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Management of Persistent Cognitive Symptoms After Sport-Related Concussion

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Purpose: This case review examines treatments speech-language pathologists at our clinic delivered to middle school, high school, and college students for the management of persistent cognitive symptoms after sport-related concussion. The goal is to examine a range of treatment options, describe clinical rationale for selecting those treatments, and report outcomes in order to identify feasible interventions for systematic evaluation through efficacy research.

Method: Review of clinic intake data identified 63 cases referred for cognitive rehabilitation over a 36-month period. Twenty-four cases (14 women and 10 men) met selection criteria, including documented sport-related concussion, postconcussion symptoms persisting at least 2 months with deleterious effect on school performance, and enrollment in secondary or postsecondary education. The authors independently coded demographics, treatment approaches, functional goal domains, and outcomes.

Results: Treatment approaches fell into 4 broad categories: direct attention training, metacognitive strategy training, training assistive technology for cognition, and psychoeducational supports. Eighty-three percent of clients achieved self-selected functional goals.

Conclusions: Research has focused primarily on return to play and provision of academic accommodations in the initial weeks following concussion. Findings from this case series suggest that speech-language pathologists can deliver individualized interventions that lead to positive clinical outcomes. The authors hope findings encourage efficacy research.

Sport-related concussion cases in the United States occur at levels reported as high as 1.6–3.8 million annually, with as many as 50% of concussions going unreported (Doolan, Day, Maerlender, Goforth, & Brolinson, 2012; Harmon et al., 2013). An estimated 5%–15% of these cases experience ongoing cognitive and somatic symptoms persisting 90 or more days following a concussion event (Barlow et al., 2010; De Beaumont, Henry, & Gosselin, 2012; Eisenberg, Meehan, & Mannix, 2014). High school athletes appear to have some of the most disruptive and persistent symptoms after sustaining concussions, and the numbers of these cases seem to be increasing (Cancelliere et al., 2014; Karr, Areshenkoff, & Garcia-Barrera, 2014; Mitka, 2010).

Recommendations for symptom assessment and management to determine when, and if, athletes are ready to return to play following concussive injuries are a primary focus in the sport concussion literature (Doolan et al., 2012; Harmon et al., 2013). Current clinical management protocols almost exclusively address management within the first 1 to 2 months postconcussion and recommend the following: (a) preconcussion education and neurocognitive baseline testing, (b) immediate concussion screening and ongoing follow-up if symptomatic, (c) neurocognitive assessment with physical and cognitive rest if symptomatic, (d) physician management of any residual somatic symptoms, and (e) academic accommodations if school performance is affected (Knollman-Porter, Constantinidou, & Marron, 2014). Less studied are therapeutic methods to manage and mitigate persistent cognitive and somatic symptoms adversely affecting school performance and participation in extracurricular activities beyond return to a target sport. Although clinical researchers have set forth guidelines for concussion management to clarify roles of speech-language pathologists (SLPs; e.g., Knollman-Porter et al., 2014; Salvatore & Fjordbak, 2011), little direction exists to guide SLPs in making treatment decisions for clients presenting with persistent cognitive symptoms postconcussion.

Implementation science reveals that it takes one to two decades to translate research into evidence-based practice using traditional phased research (Burke & Gitlin, 2012), and calls for early partnering between practitioners and researchers to direct research that will ultimately result in clinical practices that can be adopted by care providers in real contexts (Turner, Misso, Harris, & Green, 2008).

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Currently there are no evidence-based guidelines for the management of persistent cognitive symptoms following concussion. This article summarizes the clinical course of students with persistent cognitive symptoms following sport-related concussion. The goal of this retrospective case review is to examine a range of treatment options, including the clinical rationale for treatment selection and the associated clinical outcomes, in order to identify feasible intervention approaches that can be subjected to experimental evaluation. The ultimate objective is to generate evidence-based practice guidelines. We begin with a review of the characteristics of this population and the current treatment context for young athletes with persistent cognitive and somatic symptoms following concussion.

Concussion Symptomatology

A consensus panel of the Fourth International Conference on Concussion in Sport held in Zurich, in November 2012, defined concussion as "a brain injury [and] complex pathophysiological process affecting the brain, induced by biomechanical forces" (McCrory et al., 2013, p. 250). According to the panel, one of the following symptom domains should be present to meet criteria for a concussion diagnosis: somatic, cognitive, or emotional symptoms; physical signs; behavior changes; cognitive impairment; or sleep disturbance (McCrory et al., 2013). The panel listed four constructs of clinical, pathologic, and biomechanical injury for use in defining concussive head injury: (a) direct blow to head, face, neck, or somewhere on the body and transmitting impulsive force to the head; (b) rapid onset (over minutes or hours) of short-lived, spontaneously resolving neurological impairment; (c) possible neuropathological changes with acute clinical symptoms reflecting mainly functional disturbance versus structural injury, and no structural abnormalities observed via standard neuroimaging; and (d) may or may not involve loss of consciousness (LOC), usually sequential symptom resolution, with some symptoms taking longer to resolve (McCrory et al., 2013). Other definitions have specified objective time and severity parameters such as LOC that must be less than 30 min, posttraumatic amnesia absent or less than 24 hr in duration, and an initial Glasgow Coma Scale score greater than 13 (Chachad & Khan, 2006).

The concussion descriptors overlap with the definition of mild traumatic brain injury (mTBI; Carroll et al., 2004). Recent guidelines support the interchangeable use of the terms *mTBI* and *concussion* (S. Marshall, Bayley, McCullagh, Velikonja, & Berrigan, 2012). Giza et al. (2013) provided a general definition of concussion that encompasses relevant parameters: "a recognized clinical syndrome of biomechanically induced alteration of brain function, typically affecting memory and orientation, which may involve LOC" (p. 2250). There is agreement across all definitions of concussion and mTBI that the mechanism is a biomechanical force sufficient to cause temporary alteration in mental status and that LOC is not a required defining component.

Cases With Persistent Cognitive Symptoms

A subset of concussion patients suffers cognitive and somatic symptoms persisting greater than 90 days after sustaining a concussive injury (Eisenberg et al., 2014). These complex concussion cases have been recognized as a clinical group with symptom profiles that have a deleterious effect on individuals' day-to-day functioning (Makdissi, Cantu, Johnston, McCrory, & Meeuwisse, 2013; McCrory et al., 2013; Shenton et al., 2012). Common symptoms that can persist include fatigue, lightheadedness, persistent headaches, sensitivity to light and sound, irritability, emotional lability, as well as attention and memory problems, and in some cases, anxiety and depression (Chachad & Khan, 2006; Eisenberg et al., 2014; C. M. Marshall, 2012). Some researchers have described cases with persistent symptoms as having *postconcussion syndrome* (PCS; Barlow et al., 2010; Chachad & Khan, 2006; McCrea, 2008). McCrea (2008) characterized PCS as involving symptoms persisting more than 3 months after injury, explaining that some PCS cases involve psychosocial and iatrogenic factors influencing or mediating ongoing symptoms beyond neurological effects (McCrea, 2008). Barlow et al. (2010) found that 13.7% of 670 school-aged children with PCS symptoms following mTBI remained symptomatic 3 months after injury. The authors noted that their findings could not be explained by trauma, family dysfunction, or maternal psychological adjustment (Barlow et al., 2010). Of relevance, neuroimaging findings have provided evidence of subtle brain changes associated with persistent postconcussion symptoms (FitzGerald & Crosson, 2011; Green, Koshimori, & Turner, 2010; Shenton et al., 2012).

Prevalence of Cognitive Impairments

In a systematic review summarizing the evidence on concussion prognosis, Cancelliere et al. (2014) found that memory and attention difficulties were the most commonly reported cognitive symptoms persisting following concussion. The review revealed that the cognitive symptoms associated with longer recovery included impaired reaction time, visual memory, verbal memory, and in some studies, amnesia (Cancelliere et al., 2014). Eisenberg et al. (2014) reported that slowed processing and poor concentration persisted at the 90-day mark for fewer than 5% of individuals 11–22 years old, but that these cognitive symptoms persisted for a higher percentage of those patients than did emotional or somatic symptoms.

Contributing Factors

The mechanisms responsible for the cognitive, as well as psychosocial and somatic, symptoms affecting return to typical activity following concussion are multifactorial (Cancelliere et al., 2014; Harmon et al., 2013). Ongoing symptoms may be related to structural brain damage or changes mediated by functional neurometabolic processes (Giza & Hovda, 2001; Harmon et al., 2013). Somatic symptoms such as headache can also affect cognitive and psychosocial functioning (Eisenberg et al., 2014). Medication effects, iatrogenesis, psychological factors including symptom magnification, and reinforced behavior have all been implicated as possible contributors to persistent symptoms following concussion (McCrea, 2008). Recent efforts to clarify prognosticators of persistent concussion symptoms suggest that children and adolescents may develop symptoms with an emotional component either due to pathophysiologic changes, psychosocial consequences resulting from the rest protocol during recovery, or a combination of these factors (Eisenberg et al., 2014; Zemek, Farion, Sampson, & McGahern, 2013).

Cancelliere et al. (2014) found that recovery is lengthier for high school athletes, those with prior concussions, and those with greater duration and number of symptoms following concussion. Style of play and returning to higher levels of sports activity following concussion have been associated with greater incidence of cognitive impairment among high school athletes, (Maher, Hutchison, Cusimano, Comper, & Schweizer, 2014; Majerske et al., 2008). Athletes tend to sustain more concussions in sports and game positions where collision and impacts occur more frequently, as in soccer (Harmon et al., 2013; Maher et al., 2014). Level of sports activity following concussion is also a possible contributor to ongoing cognitive symptoms (Majerske et al., 2008). Majerske et al. (2008) analyzed neuropsychological test performance of high school athletes who had received concussions. They found that higher activity levels postconcussion predicted poorer performance on visual memory and reaction time tasks (Majerske et al., 2008). Gender differences have also been implicated in persistent cognitive symptoms. Majerske et al. (2008) found that female athletes were followed longer clinically than male athletes in their sample, and female athletes showed greater impairment on tests of visual motor speed.

A history of previous concussions has also been linked to increased risk for persistent symptoms (Cancelliere et al., 2014). According to the Zurich 2012 consensus panel, teen athletes demonstrate an increased risk for multiple concussions, with repeated concussions increasing the likelihood of persistent cognitive symptoms (De Beaumont et al., 2012; McCrory et al., 2013). Studies suggest that repeated concussions may result in neuropsychological impairments of a cumulative nature (Chachad & Khan, 2006; Covassin, Moran, & Wilhelm, 2013). Initial research has implicated a genetic predisposition for some athletes to develop chronic traumatic encephalopathy and mild cognitive impairment later in their sports careers (Meehan & Bachur, 2009). Overall, a positive prior concussion history, repeated concussions, an intensive style of play, and younger age are among variables hypothesized to account for persistent cognitive symptoms (Giza et al., 2013).

The underlying causes of persistent symptoms for those individuals who are unable to resume routine activities following concussion are complex and not well understood. Although it is recognized that these individuals require coordinated care with multidisciplinary supports (Kirkwood, Yeates, & Wilson, 2006), options for these supports have not been well described and the recommendations offered have not been systematically evaluated.

Clinical Management

The concussion management literature focuses almost exclusively on the initial weeks following injury and calls for periods of prescribed cognitive and physical rest with gradual return to play protocols (Doolan et. al., 2012; C. M. Marshall, 2012). For the management of persistent symptoms, the Zurich 2012 consensus panel recommended administration of neuropsychological testing with a multidisciplinary team delivering medical, vestibular, counseling, and cognitive interventions. They did not describe practice options to be investigated for possible benefits in addressing persistent cognitive symptoms (McCrory et al., 2013). The absence of an evidence base means that consensus and expert opinion currently direct intervention practices.

A common treatment response to persistent cognitive symptoms following sport-related concussion in youth has been to introduce school accommodations to support academic performance during the recovery period (Kirkwood et al., 2006; Nationwide Children's Hospital, n.d.). This approach reduces symptom burden and, though consensus-based, is inadequate by itself to serve the unique needs of a complicated clinical population presenting with diverse, persistent symptoms. Halstead et al. (2013) described barriers to academic reentry for young athletes who face cognitive challenges that interfere with school performance after a concussion, noting the importance of communication between medical and school settings to support return to learning. Brain injury literature on academic reentry has emphasized the same points (Glang, Todis, et al., 2008; Hux & Hacksley, 1996). Also, the fact that college students with brain injury must self-report their diagnosis presents a barrier for those in need of academic supports (Kennedy, Krause, & Turkstra, 2008). A recent report details the early clinical management of concussion in an intercollegiate setting, encourages the implementation of academic accommodations if symptoms persist, and highlights the role of SLPs in all phases of concussion assessment and management (Knollman-Porter et al., 2014). The need for more direct neurocognitive therapies when symptoms persist has just begun to be recognized and recommended (Makdissi et al., 2013). The current article seeks to build on these recommendations and detail options for direct and indirect rehabilitation therapies.

The remainder of this article presents a retrospective case review of high school and college students treated for persistent cognitive and somatic symptoms affecting school performance after sport-related concussion. The intended contributions are (a) to introduce feasible, theoretically grounded treatment approaches that SLPs can implement and (b) to guide current clinical decision making in the absence of an evidence base. The overarching goal is to stimulate treatment efficacy research for this underserved population.

Method

This case review consisted of 24 clients referred to a university speech-language pathology graduate training clinic at the University of Oregon. Clients were referred for the management of persistent concussion symptoms and treated by graduate student clinicians supervised by licensed and certified SLPs. Concussion cases referred to this clinic had already been prescribed cognitive rest, followed by a graduated return to play and return to school protocol that included a list of school accommodations such as taking tests in a quiet environment. Some of the clients received other adjuvant therapies including pharmacological intervention, most typically for headache pain and vestibular therapy for management of dizziness. All clients were under the care of a physician who reviewed cognitive rehabilitation goals and treatment progress. Upon referral, all clients participated in a 2-hr consultation with the supervising SLP that consisted of a review of records, clinical interview, cognitive testing, and facilitation of self-selected functional goals, followed by discussion of treatment options.

File Review and Data Extraction

We examined intake data for cases seen in our clinic for cognitive rehabilitation since January 2012 and identified 63 cases. Of the total cognitive rehabilitation referrals, 24 were specifically referred for management of persistent concussion symptoms after sport-related injury. The clinic files for clients referred for management of postconcussion symptoms were reviewed to identify the cases that met the following selection criteria: (a) documented concussion in client's medical record due to sport-related injury; (b) referred by a medical doctor who diagnosed postconcussion symptoms persisting at least 2 months after the event; (c) enrolled in middle school, high school, or college; and (d) measurable change in school performance postconcussion (i.e., grades, course load, attendance) documented by school records, treating physician, and/or parent or guardian of minors. The criterion for including clients at least 2 months postinjury was somewhat arbitrary, as the literature is unclear about the length of time postinjury required for concussion symptoms to be considered persistent. The consensus conference report (McCrory et al., 2013) suggested that greater than 10 days exceeded typical recovery, and Eisenberg et al. (2014) reported data showing that 15% of postconcussion cases included in their study had symptoms persisting at 90 days postinjury. Our inclusion criteria were based on referrals from treating physicians who had diagnosed persistent symptoms, and average time postinjury was 8.17 months. Twenty-four clients met all of the above criteria and constituted the data set for this descriptive analysis. All clinic clients consented for records review in accordance with Institutional Review Board policy.

We were the supervising SLPs for 15 of the cases and reviewed each other's files. Two additional SLPs supervised graduate student clinicians for the remaining nine cases. We independently reviewed the files and coded characteristics related to participant variables, treatment parameters, and outcomes. We then conferred to calculate interreviewer agreement in coding assignments for all participant variables, treatment parameters, and outcomes. Independently, the reviews achieved 90% agreement, with disagreements in coding easily resolved through discussion.

Demographic and injury-related client variables included the parameters listed in Table 1. Treatment categories were initially coded by the first author and fell into four types of clinical management: (a) direct attention training (DAT); (b) metacognitive strategy instruction (MSI) to facilitate self-regulation of states of mind, academic tasks, and study skills; (c) training assistive technology for cognition (ATC) for use in school; and (d) psychoeducational supports, which included symptom monitoring paired with goal setting and/or concussion education. Treatment components corresponding to each of these approaches are detailed in the next section. When a client received more than one type of intervention, each intervention was coded; thus, two or more treatments could be coded for one client.

Table 1. Case demographics.

Variable	*N*
Age[a]	24
Time postinjury[b]	24
PCS score[c,d]	15[e]
Gender	
Female	14
Male	10
Activity at injury	
Basketball	1
Cheerleading	2
Cycling	4
Dancing	3
Football	5
Long board	1
Pole vaulting	1
Softball	1
Soccer	4
Other[f]	2
Premorbid condition	
ADD/ADHD	5
LD	1
Migraines	1
Concussions	13
Seizures	1
None	5

Note. PCS = Post Concussion Scale (Lovell & Collins, 1998); ADHD = attention-deficit/hyperactivity disorder; LD = learning disability.

[a]Range = 14.0–26.0 (M = 17.54; SD = 3.15). [b]Time postinjury reported as range of months postinjury and includes the fewest and greatest number of months elapsed from most recent concussion to initial consultation (range = 2.0–36.0; M = 8.17; SD = 8.63). [c]PCS scores are those most recently reported by referring physician prior to initial consultation date at our clinic (range = 3.0–67.0; M = 32.80; SD = 21.10). [d]The median PCS score was 22.00, and scores were bimodal in distribution. [e]PCS scores were not reported for six cases. [f]Two participants sustained concussions without loss of consciousness in falls that were not sport related.

The types of metacognitive strategies, ATC, and psychoeducational supports were coded for those clients receiving the other two general management approaches. Table 2 lists the treatment approaches.

Outcomes were coded to identify progress toward a client-selected functional goal. It is a general practice for all clients seen for cognitive rehabilitation in our clinic to collaboratively identify a meaningful, functional goal domain that they hope will change as a result of the intervention. Measurable, objective outcomes are delineated on the basis of the selected functional goal using principles of goal attainment scaling with a delineation of levels of goal attainment (Bovend'Eerdt, Botell, & Wade, 2009; Malec, 1999). There were some exceptions, however, as some goals (e.g., improving reading comprehension in order to pass the written driver's test) had binary outcomes (passed or not passed). Further, the use of neuropsychological tests served as an additional outcome measure for DAT.

The second author reviewed each of the 24 files selected for review and recorded outcomes for each client-centered functional goal listed in the discharge reports. We independently reviewed the list of outcomes for each

Table 2. Treatment approaches with functional goal domains and outcomes summary.

Approach	Description	Functional goal domain[a]	Outcomes summary[b]
Direct attention training (*n* = 13)	Computerized drills targeting different attention domains (e.g., sustained, selective, suppression, working memory) combined with strategy training	Improve attention during lecture (*n* = 4) Improve attention during homework sessions (*n* = 2) Increase reading with comprehension (*n* = 3) Increase homework completion (*n* = 1) Increase study efficiency (*n* = 1)	Improved class test/probe scores (*n* = 4) Passed written driving test (*n* = 1) Decreased number of missing assignments (*n* = 2) Decreased time needed to review lecture notes (*n* = 1) Improved grades (*n* = 2) Increased sustained attention for lecture/homework (*n* = 2) No change in homework completion (*n* = 1) Improvement on standardized attention test[c] (*n* = 5) No improvement on standardized attention test (*n* = 1)
Metacognitive strategy instruction (*n* = 9)	Instruction in use of strategies to facilitate self-regulation of states of mind, academic tasks, and study skills	Learn to use Cornell notetaking strategy (*n* = 1) Make study agenda (*n* = 1) Learn to use reading comprehension strategy (*n* = 2) Self-monitoring of social behavior (*n* = 2) Learn to use conversation marking strategy (*n* = 1) Learn to use internal memory strategies (*n* = 1)	Increased use of notetaking strategies in class (*n* = 2) Increased study efficiency (*n* = 1) Improved reading comprehension (*n* = 2) Increased social initiation (*n* = 2) Increased retention of conversation (*n* = 1) Improved school performance (*n* = 1)
Training assistive technology for cognition (*n* = 5)	Direct instruction in use of external cognitive aids	Learn to use smart pen for notetaking (*n* = 2) Learn to use homework-tracking app (*n* = 2) Learn to use e-reader (*n* = 1) Learn to use Google calendar (1)	Completed all missing assignments (*n* = 1) Improved homework completion (*n* = 1) Improved grades (*n* = 2) Improved class performance (*n* = 1)
Psychoeducational support (*n* = 24)	Provision of concussion education; facilitation of symptom monitoring and goal setting	Engage in symptom monitoring (*n* = 6) Concussion education (*n* = 3) Goal setting (*n* = 24)	Increased school attendance (*n* = 5) Decrease reported in symptom severity (n = 2) Decreased dizziness (*n* = 1) Completed graduation requirements (*n* = 1) Increase in perceived social support (*n* = 3) Addition of new recreational activities (*n* = 1)

Note. Some clients received more than one treatment.

[a]Clients self-selected functional goals through clinician-facilitated goal setting process; some self-selected goals in more than one domain. [b]Summarized outcomes represent specific outcomes for commonly self-selected functional goals. [c]Demonstrated measurable improvement on at least one subtest of a standardized attention test.

of the 24 cases, with the first author independently reviewing and coding outcomes for 20% of the files as a reliability check. Outcome summaries are provided in Table 2.

Treatments Delivered

The four distinct categories of treatment implemented with the 24 postconcussion cases seen in our clinic are described below.

DAT

DAT refers to treatment that is process oriented with a restorative or impairment-based theoretical rationale (Dams-O'Connor & Gordon, 2013). Restorative approaches to cognitive rehabilitation rely on neuroplasticity and utilize intensive drill with graded exercises of increasing complexity to strengthen associated neural networks (Sohlberg, Harn, MacPherson, & Wade, 2014). DAT interventions that combine drill-based exercises (typically computer-delivered tasks) with metacognitive strategies show promise for improving attention and working memory in youth with acquired cognitive impairments (Cicerone et al., 2011; Dams-O'Connor & Gordon, 2013; Sohlberg et al., 2014). Several studies have investigated the efficacy of combined drill-based attention training and MSI to treat pediatric clients with attention deficits due to acquired brain injury and reported improvements on cognitive measures and/or assessments of everyday functioning (Butler et al., 2008; Galbiati et al., 2009; Luton, Reed-Knight, Loiselle, O'Toole, & Blount, 2011; Sohlberg et al., 2014; van't Hooft et al., 2007).

The specific DAT program utilized with young athletes in our concussion clinic delivered individualized attention drills for each client on the basis of presenting concerns and performance on standardized measures of attention, working memory, and executive function. Drills were organized into exercises that tapped sustained, selective, and alternating attention as well as suppression and working memory. The clinician and client also collaboratively selected metacognitive strategies (e.g., self-talk, visualization, pacing) for integration with attention drills, customizing each strategy description using the clients' own words (e.g., "I need to keep my head in the game"). After each exercise, participants self-rated motivation and effort on a 1 to 10 scale (10 = *high*). This program has been described in the literature (Lee, Harn, Sohlberg, & Wade, 2012; Sohlberg et al., 2014).

Clinical Rationale for Selecting DAT

Candidacy issues for DAT have not been examined in the literature. That said, the process-oriented theoretical rationale depends upon neuroplasticity as the mechanism of change (Sohlberg et al., 2014); hence, candidates must have sufficient practice on the drills and be able to devote time to the therapy. Important for concussion patients, candidates would need to be able to tolerate computer screen use. Implicit in this approach is that the selection of DAT will be motivated by a client having an impairment profile with reduced functioning in one or more of the target attentional domains, usually documented on standardized testing.

MSI

The second broad category of direct interventions was the instruction of task-specific as well as generalized metacognitive strategies (Sohlberg & Turkstra, 2011), MSI consists of systematic, step-by-step instruction in the use of strategies to facilitate self-regulation of states of mind, task preparation, and task execution (Kennedy, Coelho, et al., 2008; Sohlberg & Turkstra, 2011). Whereas the metacognitive instruction used in DAT was tied to the execution of the attention drills, MSI as an explicit approach is tied to naturalistic task performance. Metacognitive strategy training is considered a compensatory approach involving explicit, systematic instruction in the practice and use of strategies for self-regulation of tasks or internal states (Dams-O'Connor & Gordon, 2013; Sohlberg & Turkstra, 2011). Strategies can be generalized processes designed to increase performance across tasks and contexts (e.g., attention or problem-solving strategies, internal memory strategies) or may be task specific and designed to improve performance in a particular academic domain or study skill (e.g., reading comprehension strategy, note-taking strategy). MSI has been shown to be effective with youth with acquired cognitive impairments and may include generating goals, self-recording of performance, and making strategy decisions on the basis of comparing performance to goals, with individuals making adjustments given external and/or self-feedback (Glang, Ylvisaker, et al., 2008; Kennedy & Coelho, 2005; Kennedy, Coelho, et al., 2008; Sohlberg & Turkstra, 2011).

The MSI used with the clients with postconcussive symptoms primarily focused on instructing the self-regulation of academic task preparation and execution. Instructional targets for strategy use included reading comprehension, studying for tests, taking notes, and self-monitoring social behavior. Instruction in the use of internal memory compensation strategies targeted the use of association, imagery, and elaborative encoding to assist students in recall of content for classroom tasks (e.g., tests).

Clinical Rationale for Selecting MSI

Candidates for MSI typically must demonstrate a requisite level of self-awareness and engagement to recognize that a strategy would be useful and show sufficient initiation to execute the strategy (Sohlberg & Turkstra, 2011). The selection of MSI is predicated on a needs assessment leading to the identification of a strategy that would facilitate completion of a specific task or set of tasks meaningful to the client.

Training ATC

The treatment category of ATC refers to clinical practices involved in the selection and instruction of external tools to compensate for cognitive impairments. Use of ATC serves to compensate for cognitive impairments through limiting demands on cognition or by furnishing an environmental modification such that task demands better match the person's present levels of cognitive performance (Sohlberg & Turkstra, 2011). ATC ranges from basic products, such as planner books, calendars, and wristwatches, to specialized devices that use computer software and networking capabilities (Scherer, Hart, Kirsch, & Schulthesis, 2005). ATC has been shown to be effective in supporting cognitive functions related to memory, attention, calculation, emotion, experience of self, planning, and time management in individuals with brain injury (e.g., de Joode, van Heugten, Verhey, & van Boxtel, 2010; Gillespie, Best, & O'Neill, 2012; Sohlberg et al., 2007). ATC typically is selected through a needs assessment and then trained using systematic instruction with programming generalization of use in naturalistic settings (Federici & Scherer, 2012; Sohlberg & Turkstra, 2011).

Clinical Rationale for Selecting ATC

The needs assessment that matches person, device, and contextual variables (Federici & Scherer, 2012) drives the decision to recommend ATC. A requisite component for successful adoption is the provision of training and ongoing evaluation of use in the natural environment (Federici & Scherer, 2012; Sohlberg & Turkstra, 2011). The selection of ATC will in part be based on opportunity to train and monitor its use.

The majority of ATC implemented with our case samples compensated for attention, memory, and organizational impairments affecting academic tasks. Instructional targets for external compensation with ATC included use of e-readers, homework-tracking apps, smart pens for classroom note taking, and electronic calendars.

Psychoeducational Supports

This treatment category refers to a range of supports designed to increase clients' self-awareness and acceptance of the need for supports or treatment, as well as therapeutic activities designed to enhance feelings of well-being. There were three types of psychoeducational supports: concussion education, goal setting, and symptom monitoring. *Concussion education* included didactic instruction on the mechanism of concussion including the pathophysiology, as well as concepts related to the recovery process. Our clinic uses a series of handouts on concussion that were reviewed on the basis of client questioning or clinician-perceived need. It has been shown that provision of education and reassurance in individuals affected by brain injury can be helpful (Wade, Crawford, Wenden, King, & Moss, 1997). Another group of educational supports includes goal setting. As noted, all clients were involved in a process of personalized goal selection to establish functional goal domains they wanted to address as a result of participating in cognitive rehabilitation. This incorporated the principles of goal attainment scaling and motivational interviewing, as goal selection has been shown to enhance cognitive rehabilitation outcomes (Malec, 1999; Medley & Powell, 2010). *Symptom monitoring* involves the tracking of parameters related to one's own symptoms. In the case of concussion, clients may be asked to track the type of somatic symptom (e.g., headache), timing, duration, severity, triggers, and self-management attempts. The notion is to increase clients' self-management by assisting them with the analysis of patterns. One study suggested that helping youth track their symptoms, with a focus on identifying solutions or coping with emotions, can be effective in reducing their perceived symptom burden (Woodrome et al., 2011). The symptom monitoring with the clients in our case review primarily addressed headache management.

Clinical Rationale for Providing Psychoeducational Supports

Education and goal setting in rehabilitation is fundamental to intervention, and as such, it is integrated into every program, although it may be a more primary focus depending upon a client's need. Candidacy for symptom monitoring, however, has not been investigated. Much of the endorsement for this type of support comes from the disease management literature outside neurorehabilitation, with some suggestion that symptom monitoring can be helpful for increasing symptom management in some clients for whom somatic symptoms are the primary barrier to functioning (Devineni & Blanchard, 2005). An exception would be those clients whose symptoms or pain profiles are tied to symptom magnification and who are better served by efforts to limit focus on symptoms (McCrea, 2008).

Results

Participants

Clients ranged in age from 14 to 26 years (M = 17.54) and included 14 women and 10 men. Time postonset was variable and ranged from 2 to 36 months (M = 8.17; median = 5.00). Thirteen clients had experienced one or more previous concussions. One client had a documented learning disability, and five had a documented diagnosis of attention-deficit disorder/attention-deficit/hyperactivity disorder. The three most common activities at the time of injury were football (n = 5), soccer (n = 4), and cycling (n = 4). Of the 15 clients who were referred by a physician who had administered a Post Concussion Scale (Lovell & Collins, 1998), scores ranged from 3 to 67 with a mean score of 32.80 (median = 22.00). Given that patients' PCS scores were obtained at varied points during their recovery, comparison of outcomes by score would not be valid. However, it is notable that patients of varied time postinjury and varied levels of severity sought treatment. The referring physician, in consultation with SLP evaluation, recommended academic accommodations for all clients and sent documentation to the schools.

Treatment

Treatment Dosage

The second author reviewed all 24 files to determine treatment dosage for each case. The reviewer recorded the number of treatment sessions delivered overall, the length of the treatment sessions, and treatment duration, operationalized as the number of weeks over which treatment sessions were delivered, excluding breaks and holidays. The mean number of sessions was 8.33 (range: 1–25) delivered over a mean duration of 9.63 weeks (range: 1–26). All sessions were between 30 and 90 min in duration, (*M* = 51.00). Treatment dosage ranged from 30 min to 20.83 hr (*M* = 6.71).

Type of Treatment

The previously described four broad categories of treatment were delivered either singly or in combination and included DAT, MSI, training ATC, and psychoeducational supports. The supervising SLPs and their graduate student supervisees were the primary interventionists and selected and implemented all of the treatments (see Table 2).

DAT

Thirteen clients received DAT. The file review suggested that DAT was selected for clients who had attention impairments as a primary presenting complaint on the basis of clinical interview and/or on standardized testing, and that the clinician judged the attention impairment to have a deleterious effect on school performance. In addition, all clients receiving DAT were able to tolerate computer screen use for a minimum of 30 min without somatic compliant.

MSI

Nine clients received MSI. A review of the clinic reports suggested that specific study strategies were selected when the client's primary complaint related to a specific aspect of school or social functioning (e.g., poor comprehension and retention of lecture or reading assignments or perceived social isolation). One client who received MSI targeting reading comprehension also received training in the use of ATC for a homework tracking application.

ATC

Five clients received training in the use of ATC. Two of these clients also received DAT. All five of the trained devices or tools were to improve school performance, either through assignment management or comprehension of auditory or written material. Three clients were trained in a note-taking strategy using a smart pen that would record lecture and match written notetaking to audio lecture; one was trained to use an electronic reader that delivered reading comprehension supports; and three were trained to use a homework-tracking application, planner, or calendar to track assignments.

Psychoeducational Support

All 24 clients received psychoeducational support as part of their management of persistent cognitive symptoms, including goal setting and concussion education. As described, all clients participated in a client-centered goal-setting process. Three of the clients also participated in symptom-monitoring programs. Two of them tracked headache frequency and severity, possible triggers, and responses to their headaches and set personalized goals related to the trends observed in their self-monitoring. For example, one client began a sleep hygiene program in response to the data. The other client began a program of pacing in response to noting that headaches increased with sustained activity. The other client who engaged in symptom monitoring tracked her dizziness symptoms and contextual factors.

Functional Goals and Outcomes

Outcomes for all clients were measured by assessment of whether they met their expected level of improvement on the goals they selected within their functional goal domain. Across treatments, 22 of the 24 (83%) clients met their self-selected goals. Outcomes corresponding to the different treatment approaches are summarized below.

Of the 13 clients who received DAT, 11 met their expected level of improvement on their self-selected goal. One of the clients showed no change following completion of DAT, and one client discontinued treatment, as she did not feel it was helping. Because the rationale for DAT is to improve underlying cognitive processing, it was the only treatment for which standardized neuropsychological tests served as an additional outcome measure. However, test outcomes were not uniformly measured across clients, as clinicians administered different types of attention and executive function tests. Improvement on a standardized attention test was noted when there was a positive change of at least 1 *SD* on the test. Neuropsychological test results were reported for only six of the 13 clients who received DAT.The remaining clients either discontinued treatment prematurely or did not return for scheduled posttesting. Of those six clients who returned for testing, five demonstrated an improvement of at least 1 *SD* on at least one of the attention tests that had originally revealed impairments. One client did not improve on the neuropsychological tests.

All nine clients receiving MSI met their self-selected functional goals. All five clients receiving training in ATC met their self-selected functional goals. Twenty-two of the 24 clients who received psychoeducational support met their self-selected functional goals. One client discontinued support as he felt it was not useful. One client had no change in headache symptoms following symptom monitoring.

Discussion

This descriptive case review summarizes the clinical treatment of concussion clients with persistent cognitive and somatic symptoms affecting school performance. There currently is little to no practice evidence to direct the efforts of clinicians charged with treating these symptoms beyond recommendations for return to play protocols and school accommodations, and a general recommendation to implement cognitive rehabilitation when symptoms persist (e.g., Makdissi et al., 2013). Results of this review suggest that individualized interventions, provided singly or in combination, can be helpful. Altogether, most clients met their self-selected goals, many of which were mapped to goal attainment scales.

Review of the clinical management for the 24 clients suggests that the types of interventions selected across four different supervising clinicians were highly individualized and fell into four easily identified broad approaches, each with a different treatment rationale and set of practices. DAT was selected for clients who demonstrated specific processing deficits (e.g., impairments in sustained attention or working memory) as a primary complaint. Other treatments were more compensatory in nature and involved training the use of strategies or tools to improve academic performance. Psychoeducational supports addressed goal setting for all clients, and symptom monitoring for three clients. The referring physician had recommended academic accommodations for all clients at the outset of the treatment. Consistent with the findings of Knollman-Porter et al. (2014) and Salvatore and Fjordbak (2011), this review suggests that SLPs can play an important role in assessment and selection and delivery of treatment for this population.

Review of this convenience sample suggests that an individualized approach to management of persistent symptoms after concussion may be clinically advisable. For example, two opposing treatment approaches, both of which resulted in successful outcomes, were selected for two clients with somatic symptoms. The intervention plan implemented for one client who had some reactive depression following prolonged cognitive rest resulted in facilitation and support to increase activity and initiation using MSI, whereas another client with this same profile was treated using symptom monitoring to support a decrease in activity level and institute pacing and rest breaks. A "one size fits all" approach of continued cognitive rest when symptomatic would not have been helpful for either of these clients. Some clients with more cognitive processing deficits may benefit from process-specific training, whereas others whose persistent symptoms are limited to primary difficulty with a specific school function (e.g., auditory or reading comprehension) may benefit from MSI to target specific study skills. Other clients in need of external compensation for managing academic tasks and routines may best be served through training in the use of ATC. Collaboration with school staff would facilitate connections to ensure the relevance and usefulness of in-clinic treatment efforts to support academic performance after concussion (Halstead et al., 2013).

Perhaps the largest contribution of this review is that it delineates several treatment approaches with theoretical grounding in the field of cognitive rehabilitation that may be helpful for concussion management and could be subjected to future experimental evaluation. The eventual goal should be to outline evidence-based practice guidelines for the treatment of persistent concussion symptoms or complicated concussion. Figure 1 presents a proposed decision-making graphic of management options to assist practicing clinicians and guide future investigations on the basis of our experience in an outpatient clinic staffed by SLPs. The physician-referred cases reviewed in this report all exhibited cognitive and/or somatic symptoms. Those treatments marked with an asterisk represent those selected and implemented by SLPs.

The treating clinicians collaborated with other professionals across disciplines when indicated to facilitate management. Clinicians coordinated with school staff in making recommendations for academic accommodations. Connecting medical management with school management teams to facilitate academic reentry is crucial to academic performance and progress for young athletes (Halstead et al., 2013).

Clinic cases that did not meet inclusion criteria for this review were placed on monitoring status or referred for ancillary services as indicated in this proposed decision-making graphic for management of complicated concussion.

Limitations

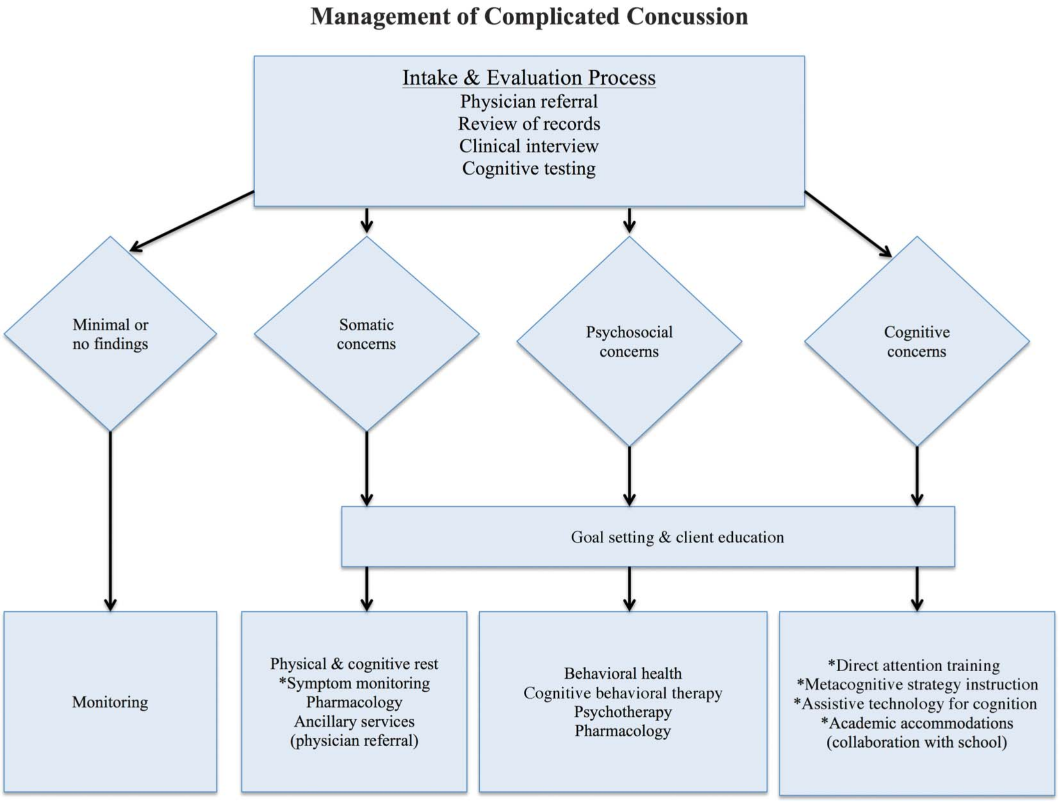
The cases reviewed represent a small biased sample from one clinic. It is thus not possible to extrapolate findings to a larger population. The treatments implemented may reflect treatment biases particular to our clinic and may not apply as well to other clinics' practice models. Of some consolation is that the client profiles for the 24 cases share some of the demographics documented in the literature, suggesting the sample is at least somewhat representative. For example, soccer and football represent the high-incidence concussion sports, with female soccer injuries occurring more frequently than male injuries (Maher et al., 2014), which was also true in this sample.

Another limitation to our findings is that graduate student clinicians and supervising SLPs made differing choices in treating the clients in this limited sample, resulting in inconsistency across selected assessments and interventions. There was not a uniform set of treatment guidelines, with the exception that clients participated in an extensive clinical interview with established questions, completed a standardized cognitive battery, and engaged in a personalized goal selection process. However, the treatment selection and goal prioritization process did not follow a standard, operationalized protocol. Therefore, it is difficult to make accurate summary statements about clinical decision making.

Similar is the inconsistency relative to the lack of standardized outcome measures. Although goal attainment scaling has the potential to offer objective, quantifiable methods for evaluating personalized rehabilitation goals (Bouwens, van Heugten, & Verhey, 2009), this process was not used in a standardized fashion in our clinic. Also, a number of methodological issues need to be addressed in order for goal attainment scaling to constitute a valid measurement of treatment outcomes (Grant & Ponsford, 2014). It is fortunate that the use of goal attainment scaling is expanding in both clinical and research settings and holds promise.

Last, precise mechanisms of improvement require clarification in future experimental research. All clients received some degree of psychoeducational support in the

Figure 1. Management of complicated concussion. This graphic proposes a model to guide the management of complicated concussion. * = SLP-delivered interventions.



form of goal setting, and some clients received MSI in combination with training the use of ATC. Also, when clients received more than one treatment, it was at times unclear in the files precisely what dosage of which treatment clients received over the course of treatment. Another factor potentially accounting for some degree of improvement is the implementation of recommended academic accommodations at school, but tracking their implementation in the school setting was beyond the scope of this review. The descriptive nature of this review cannot adequately account for mechanisms of improvement for the 83% of clients who met their self-selected goals.

Conclusions

The primary merit in this case review is that it encourages future study of an ignored population in need of treatment: complicated concussion cases presenting with persistent cognitive symptoms. Implementation science calls for feasibility and efficacy research to occur in concert in order to (a) increase the adoptability of experimentally tested interventions, and (b) decrease the time lag between research and practice implementation (Burke & Gitlin, 2012; Turner et al., 2008). We hope this clinical review will stimulate the development of feasible management protocols for complicated concussion that can be evaluated by systematic efficacy research.

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References

Barlow, K. M., Crawford, S., Stevenson, A., Sandhu, S. S., Belanger, F., & Dewey, D. (2010). Epidemiology of postconcussion syndrome in pediatric mild traumatic brain injury. *Pediatrics, 126,* e374–e381. doi:10.1542/peds.2009-0925

Bouwens, S. F., van Heugten, C. M., & Verhey, F. R. (2009). The practical use of goal attainment scaling for people with acquired brain injury who receive cognitive rehabilitation. *Clinical Rehabilitation, 23,* 310–320.

Bovend'Eerdt, T. J., Botell, R. E., & Wade, D. T. (2009). Writing SMART rehabilitation goals and achieving goal attainment scaling: A practical guide. *Clinical Rehabilitation, 23,* 352–361.

Burke, J. P., & Gitlin, L. N. (2012). How do we change practice when we have the evidence? *American Journal of Occupational Therapy, 66,* e85–e88.

Butler, R. W., Copeland, D. R., Fairclough, D. L., Mulhern, R. K., Katz, E. R., Kazak, A. E., . . . Sahler, O. J. (2008). A multicenter, randomized clinical trial of a cognitive remediation program for childhood survivors of a pediatric malignancy. *Journal of Consulting and Clinical Psychology, 76,* 367–378. doi:10.1037/0022-006X.76.3.367

Cancelliere, C., Hincapié, C. A., Keightley, M., Godbolt, A. K., Côté, P., Kristman, V. L., . . . Cassidy, J. D. (2014). Systematic review of prognosis and return to play after sport concussion: Results of the International Collaboration on Mild Traumatic Brain Injury Prognosis. *Archives of Physical Medicine and Rehabilitation, 95,* S210–S229. doi:10.1016/j.apmr.2013.06.035

Carroll, L., Cassidy, J. D., Holm, L., Kraus, J., Coronado, V., & WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. (2004). Methodological issues and research recommendations for mild traumatic brain injury: The WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *Journal of Rehabilitation Medicine, 36,* 113–125. doi:10.1080/16501960410023877

Chachad, S., & Khan, A. (2006). Concussion in the athlete: A review. *Clinical Pediatrics, 45,* 285–288. doi:10.1177/000992280604500314

Cicerone, K. D., Langenbahn, D. M., Braden, C., Malec, J. F., Kalmar, K., Fraas, M., . . . Ashman, T. (2011). Evidence-based cognitive rehabilitation: Updated review of the literature from 2003 through 2008. *Archives of Physical Medicine and Rehabilitation, 92,* 519–530. doi:10.1016/j.apmr.2010.11.015

Covassin, T., Moran, R., & Wilhelm, K. (2013). Concussion symptoms and neurocognitive performance of high school and college athletes who incur multiple concussions. *The American Journal of Sports Medicine, 41,* 2885–2889. doi:10.1177/0363546513499230

Dams-O'Connor, K., & Gordon, W. A. (2013). Integrating interventions after traumatic brain injury: A synergistic approach to neurorehabilitation. *Brain Impairment, 14,* 51–62. doi:10.1017/BrImp.2013.9

De Beaumont, L., Henry, L. C., & Gosselin, N. (2012). Long-term functional alterations in sports concussion. *Neurosurgical Focus, 33,* E8. doi:10.3171/2012.9.FOCUS12278

de Joode, E., van Heugten, C., Verhey, F., & van Boxtel, M. (2010). Efficacy and usability of assistive technology for patients with cognitive deficits: A systematic review. *Clinical Rehabilitation, 24,* 701–714.

Devineni, T., & Blanchard, E. B. (2005). A randomized controlled trial of internet-based treatment for chronic headache. *Behavioral Research Therapy, 43,* 277–292.

Doolan, A. W., Day, D. D., Maerlender, A. C., Goforth, M., & Brolinson, P. G. (2012). A review of return to play issues and sports-related concussion. *Annals of Biomedical Engineering, 40,* 106–113. doi:10.1007/s10439-011-0413-3

Eisenberg, M. A., Meehan, W. P., III, & Mannix, R. (2014). Duration and course of post-concussive symptoms. *Pediatrics, 133,* 999–1006. doi:10.1542/peds.2014-0158

Federici, S., & Scherer, M. (Eds.). (2012). *Assistive technology assessment handbook*. Boca Raton, FL: CRC Press.

FitzGerald, D. B., & Crosson, B. A. (2011). Diffusion weighted imaging and neuropsychological correlates in adults with mild traumatic brain injury. *International Journal of Psychophysiology, 82*(1), 79–85. doi:10.1016/j.ijpsycho.2011.02.011

Galbiati, S., Recla, M., Pastore, V., Liscio, M., Bardoni, A., Castelli, E., & Strazzer, S. (2009). Attention remediation following traumatic brain injury in childhood and adolescence. *Neuropsychology, 23,* 40–49. doi:10.1037/a0013409

Gillespie, A., Best, C., & O'Neill, B. (2012). Cognitive function and assistive technology for cognition: A systematic review. *Journal of the International Neuropsychological Society, 18,* 1–19. doi:10.1017/S1355617711001548

Giza, C. C., & Hovda, D. A. (2001). The neurometabolic cascade of concussion. *Journal of Athletic Training, 36,* 228–235. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=155411&tool=pmcentrez&rendertype=abstract

Giza, C. C., Kutcher, J. S., Ashwal, S., Barth, J., Getchius, T. S., Gioia, G. A., . . . Zafonte, R. (2013). Summary of evidence-based guideline update: Evaluation and management of concussion in sports: Report of the Guideline Development Subcommittee of the American Academy of Neurology. *Neurology, 80,* 2250–2257. doi:10.1212/WNL.0b013e31828d57dd

Glang, A., Todis, B., Thomas, C. W., Hood, D., Bedell, G., & Cockrell, J. (2008). Return to school following childhood TBI: Who gets services? *NeuroRehabilitation, 23,* 477–486.

Glang, A., Ylvisaker, M., Stein, M., Ehlhardt, L., Todis, B., & Tyler, J. (2008). Validated instructional practices: Application to students with traumatic brain injury. *The Journal of Head Trauma Rehabilitation, 23,* 243–251. doi:10.1097/01.HTR.0000327256.46504.9f

Grant, M., & Ponsford, J. (2014). Goal attainment scaling in brain injury rehabilitation: Strengths, limitations and recommendations for future applications. *Neuropsychological Rehabilitation, 24*(5), 661–667. doi:10.1080/09602011.2014.901228

Green, R., Koshimori, Y., & Turner, G. (2010). Research digest. Understanding the organic basis of persistent complaints in mTBI: Findings from functional and structural neuroimaging. *Neuropsychological Rehabilitation, 20,* 471–478. doi:10.1080/09602011003693298

Halstead, M. E., McAvoy, K., Devore, C. D., Carl, R., Lee, M., Logan, K., Council on Sports Medicine and Fitness, & Council on School Health. (2013). Returning to learning following a concussion. *Pediatrics, 132,* 948–957. doi:10.1542/peds.2013-2867

Harmon, K. G., Drezner, J., Gammons, M., Guskiewicz, K., Halstead, M., Herring, S., . . . Roberts, W. (2013). American Medical Society for Sports Medicine position statement: Concussion in sport. *British Journal of Sports Medicine, 47,* 15–26.

Hux, K., & Hacksley, C. (1996). Mild traumatic brain injury: Facilitating school success. *Intervention in School and Clinic, 31,* 158–165. doi:10.1177/105345129603100305

Karr, J. E., Areshenkoff, C. N., & Garcia-Barrera, M. A. (2014). The neuropsychological outcomes of concussion: A systematic review of meta-analyses on the cognitive sequelae of mild traumatic brain injury. *Neuropsychology, 28,* 321–336. doi:10.1037/neu0000037

Kennedy, M. R., & Coelho, C. (2005). Self-regulation after traumatic brain injury: A framework for intervention of memory and problem solving. *Seminars in Speech & Language, 26,* 242–255.

Kennedy, M. R., Coelho, C., Turkstra, L., Ylvisaker, M., Sohlberg, M. M., Yorkston, K., . . . Kan, P.-F. (2008). Intervention for executive functions after traumatic brain injury: A systematic review, meta-analysis and clinical recommendations. *Neuropsychological Rehabilitation, 18,* 257–299. doi:10.1080/09602010701748644

Kennedy, M. R., Krause, M. O., & Turkstra, L. S. (2008). An electronic survey about college experiences after traumatic brain injury. *NeuroRehabilitation, 23,* 511–520.

Kirkwood, M. W., Yeates, K. O., & Wilson, P. E. (2006). Pediatric sport-related concussion: A review of the clinical management of an oft-neglected population. *Pediatrics, 117,* 1359–1371. doi:10.1542/peds.2005-0994

Knollman-Porter, K., Constantinidou, F., & Marron, K. H. (2014). Speech-language pathology and concussion management in intercollegiate athletics: The Miami University concussion management program. *American Journal of Speech-Language Pathology, 23,* 507–519.

Lee, J. B., Harn, B., Sohlberg, M. M., & Wade, S. L. (2012). An overview of the Attention Improvement Management (AIM) program with outcomes for three pilot participants. *Perspectives on Neurophysiology and Neurogenic Speech and Language Disorders, 22,* 90–105.

Lovell, M. R., & Collins, M. W. (1998). Neuropsychological assessment of the college football player. *Journal of Head Trauma Rehabilitation, 13*(2), 9–26.

Luton, L. M., Reed-Knight, B., Loiselle, K., O'Toole, K., & Blount, R. (2011). A pilot study evaluating an abbreviated version of the cognitive remediation programme for youth with neurocognitive deficits. *Brain Injury, 25*(4), 409–415.

Maher, M. E., Hutchison, M., Cusimano, M., Comper, P., & Schweizer, T. A. (2014). Concussions and heading in soccer: A review of the evidence of incidence, mechanisms, biomarkers and neurocognitive outcomes. *Brain Injury, 28,* 271–285. doi:10.3109/02699052.2013.865269

Majerske, C. W., Mihalik, J. P., Ren, D., Collins, M. W., Reddy, C. C., Lovell, M. R., & Wagner, A. K. (2008). Concussion in sports: Postconcussive activity levels, symptoms, and neurocognitive performance. *Journal of Athletic Training, 43,* 265–274.

Makdissi, M., Cantu, R. C., Johnston, K. M., McCrory, P., & Meeuwisse, W. H. (2013). The difficult concussion patient: What is the best approach to investigation and management of persistent (>10 days) postconcussive symptoms? *British Journal of Sports Medicine, 47,* 308–313.

Malec, J. F. (1999). Goal attainment scaling in rehabilitation. *Neuropsychological Rehabilitation, 9,* 253–275.

Marshall, C. M. (2012). Sports-related concussion: A narrative review of the literature. *The Journal of the Canadian Chiropractic Association, 56,* 299–310.

Marshall, S., Bayley, M., McCullagh, S., Velikonja, D., & Berrigan, L. (2012). Clinical practice guidelines for mild traumatic brain injury and persistent symptoms. *Canadian Family Physician, 58,* 257–267.

McCrea, M. A. (2008). *Mild traumatic brain injury and postconcussion syndrome: The new evidence base for diagnosis and treatment.* New York, NY: Oxford University Press.

McCrory, P., Meeuwisse, W. H., Aubry, M., Cantu, B., Dvoràk, J., Echemendia, R. J., . . . Turner, M. (2013). Consensus statement on concussion in sport: The 4th International Conference on Concussion in Sport held in Zurich, November 2012. *British Journal of Sports Medicine, 47,* 250–258. doi:10.1136/bjsports-2013-092313

Medley, A. R., & Powell, T. (2010). Motivational Interviewing to promote self-awareness and engagement in rehabilitation following acquired brain injury: A conceptual review. *Neuropsychological Rehabilitation, 20,* 481–508. doi:10.1080/09602010903529610

Meehan, W. P., III, & Bachur, R. G. (2009). Sport-related concussion. *Pediatrics, 123,* 114–123. doi:10.1542/peds.2008-0309

Mitka, M. (2010). Reports of concussions from youth sports rise along with awareness of the problem. *Journal of the American Medical Association, 304,* 1775–1776. doi:10.1001/jama.2010.1487

Nationwide Children's Hospital. (n.d.). *An educator's guide to concussions in the classroom* (2nd ed.). Retrieved from http://www.nationwidechildrens.org/concussions-in-the-classroom

Salvatore, A. P., & Fjordbak, B. S. (2011). Concussion management: The speech-language pathologist's role. *Journal of Medical Speech-Language Pathology, 19,* 1–12.

Scherer, M. J., Hart, T., Kirsch, N., & Schulthesis, M. (2005). Assistive technologies for cognitive disabilities. *Critical Reviews in Physical and Rehabilitation Medicine, 17*(3), 195–215.

Shenton, M. E., Hamoda, H. M., Schneiderman, J. S., Boulx, S., Pasternak, O., Rathi, Y., . . . Zafonte, R. (2012). A review of magnetic resonance imaging and diffusion tensor imaging findings in mild traumatic brain injury. *Brain Imaging and Behavior, 6,* 137–192. doi:10.1007/s11682-012-9156-5.A

Sohlberg, M. M., Harn, B., MacPherson, H., & Wade, S. (2014). A pilot study evaluating attention and strategy training following pediatric traumatic brain injury. *Clinical Practice in Pediatric Psychology, 2,* 263–280.

Sohlberg, M. M., Kennedy, M., Avery, J., Coelho, C., Turkstra, L., Tlvisaker, M., & Yorkston, K. (2007). Evidence-based practice for the use of external aids as a memory compensation technique. *Journal of Medical Speech-Language Pathology, 15*(1), xv–li.

Sohlberg, M. M., & Turkstra, L. S. (2011). *Optimizing cognitive rehabilitation.* New York, NY: Guilford.

Turner, T., Misso, M., Harris, C., & Green, S. (2008). Development of evidence-based clinical practice guidelines (CPGs): Comparing approaches. *Implementation Science, 3,* 45.

Van't Hooft, I., Andersson, K., Bergman, B., Sejersen, T., von Wendt, L., & Bartfai, A. (2007). Sustained favorable effects of cognitive training in children with acquired brain injuries. *NeuroRehabilitation, 22,* 109–116.

Wade, D. T., Crawford, S., Wenden, F. J., King, N. S., & Moss, N. E. (1997). Does routine follow up after head injury help? A randomised controlled trial. *Journal of Neurology, Neurosurgery & Psychiatry, 62*(5), 478–484.

Woodrome, S. E., Yeates, K. O., Taylor, H. G., Rusin, J., Bangert, B., Dietrich, A., . . . Wright, M. (2011). Coping strategies as a predictor of post-concussive symptoms in children with mild traumatic brain injury versus mild orthopedic injury. *Journal of the International Neuropsychological Society, 17,* 317–326.

Zemek, R. L., Farion, K. J., Sampson, M., & McGahern, C. (2013). Prognosticators of persistent symptoms following pediatric concussion: A systematic review. *JAMA Pediatrics, 167,* 259–265. doi:10.1001/2013.jamapediatrics.216