demonstrates, visual processing contributes considerably to the learning process, and hence, vision therapy becomes an essential aspect of intervention programs devised for these individuals. In this regard, this article supports the theme by arguing that it is essential to appreciate the potential and limitations of vision therapy in education and improving the lives of people with learning disabilities. In recent years, the intersection of vision therapy and educational outcomes has garnered significant attention from both practitioners and researchers. Furthermore, research suggests difficulties in academics especially in reading as well as writing are caused by problems in vision that are usually unnoticed in standard eye examinations. Therefore, individualized and structured vision therapy programs targeted at specific visual impairments may enhance ocular motor control and depth perception in students, which are critical for processing complex visual information. Hence, whilst understanding and addressing such visual challenges improves academic performance, it also builds confidence in education settings and the overall development of students.

The execution of vision therapy requires the joint efforts of educational personnel and optometrists in order to provide a holistic solution to learning challenges. Carrying out regular checks that consist of both a visual component and an academic one can help in diagnosing issues in good time and therefore help prevent any learning difficulties from worsening.

Looking ahead, overarching conclusions drawn from this review suggest that future research should focus on multidisciplinary approaches that consider the intersection of visual, cognitive, and emotional factors in learning. Particularly noteworthy is the need to consider and investigate collaborative approaches to vision therapy incorporating knowledge from educational psychology, neurosciences, and advanced diagnostic therapy practices. Furthermore, while there is concern over the research evidence for the effectiveness of vision therapy, focused attention on the re-evaluation of the current technologies concerned with both diagnosis and treatment is important for coming up with sound effective interventions to aid learning with visual processing disabilities. Exploring these areas of future research will help vision therapists and educators improve its effectiveness and reach in educational systems, thus helping children with learning disabilities.

CONCLUSION

The efficacy of vision therapy in treating neurological, cognitive and vision related issues such as accommodation dysfunctions, convergence problems, oculomotor functions, perceptual and spatial functions, which primarily affect the literacy skills of children, have been supported by significant data. Additionally, whilst visual impairments

associated with Specific Learning Disabilities like Dyslexia, Dysgraphia, ADHD and autism can be alleviated by vision therapy, it is not regarded as a treatment for Specific Learning Disabilities as these are neurological processing issues. There is research that supports that vision therapy may help in improving Magnocellular cells processing and hence improving reading ability. The relationship between M-cells and dyslexia, however, needs a stronger validation. Although, there are certain areas that support the efficacy of vision therapy, such as convergence insufficiency and vision rehabilitation by using interventions such as prisms and syntonics to treat patients with Traumatic Brain Injury, there is still a lack of strong evidence that can support vision therapy as a treatment for reading disabilities in Specific Learning Disorders.

Further studies need to be conducted in order to arrive at standardized treatment plans and assess the efficacy of vision therapy in education on a long-term basis. Moreover, while the perception of the role of vision in learning continues to grow, there is a growing demand in the society to educate people and advocate about vision and the need for it in academic performance. Achieving access to vision therapy services will also depend strongly on promoting a culture of assessment and working collaboratively with teachers, healthcare providers, and families. Ultimately, integrating the insights gained from ongoing research will empower children experiencing visual challenges, equipping them with both the skills needed to thrive academically and the assurance to navigate their educational journeys confidently.

REFERENCES

Bagabas, H., & Ali. (n.d.). *The effectiveness of colored overlays on reading achievement and attitudes toward reading for students with Scotopic Sensitive Syndrome Recommended Citation*. Retrieved September 23, 2024, from

Borsting, E. (2002). Dyslexia and Vision. *Optometry and Vision Science*, *79*(6), 345. https://doi.org/10.1097/00006324-200206000-00006

Cardinal, D., & Nannemann, G. (2006). *There is More to Vision than Seeing Clearly*. https://core.ac.uk/download/235073676.pdf

Ciuffreda, K. J. (2002). The scientific basis for and efficacy of optometric vision therapy in nonstrabismic accommodative and vergence disorders. *Optometry (St. Louis, Mo.)*, *73*(12), 735–762.

Dennis, R., Edelman, S., Giangreco, M., Rubin, R., & Thoms, P. (1999). *Related Services for Vermont' s Students with Disabilities*. https://core.ac.uk/download/51067326.pdf

DeWitt, N., & Whitman, T. L. (2011). *Key Learning Skills for Children with Autism Spectrum Disorders*. Jessica Kingsley Publishers.

Flax, N. (1985, June). *Functional Case Analysis: An Interpretation of the Skeffington Model*. American Academy of Optometry; American Journal of Optometry and

Physiological Optics. https://journals.lww.com/optvissci/abstract/1985/06000/functional_case_analysis__an_interpretation_of_the.2.aspx

Granet, D. B., Gomi, C. F., Ventura, R., & Miller-Scholte, A. (2005). The Relationship between Convergence Insufficiency and ADHD. *Strabismus*, *13*(4), 163–168. https://doi.org/10.1080/09273970500455436

Griffin, J. R. (1987). Efficacy of Vision Therapy for Nonstrabismic Vergence Anomalies. *Optometry and Vision Science*, *64*(6), 411–414. https://doi.org/10.1097/00006324-198706000-00005

Halligan, P.W., & Robertson, I. (2014). *Spatial Neglect : a Clinical Handbook for Diagnosis and Treatment*. Taylor and Francis.

Hopkins, S., Sampson, G. P., Hendicott, P. L., & Wood, J. M. (2017). Vision Problems and Reduced Reading Outcomes in Queensland Schoolchildren. *Optometry and Vision Science*, *94*(3), 345–352. https://doi.org/10.1097/opx.0000000000001032

Hussaindeen, J. R., Shah, P., Ramani, K. K., & Ramanujan, L. (2018). Efficacy of vision therapy in children with learning disability and associated binocular vision anomalies. *Journal of Optometry*, *11*(1), 40–48. https://doi.org/10.1016/j.optom.2017.02.002

Johansson, J., Berthold Lindstedt, M., & Borg, K. (2020). Vision therapy as part of neurorehabilitation after acquired brain injury – a clinical study in an outpatient setting. *Brain Injury*, 1–8. https://doi.org/10.1080/02699052.2020.1858495

Mcnair, R., Program, S., & Atari, R. (2014). *Rawan Atari -The Influence of Multi-Sensory Environment on Physiological Response in Children with Autism Spectrum Disorders and Children with Special Health Care Needs*. https://core.ac.uk/download/67757154.pdf

Ostrogska, P. (2013). *Phonological processing deficit- a culprit behind developmental dyslexia?* https://doi.org/10.18778/7969-032-9.19

Overmann, K. A., & Wynn, T. (2018). Materiality and Human Cognition. *Journal of Archaeological Method and Theory*, *26*(2), 457–478. https://doi.org/10.1007/s10816-018-9378-y

Palomo-Álvarez, C., & Puell, M. C. (2009). Binocular function in school children with reading difficulties. *Graefe's Archive for Clinical and Experimental Ophthalmology*, *248*(6), 885–892. https://doi.org/10.1007/s00417-009-1251-y

Phillips, L. A., & Clark, E. (2008). Dysgraphia. *Encyclopedia of Special Education*, 771–772. https://doi.org/10.1002/9780470373699.speced0706

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological*

Bulletin, *124*(3), 372–422. https://doi.org/10.1037/0033-2909.124.3.372

Scheiman, M. (2005). *A Randomized Clinical Trial of Treatments for Convergence Insufficiency in Children*. Archives of Ophthalmology. https://jamanetwork.com/journals/jamaophthalmology/article-abstract/416768

Scheiman, M. (2024). *Understanding and Managing Vision Deficits*. Routledge. https://doi.org/10.4324/9781003526834

Scheiman, M. M. (2018). 2017 Glenn A. Fry Award Lecture: Establishing an Evidence-based Literature for Vision Therapy — A 25-year Journey. *Optometry and Vision Science*, *95*(8), 632–642. https://doi.org/10.1097/opx.0000000000001257

Scheiman, M., Cotter, S., Kulp, M. T., Mitchell, G. L., Cooper, J., Gallaway, M., Hopkins, K. B., Bartuccio, M., & Chung, I. (2011). Treatment of Accommodative Dysfunction in Children: Results from a Randomized Clinical Trial. *Optometry and Vision Science*, *88*(11), 1343–1352. https://doi.org/10.1097/opx.0b013e31822f4d7c

Scheiman, M., Kulp, M. T., Cotter, S. A., Lawrenson, J. G., Wang, L., & Li, T. (2020). Interventions for convergence insufficiency: a network meta-analysis. *The Cochrane database of systematic reviews*, *12*(12), CD006768. https://doi.org/10.1002/14651858.CD006768.pub3

Schmitt, E. P. (2006). *The Skeffington Perspective of the Behavioral Model of Optometric Data Analysis and Vision Care*. AuthorHouse.

Shaywitz, S. E. (1998). Dyslexia. *New England Journal of Medicine*, *338*(5), 307–312. https://doi.org/10.1056/nejm199801293380507

Shaywitz, S. E., & Shaywitz, B. A. (2007). The Neurobiology of Reading and Dyslexia. *The ASHA Leader*, *12*(12), 20–21. https://doi.org/10.1044/leader.ftr7.12122007.20

Smaakjær, P., Wachner, L. G., & Rasmussen, R. S. (2021). Vision therapy improves binocular visual dysfunction in patients with mild traumatic brain injury. *Neurological Research*, 1–7. https://doi.org/10.1080/01616412.2021.2000825

Solan, H. A., Shelley-Tremblay, J., Hansen, P. C., Silverman, M. E., Larsone, S., & Ficarra, A. (2004). M-Cell deficit and reading disability: a preliminary study of the effects of temporal vision-processing therapy. *Optometry - Journal of the American Optometric Association*, *75*(10), 640–650. https://doi.org/10.1016/s1529-1839(04)70211-0

Stein, J. (2001). The magnocellular theory of developmental dyslexia. *Dyslexia*, *7*(1), 12–36. https://doi.org/10.1002/dys.186