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Occupational Therapist-Led Remedial Vision Program after Mild Traumatic Brain Injury: Pre/Post Pilot Study

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Occupational Therapist-Led Remedial Vision Program after Mild Traumatic Brain Injury: Pre/Post Pilot Study

Abstract

Background: Vision disorders are common after mild traumatic brain injury (mTBI) and can affect occupational performance. The study was designed to support occupational therapy's role in providing remedial vision rehabilitation (RVR) by demonstrating changes in vision efficiency and patient reports of vision-related occupational performance in adult patients with a mTBI after occupational therapy-led RVR.

Method: In this retrospective study, data was collected pre/post-RVR treatment at an outpatient clinic using a convenience sample of adults 18 years of age and older with vision disorder diagnosis and mTBI diagnosis. Vertical/horizontal saccades, vergence jumps, near-point convergence, Convergence Insufficiency Symptom Survey (CISS), and Canadian Occupational Performance Measurement (COPM) were measured before and after RVR.

Results: Statistically significant changes were found in all outcome measurement scores after RVR with a large-size effect using t-test analysis. (Vertical saccades: $t = -2.71$; $p = .022$. Horizontal saccades $t = -3.87$; $p = .003$. Vergence jumps $t =- 4.98$; $p= .001$

Conclusions: Evidence-based RVR after mTBI injury may improve vision efficiency disorders and vision-related occupational performance and satisfaction, demonstrating occupational therapy's distinct role.

Comments

The authors declare that they have no competing financial, professional, or personal interests that might have influenced the performance or presentation of the work described in this manuscript.

Keywords

vision rehabilitation, performance, satisfaction, optometry, traumatic brain injury, collaboration

Cover Page Footnote

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Credentials Display

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The incidence of mild traumatic brain injury (mTBI) increases yearly, as does the demand for rehabilitation. Lefervre-Dognin et al. (2020) reported, "The incidence of mTBI is 200-300/100,000 persons per year for hospitalized patients and probably twice as high if non-hospitalized patients are included" (p. 2). With this rate of incidence, the authors project that mTBI will become the "third largest cause of global disease burden by 2020" (Lefevre-Dognin et al., 2020, p. 6). With an increase in mTBI cases, there is a growing need to manage mTBI-induced disorders during rehabilitation effectively.

Research has found that vision disorders are common after mTBI. Brahm et al. (2009) and Capo-Aponte et al. (2012) researched adults in the military. They found that the most common mTBI visual disorders were associated with vergence, eye movements, and accommodation, which is supported by more recent research (Ciuffreda et al., 2018; Ciuffreda & Thiagarajan, 2022; Gallaway et al., 2017; Smaakjaer et al., 2022). Specific vision disorders commonly found after mTBI were convergence insufficiency, accommodative insufficiency, and saccadic dysfunction (Brahm et al., 2009; Ciuffreda et al., 2018). Scheiman et al. (2011) defined convergence insufficiency as the "tendency of the eyes to drift outward when being used for near work such as reading, while at a far distance, the eyes work well together" (p. 66). Accommodative insufficiency occurs when one has blurry vision with near-vision tasks because the lens cannot change shape enough to focus and obtain clear vision (Scheiman et al., 2011). A saccadic dysfunction is a condition where "the accuracy and speed of saccadic eye movements are reduced relative to expected findings for age" (Scheiman et al., 2011, p. 74).

The same vision disorders common in mTBI survivors are also found in the non-TBI population but with a much lower frequency. Best practice can be found using research from the non-TBI population in which effective treatment has been shown to improve these vision disorders. Non-TBI vision disorder treatment using a bottom-up approach, office-based vision therapy, has been administered by optometrists since the 1930s. Randomized clinical trials, along with the systematic review by Scheiman (2020), have demonstrated that the most effective treatment for convergence insufficiency and accommodative insufficiency is office-based vision therapy (Ciuffreda & Thiagarajan, 2022; Scheiman et al., 2005). However, the evidence for the treatment of mTBI-related vision disorders using office-based therapy is less robust than it is in the non-TBI population.

Optometric research for best practices and the effectiveness of office-based therapy in mTBI survivors has increased. Multiple studies have demonstrated that office-based therapy using a bottom-up approach is effective in improving accommodative and binocular vision disorders after a mTBI, which can be referred to as the best-practice treatment (Ciuffreda et al., 2018; Ciuffreda & Thiagarajan, 2022; Gallaway et al., 2017; Scheiman et al., 2017). Furthermore, studies that recognized mTBI-related vision disorders affect the mTBI survivors' ability to participate in vision-related occupational performance to return to work, school, or play are also crucial in supporting office-based therapy. Simpson-Jones and Hunt (2019) completed a scoping review of vision rehabilitation research following mTBI. The studies showed that visual deficits can contribute to difficulty participating in "meaningful daily activities" (Simpson-Jones & Hunt, 2019, p. 2206). Effectiveness studies completed by optometrists provide a foundation and knowledge of office-based therapy to the occupational therapists who treat visual efficiency disorders. Studies linking visual efficiency disorders to vision-related occupational performance can also provide occupational therapy with a path to treating visual efficiency disorders in mTBI adults (Ciuffreda & Thiagarajan, 2022; Smaakjaer et al., 2022).

Occupational Therapy Remedial Vision Rehabilitation Research

In recent years, occupational therapists have become more involved in vision rehabilitation while collaborating with optometrists (Berryman et al., 2020; Reiser et al., 2020). In this paper, we will use the term remedial vision rehabilitation (RVR) to refer to office-based therapy provided by occupational therapists in collaboration with optometrists. RVR is designed to normalize visual performance and differs from low vision rehabilitation, which is purely compensatory. Low vision rehabilitation is used when an individual has permanent vision loss because of underlying eye disease (McGuire, 2022; Warren, 1993). In the presence of vision disorders that do not affect acuity or visual fields, RVR can restore normal visual function. RVR is based on the three-component model of vision (visual integrity, visual efficiency, and visual information processing), which is a bottom-up hierarchical method commonly used by optometrists (Scheiman, 2011).

Occupational therapy research on remedial vision rehabilitation has been limited. Berryman et al. (2020) completed a pilot study and bridged a gap between optometric and occupational therapist-led RVR using the foundation of optometric office-based vision therapy effectiveness research. The study demonstrated improved visual function after occupational therapy-led RVR performed by a vision specialty-trained therapist using evidence-based, bottom-up vision rehabilitation in a hospital setting with moderate TBI adult patients, improving the survivor's reading ability (Berryman et al., 2020).

Although occupational therapy-led RVR was shown to be applicable, not all occupational therapists use evidence-based, bottom-up treatments. Reiser et al. (2020) found inconsistencies in evaluation and treatment with occupational therapists when managing mTBI-related vision disorders. Some occupational therapists used top-down treatments, and others used bottom-up treatments shown to be effective in treating mTBI. Some treatments that are effective for vision diagnoses in patients without mTBI may not be effective for patients with mTBI. These findings, supported by other studies, found a need to understand RVR and standardize care in occupational therapy (Johansson et al., 2021; Smaakjaer et al., 2022).

Standardizing care for mTBI survivors in the occupational therapy profession could be influenced at the curriculum level. Schmeiser et al. (2023) found that treatment interventions taught to entry-level students were primarily functionally based and did not address the underlying vision disorders. Treatment using the tools required to treat common mTBI-related vision disorders was only taught by 35% of the educators surveyed. If there is inconsistency in what students are taught when treating mTBI-related vision disorders in schools, a lack of standardization of care will continue to affect occupational therapy interventions. Standardization of care is crucial because an occupational therapist is often one of the first rehabilitation professionals who work with mTBI survivors and treat occupational performance limitations.

While there is growing evidence of the effectiveness of RVR, more research is needed to investigate how improvement in visual function affects everyday functional activities and quality of life (Berger et al., 2016; Johansson et al., 2021; Roberts et al., 2016; Simpson-Jones & Hunt, 2019). Finding a link between vision and occupational performance could improve our understanding of how mTBI can limit vision efficiency and vision-related occupational performance. Further research is necessary to clarify the role of occupational therapists with advanced training providing RVR after mTBI and the link to vision-related occupational performance and satisfaction changes.

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Occupational Therapy's Role

Occupational performance in the context of occupational therapy is defined in *The Occupational Therapy Practice Framework* (OTPF-4) using the aspects of the occupational therapy domain. The aspects of the occupational therapy domain include occupations, contexts, performance patterns, performance skills, and client factors (AOTA, 2020). An occupational therapist can treat the client factor of vision: "Quality of vision, visual acuity, visual stability, and visual field functions to promote visual awareness of environment at various distances for functioning" (AOTA, 2020, p. 52). A limited client factor (vision) then affects performance patterns (length of time/speed/accuracy required to read or work on the computer, driving safety) in various contexts (home, classroom, or office, driving on highway/surface streets/heavy traffic), affecting the successful performance of occupations in life (student or any job requiring computer use, driver). Therefore, when assessing limitations after an mTBI, an occupational therapist can treat the client factor, vision, which affects skills required to perform vision-related occupational performance and performance patterns in various contexts, affecting the successful performance of occupations in life.

Research Purpose

The study was designed to support occupational therapy's role in providing RVR by examining improvements in visual efficiency disorders and patient reports of vision-related occupational performance in adult patients with mTBI after occupational therapy-led RVR. A secondary aim was to assess changes in patient satisfaction with vision-related occupational performance after occupational therapy-led RVR.

Method

Research Design

This retrospective study gathered pre/post RVR treatment data via chart review at one location. The study was pilot investigational in nature because of the small sample size. A retrospective chart review was conducted to increase the number of participants and allow for a longer time frame for review. RVR treatment and data collection occurred at CommonSpirit Penrose Hospital Outpatient Rehabilitation Clinic, a hospital-based outpatient clinic. Salus University and CommonSpirit Penrose Hospital Outpatient Rehabilitation Clinic granted institutional review board (IRB) approval.

Participants

A convenience sampling of participants aged 18 years of age and older, of any gender, ethnicity, or race, with a binocular vision diagnosis and mTBI diagnosis who received rehabilitation services at CommonSpirit Penrose Hospital Outpatient Rehabilitation Clinic between January 1, 2022, and December 31, 2022, were included in the study. Participants were referred to the clinic by either a neuro-optometrist or a medical doctor. An initial search was conducted in the outpatient clinic's data system to identify participants who met both the diagnosis criteria within the acceptable time frame and inclusion criteria. From this list, a second search was conducted to identify participants who met diagnosis criteria and time frame requirements and completed both pre/post remedial vision rehabilitation measurements.

Diagnostic Criteria

A neuro-optometrist diagnosed the participants with binocular/accommodation/eye movement disorders. Binocular/accommodation/eye movement diagnoses included the following: convergence insufficiency, convergence excess, esophoria, exophoria, accommodation insufficiency, saccadic dysfunction, sixth nerve palsy, and fourth nerve palsy. A medical doctor provided the mTBI diagnosis.

Inclusion Criteria

The participants included in the study were adults 18 years of age and older with both diagnoses of a binocular/accommodation/eye movement disorder and a mTBI. They completed RVR with an occupational therapist, certified in remedial vision from January 1, 2022, to December 31, 2022. The participants completed all the pre/post measurements without any missing data.

Exclusion Criteria

The participants were removed from the study if the patient records showed missing data for pre or posttest measurements. Records that indicated the patient could not complete the measurements and surveys because of cognition limitations were removed from the study. Participants were excluded from the study if RVR services were conducted outside of January 1, 2022, to December 31, 2022.

Data Collection

All eligible participants completed pre/post RVR measurements: near-point convergence, horizontal/vertical saccades, vergence jumps, Convergence Insufficiency Symptom Survey (CISS), and Canadian Occupational Performance Measurement (COPM). An occupational therapist, certified in remedial vision, completed the premeasurements at the time of evaluation or before treatment started and postmeasurements on the last day of treatment or discharge from occupational therapy services, which is synonymous with completion of RVR. One occupational therapist, certified in remedial vision, completed all the pre/posttreatment measurements and RVR to improve rater reliability. The chart review to gather data was completed on January 5 through 10, 2023.

Plan of Care

The participants completed speech, physical, and occupational therapy services according to their plan of care at the CommonSpirit Penrose Hospital Outpatient Rehabilitation Clinic. A speech therapy care plan could include compensatory memory strategies, executive function, attention span, problem-solving, and emotion regulation. Physical therapy care plans could include vestibular, balance, and strengthening treatments. Occupational therapy care plans included RVR and interventions with activities of daily living (ADLs) and instrumental activities of daily living (IADLs), strengthening, fine motor coordination, and a return to driving program. Prisms were prescribed (by the optometrist) as needed and were not a factor for exclusion from the research.

Instruments

Vision Testing

OculoMotor Assessment Tool. The OculoMotor Assessment Tool (OMAT) is an objective measurement tool that assesses participants' endurance of eye movements and vergence control, which can limit vision-related occupational performance. Near point convergence (NPC) of 5cm or less was considered the standard limit (Scheiman, 2011). Horizontal saccades of at least 106 eye movements per minute, vertical saccades of at least 105 eye movements per minute and vergence jumps of at least 60 jumps per minute were considered the standard limit (Yaramothu et al., 2021). Reliability and validity had yet to be completed at the time of this study.

Vision-Related Occupational Performance Measurements

Convergence Insufficiency Symptom Survey. The Convergence Insufficiency Symptom Survey (CISS) is a measurement tool used in research as an outcome measure before and after intervention. Optometrists and other health care professionals also use it in clinical practice. The questionnaire has 15 items, and the participant was instructed to choose one of five possible answers (*never*, *infrequently*, *sometimes*, *fairly often*, *always*). Each answer was scored from 0 to four, with four representing the highest frequency of symptom occurrence (i.e., always) during vision-related occupational performance. The 15 items were summed to obtain the Symptom Survey score, with the lowest possible score (totally asymptomatic) at 0 and the highest score at 60 (most symptomatic). A symptom score of 21 or higher suggests the level at which the person is symptomatic (Rouse et al., 2004).

Adequate responsiveness was measured with sensitivity = 97.8% and specificity = 87%. The results indicate that the CISS can discriminate between convergence insufficiency symptoms and normal binocular vision. The intraclass correlation coefficient was .885, and 95% limits of agreement were -9.0 to 7.6, demonstrating adequate reliability and good repeatability (Rouse et al., 2004).

COPM. The COPM is a measurement tool used to report three to five perceived vision-related limitations with ADLs and IADLs, using a 10-point Likert scale. Each perceived limitation was given a performance and satisfaction score using the same Likert scale. The COPM provides quantitative measures using a Likert scale for the participant's perception of vision-related occupational performance and satisfaction. A change score of two is the minimum clinical significance (Law et al., 2019). The COPM was found to have good test-retest reliability, using Spearman and Pearson's Coefficient: Spearman Coefficient is .89 for performance and .88 for satisfaction, and Pearson's Coefficient resulted in .80 for performance and .84 for satisfaction (Ohno et al., 2021). Ohno et al. (2021) found validity challenging to measure because of the interview nature of the measurement tool and the different answers given.

Data Management

Data were extrapolated from the chart onto a paper copy of an Excel spreadsheet and then transcribed to an electronic copy. Once study data were collected, PHI was placed in a classified shred bin to be destroyed within 36 months. There was no coding of patient study data to link to PHI information. Data collected on paper were stored in a locked cabinet at the hospital-based outpatient clinic. An electronic copy of the chart review, non-PHI, and Excel spreadsheet was on a CommonSpirit Penrose Hospital Outpatient Rehabilitation Clinic-owned, password-protected, secured laptop.

Procedures

One occupational therapist certified in remedial vision conducted the pre/posttest measurements and RVR to improve inter-rater reliability and intervention fidelity.

Pretreatment Measurements

The participants completed the following test measurements before RVR: NPC, horizontal/vertical saccades, vergence jumps, CISS, and COPM. One occupational therapist, certified in remedial vision, conducted test measurements following the standardized directions.

Remedial Vision Rehabilitation

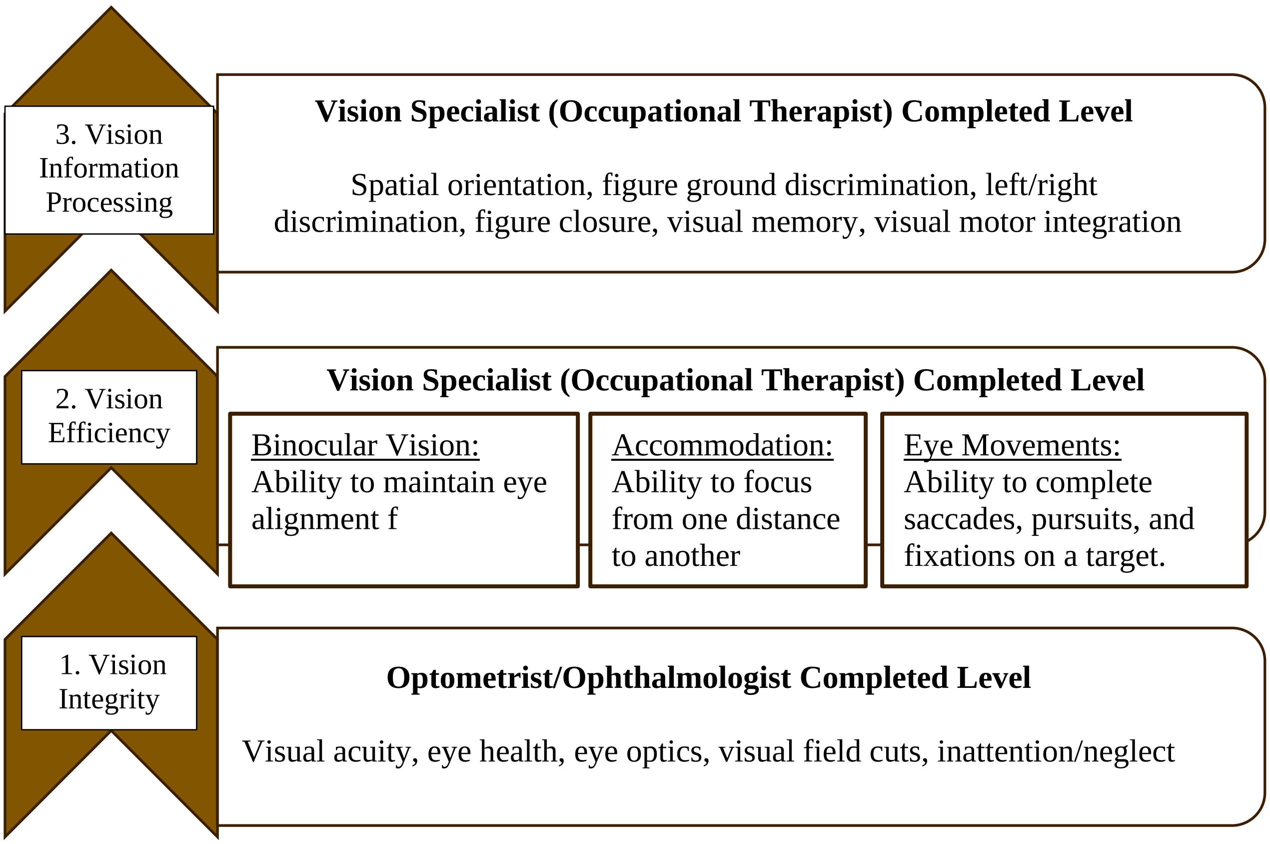
A remedial vision-certified occupational therapist provided bottom-up treatment following the Three Component Model of Vision (see Figure 1) (Scheiman, 2011).

The neuro-optometrist collaborated with the occupational therapist and provided a vision diagnosis and a change in lens prescription or prisms for the participants when appropriate. The diagnosis-specific RVR program was used for the following: convergence insufficiency, convergence excess, fusional vergence dysfunction, accommodation insufficiency, accommodation excess, infacility, and oculomotor dysfunction (Scheiman, 2011). The program progression was first eye movements, accommodation, and then vergence. Eye movements (pursuits/saccade) started one eye at a time, then both eyes, adding balance challenges if no discomfort was felt. Accommodation was completed one eye at a time; balance challenges were added if no discomfort was felt. Next, the vergence progression started with Brock String and then

Vectograms, continuing with Aperture Rule Trainer, next large Eccentric Circles to small Eccentric Circles, adding vergence jumps, and then balance challenges if no discomfort was felt. For example, if the diagnosis was convergence insufficiency, the participant completed the specific RVR program steps to endpoint given in parenthesis: two popsicle sticks with letters-horizontal saccades-head still slow to fast (no discomfort felt), Marsden Ball-pursuits left to right-body still (no discomfort felt), Brock string (1 inch), Quoit Vectogram (25 base-out), Near-Far Hart Chart (10 feet to 2 inches). The program progressed to the following procedure step when an endpoint was met. The length of the program would vary based on individual needs.

Figure 1

Three-Component Model of Vision: Hierarchy Process



When more than one diagnosis was present, the remedial vision program used was based on the binocular disorder provided by the neuro-optometrist. The participants received office-based RVR 1 to 2/week for 40 min (see Figure 2) with home reinforcement to be completed 15 min a day for 5 days a week (see Figure 3). Office-based RVR was based on the participants' individual needs and diagnoses. Each participant had a custom program developed based on the vision diagnosis and vision-related occupational performance. Office-based RVR included the vision diagnosis-specific treatment (as previously listed) and vision-related ADLs and IADLs, such as pre-driving skills, shopping, reading, scanning busy environments, paper to computer or whiteboard activities, and balance and somatosensory challenges. Home reinforcement included horizontal and vertical saccades progression from sitting to walking, Brock string, and Eccentric Circles progression per individual program needs.

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Remeasurements occurred every 8 to 10 days or when the participants completed a category endpoint (see Figure 2 and Figure 3). The remeasurements included NPC, horizontal/vertical saccades, and vergence jumps, which were conducted to assess readiness for discharge. The participant was considered ready for discharge when the vision measurements were within standard limits or consecutively had no change. There were no time limits placed on the participant to complete the RVR program because individual needs altering the duration of the program.

Figure 2

Office-Based Remedial Vision Rehabilitation, Convergence Insufficiency Example Program

CATEGORY	***ENDPOINT***
Eye Movements (Pursuits) • *Marsden Ball* *Left to right (Head Still)* *Forward and Backward (Head Still)*	 *No Discomfort* *No Discomfort*
Eye Movements (Saccades) • *2 popsicle sticks with letters:* *Horizontal (Head Still)* *Vertical (Head Still)*	 *No Discomfort* *No Discomfort*
Accommodation • *Near-Far Hart Chart*	 *10 feet to 2 inches*
Binocular • *Vectograms (Base-Out): Quoit* *Spirangle* • *Vectograms (Base-In): Quoit* *Spirangle* • *Aperture Ruler: Base-Out*	 *25 Base-Out* *25 Base-Out* *12 Base- In* *12 Base-In* *Card number 12*
Voluntary Convergence • *Brock String* • *Bug on string*	 *1 inch* *1 inch*

Figure 3

Home Reinforcement of Remedial Vision Rehabilitation Example

Category	**Endpoint**	**Category**	**Endpoint**
Eye Movements (Pursuits) • Figure-8: Sitting Head movement Left/Right Up/Down Standing Head movement Left/Right Up/Down Walking Head movement Left/Right Up/Down	 No Discomfort No Discomfort No Discomfort No Discomfort No Discomfort No Discomfort	**Eye Movements (Saccades)** • Letters on two Popsicle Sticks: left/right up/down upper left/lower right diagonal upper right/lower left Walk with saccades Forward/backward/circles/rotation	 No Discomfort No Discomfort No Discomfort No Discomfort No Discomfort
Accommodation • Hart Chart Near/Far • Bull's Eye	 1D feet to 2 feet 1D feet to 2 feet	**Binocular** • Brock string One bead Bug on String Increase the speed of bug Increase the distance of bead separation	 1 inch from nose Ability to keep X Ability to keep X

Treatment was not limited to RVR. The participants engaged in other therapies and treatments, such as occupational therapy, physical therapy, and speech therapy, per individual needs for specific diagnoses and limitations.

Posttreatment Measurements

The participants' test measurements were completed after RVR: NPC, horizontal/vertical saccades, vergence jumps, CISS, and COPM. When the participant's vision remeasurements (NPC, horizontal/vertical saccades, vergence jumps) were within standard limits or did not improve from the last measurement, the vision-related occupational performance measurements were completed (COPM and CISS), and discharge occurred. No time limits were placed on the participants completing the program.

Data Analysis

Data were analyzed as percentages, means, standard deviations, and 95% confidence intervals. Paired t-test was used to analyze the pre/post-score changes. Cohen's d was used to show the effect and adjusted for sample size using Hedge's correction as needed. Pearson's r was also used to analyze correlations between the outcomes pre/post mean score changes.

Results

Fourteen participants were identified as meeting the diagnosis criteria, but three were disqualified because they did not complete the postmeasurements after RVR. Eleven of the participants completed the study: nine females (81.8%) and two males (18.2%). The average participant age was 53.6 years, ranging from 22 to 75 years of age. The length of RVR treatment ranged from 8 weeks to 30 weeks, with an average of 15.54 weeks.

Normal distribution was confirmed, and a paired t-test was computed to analyze the difference between the measurement scores pre-RVR and post-RVR (see Table 1). Statistically significant results were found at an alpha of .05 for all the pre/post RVR mean score changes. Cohen's d was used to show the effect size of the pre/post mean score changes with the addition of Hedge's Correction to demonstrate that the effect size is appropriate for sample size n = 11 (see Table 1). The results showed significant effect sizes except for the vertical saccade (medium effect size) using Hedge's Correction. A nonparametric adjustment was not required because of the normal distribution of the results.

Table 1

Results for Pre/Posttreatment Measurement Score Changes (n = 11)

Assessments	Pre-treatment Mean (*SD*)	Post-treatment Mean (*SD*)	Paired t-Test	p-Value	Cohen's d	Hedge's Correction
NPC	8.50 (6.16)	4.23 (1.92)	2.78	.020*	.837 ††	.805 ††
Horizontal Saccades (eye movements per minute)	92.18 (27.29)	115.64 (17.60)	-3.87	.003**	-1.168 ††	-1.123 ††
Vertical Saccades (eye movements per minute)	98.82 (32.01)	116.64 (21.86)	-2.71	.022*	-.818 ††	-.786 †
Vergence Jumps (near/far jumps per minute)	29.36 (26.72)	79.18 (21.60)	-4.98	<.001***	-1.502 ††	-1.445††
CISS	32.82 (10.94)	18.45 (9.78)	3.88	.003**	1.169 ††	1.125 ††
COPM-performance	4.22 (.70)	7.49 (1.96)	-6.38	<.001***	-1.925 ††	-1.851 ††
COPM-satisfaction	1.93 (.91)	6.91 (2.4)	-6.50	<.001***	-1.961 ††	-1.886 ††

* p < .05, **p < .01, ***p < .001, Confidence interval 95%. Effect size: †.5 - .799 = medium, ††.8+ = large.

Note. M = Mean, *SD* = Standard Deviation, NPC = near point convergence, CISS = Convergence Insufficiency Symptom Survey, COPM = Canadian Occupational Performance Measurement.

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The small sample size, n = 11, did not allow for a correlation to be reported; instead, it identified a relationship. Pearson's r was used to analyze relationships between the pre/post mean score changes for RVR measurements. Vertical and horizontal saccade mean score changes were found to have a strong relationship with $r = .932$; $p < .001$. Vertical and horizontal saccade mean score changes were also found to have a significantly high negative relationship to CISS mean score change with $r = -.698$; $p = .017$ and $r = -.633$; $p = .026$, respectively. A significant relationship was found between NPC and COPM performance mean score change with $r = -.716$; $p = .013$. A strong relationship was found in the mean score change between the COPM satisfaction and the COPM performance with $r = .779$; $p = .005$.

Discussion

In this retrospective pre/post study of adults with mTBI-related vision disorders, significant improvements were found after RVR. All vision measurements and participant perception of symptoms, vision-related occupational performance, and satisfaction with performance improved. Significant improvements in perceived vision-related occupational performance after RVR completion were found using the CISS and the COPM as outcome measurements. In addition, a relationship between the improvement in vision testing and perceived vision-related occupational performance was found: saccades with CISS and NPC with COPM. Although the research was pilot investigational, the findings in this research help support past research and fill gaps in the literature.

The research findings show that all outcome measurements significantly improved after RVR. The significant improvements in vision efficiency function (saccades, vergence jumps, and NPC) support previous optometric literature research that demonstrated the effectiveness of remedial vision rehabilitation for binocular vision disorders (Ciuffreda et al., 2018; Gallaway et al., 2017; Murray et al., 2021; Scheiman et al., 2020; Ciuffreda & Thiagarajan, 2022). Similarly, the significant improvements in the participants' perception of vision-related occupational performance support previous research that suggested that functional activities can improve when visual efficiency improves (Murray et al., 2021; Thiagarajan et al., 2014; Ciuffreda & Thiagarajan, 2022). These findings suggest that the scope of occupational therapy practice need not be limited to compensation with functional activities, as suggested by Aravich and Troxell, 2021.

The key issues are that advanced training in remedial vision rehabilitation and collaboration with an optometrist are both required to go beyond compensation with functional activities. Multiple studies suggest a collaborative relationship between the occupational therapist and optometrist is beneficial. The significant results in this study suggest that occupational therapy working in collaboration with optometry is required for the best outcomes, which supports past research (Aravich & Troxell, 2021; Johansson et al., 2021; Reiser et al., 2020; Simpson-Jones & Hunt, 2019). The eye care professional is necessary to determine the diagnosis and the need for lenses or prism. Collaboration with vision professionals may benefit the patient using the Three Component Model of Vision (see Figure 1) to guide RVR toward improving visual function and patient-perceived vision-related occupational performance and satisfaction.

The Three Component Model of Vision improves understanding of treatment progression because the RVR interventions are advanced. Occupational therapists should complete specialized training in advanced RVR interventions, as supported by other studies (Berryman et al., 2020; McGuire, 2022; Reiser et al., 2020). The study findings help support the need for occupational therapist-led RVR after mTBI. Occupational therapists with remedial vision specialty can practice RVR with successful patient outcomes in visual efficiency function and perceived vision-related occupational performance and satisfaction.

While this research supported past research completed by optometrists and occupational therapists, it also addressed gaps in the literature related to the need to address vision-related occupational performance and satisfaction with RVR. The findings helped fill a gap in the literature identified by Johansson et al. (2021), who suggested further studies needed to include the satisfaction rating of the participants when vision disorders improved. Our research included satisfaction ratings using the COPM and found significant improvements in the satisfaction perception of vision-related occupational performance. This suggests that participants' satisfaction with the ability to complete ADL/IADLs improved when vision disorders improved. Further research might be beneficial in showing the impact of occupational performance and satisfaction on participants receiving rehabilitation services with other occupational therapy, physical therapy, speech-language therapy, and RVR. The other therapy interventions received may have positively impacted the participant's report of improvement in functional activities.

This study also addressed a problem identified by Berger et al. (2016). They systematically reviewed vision interventions with TBI and concluded that there is a need for further research to include vision-related occupational performance outcomes. Our study results provide data supporting the idea that improved visual function may lead to improved occupational performance. A possible relationship was found between saccades (vertical and horizontal) and the CISS, showing improvements in both after RVR. The clinical implications of a relationship suggest that when saccades improve, so does the perception of the ability to complete near-vision functional activities with reduced symptoms. Another possible relationship was found between NPC and the COPM, suggesting that the perceived performance of vision-related occupational performance improves with improved convergence.

Interpretation

Significant results were found when comparing the assessment pre/post-treatment measurement mean changes using paired t-tests. Hedges' Correction was completed to ensure that the effect size for the small participant group of 11 was considered. All the pre/posttreatment measurement mean changes showed significant differences with large effects in both Cohen's d and Hedge's Correction, which indicates a significant difference between the pre/posttreatment measurement changes. Due to the large effect, the paired t-test was considered appropriate to report. Because of the normal distribution of the results, a nonparametric adjustment was not required. Cohen's d was completed to compare the pre/posttreatment measurement changes and a large effect size was found in all the changes except vertical saccades.

The statistically significant results help to show that occupational therapy delivered RVR can help improve visual efficiency function (saccades, near point convergence, vergence jumps) and vision-related occupational performance and satisfaction (CISS and COPM). The significant outcome scores can also indicate that the occupational-therapy delivered RVR intervention was successful. Therefore, occupational therapists can successfully provide RVR to adults with a vision disorder after a mTBI with the collaboration of an optometrist.

The participants perceived vision-related occupational performance scores significantly improved after treatment, showing a link between visual function and vision-related occupational performance. The significant relationship between NPC change and COPM performance change demonstrated a connection; when near-point convergence improved after RVR, the vision-related occupational performance improved. The improved near-point convergence can improve the ability to complete near-vision functional activities, such as reading or computer use.

Limitations and Implications for Future Research

While the research showed occupational therapists could provide RVR with successful outcomes, a definitive cause-and-effect conclusion cannot be claimed due to the small sample size (n = 11) and the lack of a control group. This was a small pilot investigational study in design. The retrospective chart review study design has inherent limitations. For example, participants were recruited by convenience sampling via chart review, which has limits of not being representative of the general population and, therefore, is prone to selection bias.

Information bias might be found due to the performance and satisfaction surveys being self-reported perceived levels. The CISS and COPM required each participant to provide a perceived level of symptom, performance, and satisfaction with vision-related ADLs and IADLs. The perception of symptoms, performance, and satisfaction could be influenced by intrinsic or extrinsic factors, which reduces the validity of the self-reporting instruments, thus creating information bias. The perception of success is vital to measure but it could be strengthened using objective vision-related ADL/IADL measurements, such as reading speed or accuracy.

A further limitation was that not all participants had the same vision diagnosis. Although statistically significant, the results cannot be generally applied to all populations and conditions. The medical diagnosis was an mTBI, but other medical diagnoses in medical history were not used as a disqualifier in participation. The next step would be to be more stringent in the exclusion criteria to ensure the RVR addressed the mTBI limitations and not another medical diagnosis.

RVR was not an isolated treatment in this study; other therapy, such as speech and physical therapy, was completed at the same time as RVR, which limits the ability to say that only RVR improved the outcomes. One occupational therapist completed the RVR and pre/post measurements, and the outcome measures were not masked, resulting in possible performance bias. However, the strength of this study was that samples were matched for pre- and post-interventions and yielded a large effect size. The sizeable positive effect suggests clinical significance in addition to statistical significance.

Further studies could improve our understanding of occupational therapy's role in administering RVR. A large-scale, randomized clinical trial is needed. Isolation of multiple medical and vision diagnoses, settings, and ages would improve the generalization of RVR effectiveness. Future studies that find a correlation between visual function and vision-related occupational performance could also develop a better understanding of occupational therapy's role in RVR. A comparison of optometric vision therapy and occupational therapist-led RVR could improve the knowledge of best practice methods and differences. All future studies should be adequately statistically powered to detect differences.

Implications for Occupational Therapy Practice

The findings from this study have various limitations but are promising and provide preliminary evidence to show that occupational therapy has a role in delivering evidence-based RVR. Occupational therapist-led RVR showed improved visual function and perceived vision-related occupational performance. Specialty-trained occupational therapists have a role in providing RVR to mTBI survivors when working in collaboration with optometry. Specialty-trained occupational therapists can provide RVR to improve visual efficiency function, thus improving the perceived vision-related occupational performance in ADLs and IADLs (i.e., daily meaningful tasks). Occupational performance-based assessments, such as COPM and CISS, can show perceived vision-related occupational performance success and measure progress as an outcome measure.

Future research should continue to examine the effectiveness of occupational-therapy provided RVR in multiple medical models and medical diagnoses, with specific vision diagnoses. A randomized control study would be beneficial to bridge the gap found in evidence to demonstrate occupational therapy's role in RVR and best practices.

Overall, occupational therapy's role in RVR is applicable in a collaborative environment to improve mTBI vision disorders, which may lead to improved perceived vision-related occupational performance. Occupational therapist-led RVR effectiveness and best practice methods research can use this study as a starting point to build future research.

Conclusion

Vision disorders are common after an mTBI, limiting adults' perceived vision-related occupational performance and satisfaction. Specialty-trained occupational therapists can provide an evidence-based RVR hierarchical approach to treat vision disorders successfully, in collaboration with an optometrist, and improve perceived vision-related occupational performance and satisfaction.

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