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An Evaluation of the Effectiveness of a Simulated Classroom-based Intervention on Concussion Rehabilitation Among Individuals with Persistent Post-Concussion Symptoms

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Abstract

Although recent clinical and scientific effort has focused on the development of guidelines for post-concussion return to play/work/learn, there is still relatively little literature that addresses specific treatment methods by which this can be accomplished. Accordingly, this study investigated the effect of a 7-week simulated classroom-based intervention on the self-reporting of symptom scores among 71 individuals with persistent concussion symptoms (26 men and 45 women). All participants were provided with novel strategies for reading, writing, study skills, social communication and technology use. Self-assessment of symptoms were obtained weekly, both before and after each session of the treatment program, in an effort to monitor the cognitive demands of each session, and to identify the extent to which the program produced an improvement over the course of seven weeks. Results suggested that concussion symptoms were exacerbated in the short term by treatment, $F(1, 343) = 255.69$, $p < .05$, consistently across the 7 weeks of the program. An overall downward trend was, however, observed for symptom scores, over the seven weeks of the treatment program, and a statistically significant difference was noted between the first and last week of the program, $F(6, 343) = 2.29$, $p < .05$. Post-hoc analysis of means (using Tukey's HSD) suggests that there was a significant improvement (alpha = 0.05) of self-reported symptoms when comparing weeks 1 and 6, and between weeks 1 and 7. These results suggest that, transient exacerbation of symptoms aside; the targeted simulated classroom interventions produced a statistically significant benefit in the management of persistent concussion symptoms within this particular return-to-learn protocol.

Keywords

Concussion; Return-to-learn; Intervention; Classroom-based

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Chapter 1

1.1 Background

Concussion and *Mild Traumatic Brain Injury* (mTBI) are highly similar constructs, and have been used interchangeably in some contexts within the literature. The term concussion tends, however, to be more prevalent in athletic contexts, and the term mTBI tends to be more prevalent in purely clinical contexts. For the purposes of maintaining consistency with the terminology used by most of the participants in this research, we will use the term *concussion* throughout the remainder of this document.

The most frequently cited definition of concussion is the Zurich Consensus statement (McCrory et al., 2013), which notes the following about concussion: (1) concussion results from a force exerted on the brain that may be the result of direct head impact or the result of force exerted on the body and transmitted to the head; (2) the onset of concussion symptoms is rapid, and transient, with symptom onset time ranging from a few minutes to a few hours; (3) concussion symptoms are the result of functional impairments, rather than structural damage to the brain; (4) concussion may or may not involve a loss of consciousness. The Zurich Consensus statement also notes that concussion severity will vary from person to person, and it is this variability that makes treating concussions so challenging (i.e., there are substantial individual differences in both the presentation of symptoms, and response to treatment). The force applied to the brain affects the individual through a multifaceted pathophysiological process, and the effects may spread throughout the spinal cord or any region of the brain, regardless of the original injury locus (Ling, Hardy, & Zetterberg, 2015).

The symptoms of concussion vary widely amongst individuals, and may be affected by factors such as age, or sex, as well as the location and severity of the force sustained during the injury. Scopaz and Hatzenbuehler (2013) note that collegiate and professional athletes tend to recover faster than high school students, possibly due to the prolonged and widespread cerebral swelling, and increased sensitivity to glutamate, that occurs in response to a concussion within a young developing brain. Several researchers have confirmed that female athletes have a larger chance of sustaining a concussion with greater symptom deficits when compared with male athletes, most likely due to the musculoskeletal factors (e.g., neck strength), but also possibly due to the level of competition during play (Brainard et al., 2012).

The most common concussion symptom is headache (often experienced as *pressure inside the skull*), but other symptoms include dizziness, blurred vision, light and noise sensitivity, confusion, and memory problems. As a construct, concussion may be considered to exist on a continuum, and so symptoms may range in severity from mild to severe. Not surprisingly, many students develop academic deficits that are tied to these symptoms. Physical and somatic symptoms such as headaches, blurred vision, light/noise sensitivity and fatigue may affect a student's ability to focus and participate in the classroom (Sady, Vaughan, & Gioia, 2011), and sleep disturbances (i.e, difficulties falling asleep, or an increased need for sleep) may make it difficult to remain alert and awake during class. This array of symptom difficulties leads to a significant threat to learning, in domains such as classroom work, note taking, homework and social networking (Sady et al., 2011).

Most concussion symptoms resolve spontaneously, with 80 to 90% of concussed individuals experiencing full symptom resolution within 7 to 10 days of their injury (Reed et al., 2015). The remaining individuals experience persistent post-concussion syndrome (PPCS), and may require further care, management, and rehabilitation beyond this initial period. The World Health Organization's International Classification of Diseases defined persistent post-concussion syndrome as the continuity of somatic, cognitive, physical and emotional symptoms for longer than the usual average period of time after sustaining the injury (WHO, 2010). This prolonged recovery and struggle may result in secondary effects of concussion symptoms, such as depression, mood disruption, school absenteeism, reduced academic performances, and social dysfunction (Zemek et al., 2016).

Research on the incidence rate of sport-related concussions is hampered by reporting inconsistencies – many concussions are misdiagnosed or missed, and others are unreported, perhaps due to a lack of belief in the seriousness in the injury (Echlin et al., 2010). It is estimated, however, that approximately 1.6 million to 3.8 million sports-related concussions occur yearly in the United States (Hobbs et al., 2016). It is also estimated by The Centers of Disease Control and Prevention (CDC), that more than 300,000 children and adolescence sustain a concussion through contact sports every year. There has been a notable recent increase in reported sport-related concussions recently as individuals are more aware of what a concussion is and its risks (Hobbs, Young, & Bailes, 2016). Current research has suggested that the highest rates of sport-related concussions occur in collision and contact sports such as ice hockey, football, wrestling, soccer, basketball and rugby, with almost 30% of all sport-related concussions affecting children and adolescents between the ages of 5 and 19 (Hobbs et al., 2016).

A recent study estimated that more than 80,000 individuals (of all ages) in Ontario were diagnosed with concussion between 2002 and 2006 (Colantonio et al., 2010), which represents an incidence rate of approximately 1.29 per 1000 people per year. The North American incidence rate has been estimated at 1.4 to 9.2 percent for children aged 6 to 16 years of age (Willer, Dumas, Hutson, & Leddy, 2004). Given the potential for under-diagnosis, or under-reporting, it is likely that the true concussion incidence rate is closer to the higher end of this confidence interval, or possibly higher (Echlin et al., 2010, 2012). The highest risk population is male adolescents as they are most competitive during play. Surveys conducted among high school students in Canada and New Zealand suggest that nearly 30% of high school students sustain at least one concussion during high school (Willer et al., 2004).

1.2 Identification of Concussion

Despite the fact that concussion has become a major source of morbidity, particularly in young people, there are few concrete and objective methods for the identification of concussion (Ryu, Feinstein, Colantonio, Streiner, & Dawson, 2009). Although a number of techniques are employed in the identification of concussion, the gold standard for concussion diagnosis is still clinical assessment by a physician or psychologist. Methods for diagnosing concussion may be roughly split into standardized clinical evaluations and medical testing (i.e., imaging and blood biomarkers). There remains considerable uncertainty as to the best method for diagnosing a concussion, and so it is likely that different combinations of the methods described in this section will be employed, depending upon the clinicians involved, and their access to resources. Standardized clinical instruments are, by far, the most commonly evaluated diagnostic tools in the assessment of concussion. The most commonly cited standardized tools are the Glasgow Coma Scale, the SCAT3, the ImPACT, and the CogniStat.

1.2.1 Glasgow Coma Scale

This scale was developed to describe the level of consciousness in an individual following a head trauma, and is the most well-known scoring system used to describe the severity of a brain injury (Institute of Medicine, 2013). The scale measures three basic constructs: eye opening, verbal response, and motor response. Four points are assigned to eye opening, five to verbal response, and six to motor response. Further details on the individual constructs of the GCS are presented in Table 1. Scores within each of these three constructs are aggregated to produce a score between 3 and 15, with severity graded as follows: severe injury, GCS 3-9; moderate injury, GCS 9-12; and mild injury, GCS 13-15. In sports-related concussions, it is primarily used to determine whether immediate medical attention is required (Institute of Medicine, 2013).

Table 1.1. Measurement of Function on the GCS

Eye Opening	Verbal Response	Motor Response
1 = none 2 = to pain 3 = to voice 4 = spontaneous	1 = none 2 = no words, only sounds 3 = words, but no coherence 4 = disoriented conversation 5 = normal conversation	1 = none 2 = decerebrate 3 = decorticate 4 = withdraws to pain 5 = localized to pain 6 = normal

1.2.2 SCAT 3

The SCAT 3 (Hänninen et al., 2015) is an evaluation tool that is used to appraise athletes aged 13 years and above, in support of immediate return-to-play decisions, and can be used by a health-care professional on the field. It takes approximately 15-20 minutes to complete, and includes the GCS, a Maddocks score (assessing orientation and memory), a neck examination (assessing range of motion, tenderness, as well as sensation and strength in upper and lower limbs), a balance assessment (using the modified balance error scoring system), and a yes/no symptom checklist. The SCAT 3 was developed at the 2012 Consensus Meeting on Concussion in Sport, in Zurich (McCrory et al., 2013).

1.2.3 ImPACT

The Immediate Post-Concussion Assessment and Cognitive Testing system (ImPACT; impacttest.com) is a computerized evaluation system used to evaluate and manage concussion (Covassin, Elbin, Stiller-Ostrowski, & Kontos, 2009). The test consists 4 sections:

- *Demographic profile and health history:* In this section, the concussed individual provides demographic data, including age, sex, height, weight, sport, position, concussion history, and history of learning disabilities.
- *Current concussion symptoms and conditions:* In this section, the individual is asked several questions regarding date of injury, the number of hours slept on the day after the injury, and about current medications being taken. This section also includes a concussion symptoms rating scale.
- *Baseline and post-injury neurocognitive test:* This section is comprised of a neurocognitive test that includes 6 modules: (1) a word discrimination task, to evaluate attention processing and verbal recognition memory; (2) a design discrimination task, to evaluate attention processing and verbal recognition memory; (3) a visual working memory and visual processing speed task; (4) a symbol matching task to evaluate visual processing speed, learning and memory; (5) a colour matching task to measure impulse control and response inhibition; and (6) a working memory and visual-motor response speed task.
- *Score Summary:* In this section, 5 different combinations of symptom test scores from the neuropsychological tests are calculated and presented graphically. This

is also where the total symptom composite for all 22 symptom descriptors is presented.

1.2.4 Cognistat

The Cognistat cognitive assessment (cognistat.com) is a cognitive screening tool that measures orientation, attention, language, spatial skills, memory, calculations and reasoning (Rice, Campbell, Friedman, Speechley, & Teasell, 2015). The Cognistat was developed for individuals for the assessment of individuals with stroke, dementia, concussion, major psychiatric disorders, substance abuse and epilepsy, and there are a variety of different forms available that are appropriate for a wide array of ages. The test is designed to be administered by a health-care professional, and is available in three basic formats: a paper and pencil test, an offline computerized PDF format, and an online computer-assisted format. All of these forms of the Cognistat take between 15 and 30 minutes, depending upon the level of cognitive impairment. A short-form of the Cognistat (the Cognistat Five) is also available, that takes approximately five minutes to administer, and is intended for use in emergency rooms and other settings where there is less time available for assessment.

1.2.5 Medical Testing

Medical testing can also be important in the evaluation of a concussion. A substantial amount of research has recently been oriented towards the identification of blood biomarkers, owing to their potential to provide a rapid method of screening for concussion (either in an emergency situation, or for an athlete that has been sidelined by injury). A biomarker is a quantitative indication of medical state such as a biological disease or injury state that is externally observed from the patient's body (Strimbu & Tavel, 2011). Biomarkers may possibly be identified through laboratory testing of biological indicators like lipids, peptides, proteins etc. apposed to proteins released from diseased or injured tissue (Jeter et al., 2013).

More commonly, however, medical testing involves the use of medical imaging. There are several forms of medical imaging that can be used to support a diagnosis of concussion, with the most common imaging techniques being Computed Tomography (CT) and Magnetic Resonance Imagery MRI Scans.

Computed tomography (CT) can improve on the sensitivity of an x-ray, through the use of computer-processed combinations of x-ray images – effectively creating a three-dimensional representation of the brain. Although the resolution of CT scans is typically too coarse to identify subtle brain injuries (e.g., diffuse axonal impairment), it can be useful for ruling out the existence of an intracranial hemorrhage (Hobbs et al., 2016). The current use of medical imaging has increased rapidly in large Canadian hospitals, despite the fact that almost 90% of these scans are negative (Stiell et al., 2005). The Canadian CT Head Rule was developed to help physicians determine who to image, among individuals with a GCS of 13 to 15, using CT scanning. Rather than recommending CT scans for all individuals with concussion, it uses information from the clinical assessment to make this decision (e.g., presence of skull fracture, frequency of vomiting, presence of retrograde amnesia, and mechanism of injury).

Magnetic Resonance Imagery (MRI) is a technique that leverages the natural magnetic field of the body to generate high-resolution images of the brain. There are a number of different methods for analyzing these imaging results, which utilize different parameters within the scan. Although the resolution of these scans is better than that seen with CT scans, there is considerable ongoing debate as to the best method for interpreting these scans in the diagnosis of concussion (Helmer et al., 2014; Koerte et al., 2012; Pasternak et al., 2014; Sasaki et al., 2014).

1.3 Treatment and Management of Concussion

No two concussions are identical, and this makes it challenging to identify a singular diagnostic and treatment protocol. There is no real *treatment* for concussion, insofar as there is no known method for repairing a damaged brain. There is, however, a pressing need to manage concussion symptoms in the immediate aftermath of a concussion, to prevent these symptoms from worsening. Therefore, there is a need for an appropriate management plan that will allow medical professionals, coaches, teachers and families to help concussed individuals recover from their injury. This recovery trajectory becomes particularly important in children, as there is a substantial risk within this demographic of sustaining a second concussion while recovering from the initial concussion (McGrath, 2010). This has come to be known as *second impact syndrome*, with symptoms dramatically worsening, and lasting for a significantly longer period, or even resulting in death.

There are two basic domains in which an individual will be returning to their former activities: occupational activities, which may depend upon the age or vocation of the individual (e.g., school, work, and leisure activities); and physical activity. The literature surrounding *return to play* (i.e., returning to physical activity) is considerably larger than the literature surrounding *return to learn* (i.e., returning to cognitively demanding activities).

1.3.1 Return to Play

Individuals who have sustained a concussion are instructed to refrain from physical activity, or participating in any sports, until they are cleared by a health care professional. Limiting concussed athletes from physical activity protects the individual from sustaining another concussion, and may also decrease the risk of worsening symptoms (Sady, Vaughan, & Gioia, 2011). Typically, the individual is cleared to return to their normal activities after all of his or her symptoms have completely resolved.

The graded return to play protocol described within the Zurich consensus statement was based on five progressive steps. During each step, the athlete is monitored by a health-care professional who watches for the reoccurrence of symptoms. Progression between stages of the treatment is permitted only when the activities within the current stage may be performed without symptoms. Step one is a recovery period that involves no activity at all, until the individual is symptom free for 24 hours. The goal of step two is to observe the effects of increasing heart rate, and so it introduces light physical activity (heart rate may be elevated to 70% of maximum for up to fifteen minutes at a time) that has a minimal risk of head injury, such as walking, or stationary bicycle usage. Step three is focused on the effects of adding more complex movement and balance, as well as increasing the intensity and duration of the activity (heart rate may be elevated to

80% of maximum for up to 45 minutes), introducing simple movements like jogging, and eventually, sport-specific exercises like skating. The fourth step adds resistance training (if desired by the individual), increases the intensity of the exercise (90% of maximum for up to 60 minutes), and looks at the effects of activities that require additional attention and coordination, and may include more complicated multidirectional movements. The final step involves a well-supervised return to full-contact practice. If no symptoms are evident within 24 hours of full-contact practice, the individual may be cleared to return to normal activities.

McGrath and colleagues (McGrath, 2010) describe a protocol for educating athletic trainers, to facilitate their ability to advise concussed student-athletes about health and academic needs within a successful return to play/learn process. The authors note that many coaches mistakenly believe that a concussion requires a loss of consciousness – and also note that some symptoms have a more gradual onset (perhaps due to the effects of frequent subconcussive injuries). Their comprehensive approach includes five components:

(1) *Concussion education*, wherein athletes, coaches, parents and school staff receive concussion-specific education during the school year, so that they are prepared to aid injured students during recovery.

(2) *Preseason baseline testing*, which provides baseline neurocognitive testing and neuropsychological testing to student athletes. This provides a better context for any injuries that may occur over the course of the season, accounting for

individual differences such as cognitive ability, learning disabilities, attention deficits, or behavioral issues.

(3) *Post-injury testing*, where a responsible adult (coach or trainer) must complete a simple assessment protocol such as the Sideline Assessment and Neurocognitive Evaluation immediately post-injury.

(4) *Academic support during recovery*, meaning that the injured individual must be provided with supports for his or her academic demands, with the goal of reducing the risk of symptoms worsening.

(5) *Return-to-play decision*, meaning that there is to be a return-to-play protocol in place within the school, and that the student is not to return to play until such a time as he or she is cleared to return to the activity. This decision will be derived from a close monitoring of the athlete's medical status, as well as his or her physical and neurocognitive performances.

1.3.2 Return to Learn

Perhaps owing to the complexity of weaving together the cognitive and physical aspects of returning to school, there has been less work done to create specific return to learn protocols. Much of the work that has been done in this domain has focused on the need for specific accommodations, and environment management strategies, that may assist an individual's return to the classroom (Sady et al., 2011). The main component of any such protocol is to avoid surpassing the individual's threshold for cognitive and physical stimulation, as this may exacerbate concussion symptoms.

Once an individual has been diagnosed with a concussion, his or her symptoms should be evaluated in the context of determining whether or not school should be attended full-time, or whether a gradual part-time return to school is warranted. In the same way that return-to-play guidelines recommend a period of total rest before returning to physical activity, return-to-learn guidelines typically include a recommendation to rest at home until symptoms are tolerable. Students may also attempt to do some of their school work at home, as this may facilitate *pacing* their work (i.e., working in small blocks of time, resting, and then completing further work). Other students may return to school with a recommendation from a concussion specialist on further accommodations to the learning environment (Sady et al., 2011). McGrath and colleagues (2010) propose a detailed approach on the reasonable accommodations that should be provided to a concussed individual during recovery. These accommodations include:

- excused absence from class
- rest periods during the school day
- extension of assignment deadlines
- postponement or staggering of tests
- excuse from specific tests and assignments
- extended testing time
- accommodation for oversensitivity to light/noise
- excuse from team sports practice and gym activities
- avoidance of other physical exertion
- use of a reader for assignments and testing
- use of a note taker or scribe

- use of a smaller, quieter exam room to reduce stimulation and distraction
- preferential classroom seating to lessen distraction
- temporary assistance of a tutor to assist with organizing and prioritizing homework assignments

More recently, Baker et al. (2014) proposed return to school guidelines based on a synthesis of published return to learn protocols and guidelines, for students that have sustained a concussion:

(1) Full physical and mental rest (i.e., a recovery phase) is recommended immediately after sustaining a concussion until substantial symptoms are resolved. Avoidance of cognitive and physical exertion is highly advised to avoid re-injury.

(2) Cognitive and environmental stimulation may be gradually increased as symptoms improve.

(3) It is critical to stay below the student's cognitive and physical threshold, as increasing stimulation beyond this point may worsen symptoms to a point where they increase the student's overall recovery time.

(4) Once the student is ready to return to school, academic accommodation is necessary, and should include appropriate environmental adjustments.

(5) Pacing and planning certain activities may be necessary in order to decrease cognitive effort. The student should be coached to discontinue activities and rest <u>before</u> symptom threshold is reached.

(6) Academic staff members should support and acknowledge cognitive difficulties observed in the student, including: difficulties concentrating, delayed processing time, and memory complications.

(7) The family, student, healthcare professionals and school staff should work as a team together in helping the student overcome and manage symptoms.

(8) The concussed student should be encouraged to reduce academic load, and overall stress, as he or she works towards recovery. Sustaining academic progress while recovering from a concussion may not be possible for all students, and so the latter should be facilitated until symptoms are sufficiently resolved.

The authors suggest that although a standard step-by-step return to learn protocol would be a welcome advance for parents, health professionals, and school staff (owing to the fact that a *one size fits all* approach would be easy to implement within the school system), this is not likely to be practical. Student re-integration should encompass a gradual increase in activity and stimulation, while staying below the individual's symptom threshold. As student recovery progresses, academic accommodations should be gradually adjusted according to student needs, until full recovery is achieved (Baker et al., 2014).

1.4 Management of Individuals with Persistent Symptoms

Unfortunately, some individuals see no improvement in their symptoms after the typical recovery period for a concussion (i.e., up to 3 weeks). Individuals with persistent symptoms are said to have *persistent post-concussion syndrome* (PPCS), and will need substantially more rehabilitation and intervention than individuals that have symptoms that resolve in a *normal* time frame. Unfortunately, there are few treatment or management paradigms that focus on this population.

Grubenhoff and colleagues (2015) present evidence of the lack of follow-up typically provided for the individual with PPCS. They conducted a longitudinal cohort study that investigated the differences between asymptomatic concussed individuals and persistent symptomatic concussed individuals, aged 8 to 18 years, receiving academic accommodation and attending outpatient follow-up after emergency department evaluation. Although it might be expected that individuals with ongoing symptoms for more than one month after injury would have frequent follow-up appointments, additional absenteeism privileges, receive academic accommodations to transition effectively to return to learn, results suggested that asymptomatic and persistently symptomatic individuals received similar academic accommodations over the course of the one month study. Results suggested that only 45% of all participants had follow-up visits, and children with PPCS missed twice the amount of school days when compared with asymptomatic individuals. These findings suggest that a key aspect of the return to learn process (i.e., expert management and advice from a healthcare professional) is missing within the population that has the greatest need for this care.

Sohlberg and Ledbetter (2016) evaluated a variety of treatment options for the management of individuals with persistent concussion symptoms, in a sample of twenty-four participants (14 women and 10 men) aged 14 to 26 years, who were symptomatic for more than 2 months post-injury. Participants exhibited poor school performance, attention impairments and diminished working memory. All participants underwent a 2-

hour consultation with a speech language pathologist to review records, test cognitive abilities, discuss treatment options and discourse self-selected functional goals. Clinical management conducted by speech language pathologists consisted of:

(1) Direct attention training, including computerized drills that integrated several different attentional domains with strategy training.
(2) Metacognitive strategy instruction that provided different training strategies on self-regulation, with regards to state of mind, academic tasks and study skills.
(3) Training in assistive technology for support of cognitive activities.
(4) Psychoeducational support, in the form of concussion education on symptom monitoring and goal setting.

Results suggested that 22 out of the 24 participants receiving psychoeducational support met their self-selected goals. Furthermore, eleven out of thirteen participants who received direct attention training met their self-selected goals, all participants (nine) who received meta-cognitive instruction met their self-selected functional goals, and all five participants receiving training in assistive technology met their self-selected goals. The authors propose that individualized interventions in one or more of these domains may be effective in helping students return to the learning environment.

The common denominator for return to play and return to learn protocols – regardless of whether they are carried out in populations of individuals that exhibit a typical recovery profile, or in populations with persistent symptoms – is the provision of education. The overarching goal for these programs is to provide individuals with a method of accommodating their new reality (i.e., living with the symptoms of their concussion).

Previous educational initiatives have, however, involved personalized, individualized educational plans, and so the treatment plans are highly resource intensive. What is needed, therefore, is a group-administered educational program that focuses on accommodating the educational needs of individuals with persistent concussion symptoms.

1.5 The Present Research

This thesis describes a seven-week outpatient intervention that was undertaken at a rehabilitation institute to examine the effect of a simulated classroom-based intervention program on self-reporting of symptom scores amongst concussed participants with PPCS. The program involved group sessions of 7-10 individuals per group, conducted by Speech Language Pathologists, once per week for two hours. Individuals with persistent post-concussion symptoms were educated on specific topics, and given instructions on symptom management interventions that may assist in their environment adjustment, and facilitate a healthy return to learn, or return to work process. Each of these weekly sessions covered a different module with different interventions proposed, and participants were asked to self-report their symptoms on a weekly basis, both before and after the intervention. Additionally, all participants were assessed on a cognitive-communication testing battery, at the beginning of the treatment program, and again after the seven-week program was complete. These measures were intended to evaluate the overall effectiveness of the program, as well as the (hopefully) transient symptom exacerbation that occurred within each week of the program, with the cognitive stimulation that was inherent within the treatments provided to the participants.

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Chapter 2

2.1 Introduction

Concussion is a pressing public health problem that is rapidly increasing in prevalence across North America (Ling, Hardy, & Zetterberg, 2015), with between 1.5 and 2 million new concussions diagnosed every year (Levy et al., 2012). Concussion results from a blow to the head, or to any other part of the human body, in a way that results in force being transmitted to the brain (Navarro, 2011). It affects the brain through a multifaceted pathophysiological process which results in an alteration in brain function that produces physical, emotional, behavioral, or cognitive symptoms (McCrory et al., 2013).

The effects of concussion may range from acute asymptomatic, to life threatening symptomatic complications (Ontario Neurotrauma Foundation, 2013). There is significant variability in the presentation of concussion symptoms that include physical, psychological, emotional and cognitive disturbances, with the most commonly reported concussion symptoms being headache, confusion, and dizziness (Williams, Puetz, Giza, & Broglio, 2015). In addition to varying in presentation and severity, concussion symptoms vary in terms of their duration, and response to treatment.

Fortunately, most concussion symptoms resolve spontaneously (Zuckerman et al., 2012), with 80% to 90% of individuals seeing a complete resolution of symptoms within

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seven to ten days from the time of injury (Williams et al., 2015). Most studies that have evaluated treatment effectiveness have focused on the importance of rest, as well as withdrawal from physical and cognitive stimulation (Wright, 2014). This includes significantly decreasing or eliminating homework expectations, as well as restricting reading and visual scanning activities (i.e., computers, cell phones, video games, and TV) that may aggravate symptoms. Participation in exercise is limited as it is thought to increase metabolic brain activity, which might exacerbate symptoms and slow recovery (Wright, 2014). A recent review by The American Academy of Pediatrics (Halstead et al., 2013) suggested a need for guidance regarding what can reasonably be expected from concussed children and youth as they are re-integrated into the classroom setting, and noted that classroom modification strategies are critical for these individuals within the first few weeks post-injury. When symptoms persist beyond this period of time the individual should be referred for additional management, with particular attention to the individual's chronic concussion symptoms (Halstead et al., 2013).

Not all research has, however, suggested that post-concussion cognitive rest is indicated as a primary treatment method for concussion symptoms. For example, in a retrospective randomized study, 107 patients diagnosed with a concussion, 53 patients were prescribed with cognitive bed rest as a primary treatment method, were compared with 54 patients for whom rest was not recommended. The authors found no significant relation between the completion of post-concussion cognitive rest and the duration of concussion symptoms, or on general health status (de Kruijk, Leffers, Meerhoff, Rutten, & Twijnstra, 2002). It would seem that finding the balance between cognitive rest and mild cognitive stimulation, is important to creating a successful protocol for reducing the likelihood of persistent symptoms.

Approximately 15% of individuals with concussion experience symptoms that persist for more than a month post-injury (Ontario Neurotrauma Foundation, 2013). Concussion recovery for these individuals may be a lengthy process that varies with the severity of the injury, and the extent to which the individual remains sensitive to physical and cognitive exertion (Sady, Vaughan, & Gioia, 2011). Not surprisingly, concussion symptoms may have a major effect on learning. Concussions are associated with cognitive symptoms such as memory difficulties, feeling foggy or unfocused, and delays in information processing, and reaction time. Furthermore, symptoms such as headache, blurred vision, light sensitivity, noise sensitivity, and fatigue can negatively influence a student's performance in class. Outside of the classroom, many concussed individuals experience an increased need for sleep, or disturbances in the sleep/wake cycle – and this may affect mood, and make it difficult for the student to stay awake, focused and alert during class (Sady et al., 2011). Balancing all of these challenges while simultaneously focusing on school demands may force concussed students to 'push through' their symptoms rather than 'plan and pace'. Students have reported that missed classes and incomplete schoolwork are significantly more distressing than the symptoms themselves. All of these competing demands may exacerbate emotional symptoms, including frustration, depression and anxiety, leading to a non-successful return to learn.

A recent study by Wolfe et al. (2015) further underscored the importance of understanding social behavior among children with persistent post-concussion symptoms. Participants were children aged 8-13 years, and had been injured 12-63 months before the study began. Although self-reported social behaviors (measured using the Revised Class Play questionnaire) demonstrated no significant differences when comparing children with concussion, and children that had orthopaedic injuries without concussion, peer-ratings suggested that children who had sustained a concussion tended to underestimate the extent to which they exhibited signs of social withdrawal. The authors suggest a need for the development of intervention programs (within return to learn programs) that can increase awareness and significantly improve children's social communication and interaction outcomes.

Unfortunately, evidence supporting specific treatment guidelines for successful return to learn remains sparse. McAvoy et al. (2011) implemented an individualized, counseling-based program, developed by teachers and medical practitioners, that encompassed structured guidelines for helping a child return to both cognitive and physical activities within the learning environment. The program, called REAP, consisted of 4 modules: (1) Reducing physical and cognitive strain; (2) Educating students as to the nature of their injury; (3) Accommodating difficulties within the school and classroom, by modifying physical and cognitive activities; and (4) Pacing activities to encourage a gradual return to learn and play, increasing intensity as appropriate.

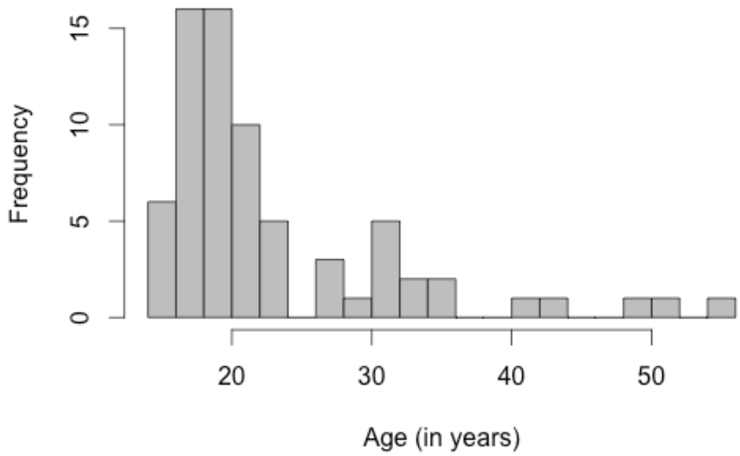
The present research describes a return to learn program that is administered in a group setting (specifically, within a simulated classroom setting) that supports individuals of all ages as they return to work and/or school. In this program, group counseling and education are key components of the intervention, but unlike other return to learn programs, there is also a focus on finding specific interventions that may assist individuals with persistent concussion symptoms in developing coping strategies and study skills that they can apply in their own personal return to learn process. In addition to allowing practitioners to facilitate recovery in a group setting, a key benefit of this classroom-based approach is that it was done in the context of supportive peers who are experiencing similar post-concussion symptoms.

2.2 Methods

2.2.1 Participants

Participants (n = 71; 45 females) were drawn consecutively from referrals to the outpatient acquired brain injury (ABI) team by family physicians, the facility's inpatient program or through an area sports medicine clinic. Participants were aged 15 to 56 (*M* = 23.6, SD = 8.8), with the majority aged 18-24. A histogram of participant ages is presented as Figure 2.1.

Figure 2.1. Histogram of participant ages



Every participant had a formal diagnosis of concussion by a physician or psychologist, and all had exhibited some (or all) of the following symptoms: fatigue, memory loss, attention deficits, social communication challenges, verbal difficulties, speed of processing issues, and writing challenges (i.e. difficulty generating ideas, no cohesiveness, difficulty organizing writing structure and brain storming challenges). Additionally, many of these participants experienced insomnia, anxiety and light/noise sensitivity. The mechanism of injury for these participants varied, as did their report of the constellation of symptoms they experienced. The average time from injury to admission in the program was nineteen months and 9 days – accordingly, there had been ample opportunity for spontaneous remission of concussion symptoms – and all participants had completed a period of post-concussion rest. All participants were required to participate in a formal cognitive-communication assessment that was supervised by a speech-language pathologist (SLP). This cognitive-communication assessment was used to determine the suitability of the individual for the intervention, and individuals who demonstrated significant behavioral or social communication challenges that might hinder the participation of other group members were excluded from the study.

2.2.2 Procedure

The group therapy described in this study is a seven-week classroom-based intervention facilitated by Speech Language Pathology services within a rehabilitation institute for physical and mental health care. Over the course of a two-year period, 8 groups of 7-10 individuals completed the 7-week block of treatment for a total of 56 non-consecutive sessions. Each of the weekly sessions (typically held on Mondays) were two hours in duration and involved providing instruction on topic-specific interventions that might be helpful in managing re-integration into their work and/or school environments (see Appendix A for a detailed description of the weekly content). All sessions were facilitated by the same clinician, and this clinician worked from a clinical manual that was developed at the outset of the two-year period described within this program evaluation.

The weekly topics chosen for the intervention (and the strategies implemented within each topic) were selected by the clinician facilitator, based on her experience with this population. Each of the weekly topics were, however, developed with an eye to improving components of cognitive performance through the use of learning strategy instruction. Although this has not, to the best of our knowledge, been specifically evaluated among individuals recovering from concussion, learning strategy instruction has been demonstrated to be useful for individuals with a wide variety of ability levels

(Donker, de Boer, Kostons, Dignath van Ewijk, & van der Werf, 2014), and so it is reasonable to expect that it will have a positive effect on individuals with persistent post-concussion symptoms. The specific topics chosen for the intervention were as follows:

Week 1 (introduction). This consisted of a full overview of concussion, including basic neuroanatomy, as well as what to expect in terms of symptoms. Access to guidance, as well as student services and accommodations, were introduced. Also, this class introduced methods of pacing and planning in the management of symptom threshold.

Week 2 (social communication). During this week, participants were shown methods of addressing their experiences with increased irritability and frustration, as well as decision-making strategies that may be used when filtering their own speech.

Week 3 (reading). Participants were introduced to several different methods of facilitating reading. For example, instruction was provided on the use of blinders, to improve reading efficiency, and visual retraining through reduction of competing visual noise.

Week 4 (technology). In this topic, individuals were given an opportunity to experience and explore different types of technology to assist them in their return to the learning environment. Several software applications were presented to address some of the attention and organization issues in this population.

Week 5 (study skills). This module covered learning and memory techniques for encoding and retention. Given known issues with fatigue and the need for energy conservation, evidence based approaches to study skills were emphasized (e.g., the importance of using practise tests for studying).

Week 6 (writing). This week explored approaches for facilitating written expression. For example, challenges getting ideas to paper and brainstorming. In addition, an approach to note taking called *Cornell notes* was presented and practiced in this class (Donohoo, 2010).

Week 7 (wrap-up). Participants were given the opportunity to go over specific areas of difficulties that they identified in week 5 when asked to submit questions on topics that they had found challenging. This was, essentially, a review class that participants could use to go over techniques and methods.

Prior to the beginning of each session, participants were given an evaluation form on which they were asked to rate their overall symptom severity on a scale from 0-10, where zero indicated no symptoms or difficulties, and ten indicated severe symptoms. Once the session was completed, participants were asked to re-rate their symptoms on the same scale. Participants were unable to review their pre-session scores while completing their post-session evaluation, but scores were matched within session. All responses were submitted anonymously, to ensure that participants would feel comfortable providing accurate and honest self-appraisals. Unfortunately, this meant that it was not possible to match scores between sessions.

Participants were also given a cognitive-communication assessment by a speech-language pathologist, before their first weekly session, and again after their seventh weekly session. Participants were given oral scripted descriptions, along with concrete examples, for each of the nine cognitive-communication domains: (1)

Attention/Concentration; (2) Verbal Memory/New Learning; (3) Auditory Comprehension/Information Processing; (4) Verbal Expression; (5) Reading Comprehension; (6) Written Expression; (7) Social Communication; (8) Reasoning/Problem Solving; and (9) Executive Function. Participants orally rated their function on each domain, on a scale of 1 to 10, with higher scores indicating more concern with that domain. The clinician script for this measurement is presented in Appendix B.

2.2.3 Results

In total, 71 participants completed the training sessions with an average attendance rate of 6.47 out of 7 sessions. The effectiveness of the intervention was assessed in two separate analyses: week-by-week changes in symptom severity using the self-reported overall symptom score that was assessed weekly, and overall effectiveness using the nine dimensions of the cognitive-communication screen that was assessed before and after the 7-week intervention.

Weekly Changes in Overall Symptom Severity

Week-by-week changes in symptom severity were evaluated within a split-plot analysis of variance (ANOVA), in which *week* (7 levels) and *time* (2 levels - *before* versus *after*) were used as between- and within-subjects independent variables, respectively. Descriptive statistics for this analysis are presented in Table 2.1.

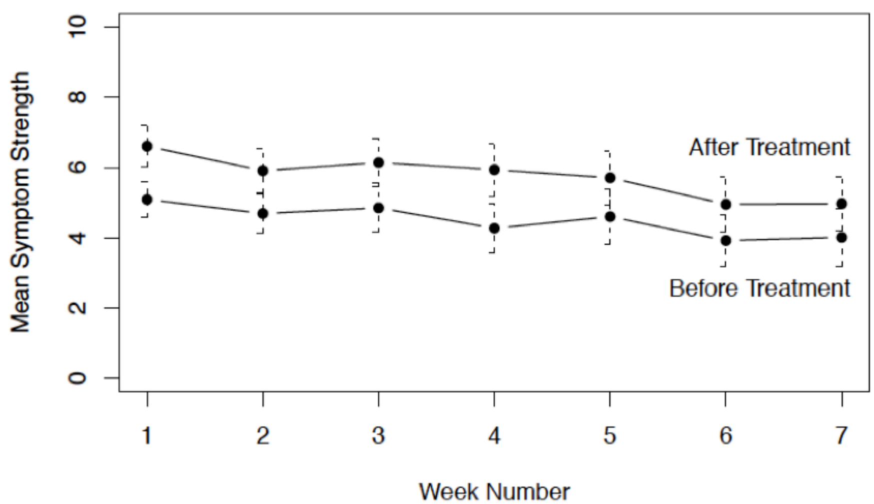
Table 2.1. Descriptive statistics for each session

Week	Topic	Pre-treatment Mean (SD)	Post-treatment Mean (SD)
1	Introduction	5.09 (1.94)	6.61 (2.22)
2	Communication	4.69 (2.09)	5.91 (2.41)
3	Reading	4.85 (2.53)	6.14 (2.49)
4	Technology	4.27 (2.53)	5.94 (2.79)
5	Study Skills	4.60 (2.69)	5.17 (2.66)
6	Writing	3.92 (2.57)	4.95 (2.75)
7	Wrap-up	4.01 (2.82)	4.97 (2.67)

The interaction effect between *week* and *time* (i.e., before and after treatment) was not statistically significant, $F(6, 343) = 1.53$, suggesting that symptom exacerbation by treatment was consistent between weeks. There was, however, a main effect of week, $F(6, 343) = 2.29$, $p < 0.05$, suggesting that there was a significant difference between the weeks, in terms of self-reported symptom severity. Furthermore, there was a main effect of time, $F(1, 343) = 255.69$, $p < .05$, suggesting that there was a difference in symptom severity before and after treatment.

An examination of the quantile-quantile plot of the model residuals suggested that there is no substantively significant departure from normality and Levene's test revealed no statistically significant heterogeneity of variance. Examination of the descriptive statistics presented in Table 2.1 suggested that scores demonstrate a statistically significant within-session increase, before returning to a value close to baseline by the beginning of the next weekly session. Furthermore, there is a general downward trend for the symptom scores across the seven weeks of the educational intervention. Post-hoc analysis of means (using Tukey's HSD) suggests that self-reported symptoms were significantly higher in week 1 than in either week 6 or week 7. This is presented graphically in Figure 2.2.

Figure 2.2 Mean weekly symptom strength (+/- SE)



Changes in Self-Reported Domains of Cognitive-Communication Performance

The nine self-reported domains of cognitive-communication performance were evaluated within a multivariate repeated measures analysis of variance, with two levels of the repeated measure (i.e., *before* and *after* the 7-week intervention). Descriptive statistics for this analysis are presented in Table 2.2

The multivariate effect was statistically significant, $F(9, 56) = 2.162$, $p < .05$, suggesting that the canonical variate created from an optimally-weighted composite of the nine domains of cognitive performance demonstrated a statistically significant change over the course of the intervention. This significant multivariate effect also suggests that the univariate tests associated with each of the nine domains may be evaluated without adjustment to their individual alphas (Hummel & Sligo, 1971). Univariate F-ratios are also presented in Table 2.2. Results suggest that attention and concentration, verbal memory and new learning, reading comprehension, and social communication demonstrate a statistically significant improvement following treatment.

Table 2.2. Descriptive statistics for the nine cognitive-communication domains, before and after the 7-week intervention.

Cognitive-Communication Domain	**Mean (SD)**		**Change F(1,64)**
	Before Treatment	**After Treatment**	
Attention and Concentration	6.45 (2.22)	5.77 (2.24)	7.68*
Verbal Memory and New Learning	6.20 (2.44)	5.52 (2.33)	5.35*
Auditory Comprehension and Information Processing	5.20 (2.75)	5.08 (2.18)	0.10
Verbal Expression	4.73 (2.61)	4.68 (2.36)	0.03
Reading Comprehension	5.50 (2.73)	4.66 (2.54)	6.99*
Written Expression	4.62 (2.78)	4.32 (2.64)	0.74
Social Communication	5.72 (2.87)	4.62 (2.38)	7.35*
Reasoning and Problem Solving	4.17 (2.98)	4.31 (2.57)	0.15
Executive Function	4.73 (2.96)	4.08 (2.55)	2.33

* significant at $p < 0.05$

2.3 Discussion

The present findings suggest that individuals with concussion who are rehabilitated in a simulated classroom environment, with the help of specific modalities and interventions presented and practiced, show a statistically significant reduction in post-concussion symptoms. These individuals do, however, show a statistically significant increase in symptom scores immediately after each session, as compared with their self-reported symptom scores before each session. This is not unexpected, as the intervention is likely to provide some level of cognitive stimulation, in the course of providing instruction on practical strategies that are useful to participants in their management of symptoms. Furthermore, given the persistent nature of the symptoms reported by individuals within this treatment cohort, it is also possible that there is a significant emotional overlay associated with the symptoms, thereby increasing perceived symptom severity without necessarily requiring substantive cognitive stimulation.

Despite this transient increase in symptom complaint, however, the overall trend in symptom strength is downward, suggesting that the treatment is, by and large, effective. Furthermore, the week-to-week exacerbation of symptoms was not perceived to be sufficiently aversive as to markedly affect treatment adherence – approximately 92.5% of participants maintained full attendance in the treatment program. Qualitative feedback (not reported in this paper) further supports the notion that the sessions were perceived by the participants to be helpful.

The intervention appears to have been particularly helpful for the amelioration of attentional issues, verbal memory and new learning, reading comprehension, and social communication. No significant improvement was demonstrated for self-reported memory function, auditory comprehension, written expression, reasoning and problem solving, or executive function. Future iterations of this intervention may need to focus additional efforts on improvements within these domains.

Recent studies have illustrated the importance of having a return-to-learn team that consists of academic members (teachers, counselors, school nurses, etc.) and non-academic members (physicians and other healthcare providers, parents, etc.). This team can work towards the modification of both the school and home setting, with the goal of improving rehabilitation, as well as reducing the risk of re-injury (Halstead et al., 2013). Many students require adjustments to the classroom environment such as; preferential seating, dimming lights or working in natural light which may help with the student's performance in the class. It is essential to accommodate and modify the school setting to optimize the transition back to school. There has not, however, been one specific guideline established for return to learn for those suffering a concussion, however, numerous researchers agree on the demand for essential return to learn accommodation such as, excused absences, rest periods (pacing and planning), assignment extension, rescheduling of test and exams etc. (Wright, 2014).

Also significant within this intervention is the key role played by speech pathology in the design and implementation of the intervention. There is a growing appreciation for the role of speech-language pathologists in the clinical management of individuals with concussion, as individuals with such injuries may benefit more from speech-language pathology services than they would from the provision of medical treatment, particularly with regards to the restoration of cognitive, psychosocial, and communication deficits (Krug & Turkstra, 2015). As the present research does not include a medical treatment control group, future research may benefit from systematic evaluation and comparison of treatments that are based on biomedical approaches, and treatments that are based on rehabilitation theory.

The present research represents the first attempt at describing a group intervention aimed at providing individuals with persistent post-concussion symptoms with adaptive skills for returning to learn. While the core recommended concussion treatment continues to be physical and cognitive rest, the present study provides direction for healthcare providers in working with individuals that are unable to return to learn after this preliminary treatment strategy. This strategy of extending beyond a simple *rest to recover* approach is supported by other researchers (e.g., de Kruijk et al., 2002) who find consistently that some individuals do not experience full recovery with this approach alone. Modified learning strategies are critical for individuals of all ages in the management and control of their symptoms, and in their ongoing efforts to accommodate their new cognitive-communication reality.

The present study is, of course, limited by its relatively small sample size – and the fact that this initial evaluation of the intervention has no control group (owing to the fact that it is based on information collected as part of a program evaluation of ongoing clinical care). Participants were also quite heterogeneous in their age (again, owing to the clinical context in which the data was collected), which may be problematic for application to narrower age bands. Future research should include greater measurement of demographic variables, in an effort to identify individual differences that predict greater responsiveness to modified learning strategies. This may result in finding profiles that better predict which individuals are ready to return to school and most importantly, which personal or environmental factors might be predictive of eventual graduation success.

The present research also relied on self-reported symptom severity, which may differ from objective measurements of symptom strength, as might be obtained through the evaluation of standardized cognitive-communication measurements. Although this is a weakness of the present research, particularly given that research has suggested that there may be a lack of awareness of some types of cognitive / social deficits among individuals with concussion (Wolfe et al., 2015), this variable does speak to individual perceptions of function, which is quite important as a clinical outcome variable. In other words, the present study suggests that individuals *perceive* themselves to have experienced a positive change – and this is, inarguably, a positive step on the road to recovery from persistent post-concussion symptoms. Future research may extend this measurement to functional outcome variables that are more representative of the central goal of this rehabilitation strategy, in an effort to evaluate the extent to which individuals are successful in their efforts at returning to their pre-injury functional capacity within their activities of daily living.

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Chapter 3

3.1 Discussion

Although there continues to be a significant amount of research on the identification and diagnosis of concussion, there is a lack of evidence for effective methods of treating and managing this injury, and so there is very little data surrounding the effectiveness of return-to-learn and return-to-play protocols (Bloom, Loughead, Shapcott, Johnston, & Delaney, 2008). Advances in our understanding of the basic underlying physiological and psychological effects of concussion may, however, enhance management protocols for individuals with concussion (Losoi et al., 2015).

In the present study (chapter 2), we evaluated a seven-week simulated classroom-based intervention program for the rehabilitation of individuals with persistent concussion symptoms. Prior to beginning the program, participants had persistent symptoms that resulted in difficulties in coping with returning to the learning environment, as well as with activities of daily living. Despite the fact that this program was primarily group-based, and was not designed around an individualized, one-on-one therapeutic approach, participants demonstrated an overall decrease in symptom severity (i.e., over the seven weeks of the treatment program).

Not surprisingly, participants demonstrated a transient increase in their weekly symptom scores, when measured before and after their weekly sessions. Given that individuals were given cognitive activities to perform within each session (not to mention the cognitive stimulation that was occurring as they learned new skills and strategies within the sessions), this is likely to lead to significant neuronal activation, and it is likely that this produced higher symptom scores. According to Wright et al. (2014), cognitive stimulation and exercise increases metabolic activity in the brain. This may increase symptoms, and may degrade the energy mismatch in the brain. Energy mismatch is produced by cellular membrane disruption from the robust force to the head, correspondingly reducing cerebral blood flow (Wright, 2014). We believe that the increase in symptoms seen within sessions is indicative of an appropriate level of cognitive stimulation – owing both to its transient nature, and the fact that participants saw an overall downward trend in their symptoms. Thus, this cognitive stimulation is not harmful, but is a method of allowing individuals to gradually progress in their recovery.

Recent research (e.g., Thomas et al., 2015) has examined the effects of rest on symptom management and concussion recovery, and has found no differences between patients that were prescribed full rest, and patients that were prescribed a gradual trajectory for their return to learn. Coupled with results of the present research, this suggests that there is a benefit from a gradual increase in physical and cognitive intensity until symptoms have resolved, whereupon the individual can return to his or her former level of activity.

Thomas et al. (2015) conducted a randomized control trial that evaluated the effects of rest recommended at the emergency room for patients who sustained a concussion. They studied a total of 88 individuals with concussion, aged 11 to 22 years. Forty-five of these individuals were instructed to rest for 5 days (i.e., no school, work, or physical activity), while the remaining 43 individuals were instructed to take 1 to 2 days of rest, followed by a gradual return to physical activity. All participants underwent neurocognitive, balance, and symptom assessments at baseline, and the groups were found to be similar on these standardized metrics. Results showed no between-group differences in symptom recovery between both groups, leading the authors to conclude that recommending strict bed rest following a concussion provides no benefit to adolescents with concussion symptoms.

Most individuals report a complete resolution of post-concussion symptoms within a few weeks of their injury – but approximately 15% to 20% of individuals with concussion continue to struggle with their symptoms for months, or even years (Ryu et al., 2009). Eisenberg, Meehan, and Mannix (2014) examined the incidence and duration of post-concussion symptoms in patients with concussion, and found that headache, sleep disturbances, attentional difficulties, irritability, and delayed thinking were the most common symptoms associated with such injury – and took the longest to resolve (persisting to more than a month post-injury for approximately 20% of the sample). These results were echoed within the present research, as the majority of our participants anecdotally reported that sleep disturbances, irritability, frustration, and attentional difficulties were making it very difficult to maintain successful academic performance.

3.2 Future directions

As illustrated briefly in the foregoing, there is a dearth of research on guidelines for the treatment of concussion – and substantial equivocation as to the utility of full rest. This has resulted in substantial variability in published guidelines for concussion management within ‘return to play’ and ‘return to learn’ protocols. population. Furthermore, because the diagnosis of concussion is primarily based on the clinical identification and cataloguing of symptoms, there is a substantial need for objective diagnostic indicators for concussion, as these may be useful for the objective quantification of recovery (and may be useful in establishing programs of gradual cognitive and physical stimulation).

Because concussion treatment and management remains a fairly subjective domain, that is largely based on clinical expertise rather than objective criteria, further research that includes individuals with atypical recovery times (i.e., individuals with persistent post-concussion symptoms) is needed. This research is likely to produce better clinical guidelines that may establish both the nature and intensity of interventions that may be utilized within return-to-learn protocols, As this is likely to involve having individuals return to the workplace or classroom before symptoms have fully resolved, this research should also investigate methods of accommodating these symptoms throughout the recovery process. This will necessitate the development and testing of evidence-based educational programs for health care providers, school administers, teachers, counselors, school nurses and parents, surrounding the effects of concussion on cognitive and physical function, as well as social behaviors. Finally, further research needs to be conducted on the emotional supports that are necessary for individuals that are re-integrating into their former activities following concussion. This support is critical in maintaining the mental health of concussed individuals throughout their recovery, as well as ensuring a reasonable level of adherence to return-to-learn and return-to-play recommendations.

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Appendices

Appendix A. Detailed description of the weekly content.

Week	Interventions	Objective / Description
1. Introduction	Education • neuroanatomy overview • diagnostic criteria for post-concussion syndrome • symptoms review and discussion of accommodations	• provision of early education and reassurance is known to reduce the risk of persistent symptoms in concussion • reassurances to participants that they are not alone • reassurances that others share similar symptoms may reduce feelings of anxiety, aloneness and stigma
	Planning and Pacing Graphs	• learning to gradually increase activity tolerance without increasing symptoms or crossing the symptom threshold • learning to gradually increase activity tolerance without increasing symptoms or crossing the symptom threshold
2. Social Communication	Mentor Imaging	Exercise designed to bring to life someone of great personal influence. This mentor image is then used to drive decision making about when to speak up and when to filter.
	Power Posing	Attempts to influence anxiety and eroded confidence by changing hormone balance of cortisol and testosterone through power posing.
	Education • social communication changes post-concussion • verbal versus non-verbal communication • importance of reframing • using positive momentum to move forward • presentation tips for success	Review / Discussion of TED Talk: Make Stress Your Friend

Appendix A. Detailed description of the weekly content (continued)

3. Reading	Timer	Using a timer to facilitate planning and pacing, and stay aware of symptom onset where possible. May assist in recalibrating temporal disorientation and loss of sense of passage of time in patients post-injury.
	Vision Exercises – Saccades	Occupational Therapist presents on the topic of visual scanning within the visual system. Home practice materials are assigned
	Blinder	Use of a blank sheet of paper, index card, or *window* for reading assists in improving reading efficiency when struggling to ignore competing text, keep their place on the page and efficiently scan text.
	Binasal Occlusion (BNO) under the guidance of an optometrist	Review of, and practice with, BNO as an intervention for reading issues encountered post-concussion
	Reading Aloud	Used as a means of improving attention to text, processing, and later recall. Reading aloud activates visual, motor, and auditory areas of the brain to promote push to memory.
	Colour Overlays	Borrowed from the literature on learning disabilities and dyslexia, use of colour overlaps may reduce strain and improve efficiency and retention during reading tasks. Individuals explore the impact of different coloured overlays on text. Packages of colour overlays provided in resource materials
	SQ3R • Survey • Question • Read • Recite • Review	A structured approach to reading is introduced and practiced. In particular, individuals are encouraged to implement Survey and Question as priorities in their reading moving forward.
	Kurzwell / Voice Dream	Both techniques provide text to speech support. Voice dream has built-in blinders. Kurzwell techniques are supported by many College and University Student Services Departments.
	Evernote Clearly	Participants are introduced to this application for distraction-free web browsing with Chrome and Firefox platforms.

Appendix A. Detailed description of the weekly content (continued)

4. Technology	Education on the role of technology as an aid, as opposed to a distraction	Video: Look Up
	Review of Kurzwell / Voice Dream	See week 3 (Reading) section
	Accessibility Controls	Increase awareness of internal settings available on devices to reduce symptoms (e.g., brightness, invert colours, narrator and text to speech)
	Dragon Natural Speaking and Dragon Dictate	Speech to text options are presented for individuals who may find it easier to dictate their ideas or brainstorm aloud. DNS is a user-trained option that has learning capabilities. Dragon Dictate is an app version that is simplified but not capable of learning.
	LiveScribe SmartPen	The SmartPen is presented to participants as a means of more efficient note-taking, and is camera-driven. It uses specialized notepaper to allow synchronized audio recording with handwritten note-taking. Handwritten note-taking may improve recall over keyboard note-taking.
	Digital Highlighter	While traditional highlight during reading shows low utility, efficiency in highlighting is possible with optical character recognition technology. Great for article reviewing.
	Digital Recorders	Discussion of the possible role of digital recording, and discussion of consent.
	Apps / Software: • OneNote • Evernote Clearly • Stay Focused • It's Done • 30/30	**OneNote:** Participants are made aware of the organization capabilities of this software but most importantly its ability to serve as a digital recorder. It is able to synchronize audio recording with their note-taking via laptop. Additionally, OneNote ensures backup and saving through its auto-saving feature. **Stay Focused:** Limits time spent on websites that you pre-identify as *off task*. **It's Done:** Reassures participant that routine tasks (e.g., turning off the coffee maker) are completed, through tracking and notifications **30/30:** A planning and pacing assist. You establish the task lists and this app helps you set the pace and rest periods. Also assists with temporal re-orientation (i.e., awareness of passage of time), as this is often an area of concern post-concussion.

Appendix A. Detailed description of the weekly content (continued)

5. Study Skills	Learning Channels	Individuals are made aware of, and encouraged to use, different channels for learning, including visual, auditory, and kinaesthetic. Approach to study may change according to material.
	Memory Techniques	Various techniques for encoding and retaining are presented (visual imagery, association, first letter clues, auditory rehearsal, rhymes, mnemonic devices, story method, chunking, diagrams, and mind mapping).
	Education: • Neurobonkers (evidence-based studying) • Exam-time / GoConqr	Presentation of common techniques used in studying, and the utility of each.
6. Writing	Cornell Notes	Structured note-taking method presented and practiced.
	LiveScribe SmartPen	See week 4 (Technology) section.
	Voice Dream Writer	Writing assistance using software support for spelling, proof reading, text to speech, and idea generation.
	Mindmapping	Approach to brainstorming and creating outlines, as well as support for essay writing.
7. Wrapup	Education / Review	Topics for this session are generated, in part, by the participants in each series
	Review and Collection of Attention Process Training (APT) and Jump Drives	For those individuals identified as having greater attention issues on pre-measures (APT Testing), home practice jump drives that had been given are now collected. Discussion about level of difficulty, and a decision concerning further programming and practice with these devices is made

Appendix B. Patient Self-rating/Reporting Form

Pre	Post	
/10	/10	**<u>Attention/Concentration</u>** *Start with open-ended question: Tell me about your attention/concentration...* *Do you have trouble with interruption and coming back to task?*
/10	/10	**<u>Verbal Memory/New Learning</u>** *How well do you remember what you hear? If someone tells you to do something, can you remember what it was and follow? What about your ability to learn new things? Not so much from your past, but since your injury, how is your memory?*
/10	/10	**<u>Auditory Comprehension and Information Processing</u>** *How well do you understand what others are saying? In the classroom do you easily process what the instructor is presenting?*
/10	/10	**<u>Verbal Expression and Discourse</u>** *How are you at word-finding? Formulating your thoughts? Expressing your ideas? Presenting?*
/10	/10	**<u>Reading Comprehension</u>** *Can you understand what you read or do you need to re-read it several times to understand it? Do you need to use a dictionary to help you understand what you read? Is your reading efficient (consider: email, textbooks, novels)?*
/10	/10	**<u>Written Expression</u>** *Consider text, emails, essays, tests. Are you able to get your ideas down on paper?* *Do you make errors in your writing that are surprising (e.g. exchange words, spelling)?*
/10	/10	**<u>Social Communication and Pragmatics</u>** *Are there any changes to your personality? (Introvert <--> extrovert)?* *Short fuse, temper, irritability? (Different than pre-injury emotions)*
/10	/10	**<u>Reasoning and Problem Solving</u>** *If faced with a challenge, can you come up with a solution? Sometimes I give an example, if you are locked out of the house, can you figure out how you could get in? If you forgot your assignment at home and it's due today, can you come up with a decision/conclusion? Can you see things from multiple perspectives (e.g. point of view of another group member during group work)?*
/10	/10	**<u>Executive Functions</u>** *How is your planning and organizing?* *How did you get to this appointment today?*

Appendix C. Ethics Documentation

Western Research

Research Ethics

December 18, 2015

Re: Evaluation of the Return to School (RTS) Group Initiative

The HSREB Chair has reviewed the above-referenced project and it does not require approval of a Research Ethics Board. In accordance with the Tri-Council Policy Statement 2: Ethical Conduct of Research Involving Humans, Article 2.5. "Quality assurance and quality improvement studies, program evaluation activities, and performance reviews, or testing within normal educational requirements when used exclusively for assessment, management or improvement purposes, do not constitute research for the purposes of this Policy, and do not fall within the scope of REB review".

In my opinion, the above-referenced research project falls within that description.

I wish you the best of luck with your work.

Curriculum Vitae

Education:

- Kuwait University, Allied Health Sciences, BSc in Physical Therapy, June 2013
- The University of Western Ontario, MSc in Health and Rehabilitation Sciences, Health Promotion, 2014-Present

Awards:

- 1st Place award, Annual Poster Day 2013, Kuwait University

Volunteer work:

- Kuwait Group for Peritoneal Surface Malignancy Campaign (Sponsor and Founder by Dr. Amani Al-Bedah)
- Dr. Peter Lemon (School of Kinesiology, U.W.O.)
- Dr. Susan Scollie (School of Communication Sciences and Disorders, U.W.O.)

Employment:

- Research Assistant, School of Communication Sciences and Disorders, U.W.O., Dr. Susan Scollie, 2014
- Teaching Assistant, U.W.O., Introduction to Ethics (HS 2610G), April 2014
- Teaching Assistant, U.W.O., Introduction to Ethics (HS 2610G), April 2015

Presentation:

- Annual Poster Day at the Faculty of Allied Health Sciences, May 2013
- Al-Qenai, B., Welch-West, P., Longval, M., Holmes, J.D., and Johnson, A.M. (2016). An evaluation of the effectiveness of a simulated classroom-based intervention on concussion rehabilitation. *HRS Research Forum, U.W.O., February.*

Publications:

- Welch-West, P., Al-Qenai, B., Longval, M., Marshall, C., Holmes, J.D., and Johnson, A.M. (in preparation). An Evaluation of the Effectiveness of a Simulated Classroom-based Intervention on Concussion Rehabilitation.