ERABI EVIDENCE-BASED REVIEW of moderate to severe ACQUIRED BRAIN INJURY

Clinical Guidebook

2. Cognition and Cognitive-Communication Following Acquired Brain Injury

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Cognition and Cognitive-Communication Disorders Post-ABI

By the end of this chapter you should know:

- What are cognitive and cognitive-communication deficits
- How to identify multiple cognitive and cognitive-communication deficits through clinical presentations
- Common assessments for evaluating these deficits and dysfunctions
- What interventions are supported by both the evidence and clinical practice in different cognitive areas
- How to explain a possible pathway of care for an individual with cognitive or cognitive-communication deficits post-ABI

2.1 Introduction to Cognition and Cognitive-Communication

Cognitive dysfunction is a common symptom of acquired brain injury (ABI) which can negatively affect many areas of cognition such as attention, memory, executive function, learning, communication, and social cognition. Each of these functions represents a unique area of cognition that allows individuals to execute basic and instrumental activities of daily living. Cognitive impairment can be caused not only by the initial trauma, but also by secondary inflammation or insult. Compared to mild traumatic brain injury (TBI), moderate/severe TBI is associated with more severe and persistent cognitive deficits, with 65% of patients reporting long-term cognitive problems (Rabinowitz & Levin, 2014). The effects of TBI on overall cognitive functioning vary depending on the time post-injury (Schretlen & Shapiro, 2003), with a significant amount of individuals gradually recovering over time. Even with good medical prognosis, cognitive ability remains one of the best predictors of successful return to work and independent living following an ABI (Murdoch, 2013). With the diverse nature of the brain there are a multitude of ways that each trauma can impact cognition. As a result, there are a variety of interventions available to clinicians to help rehabilitate the different areas of cognitive functioning post ABI.

As mentioned, cognitive deficits include difficulties in attention, concentration, processing speed, learning, memory, and executive functions such as decision making. Evaluating the efficacy of remediation or rehabilitation of cognitive deficits following a brain injury is complicated by a number of factors. 1) There is limited consensus on the operational definitions of cognitive deficits such as attention, and executive function**.** 2) Different researchers and clinicians will report using the same or similar tests to measure different aspects of cognition thereby confounding their results. 3) A study may use the same outcome measures repeatedly, increasing the likelihood of practice effects (e.g., Paced Auditory Serial Addition Test [PASAT] performance improves significantly with repeated exposure to the test). 4) Studies may not consider and account for the rate of spontaneous recovery following brain injury (e.g., would participants naturally show recovery of function in the absence of treatment?). For all of these reasons it may be difficult to use the research literature to examine efficacious interventions for cognitive deficits. To better support the conclusions in this chapter we have included not only key studies but also clinical guidelines, meta-analyses, and clinical resources to help consolidate the existing information on cognitive rehabilitation post ABI. Each area of cognition and cognitive-communication is explored further in the Clinical Presentation section.

Cognitive-communication deficits are another area of cognitive injury that may develop as a result of an acquired brain injury. Cognitive-communication deficits represent the intersection of linguistic abilities (syntax, semantics, and metalinguistics) and the non-linguistic cognitive functions (attention, memory, executive function) needed for both verbal and non-verbal communication. "Communication difficulties can include issues with hearing, listening, understanding, speaking, reading, writing, conversational interaction and social communication." (*Practice Standards and Guidelines for Acquired Cognitive Communication Disorders, College of Audiologists and Speech-Language Pathologists of Ontario, 2015,* p.2).

Clinical Tip!

Be aware of potential differential diagnoses for cognitive deficits such as depression, attention deficit hyperactivity disorder (ADHD), and sleep deprivation.

Table 2.1 The broadest categories of cognition and cognitive communication.

Category	Description
Cognitive deficits	Difficulties with attention, concentration, processing speed, memory, and learning, social cognition, self-awareness, emotional intelligence, general intelligence.
Cognitive-Communication	Deficits in syntax, semantics, metalinguistics, language execution and comprehension. This also includes deficits in the relevant cognitive processes, such as attention, and memory needed for communication.
Executive Functioning	Areas of cognitive control or processes that are responsible for observed behavior such as decision making and cognitive organization. Executive functions also include emotions, perceptions, goal setting and execution.
Social Communication	The use of language in social contexts which include but are not limited to social interaction, social cognition, pragmatics, and language processing.

*Adapted from *Traumatic Brain Injury* (2010) and *Brain Injury Medicine 2nd Ed.* (2013) and the American Speech-Language-Hearing Association.

2.2 Clinical Presentation

Due to the nature of cognitive and cognitive-communication deficits, there are large areas of overlap in the presentation of a specific deficit. For this reason, cognitive deficits have been broken down by topic but may include overlap in their presentation.

2.2.1 Attention, Concentration, and Processing Speed

Currently, attention is one of the most poorly defined cognitive functions, without an agreed upon definition. However, there is a general consensus on the components involved in attention, concentration and processing speed. **One-way attention may be defined is in two parts; intensity and selectivity. Intensity involves the level of arousal, alertness, and vigilance, while selectivity involves the ability to discriminate and filter between relevant and irrelevant sensory stimuli** (Whyte, 2010). Another concept has been proposed by Shiffrin and Schneider (Shiffrin & Schneider, 1977), where a

parallel automatic process occurs at the same time as a sequential controlled process. The first process (automatic processing) has no limitations to affect its flow such as the capacity of information for evaluation, while the second process is limited by information processing and speed. In this understanding the automatic and controlled processes are responsible for different areas of attention, concentration, and processing speed. Regardless of the model being used, there is a broad consensus that there are multiple processes which affect these cognitive functions, such as arousal, filtration of external stimuli, and conscious and unconscious processing.

Deficits in attention, concentration, and processing speed are common following acquired brain injury, with as many as 60% of individuals with TBI reporting attentional difficulties as far as ten years post-injury (Dan Hoofien, 2001; Himanen et al., 2006; Ponsford et al., 2014c). Deficits can manifest in all areas of life as individuals are unable to filter out irrelevant external stimuli, miss details in everyday work, cannot focus their attention, and have difficulty following conversations. More specifically, reaction times for questions or tasks may be slower but responses will still be accurate (Cifu, 2010). Tasks that were once automatic, such as driving and reading, may now require full attention and individuals are more conscious of their participation in these tasks. Individuals may report difficulty meeting deadlines, concentrating on school work, carrying on conversations, sleep-wake disturbances, anxiety and over all poorer quality of life (Cifu, 2010; Murdoch, 2013; Ponsford et al., 2014a; Zasler ND, 2013).

Multiple studies support this clinical presentation of attentional deficits in specific ABI populations. For example, two studies assessing the reaction times of individuals demonstrated that those with a TBI were found to have slower reaction times than individuals who had not sustained a TBI (Azouvi et al., 2004; Stuss et al., 1989). Results of the visual analogue scale also indicated that mental effort was higher for those with a TBI than for the controls. The results of this study confirmed what previous studies had found: those with a TBI have greater difficulty with attention when dealing with two simultaneous tasks (Azouvi et al., 2004).

2.2.2 Learning and Memory

Memory complaints following a TBI are common, regardless of severity or outcome (McAllister, Flashman, Sparling, & Saykin, 2004). The broad spectrum of learning and memory deficits, combined with the prevalence of these deficits despite different injuries, makes it increasingly difficult to attribute learning and memory impairments to a single clinical pattern (Eslinger, 2013). **In the broadest sense, learning and memory deficits are defined as problems with the encoding, consolidation, and/or retrieval of new or old information. Encoding** is most strongly associated with the learning process, and involves the integration of sensory, semantic, and personal experiences and information through cognitive mechanisms (Eslinger, 2013). **Consolidation** refers to the more biological processes of memory and memory traces within the brain that create interactions between the cortex, the limbic system, more specifically the hippocampus. For a review of basic neuroanatomy please see Chapter 1: Introduction to ABI. **Retrieval** is the process of accessing these memories through either recognition or recall. Unfortunately, the biological processes involved in memory retrieval are not well known, however the prefrontal cortex is implicated in this process. **Deficits can occur in one or several of the three stages of memory (encoding, consolidation, or retrieval)**. Some of the corresponding deficits that may be observed in each process are presented in Table 2.2 below.

Table 2.2 The specific deficits that may be observed for impairments in learning and memory.

Stage of Learning and Memory	Deficits observed
Encoding (learning)	• Difficulty finding one's way in new environments • Difficulty learning new words • Delays in recalling recent stimuli • Difficulty remembering appointments/commitments
Consolidation (memory)	• Delays in recalling recent stimuli • Difficulty keeping thoughts in one's head for short or long periods of time • Unable to identify words, objects, or individuals • Difficulty creating episodic memories • Difficulty linking memories to other concepts
Retrieval (memory)	• Difficulty remembering order of operations • Unable to remember words, objects, or individuals • Gaps in autobiographical, episodic, and semantic memory

One theory as to why memory challenges may be so prominent following ABI, is because of **the large-scale coordination that needs to occur between multiple areas of the brain, the frontal cortex, the limbic system, and subcortices in order to form and use memories** (Eslinger, 2013). As a single memory can encode multiple sensory and personal experiences, damage to sensory or motor areas can also result in significant memory or learning impairments. Although memory contains those three major concepts of encoding, consolidation, and retrieval, memory itself can be broken down based on the category of information encoded (Table 2.3). Individuals with an ABI may have deficits in any singule or combination of memory categories.

Table 2.3 Cognitive Categories of Memory

Memory Sub-category	Description
Declarative (explicit)	Knowing the "what" of facts or events, able to recall these memories consciously.
Procedural (implicit)	Knowing the "how" of procedures or skills, like tying a shoe or riding a bicycle. Knowledge is unconscious and a result of automatic sensorimotor behaviors.
Short-term and long-term	Short-term memory consists of what an individual is thinking in the moment, and can last up to several days, but the information may be lost following this period. Long-term memory is the indefinite storage of informative knowledge through consolidation.
Verbal	The memory of words and other abstract concepts involving the use of language.
Visuospatial	Memories corresponding to information about one's environment and spatial orientation. Also referred to as cognitive maps.
Semantic	A component of long-term memory which includes facts not drawn from personal experiences, such as the names of colors or mathematics.
Autobiographical	The subjective experiences about one's own life and self. This memory category is a combination of episodic and semantic memory.
Episodic	Memories corresponding to personal experiences encoded with emotion, factual, or conjured information.

Post-traumatic amnesia (PTA) is a unique cognitive deficit under the learning and memory components of cognition. Post traumatic amnesia begins at the moment of injury, persists through coma, prior to the return of the ability to store and retrieve new information (Russell, 1971). **PTA is defined as a "state of generalized cognitive disturbance characterized by confusion, disorientation, retrograde amnesia, inability to store new memories, and sometimes agitation and delusions"** (Ponsford et al., 2014b) (p. 307). Findings have shown that individuals with PTA perform poorly on tasks of processing speed, executive function, speech perception, and sustained attention (Stuss et al., 1999; Wilson, Baddeley, Shiel, & Patton, 1992). Delusions, hallucinations, and sleep disturbances have also been seen in individuals with PTA (Nakase-Richardson et al., 2013). PTA has recently become a recognized predictor of outcome following ABI and as a measure of severity, with a PTA duration of less than 18 days predicting a good outcome (Walker et al., 2010). Individuals with PTA will likely present with either (or both) anterograde amnesia, or retrograde amnesia (Andriessen, de Jong, Jacobs, van der Werf, & Vos, 2009; Schwartz et al., 1998; Tate, Pfaff, & Jurjevic, 2000). **Anterograde amnesia** occurs when an individual is unable to form new memories, this can be accompanied with a deficit in declarative memory, while procedural memory may be preserved. **Retrograde amnesia** on the other hand is the inability to recall memories from before the moment of injury. Retrograde amnesia usually resolves during recovery (Cantu, 2001; Russell & Nathan, 1946).

2.2.3 Executive Functioning

Executive functions are generally defined as those functions including complex processes, such as goal setting and execution, decision making, human adjustment, problem solving, and long-term planning. The region of the brain implicated in this area of cognition is the **prefrontal cortex** and it requires the coordination of various subprocesses of cognition such as attention, memory, and self monitoring. Deficits in executive functions can present as personality changes, psychosocial coping disturbances, disinhibition, psychopathic behavior, disruptions in theory of mind, poor emotional processing, and challenges understanding value-driven decision making (Andres & Van der Linden, 2002; Eslinger, 1996; Eslinger, 2013; Levine, Dawson, Boutet, Schwartz, & Stuss, 2000; Zappalà, 2008).

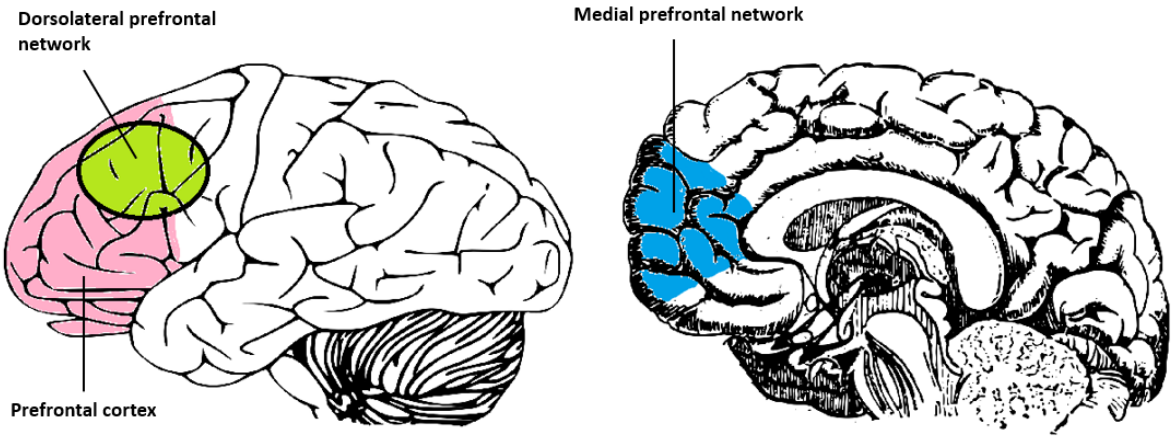

Figure 2.1 Areas of the brain implicated in executive function.

Social judgements, of oneself or others, or maintaining motivation can be a strong indicator of irregularities in executive functioning due to damage in the **medial prefrontal network** (Eslinger, 2013). This region is particularly sensitive to the tearing and shearing forces of TBI due to its location in the prefrontal cortex. In comparison damage to the **dorsolateral prefrontal network** can result in deficits in working memory, reduced reasoning capacity, poor divided attention, and an increase in impulsivity (Eslinger, 2013; Grafman, Jonas, & Salazar, 1990). Although these connections are not standardized across all individuals with an ABI, and a variety of injury locations could potentially result in similar deficits, this provides a broad overview of the common deficits that might be observed given specific injury locations. The purpose of this material is not to exclusively search for these deficits when specific injuries are present, but to be able to identify potentially subtle changes in executive functions given damage to specific areas of the brain.

2.2.4 Cognitive-Communication

Descriptions of communication disorders that exist within populations of individuals with ABI fall into four main groups: cognitive-communication, apraxia, aphasia, and dysarthria. Cognitive-communication disorders are described as deficits in communication which that are result of damage to underlying cognitive functions (College of Audiologists and Speech-Language Pathologists of Ontario, 2002). These metalinguistic skills include word retrieval, comprehension of auditory and figurative language, reading and writing, and social communication (Prigatano, 1991). As with the other cognitive deficits discussed, the presentation of cognitive-communication disorders is heterogeneous, and can result from damage to the cortical, subcortical, bulbar or cerebellar systems. A recent study of 71 individuals with moderate to severe brain injury showed that as many as 45% of individuals were still cognitively impaired 5 years post-injury, with the majority of these long-term deficits falling into the cognitive-communication category (Marsh, Ludbrook, & Gaffaney, 2016).

Several aspects of cognition that may affect language identified by the American Speech-Language-Hearing Association (ASLHA) subcommittee of Cognition and Language are:

- *Impaired attention, perception or memory*
- *Inflexibility, impulsivity, or disorganized thinking or acting*
- *Inefficient processing of information (rate, amount, and complexity)*
- *Difficulty processing abstract information*
- *Difficulty learning new information, rules and procedures*
- *Inefficient retrieval of old or stored information*
- *Ineffective problem solving and judgement*
- *Inappropriate or unconventional social behaviour*
- *Impaired executive functions – self-awareness of strengths and weaknesses, goal setting, planning, self-initiating, self-inhibiting, self-monitoring, and self-evaluating*

(ASLHA (1987) as cited in Kennedy & Deruyter, 1991)

2.2.5 Metacognition

Metacognition includes the domains of cognition such as personality traits, social skills, moral beliefs, and theory of mind (Eslinger, 2013; Stuss, Gallup, & Alexander, 2001). Changes in these areas of metacognition are usually the result of damage to the frontotemporal region. Individuals can become profane, lose inhibition, become aggressive, show a lack of empathy, and are unable to interpret social meaning from conversations such as sarcasm, irony, or humour (Eslinger, 1998; McDonald & Flanagan, 2004). These emotionally regulated processes, and theory of mind abilities are becoming increasingly targeted by cognitive and cognitive communication interventions. It should be noted that these deficits do not clinically present in consistent syndromes, but exist on independent spectrums and should not only be considered as a whole when evaluating changes in executive functions, but independently as well.

2.3 Outcome Measures and Clinical Assessments

Although there are many cognitive and cognitive communication measures available to use when evaluating cognitive deficits, three common outcome measures are discussed in detail below. Considerations for the use of each outcome measure are also discussed.

2.3.1 Wechsler Adult Intelligence Scale IV (WAIS-IV)

The WAIS-IV (2008) is a privately owned standardized cognitive assessment which consists of 10 subsets that cover topics such as verbal and perceptual cognitive domains, as well as areas of working memory, processing speed, problem solving, and reasoning. An additional five subsets are available titled Letter-Number Sequencing, Figure Weights, Comprehension, Cancelation, and Picture Completion. The WAIS-IV uses General Ability Index tables which are generated by the proprietary owner to assist in the analysis of scoring an individual.

The WAIS-IV was developed to reduce potential carry-over effects from other deficits an individual may have by reducing response dependency on motor function, hearing ability, and vocabulary. This test has been developed to be specifically used with individuals with an ABI.

The limitations of using this outcome measure include; it must be administered by a neuropsychologist, it is not open source, requires specific training for scoring, and often requires more than one subset of the test be administered which can be timely. However, it is one of the more comprehensive tests available for assessing cognitive dysfunction.

2.3.2 Montreal Cognitive Assessment (MoCA)

The original MoCA (Version 8.1) is a one-page assessment that evaluates the following cognitive and cognitive-communication components: visuospatial reasoning, executive function, naming, memory, attention, language, abstract reasoning, delayed recall, and orientation for a total score out of 30 (Figure 2.2). A score below 26 is considered cognitively impaired. If an individual scores 25 or below a referral for an in-depth cognitive assessment should be considered. The MoCA takes approximately 15 minutes to administer and is an open-source evaluation available online HERE.

The MoCA can be administered by any therapist or healthcare support worker as it provides all objective measures and stimuli needed to complete the assessment. The administrator moves through each question with the individual being examined and scores the assessment in real-time. Upon multiple examinations the MoCA has demonstrated strong psychometric properties with a Cronbach's alpha (internal consistency) of α=0.83, test-retest reliability of r=0.92, and the validity of the assessment (when correlated with scores of the Mini Mental State Exam) was also high, r=0.87 (Nasreddine et al., 2005).

One consideration when using the MoCA, is that the MoCA is heavily language-based and therefore is not ideally suited for individuals with significant aphasia or language deficits.

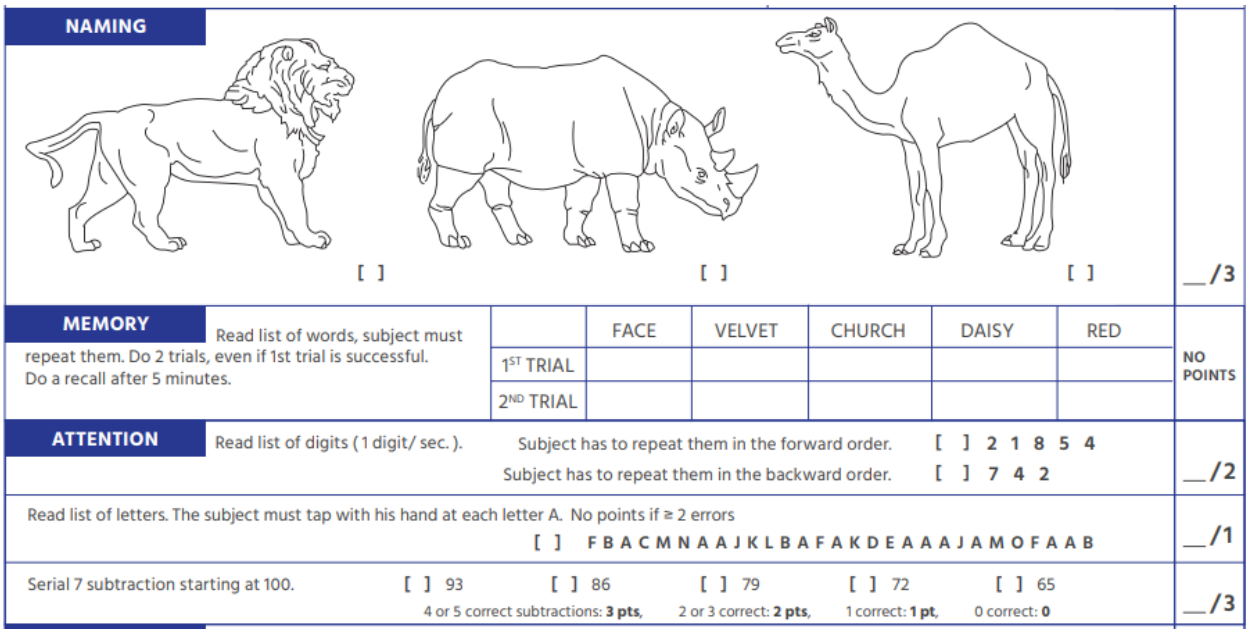

Figure 2.2 Three of the sections from the MoCA (Version 8.1) showing the evaluations for naming, memory and attention.

2.3.3 Mini-Mental State Examination

The Mini-Mental State Examination (MMSE) is a paper and pencil 30-point 1-page assessment, which is open source and provides instructions for its administration (Folstein, Folstein, & McHugh, 1975). The instructions provide the exact phrasing to be spoken to the individual being assessed. The assessment consists of a brief questionnaire that requires the individual to sometimes respond verbally, perform an action, or reproduce an image.

Clinical Tip!

Always consider adding the MMSE to any cognitive assessment as it is one of the few measures least affected by comorbid mood disorders in ABI.

The MMSE does not require any specific training for administration and takes approximately 10-15 minutes to administer, depending on the cognitive state of the individual at the time of assessment. A modified version of the test is currently held under copywrite by Psychological Assessment Resources and is available for purchase (https://www.parinc.com/), while the original test remains open source and can be found HERE along with other recommended cognitive assessments by the Heath and Stroke Foundation of Canada. Primary psychometric properties reported for the MMSE are as follows; Chronbach's alpha α=0.54-0.96, test-retest reliability r=0.87, and validity (when compared to other cognitive assessments) was seen to be r=0.70-0.90 (Fabrigoule, Lechevallier, Crasborn, Dartigues, & Orgogozo, 2003; Tombaugh & McIntyre, 1992).

With respect to the interpretation of the results, a score below 24 is considered cognitively impaired and abnormal, and further specialized assessments are recommended to determine the specific cognitive deficits present. If an individual scores below 10 they are considered "untestable" and are likely to require 24-hour supervision.

Table 2.4 A breakdown of how MMSE scores should be interpreted based on an individual's performance.

Method	Score	Interpretation
Single Cutoff	<24	Abnormal
Range	<21	Increased odds of dementia
	>25	Decreased odds of dementia
Education	21	Abnormal for 8th grade education
	<23	Abnormal for high school education
	<24	Abnormal for college education
Severity	24-30	No cognitive impairment
	18-23	Mild cognitive impairment
	0-17	Severe cognitive impairment

Table 2.5 An expanded interpretation of each range of MMSE scores, this chart also makes recommendations for care based on a particular scored range.

Score	Degree of Impairment	Formal Psychometric Assessment	Day-to-Day Functioning
25-30	Questionably significant	If clinical signs of cognitive impairment are present, formal assessment of cognition may be valuable.	May have clinically significant but mild deficits. Likely to affect only most demanding activities of daily living.
20-25	Mild	Formal assessment may be helpful to better determine pattern and extent of deficits.	Significant effect. May require some supervision, support and assistance.
10-20	Moderate	Formal assessment may be helpful if there are specific clinical indications.	Clear impairment. May require 24-hour supervision.
0-10	Severe	Patient not likely to be testable.	Marked impairment. Likely to require 24-hour supervision and assistance with ADL.

2.4 Criteria for Diagnosis

Determining the criteria for diagnosis of cognitive and cognitive-communication deficits is challenging. **Typically, a combination of assessment scores and observations by the clinical care team are used to determine if a deficit is present and if so, the area and severity of that deficit.**

Clinical Tip!

Best-practices for making conclusions based on observations are:

- Remaining objective
- Gathering observations from multiple sources
- Engaging with the individual themselves
- Independently validating your conclusions with a peer or superior

As mentioned previously, the MoCA (≤25 out of 30 indicates impairment) and MMSE (≤23 out of 30 indicates impairment) which are commonly used in clinical practice provide threshold scores for determining the presence of a deficit. Other cognitive assessments such as the Woodcock Johnson Test series, and the WAIS-IV also have scaled scores with interpretations but require specialized training for administration and interpretation. **Deficits in specific domains are usually represented by two standard deviations from normal control values.** As a result of the diverse nature of cognitive and cognitive-communication deficits, observations may play a strong role in the diagnosis of these dysfunctions. These observations may include things like an individual being unable to attend to stimuli, taking a prolonged period of time to respond to questions, and being unable to perform specific activities which would not be captured by standardized cognitive testing. **Examples of observations and assessments for each cognitive domain, and their relative deficit severity can be found HERE in the DSM-5 on pages 593-595**. The diagnostic criteria for "Major or Mild Neurocognitive Disorder Due to Traumatic Brain Injury" from the DSM-5 (Jeste, 2013)(p. 624) is also available at this link.

Ultimately, it is the combination of clinical assessments and collection of observations which should be used to determine the likelihood of a potential cognitive deficit. If there is limited insight through observations and broad-spectrum cognitive testing, further specific testing is indicated to help pinpoint areas of dysfunction.

2.5 Interventions for Cognition and Cognitive-Communication

The broadest categories of cognitive and cognitive-communication interventions can be classified as non-pharmacological or pharmacological. The sections below outline the strongest evidence-based interventions for cognition and areas of cognitive-communication. Although not all interventions are discussed here, a complete review of the literature can be found in Module 6 and 7 (Cognition and Cognitive-Communication Interventions) in ERABI.

Click HERE to access Module 6 and 7 of ERABI: Cognition and Cognitive-Communication

The pharmacological interventions discussed below use medication in an attempt to remediate cognitive deficits. These types of medications usually moderate neurotransmitters in the brain which regulate cognitive functions. By influencing the concentration and absorption of either excitatory or inhibitory neurotransmitters these medications are able to affect memory, attention, and social behaviours (Eslinger, 2013; Zasler ND, 2013). Non-pharmacological interventions span a broader spectrum of mechanisms and may include anything from physical exercise to memory programs with assistive technology. However, there are multiple challenges when evaluating the effectiveness of cognitive interventions. As stated previously, there is a lack of consensus on the definition of some cognitive functions, which in turn can create challenges when interpreting cognitive outcome measures. Additionally, multiple studies have shown that cognitive deficits show a high degree of spontaneous recovery. The role that spontaneous recovery can play in the remediation of cognitive deficits can not always be separated from the effect of the intervention and therefore creates potential confounds (Cicerone et al., 2005). Specific concerns for each intervention are discussed below when relevant, however these general considerations should also be kept in mind.

There are a few over-arching recommendations and principles that should be applied to all individuals with suspected cognitive deficits following ABI. These are highlighted below from the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI (www.braininjuryguidelines.org).

Cognitive Rehabilitation Principles (Section J1. from www.braininjuryguidelines.org)

- *Individuals with persistent cognitive deficits following traumatic brain injury should be offered functionally-oriented cognitive rehabilitation. Treatment must be considered within a framework that considers the person's pre-injury characteristics, stage of development and recovery, and personally meaningful everyday activities and life contexts.*
- *Cognitive rehabilitation in the acute phase for individuals with traumatic brain injury should be managed in a structured distraction-free environment.*
- *To facilitate/achieve generalization of skills/strategies to daily activities for the person with traumatic brain injury rehabilitation should a) focus on activities that are perceived as meaningful by the person, and b) include therapy interventions provided in the person's own environment and/or adapted to the person's own life.*

2.5.1 Attention, Concentration and Information Processing Speed

Although there is no specific agreement on the definition of attention, it is usually measured using externally directed tests, such as instructing participants to focus their attention on a sequence of stimuli or attenuating to a particular stimulus. General guideline recommendations state that metacognitive strategies and dual-task training are the most effective non-pharmacological interventions for attention (specifically those involving functional everyday activities), and methylphenidate is the most supported pharmacological intervention for attention (Ponsford et al., 2014a). An example of a specific care management strategy for individuals with attentional deficits following an ABI was developed by the INCOG group in 2014 (Figure 2.3). This clinical algorithm depicts an assessment and treatment strategy specifically for concerns regarding attention and processing speed. It should be noted that this algorithm was developed for those who have preserved visual acuity, upper-extremity motor function, and general cognitive function (such as the ability to follow instructions).

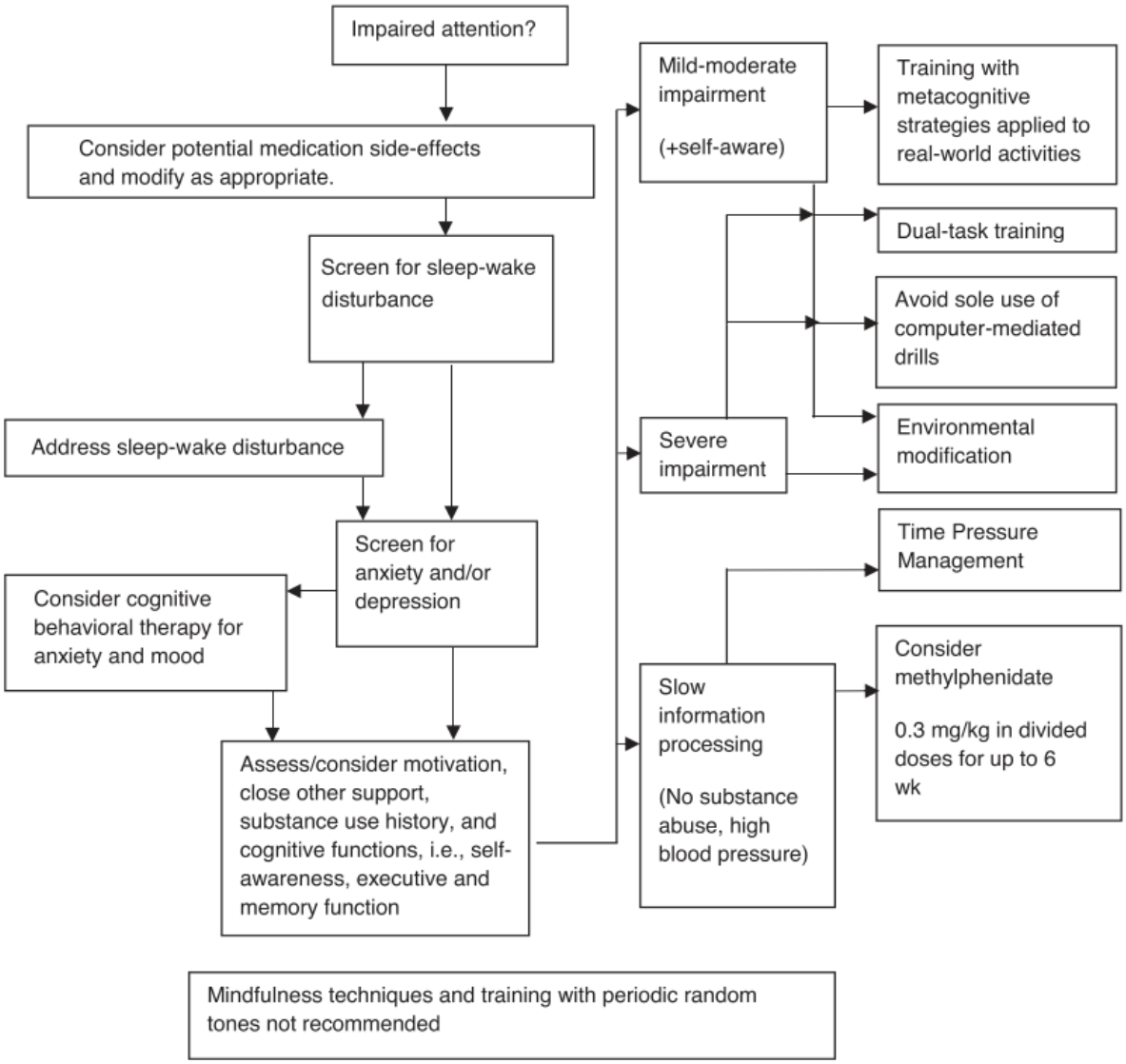

Figure 2.3 Attentional algorithm taken from the INCOG Recommendations (Ponsford et al., 2014a), showing the potential care management pathways when attempting to rehabilitate or remediate attentional deficits in individuals with an ABI.

2.5.1.1 Non-Pharmacological Interventions

Dual-Task Interventions

Q1. What is "dual-task" training? Name an intervention that falls into this category.

1. Dual-task training involves dividing attention between two stimuli in order to complete two tasks concurrently and successfully.

2. Asking an individual to walk a path while reciting as many animals as they can think of.

Overall, there is moderate evidence, that dual-task training is effective for improving attention and processing speed post-ABI (Couillet et al., 2010; Sacco et al., 2016). **Dual-task training is also supported by the INCOG Recommendations and the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI as an effective intervention for ABI populations** (Ponsford et al., 2014a). The most common dual-tasks include a combination of a motor task and a cognitive task (Fritz, Cheek, & Nichols-Larsen, 2015). The addition of a cognitive task to a mobility task has been shown to significantly increase gait variability in multiple neurologically compromised populations (Hamilton et al., 2009; Yogev et al., 2005). A recent meta-analysis of dual-task training in these neurological populations has shown that dual-task training (specifically the combination of mobile and cognitive tasks) does improve performance on concurrent walking and speaking tasks, although the gains on this measure may not be transferable to other situations (Fritz et al., 2015).

Key Study

Author/Year/ Country/Study design/PEDro Score	Methods	Outcome
Couillet et al. (2010) France RCT PEDro=5 N=12	**Population:** severe TBI; Gender: Male=9, Female=3. *Group 1 (n=5)*: Mean Age=23.8yr; Mean GCS=4.8; Mean Time Post-Injury=6.3mo. *Group 2 (n=7)*: Mean Age=26.7yr; Mean GCS=4.8; Mean Time Post-Injury=16.1mo. **Intervention:** Randomized AB versus BA design, where "A" represents the control phase and "B" represents the treatment (dual-task training) phase. In the dual-task phase, patients were trained to conduct two concurrent tasks simultaneously. Group 1 started with the control phase (AB) and Group 2 (BA) with the treatment phase. Each phase lasted 6 wk (4, 1 hr sessions/wk). **Outcome Measure:** Test Battery for Attentional Performance (TAP: divided attention and flexibility subtests), Go-no go and Digit Span, Trail Making Test, Stroop Test, Brown-Peterson Paradigm, Rating Scale of Attentional Behaviour.	1. Following training, there was a significant improvement in the 2 tasks that targeted divided attention (TAP-divided attention, Go-no go and Digit Span: $p<0.0001$ for both). 2. The two groups differed significantly at 6 wk with those in the BA design doing better on TAP reaction times ($p<0.01$), the digit span dual-task ($p<0.001$), and the Rating Scale of Attentional Behaviour ($p<0.01$). 3. There was a significant difference between groups at 6 wks on the Stroop test ($p<0.001$) and the flexibility subtest of the TAP ($p<0.001$), but not the Trail Making Test or the Brown-Peterson task. 4. Experimental training had no significant effects on non-target measures.

Dual-task training can be effective at improving divided attention and processing speed, however these skills may not be transferable to other tasks (ie. Becoming proficient at walking and speaking does not necessarily result in being proficient at writing and speaking) (Couillet et al., 2010). There is the additional challenge of maintaining these skills, and studies show that without continued training skill regression can occur (Couillet et al., 2010; Fritz et al., 2015). However, overall, dual-task training has been shown to be effective as an intervention for attention and processing speeding following an ABI.

Virtual Reality and Computer-Based Interventions for Attention and Processing Speed

Q2. What evidence exists, if any, for the use of computer-based programs and virtual reality for the remediation of attentional deficits?

1. There is limited evidence that computer-based programs, including virtual reality training, are effective at improving attentional scores, cognitive functioning (based on the Montreal Cognitive Assessment), and task completion times.

Studies evaluating computer-based cognitive interventions for attention and processing speed have consisted of name brand software programs such as BrainHQ, Luminosity, and Parrot Software (O'Neil-Pirozzi & Hsu, 2016) (Zickefoose, Hux, Brown, & Wulf, 2013) (Li, Alonso, Chadha, & Pulido, 2015) (Li, Robertson, Ramos, & Gella, 2013), and also generalized computer software (Dirette, Hinojosa, & Carnevale, 1999). Overall, the evidence shows that computer-based programs, whether brand name products or general products, can be effective for improving cognition post ABI, however the extent to which they directly improve attentional measures is mixed. BrainHQ has been shown to significantly improve attention outcome measures (O'Neil-Pirozzi & Hsu, 2016), while Parrot Software showed no significant improvements on the MoCA subsets for attention and memory, but did on other subsets. A small (N=4) pre-post study examining Luminosity showed inconsistent results when evaluating improvements in attention in ABI populations (Zickefoose et al., 2013). Virtual reality programs have shown slightly more consistent improvements in attention; these improvements increase with programs that provide performance feedback (Dvorkin et al., 2013). Overall, “brain training” programs should be used with caution and on a case-by-case basis, while virtual reality training programs have shown more consistent results over time.

Goal Management Training

Q3. What is goal management training? What components can it include?

1. Goal management training consists of a structured program that aims to help individuals identify and achieve goals.

2. Components can include: motivation, attitude, avoidance management, initiation strategies, self-evaluation, and sustainability (Tornas, Lovstad, Solbakk, Schanke, & Stubberud, 2016b).

Goal management training (GMT) consists of a variety of structured programs designed to help individuals identify and achieve goals. Specifics can vary from program to program but the components of each program are generally designed to help an individual identify their goals, initiate a process to start achieving these goals, track their progress in goal completion, and identify ways to keep individuals motivated (Tornas et al., 2016b). Overall, goal management training has been shown to be effective in remediating attentional deficits in ABI specific populations through a strong literature base, and via recommendations for brain injury guidelines.

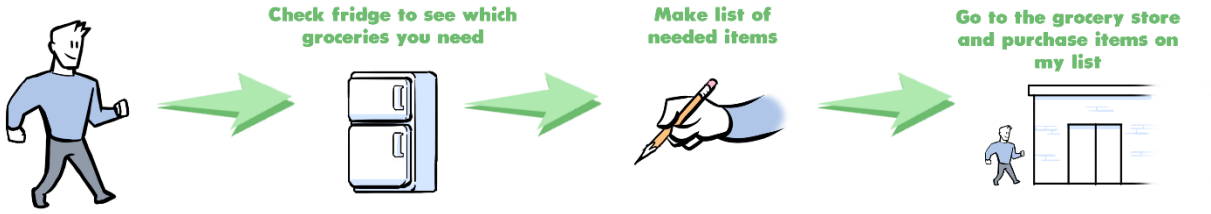

Figure 2.4 An example of a series of steps an individual can identify through GMT to execute a specific goal, in this case determining the process involved in getting groceries.

Key Study

Author/Year/ Country/Study design/PEDro Score	Methods	Outcome
Tornas et al. (2016a) Norway RCT PEDro=9 $N_{Initial}$=70, N_{Final}=67	**Population:** TBI=45, Stroke=15, Tumour=6, Anoxia=2, Other=2. Mean Age=42.89 yr; Gender: Male=38, Female=32; Mean Time Post-Injury=97.47 mo. **Intervention:** Participants were randomized to receive Goal Management Training (TG) or Brain Health Workshop (CG) group sessions. GMT group (n=33) discussed distinctions between absentmindedness/presentmindedness, slip-ups in daily life, habitual responding, stopping and thinking, working memory, importance of goals, defining/splitting goals into subtasks, and checking. BHW control group (n=37) discussed brain function/dysfunction, brain plasticity, memory, executive function, and attention. Treatment was received one day every second week, for a total of eight two-hour sessions distributed over four days. Outcomes were assessed at baseline (T1), after treatment (T2), and at six-month follow-up (T3). **Outcome Measures:** Behaviour Rating Inventory of Executive Function–Adult (BRIEF-A); Dysexecutive Questionnaire (DEX); Cognitive Failures Questionnaire (CFQ); Continuous Performance Test II (CPT-II); UCSD Performance-Based Skills Assessment (UPSA); Delis-Kaplan Executive Function System Battery–Colour-Word Interference Test (CWI), Verbal Fluency Test (VFT), and Tower Test (TT); Trail Making Test (TMT); Hotel Task (HT).	1. In the TG, significant improvements were found on BRIEF-A, DEX, and CFQ at T3 ($p<0.010$). 2. In the CG, significant improvements were found on only BRIEF-A at T2 ($p<0.050$). 3. The TG showed significant improvements on BRIEF-A and DEX ($p<0.010$), but not CFQ, compared to the CG over time 4. In the TG, significant improvements were found on CPT-II, CWI, TT, and HT at T2 and T3 ($p<0.050$), VFT at T3 ($p<0.050$), and UPSA at T2 ($p<0.001$). 5. In the CG, significant improvements were found on CPT-II, TT, and HT at T2 and T3 ($p<0.050$), and VFT and UPSA at T2 ($p<0.050$). 6. The TG showed a significant improvement on CWI, VFT, and TT ($p<0.050$), but not CPT-II, UPSA, and HT, compared to the CG over time. 7. No significant differences were found on TMT within or between groups over time.

A number of studies have shown that goal management training is effective for improving attentional measures post ABI (Chen et al., 2011; Novakovic-Agopian et al., 2011; Tornas et al., 2016a) providing strong evidence in support of the use of goal management training for attentional deficits post ABI. GMT is also a metacognitive strategy supported by a level A recommendation in the INCOG Recommendations for Management of Cognition Following Traumatic Brain Injury (Ponsford et al., 2014a; Tate et al., 2014) for the rehabilitation and remediation of both attentional deficits and executive functions.

2.5.1.2 Pharmacological Interventions

Methylphenidate

Methylphenidate is the only pharmacological intervention supported by the ABI literature (ERABI, 2018), the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI, and the INCOG Recommendations for the Management of Cognition Following TBI. No other pharmacological interventions are supported by all three of these organizations for the treatment of attentional or processing speed deficits specific to ABI populations.

Q4. What is the mechanism of action for methylphenidate and a potential dosing regimen?

1. Methylphenidate is a psychostimulant drug that "promotes release of stored dopamine from presynaptic vesicles and blocks the return of dopamine into presynaptic nerve endings." (Scahill, Carroll, & Burke, 2004). By increasing the concentrations of dopamine in the cortical and subcortical regions implicated in attention individuals are stimulated and better able to control their attentional focus to relevant stimuli.

2. For the average adult, methylphenidate is usually taken twice a day with a total daily dosage of 20-30mg, but not exceeding 60mg per day (Retrieved from "Methylphenidate (oral route)", Mayo Clinic, 2019).

Key Study

Author/Year/ Country/Study design/PEDro Score	Methods	Outcome
Zhang and Wang (2017) China RCT PEDro=10 $N_{Initial}$=36, N_{Final}=33	**Population:** TBI; Severity: mild to moderate. *Methylphenidate Group (n=18)*: Mean Age=36.3 yr; Gender: Male=13, Female=5. *Placebo Group (n=18)*: Mean Age=34.9 yr; Gender: Male=14, Female=4. **Treatment:** Participants were randomly assigned to receive methylphenidate (flexibly titrated from 5 mg/d at the beginning, then gradually increased by 2.5 mg/d until reaching 20 mg/d) or placebo for 30 wk. **Outcome Measure:** Mental Fatigue Scale	1. At baseline, there were no significant differences between groups in terms of demographics, MFS, CRT, CTT, MAT, DSST, MMSE, BDI, or HAMD. 2. Post-intervention, the experimental group had significantly lower scores compared to control group for MFS ($p=0.005$), CRT ($p<0.001$), CTT ($p<0.001$), BDI ($p=0.040$), and HAMD ($p=0.005$). 3. Post-intervention, the experimental group had significantly higher scores compared to control group for MAT

	(MFS), Choice Reaction Time (CRT), Compensatory Tracking Task (CTT), Mental Arithmetic Test (MAT), Digit Symbol Substitution Test (DSST), Mini-Mental State Examination (MMSE), Beck Depression Inventory (BDI), Hamilton Rating Scale for Depression (HAMD).	(p=0.020), DSST (p<0.001), MMSE (p<0.001).

Overall, ten studies have been found meeting the ERABI inclusion criteria that examine the effects of methylphenidate on ABI populations, they have found positive results on attention, concentration and processing speed (Plenger et al., 1996; Willmott & Ponsford, 2009; Zhang & Wang, 2017). Although there have been a few studies that have shown there are no significant effects of methylphenidate on these cognitive functions in ABI populations (Dymowski et al., 2017), the majority of the literature, and published guidelines, support the use of methylphenidate in doses of 20-30mg/day for the remediation of attention, concentration, and processing speed post ABI.

Click HERE to see the complete pharmacological evidence for cognitive interventions in ERABI

2.5.2 Learning and Memory Interventions

When evaluating intervention strategies to improve memory performance following brain injury, the literature indicates that there are two main approaches to rehabilitation: remediation of memory, and compensation for deficits. **Compensation** includes "training strategies or techniques that aim to circumvent any difficulty that arises as a result of the memory impairment." (McLean, Cardenas, Burgess, & Gamzu, 1991). Compensatory techniques include internal aids, which are "mnemonic strategies that restructure information that is to be learned." (McLean et al., 1991). On the other hand, **remediation** refers to the restoration or retraining of memory and various interventions range from assistive technology, internal memory strategies, to pharmacological interventions.

In terms of overarching practices that benefit learning and memory post ABI, the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI encouraged the use of multiple strategies to effectively recover learning and memory cognitive function. In addition to this, the INCOG group published a clinical algorithm as a potential care pathway in treating individuals with memory and learning impairments (Figure 2.5). Corresponding guideline recommendations are highlighted below alongside the relevant intervention.

Click HERE to access the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI Learning and Memory

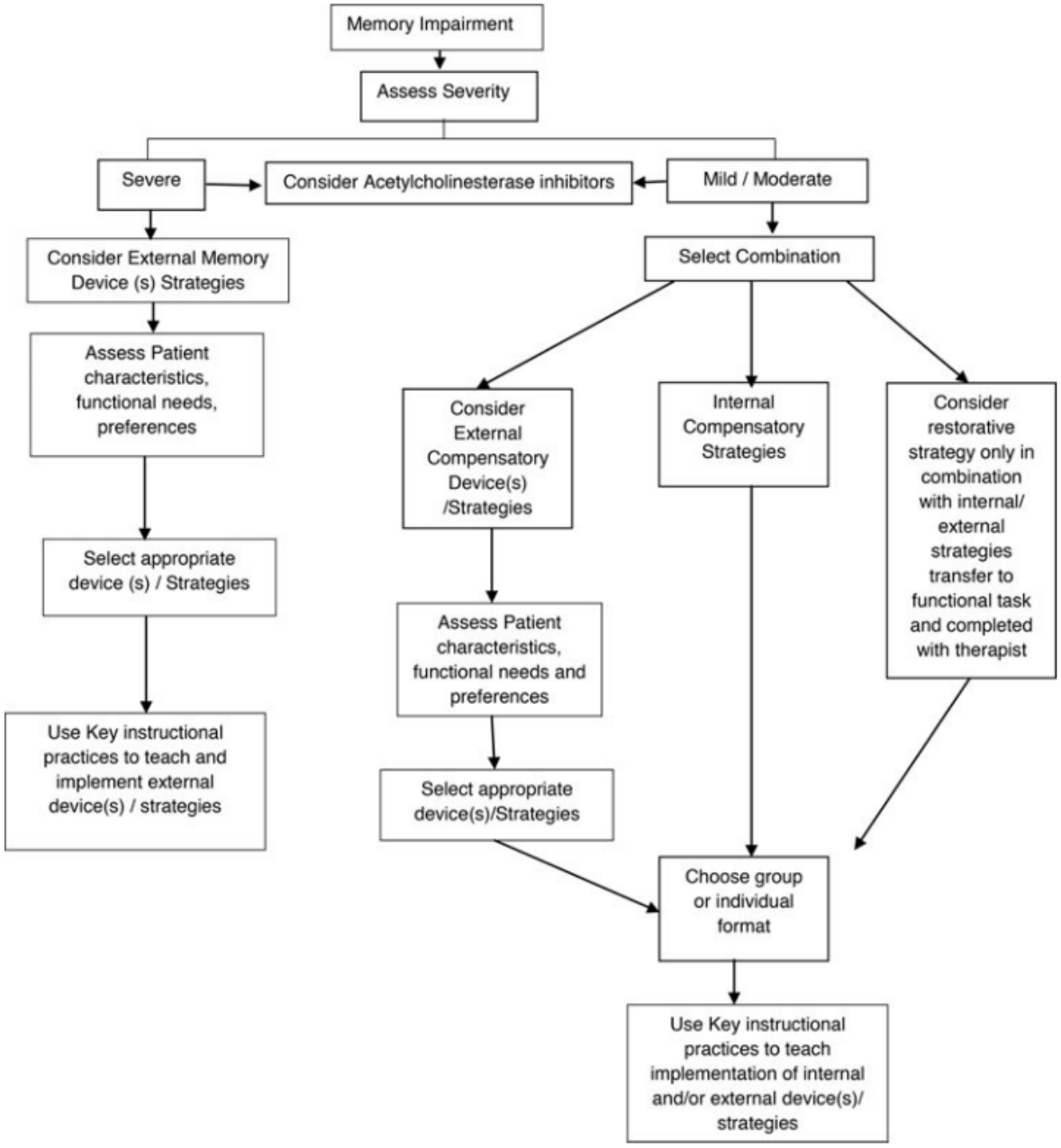

Figure 2.5 A potential pathway of care for individuals with an ABI and additional learning and memory impairments. Developed by the INCOG group as recommendations for evidence-based guidelines in ABI (Velikonja et al., 2014).

2.5.2.1 Non-Pharmacological Interventions

Q6. What are the main categories of non-pharmacological interventions for learning and memory following an ABI? What is the strength of evidence associated with each?

1. Internal memory strategies, assistive external devices (both technological and non-technological), and specific memory training programs.

2. Internal memory strategies and assistive external devices both have strong evidence. Specific memory training programs and instruction have moderate evidence. The use of these interventions is also supported by the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI and INCOG recommendations.

Assistive devices as aids for learning and memory can include anything from physical external devices, such as notebooks, smartphones, calendars, day planners and PDAs, to internal memory strategies such as mnemonic strategies. External aids can be active (technology) or passive (calendars, notebooks); both have been shown to be effective for improving memory and learning following an ABI.

External Devices for Learning and Memory

In general, external devices (technological and/or non-technological) are supported by the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI and INCOG Recommendations for learning and memory deficits. This includes devices such as paper calendars, electronic calendars, PDAs, smartphones, paging systems, and other technology which can be integrated into an individual's environment, such as their television.

Key Study

Author/Year/ Country/Study design/PEDro Score	Methods	Outcome
Lannin et al. (2014) Australia RCT PEDro=8 N=42	**Population:** TBI; Mean Age=33.5 yr; Gender: Male=26, Female=16; Mean Time Post-Injury=9.2 yr. **Intervention:** Participants were randomly allocated to either the experimental group (EG; n=21), who received 8 weeks of training in the use of a personal digital assistant (PDA) with an occupational therapist, or the control group (CG; n=21) who received 8 weeks of traditional occupational therapy. Training sessions for the EG focused on PDA training for application and organization into everyday life. **Outcome Measure:** Goal Attainment Scale (GAS), Memory Functioning Questionnaire	1. There was a significant difference between EG and CG groups in the functional memory failures subset of the GAS (p=0.0001); however, the total GAS score was not significant between groups (p=0.165). 2. The caregiver report on the frequency of forgetting and retrospective memory subset of the MFQ were significant between groups (p=0.021, p=0.042 respectively); however, seriousness of forgetting and mnemonic usage subset of the MFQ were not significant between groups (p=0.455, p=0.301 respectively) 3. Internal strategies subset of the MCQ was significant between groups (p=0.021); however, external strategies subset of the

Author/Year/ Country/Study design/PEDro Score	Methods	Outcome
	(MFQ) and Memory Compensation Questionnaire (MCQ).	MCQ was not significant between groups (p=0.580).

PDAs or electronic organizers are the most commonly evaluated technological intervention (8/17 ERABI studies) for learning and memory. Additional studies have found that PDAs also significantly increase the number of completed tasks compared to control groups (Dowds et al., 2011; Evald, 2015; Gentry, Wallace, Kvarfordt, & Lynch, 2008), and that additional goal management instruction enhances these effects (Powell et al., 2012).

The majority of individuals now use a smartphone daily which has the same capabilities as a personal digital assistant (PDA), this dramatically increases the number of individuals who have access to this assistive technology. Additional technology which has also been found to be effective are voice organizers, and paging systems such as NeuroPage which send reminders to individuals about tasks (Kim, Burke, Dowds, Boone, & Park, 2000; Wilson, Evans, Emslie, & Malinek, 1997). Of course, one of the requirements to ensure that technology is being used properly in rehabilitation is that the individual know how to use said technology, **efforts should be made to properly train and support individuals using technology as a strategy for improving learning and memory function**.

Multiple randomized controlled trials (RCTs) have examined the use of calendars and calendar tools on learning and memory (Bergquist et al., 2009; McDonald et al., 2011; Ownsworth & McFarland, 1999; Watanabe, Black, Zafonte, Millis, & Mann, 1998). In one RCT by McDonald et al. (2011), the use of a Google calendar was compared to the use of diary tracking. It was found that although both groups achieved a fair number of desired tasks, those using the Google calendar had a significant increase in task completion through the use of automated reminders and messages. Although generally the use of diaries and calendars (passive devices) are supported in ABI populations, the literature is mixed and limited compared to the available evidence from technological devices.

Internal Memory Strategies

Internal memory strategies include a variety of strategies to improve learning and memory. Spaced Retrieval Training, Time Pressure Management training, dual encoding, and spaced repetitions are all examples of internal memory strategies. Table 2.6 includes the common internal memory strategies used in ABI rehabilitation. Each of these strategies may be enhanced by combining them, and including other strategies to facilitate learning and memory, such as associating new memories with old ones, connecting the meaning of something to multiple items, and creating patterns in memorizations.

Table 2.6 A sample of the different learning and memory strategies and the corresponding evidence strength for improving learning and memory following an ABI.

Strategy	Description	Evidence
Visualization	The conversion of abstract factual information into visual imagery to help encode and retain it. This technique also forces individuals to focus and assign an associated image with the information they wish to remember.	**Strong** (Manasse, Hux, & Snell, 2005; Potvin, Rouleau, Senechal, & Giguere, 2011; Raskin & Sohlberg, 2009; Thoene & Glisky, 1995; Twum & Parente, 1994)
Repeated Practice	Involves encoding the information multiple times, this can include re-reading the original source, internal repetition of the information, or asking for the information to be presented again.	**Strong** (Hillary et al., 2003; Schefft, Dulay, & Fargo, 2008; Zlotowitz et al., 2010)
Retrieval Practice	Rehearsing and retrieving information repeatedly to improve learning. Often involves asking oneself, or another, priming questions to facilitate the retrieval process (e.g., "Do you remember what time I told you your sister is coming over?")	**Strong** (Bourgeois, Dijkstra, Burgio, & Allen-Burge, 2001; Sumowski et al., 2010)
Self-talk	Self-talk is another form of rehearsal and repetition where the individual repeats the information to themselves and can also prime themselves with hints for remembering information (e.g., "I need to write this down to help me remember").	**Strong** (Thoene & Glisky, 1995)
Preview, Question, Read, State, Test (PQRST)	PQRST is a specific method that involves 5 steps. Individuals first preview the entire content they are trying to remember (like a chapter in a book), then they ask themselves questions about the content they are trying to learn ("What does the author mean by this?"). Then the relevant content is read and stated back to the individual (self-rehearsing), and lastly one can test themselves on the information they have learned by developing priming questions related to the content (e.g., "How many times did X happen?").	**Moderate** (Glasgow, Zeiss, Barrera, & Lewinsohn, 1977)
Self-imagination	This strategy involves imagining oneself in the context of the information that is trying to be learned. Imagining experiences, knowledge, and facts through personal experience.	**Strong** (Grilli & Glisky, 2013; Grilli & McFarland, 2011; Thoene & Glisky, 1995)

Figure 2.6 Evidence suggests that the combination of more than one memory strategy, such as those pictured above (self-imagination, repeated encoding, and reminders) are more effective than using a single memory strategy alone.

External Memory Strategies

External memory strategies involve specific memory training programs with the help of an instructor, group, or software program designed to improve learning and memory. Unfortunately, the literature examining learning and training programs in the ABI population is limited, with the same training program rarely being examined more than once, however a few interventions have still been recommended by guideline groups. Below are the components recommended for memory training programs by the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI (2015) (www.braininjuryguidelines.org).

Recommendations on effective components of memory training programs (Section J5 from www.braininjuryguidelines.org)

- *An experienced therapist should be leading sessions and targeting strategy-focused skills*
- *Functional integration of skills needs to be specifically addressed*

- *Clearly defined intervention goals*
- *Teach strategies using a variety of stimuli and media (ex. Multiple formats and examples)*
- *Use teaching strategies that constrain errors*
- *Use methodologies that allow tasks to be broken down into smaller components*

Overall, the majority of cognitive interventions for learning and memory have strong to moderate evidence, such as self-imagination, emotional regulation, self-awareness training, and the Short Memory Technique. However, other interventions like Parrot Software and Brain HQ, have shown no effects on learning and memory in ABI populations and are not recommended as interventions.

2.5.2.2 Pharmacological Interventions

Acetylcholinesterase Inhibitors

Q7. What are the only two pharmacological interventions supported by the INESSS-ONF Guidelines and the ABI literature for learning and memory deficits? What are their recommended daily dosages?

1. Donepezil, recommended 5-10 mg/day
2. Rivastigmine, recommended starting dosage of 1.5 mg/day, increasing by 1.5 mg until maintenance at 3-6 mg/day.

Both Donepezil and Rivastigmine have strong evidence for improving memory and learning following an ABI (Khateb, Ammann, Annoni, & Diserens, 2005; Masanic, Bayley, VanReekum, & Simard, 2001; Morey, Cilo, Berry, & Cusick, 2003; Silver et al., 2006; Silver et al., 2009; Zhang, Plotkin, Wang, Sandel, & Lee, 2004). Both drugs have been seen to significantly improve learning and memory, and additionally improve attention and executive functioning in ABI populations. However, common side-effects of acetylcholinesterase inhibitors are nausea, vomiting, diarrhea, and anorexia, and should be strongly considered if patients are already at risk of malnutrition.

Click HERE to see the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI on pharmacological interventions for learning and memory

It should be noted that specific pharmacological interventions have been shown to be ineffective in the ABI literature as well. These include sertraline, amantadine, and growth hormone replacement therapy. These treatments have been shown to be ineffective for the remediation of learning and memory, however the results in this area of cognition may not be related to the effects of these treatments and potential benefits in other areas of cognition.

2.5.3 Interventions for Executive Function and General Cognition

Executive functions refer to higher-level cognitive functions that are primarily mediated by the frontal lobes. These functions include insight, awareness, judgment, planning, organization, problem solving, multi-tasking and working memory (Lezak, 2004). Executive deficits are particularly relevant following traumatic brain injury from both a pathophysiologic as well as a psychosocial perspective. The frontal lobes tend to be one of the brain areas most likely to be injured following trauma (Greenwald, Burnett, & Miller, 2003). Frequently bilateral frontal lobe injury occurs following TBI in contrast to typical unilateral insults following vascular injury. Not only direct contusion to the frontal and temporal lobes but also diffuse axonal injury sustained as a result of TBI affects executive functioning (Eslinger, 2013). Patients with a TBI often present with cognitive and behavioral deficits in the presence of little physical impairment.

In reviews by Cicerone et al. (Cicerone et al., 2000; Cicerone et al., 2005; Cicerone et al., 2011), a total of 41 studies have been identified and reviewed examining interventions for executive functions following an ABI. The overarching conclusion made was that interventions which have formal problem-solving strategies and are highly applicable to everyday life are the most effective. In addition to that, we have also provided the clinical algorithm from the INCOG group on executive functioning to show what an example of a care management trajectory might look like in individuals with an ABI and executive dysfunction (Figure 2.7).

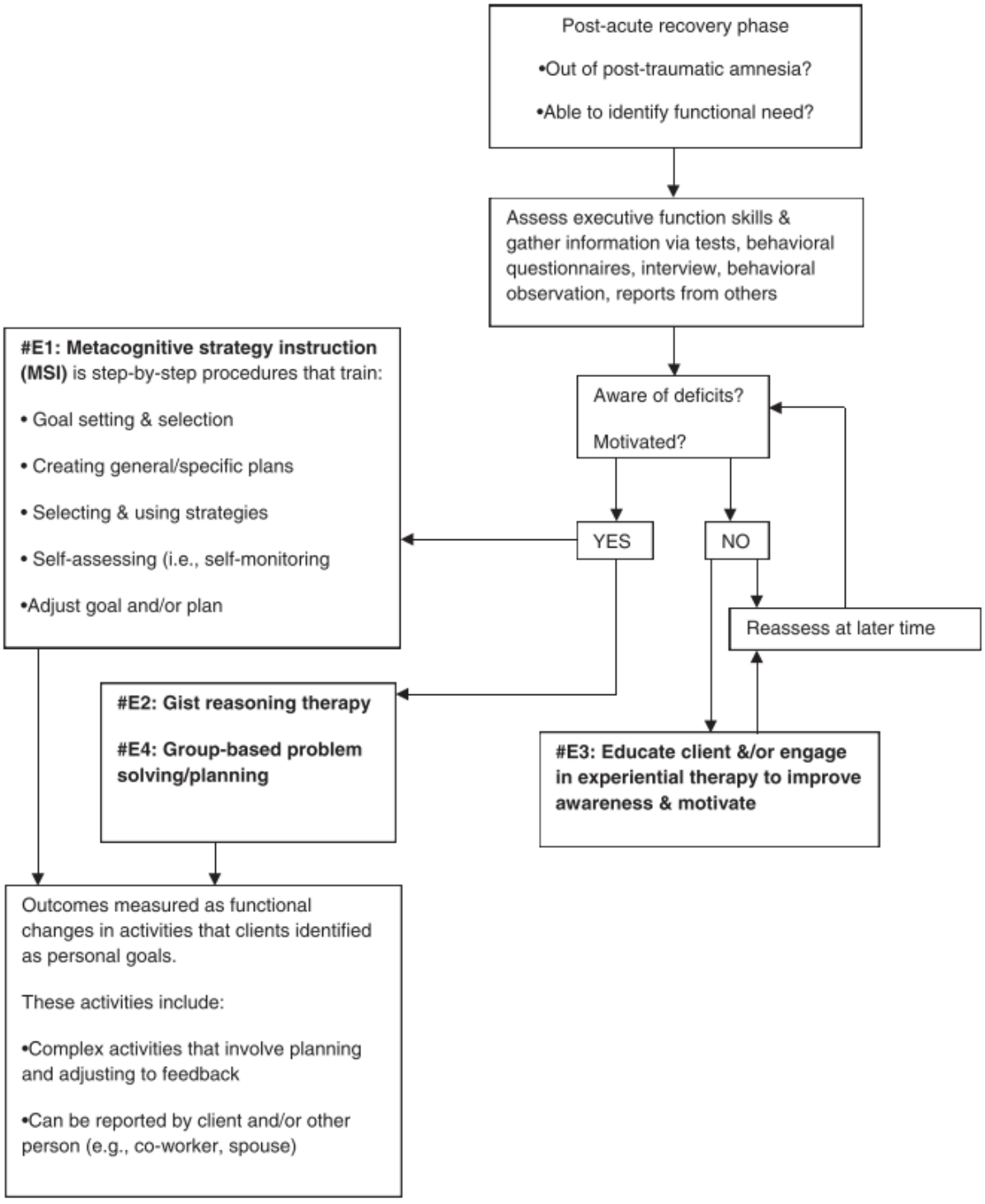

Figure 2.7 An example of the potential pathway of care for an individual with an ABI and executive dysfunction. This algorithm identifies points of assessment and treatment throughout an individual's recovery (Tate et al., 2014).

2.5.3.1 Non-Pharmacological Interventions

Metacognitive Strategies

There is strong evidence from the ABI literature, the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI, and the INCOG Guideline Recommendations that metacognitive strategies are the most effective way to remediate executive functions in individuals with an ABI. Three of the strongest metacognitive strategies are highlighted below.

Table 2.7 Examples of some of the metacognitive strategies that have been shown to be effective for the remediation of executive functions in individuals with an ABI.

Strategy	Description	Reference
Problem-solving therapy	Helps identify triggers of negative emotions, manage negative emotions, increase acceptance, create strategies of effective decision making, developing creative ways of solving problems, and identifying barriers to reaching goals.	(Fong & Howie, 2009; Man, Poon, & Lam, 2013; Man, Soong, Tam, & Hui-Chan, 2006) (APA division 12 (www.div12.org/))
Goal-management training	Main components include task practice, education, organization, mindfulness, and narrative structures all designed to help identify and execute goals.	(Levine et al., 2000; McPherson, Kayes, Weatherall, Members of the Goals, & on behalf of all members of the Goals, 2009; Spikman, Boelen, Lamberts, Brouwer, & Fasotti, 2010)
Emotional regulation	Involves modulating emotions to respond to a situation appropriately. This can include initiating or inhibiting emotions.	(Rath, Simon, Langenbahn, Sherr, & Diller, 2003)

Click HERE to access the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI on executive functioning

With advancements in technology there is an increasing desire to use computer-based programs as well as virtual reality for cognitive rehabilitation. Unfortunately, similar to the results seen on learning and memory, there has been no significant evidentiary support for the use of technologically based interventions such as BrainHQ, Parrot Software, virtual reality, ProSolv and others (Dahdah et al., 2017; Jacoby et al., 2013; O'Neil-Pirozzi & Hsu, 2016; Powell et al., 2019).

2.5.3.2 Pharmacological Interventions

Q8. What pharmacological interventions are recommended for the remediation of executive function following an ABI?

1. None. Unfortunately, there are no pharmacological interventions which have consistently shown improvement of executive function in the ABI literature.

Unlike the other areas of cognitive rehabilitation there is no universally supported pharmacological intervention for executive functioning. Although many pharmacological agents have been examined in the ABI literature (donepezil, methylphenidate, sertraline, amantadine, growth hormone replacement therapy, and other acetylcholinesterase inhibitors), none have shown consistent results for improving executive dysfunction following an ABI (ERABI, 2018).

It is worth restating that there is strong evidence for multiple non-pharmacological interventions for the remediation of executive function, and that these interventions should be used as a first line of treatment when it is appropriate for an individual to start working towards cognitive rehabilitation post injury (Tate et al., 2014).

2.6 Case Study (Part 1)

Patient Snapshot:

Mr. YY…
Is a 27 year-old male who was assaulted and kicked repeatedly sustaining a left temporal bone fracture, subdural hemorrhage, diffuse sub-arachnoid hemorrhage with mid-line shift, and left carotid canal involvement.
Mr. YY has been admitted to your inpatient Regional Rehabilitation Program for ABI 2-months post-injury for further therapy.
Lifestyle Factors: Mr. YY has a history of alcohol abuse, no post-secondary education, is currently employed, and has a parental support system in the home.
Medical History: Mr. YY had an initial GCS of 4, and a left sided decompressive craniectomy to evacuate a subdural hematoma.
Signs & Symptoms: Upon admission Mr. YY was experiencing PTA, difficulty following instructions, difficulty reading, and had reduced attention. It was observed that he benefitted from having instructions repeated multiple times. Although his speech was functional for communicating basic needs, severe anomia was present, and he was aware of this deficit. At no time did Mr. YY exhibit inappropriate behavior towards staff or family.

Mr. YY's previous treating physician has confirmed he has cognitive and cognitive-communication deficits and referred him as an inpatient to you. What do you do next?

Assess each area of cognition and communication further to determine where his deficits exist (*Reminder: those areas are attention/concentration, learning and memory, executive function, and cognitive-communication*)

Q1. What are some considerations to keep in mind while addressing Mr. YY's cognitive and communication deficits?

1. Existing comorbid functional limitations
2. Any medications taken by Mr. YY and potential drug interactions or side-effects
3. Educating and supporting Mr. YY's family throughout the rehabilitation process
4. Treating deficits simultaneously not sequentially

Attention/Concentration:

Q2. What screening tools can you use to further examine the extent of Mr. YY's PTA?

1. Galveston Orientation and Amnesia Test (GOAT)
2. Orientation Log (O-Log)

You conduct an O-Log test over two consecutive administrations and determine that Mr. YY's score is 17/30, suggesting he remains in PTA.

Q3. Based on these results, what potential therapeutic treatments can you recommend to Mr. YY? *Don't forget you can use the INCOG algorithms to help identify appropriate therapies and combinations.

1. Daily Orientation Group therapy
2. Goal Management Training
3. Dual-task Interventions

Based on Mr. YY's interest in socialization, and his lack of behavioral problems, **you assign Mr. YY to Daily Orientation Group Therapy** available at your institution**.**

Therapy Breakdown:
Daily Orientation Group Therapy → 30-minute sessions, where 15 minutes is spent reorienting individuals to their location, the date, checking the weather, and this can be facilitated by technology. The second half of Orientation Therapy consists of cognitive-communication tasks, such as memory recall, sequencing, word-finding, and social communication training/tasks.

Q4. What other considerations should you be mindful of with regards to Mr. YY's PTA?

1. The level of supervision that he may require while staying in the hospital, based on an O-Log of 18 Mr. YY should be kept to his unit and monitored regularly
2. The duration of his PTA; if PTA persists for more than 3 months an individual is unlikely to live independently ever again
3. Providing Mr. YY's family with education on supporting an individual with PTA
4. Ensuring Mr. YY is receiving appropriate rehabilitation for any other deficits outside the area of cognition and cognitive-communication

Cognitive-Communication

Q5. What tests can you use to further examine the extent of Mr. YY's cognitive-communication deficits?

1. Woodcock Johnson Tests of Oral Language (WJTOL)
2. Woodcock Johnson Test of Achievement (WJTA)
3. Western Aphasia Battery (WAB)
4. Scales of Cognitive Ability for Traumatic Brain Injury (SCATBI)

You conduct #1, #2, and #3 to better assess the specific cognitive-communication deficits that may be present. Results are presented below.

*Note: You'll need the Classification of Standard Score Ranges for Woodcock Johnson IV Tests to help you interpret Mr. YY's scores.

Standard Score Range	WJIV Classification
131 and above	Very Superior
121 to 130	Superior
111 to 120	High Average
90 to 110	Average
80 to 89	Low Average
70 to 79	Low
69 and below	Very Low

WJTOL Subtest	Description	SS	Classification
Picture Vocabulary	Identify pictured objects.	<40	Very Low
Rapid Picture Naming	Quick recall of simple pictures in a timed 2-minute test.	<40	Very Low
Retrieval Fluency	Mr. YY is to give as many examples as possible from a given category within a 1-minute time period.	<40	Very Low

WJTA Subtest	Description	SS	Classification
Letter-Word ID	Identify letters then read aloud individual words correctly.	61	Very Low
Passage Comprehension	Identify a missing key word in the context of a passage.	50	Very Low
Sentence Reading Fluency	Read simple sentences silently and quickly, deciding if the statement is true or false, circling Yes or No in a timed 3-minute test.	<40	Very Low
Word Reading Fluency	Mark the two words in each row that share some relationship (e.g., synonyms, antonyms); complete as many rows as possible within a 3 min time limit.	51	Very Low

Western Aphasia Battery	
Spontaneous Speech	16/20
Auditory Verbal Comprehension	8.8/10
Repetition	9.6/10
Naming and Word-Finding Score	4.2/10

You combine the results of these tests along with your clinical observations of Mr. YY to determine his level of impairment. Based on Mr. YY's scores, you understand that he has a significant word-finding impairment and challenges with working memory, reading comprehension, and processing speed. This is in line with your clinical observations of Mr. YY.

Clinical Tip!

Since you've identified that Mr. YY has impaired communication, now is a good time to screen for depression or other comorbid mood disorders as Mr. YY may be experiencing feelings of isolation and frustration.

Q6. Based on your conclusions, what potential therapeutic treatments can you recommend to Mr. YY?

1. Word finding therapy.
2. Social Communication Group Treatment
3. Completing functional reading packages (including answering comprehensive questions)
4. Participating in functional communication exercises (such as making telephone calls and recording information)

Based on the breadth and significance of Mr. YY's deficits, and your knowledge of clinical algorithms, you choose to assign him to all four treatments.

Therapy Breakdown:

Word Finding Therapy → A 30-minute session, 2x daily, one-on-one with a Speech-Language Pathologist and Communication Disorders Assistant (CDA). This includes generative naming exercises within specific categories and confrontation naming exercises.

Social Communication Group Treatment → Based on evidence from the Group Interactive Structured Treatment for Social Competence (GIST) program, this involved practicing and developing skills in social competence, which includes the cognitive, emotional, and communication skills needed to interact successfully, as well as the means to apply those skills in a variety of social settings.

Functional Reading Packages → Exercises contain the use and comprehension of functional words such as nouns, verbs, adjectives, prepositions, and familiar places. Words can also be illustrated to facilitate comprehension, content can be presented through common sources including newspapers, magazines, menus, grocery lists, recipes, and prescriptions.

Functional Communication Exercises → Mr. YY worked on making telephone calls to verify printed information and then recorded (in writing) the information he received on the telephone.

Learning and Memory

Q7. What tests can you use to further examine the extent of Mr. YY's learning and memory deficits?

1. Woodcock Johnson Tests of Cognitive Ability (WJTC)
2. Memory Functioning Questionnaire (MFQ)
3. Wechsler Memory Scale (WMS)
4. Scales of Cognitive Ability for Traumatic Brain Injury (SCATBI)

You administer the WJTC and combine these results with your observations about Mr. YY. Results are presented below.

WJTCA Subtest	Description	SS	Classification
Story Recall	Recall increasingly complex stories that are presented from an audio recording.	48	Very Low
Visual Auditory Learning	Learn, store, and retrieve a series of visual-auditory associations using pictographic representations of words.	<40	Very Low
Reading Recall	Read a short story silently and then retell with as much detail as possible.	65	Very Low
Numbers Reversed	Hold a span of numbers in immediate awareness while performing a mental operation on it (reversing the sequence of the numbers).	85	Low Average
Memory for Words	Repeat lists of unrelated words in the correct sequence.	82	Low Average

Mr. YY's test results, in combination with your observations of him **suggest moderate impairment.**

Q8. Based on your conclusions, what potential therapeutic treatments can you recommend to Mr. YY for his memory impairments?

1. Use of a day planner
2. A whiteboard in his room
3. External memory device (smartphone, pager, other)
4. Working Memory Group participation

Based on Mr. YY's moderate memory impairment, and the benefits of the other therapies you have decided to assign him to, you provide him with the use of a day planner and a whiteboard in his room, as well as encouraging him to participate in a Working Memory Group.

Therapy Breakdown:
Day planner → Individuals are provided with daily printed schedules of therapy appointments and are encouraged to access this resource for PROSPECTIVE MEMORY and to record what was done in each therapy session to facilitate EPISODIC MEMORY.

Whiteboard → A whiteboard may be used to orient an individual to the date, their daily schedule, and any other pertinent information. The whiteboard should be updated daily based on the type of information referenced. Updates should initially be done by nursing staff with the goal of this task being transferred to the patient to increase independence in this area and implementing memory strategies.

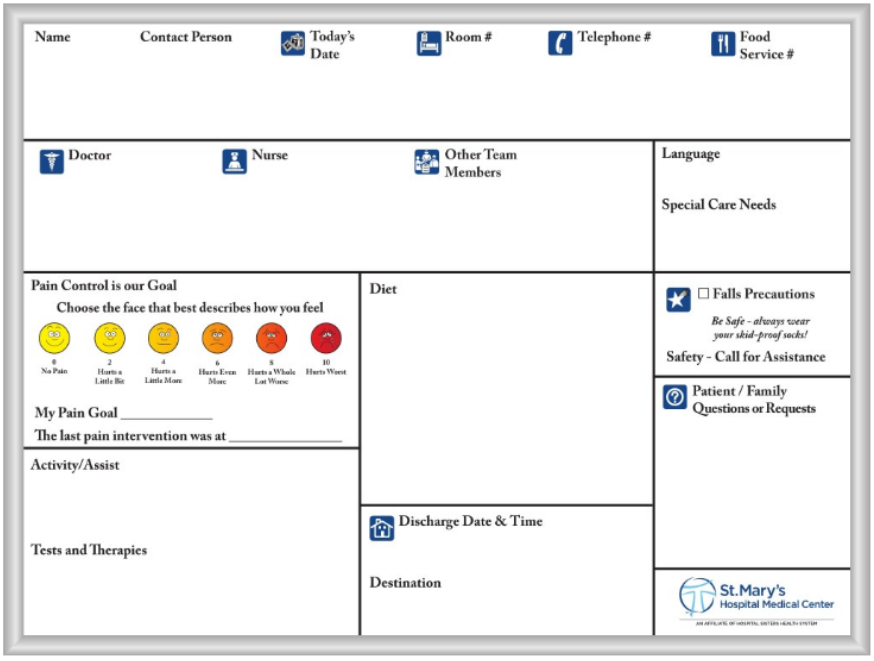

Figure 1. Sample of a patient whiteboard which may be used to orient an individual to dates, schedules, and other relevant patient information.

Working memory group → Participation in a group treatment will help Mr. YY will learn about both internal and external memory strategies to be used in a functional environment. These sessions are often organized by SLPs.

You've assessed and addressed all of Mr. YY's identified cognitive and cognitive-communication needs. But, now what?

Patient follow-up: it's been 2-weeks and it's time to check in with Mr. YY, his therapy team, and his family/support system to see how he's responding to therapy.

After re-assessing Mr. YY, speaking to the rest of the clinical team and family members you learn that:

1. Mr. YY's PTA has resolved and he says that he's enjoying group therapy and has noticed a marked improvement in his memory, word finding abilities, and social communication skills.
2. Mr. YY's family supports his conclusions and self-assessment that he has been steadily improving since therapy was initiated and they are happy with his progress. However, they do not believe he is ready to go home yet as he still has some challenges with insight.
3. Mr. YY and other members of his clinical team have identified that since other areas of cognition have improved it's become more apparent there are also underlying deficits in executive functioning. Mr. YY has difficulty making plans or strategies to achieve goals and has demonstrated difficulty providing complex responses to arguments.
4. Based on Mr. YY's mood, active participation in group therapies, and his family's engagement in his recovery you do not suspect any comorbid mood disorders or behavioral challenges that would interfere with Mr. YY's recovery.

Clinical Tip!

If you find that your patient is not responding as expected to treatment, this is an ideal time to either adjust the therapy type, the intensity or frequency of current therapies.

Q9. Based on the information you've gained at reassessment, what can you conclude? What are your next steps?

1. Mr. YY's cognitive symptoms are significantly improving through a combination of therapies and spontaneous recovery.
2. The recovery of certain cognitive skills has highlighted a new potential issue of executive dysfunction and a new intervention may have to be assigned to address this concern.
3. Mr. YY is most likely not suffering from any comorbid mood disorders which would interfere with his recovery.

Over the next 2 weeks you continue to treat, monitor, and observe Mr. YY's progress and recovery. **Eventually, you and other members of his team believe he is ready to be discharged to out-patient services where he will continue to receive care on an out-patient basis after 4 weeks as an inpatient.**

Q10. What are some factors that could lead you to conclude that Mr. YY is ready for discharge?

1. He no longer requires 5 days of therapy a week
2. He has sufficient 24-hour supervision by family in the home
3. He has successfully passed trials in his home environment demonstrating that he can prepare meals with supervision, has appropriate mobility, and is unlikely to wander away from the home
4. Has been issued day and overnight passes and used them without incident
5. His family is eager to have him return home and has demonstrated a significant investment in his recovery in terms of gaining knowledge about the rehabilitation process, attending regular therapy sessions, and modifying the home to Mr. YY's needs.

Discharge Assessment:
After discussion and assessment, you determine that at the time of discharge Mr. YY is demonstrating emerging insight into his abilities post-ABI and is eager to return home to his family. Mr. YY has demonstrated an ability to learn new information during his time in the ABI program. Mr. YY recognizes staff and their respective roles and recalls this information without difficulty. Mr. YY shows adequate episodic and prospective memory. Mr. YY is aware of and utilizes social greetings and is able to fully participate in reciprocal conversation. Mr. YY was observed to be socially interactive with others and participated fully in the rehabilitation process. At time of discharge, Mr. YY is able to functionally express his needs and concerns. He continues to benefit from cuing to his day planner so that he can share details of his therapy day. Mr. YY is able to express more complex thoughts and ideas 75-90% of the time. Fatigue persists as a factor in Mr. YY's word finding abilities. All testing results were reviewed with Mr. YY before discharge and discussions took place regarding the fact that certain test scores were still low when compared to age-related peers. His progress will continue to be monitored through out-patient care (Case Study Part 2).

2.7 Interventions for Cognitive-Communication

Q9. What is a cognitive-communication deficit?

1. A cognitive-communication deficit is the combination of basic language deficits (such as syntax, metalinguistic skills, and semantics) and cognitive deficits which prevent an individual from participating in communication fully (such as attention, memory, information processing, and executive function) (Murdoch, 2013; Togher et al., 2014).

2. Cognitive-communication disorders are communication impairments resulting from underlying cognitive deficits due to neurological impairment. These are difficulties in communicative competence (listening, speaking, reading, writing, conversation, and social interaction) that result from underlying cognitive impairments (attention, memory, organization information processing, problem solving and executive functions) (College of Audiologists and Speech Language Pathologists of Ontario, 2002).

Cognitive-communication deficits differ from those of pure communication deficits in that there are underlying cognitive impairments which prevent an individual from participating fully in communication. Some of these deficits may present as difficulties participating in a conversation (retrieving or finding

the right word to express oneself), or talking at length about any given topic, formulating sentences, and naming objects or people (Wiseman-Hakes, MacDonald, & Keightley, 2010). However, not all cognitive-communication deficits involve a verbal communication impairment. Challenges with social pragmatics, use of non-verbals/body language, and emotional recognition, are categorized as social communication deficits.

It is important to note that individuals with an ABI may have different treatment priorities when it comes to recovering communication skills compared to health professionals, and individuals should always be consulted on their own treatment priorities in order to best facilitate their recovery. This is supported by a study by Larkins et al. (Larkins, Worrall, & Hickson, 2004) that found stakeholders in the ABI healthcare system (from patients, to family members, to health professionals) differed in their treatment priorities. Health professionals identified basic communication to access help as a priority, while family members and patients identified improving listening and concentration as a priority. Per the recommendations below and those made by the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI, an individual should always be consulted with when planning rehabilitation goals for this reason.

As with other areas of cognition, general principles of care have been published specifically for the area of cognitive-communication and are presented below.

ABIKUS Recommendations (Bayley M, 2007): **Cognitive-Communication Rehabilitation**

- *A person with moderate to severe traumatic brain injury regardless of level of consciousness should be assessed by a speech-language pathologist for cognitive communication difficulties in accordance to existing practice guidelines of speech language pathologists and audiologists (ABIKUS C, adapted from Turskstra et al., 2005)(G45-p.23).*

- *Patients with severe communication disability should be assessed for and provided with appropriate alternative or augmentative communication aids (ABIKUS B, adapted from RCP, G69, p.33)(G46-p.23).*

- *A person with traumatic brain injury who has communication difficulties where achievable goals can be identified should be offered an appropriate treatment program by a speech language pathologist with monitoring of progress. (ABIKUS A)(G47-p.23).*

- *A communication rehabilitation training program should provide education and training of communication partners (ABIKUS C, adapted from Togher et al., 2004a)(G48-p.23).*

- *A communication rehabilitation program should give the opportunity to rehearse communication skills in situations appropriate to the context in which the patients will love/work/study/socialize after discharge (ABIKUS C)(G49-p.24).*

- *The assessment and prescription of, augmentative and alternative communication devices should be made by suitably accredited clinicians, speech-language pathologists (for communication) and occupational therapists (for access of devices, writing aids, etc.) (ABIKUS C)(G50-p.24).*

- *Staff should recognize that levels of communication competence may vary as a function of communication partner, environment, cognitive-communication demands, fatigue, psychosocial and physical variables (ABIKUS B, adapted from Togher et al., 2004a)(G51-p.24).*

The INCOG group (Togher et al., 2014) has also created a clinical algorithm (Figure 2.7) in support of those with cognitive-communication deficits. The algorithm provides a theoretical pathway of care for an individual with a cognitive communication deficit.

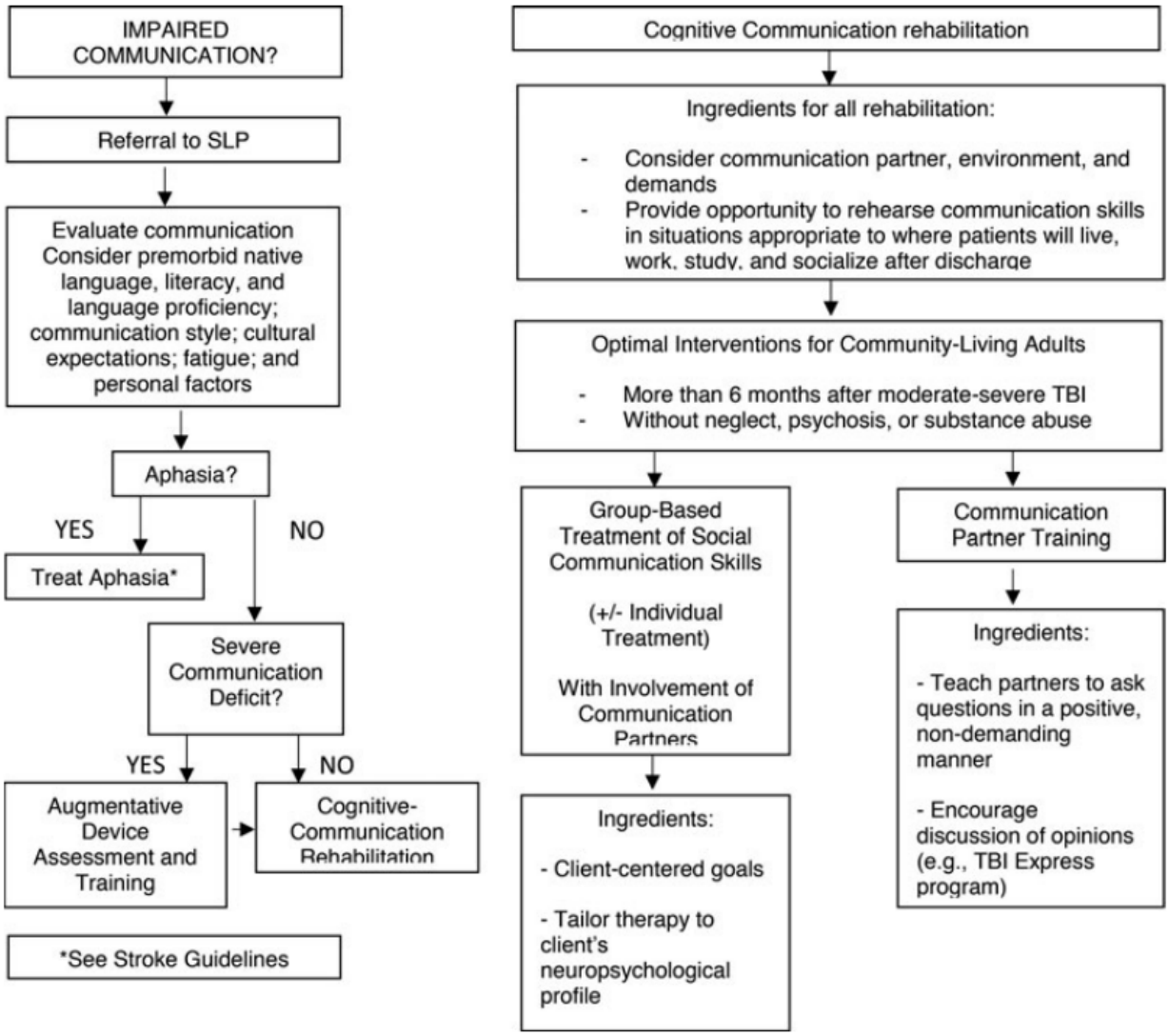

Figure 2.7 Two clinical algorithms designed to help evaluate and treat cognitive communication deficits in individuals with an ABI. One represents a potential diagnostic pathway while the other shows a treatment strategy (Togher et al., 2014).

2.7.1 Social Communication Training

Social communication deficits may have a significant impact on an individual's life, affecting everything from an individual's ability to return to work, to the breakdown of interpersonal relationships. In addition to the primary challenges experienced by social communication deficits, secondary challenges related to this, such as increased frustration and depression, can also impact recovery.

Key Study

Author/ Year/ Country/ Study Design/ N	Methods	Outcomes
Westerhof-Evers et al. (2017) Netherlands RCT PEDro=7 $N_{Initial}$=61, N_{Final}=56	**Population:** TBI; Mean Age=43.2 yr; Gender: Male=83, Female=17; Severity: Moderate to severe. **Intervention:** Participants were randomly assigned to receive Treatment for Impairments in Social Cognition and Emotion Regulation (T-ScEmo, n=30) protocol or Cogniplus (n=29) training. The TScEmo protocol is aimed at enhancing emotion perception, perspective taking, theory of mind, goal-directed social behaviour through 20 individual treatment sessions offered 1-2x/wk by neuropsychologists. Cogniplus is an individually administered computerized attention training aimed at improving general cognition. Outcomes were assessed baseline (T0), post-intervention (T1), and 3-5 mo follow-up (T2). **Outcome Measure:** The Awareness of Social Inferences Test (TASIT-short), Sixty faces test (FEEST), Cartoon test, Faux Pas test (FP), Wechsler Adult Intelligence Scale (WAIS-III digit span), Trail Making Test (TMT A and B/A), Test of Everyday Attention Lottery (TEA lottery), Dysexecutive Questionnaire-Social scales (DEX-Soc-self, DEX-Soc-proxy), Brock's Adaptive Functioning Questionnaire-Social monitoring scale (BAFQ-SM-self, BAFQ-SM-proxy), BAFQ empathy scale (BAFQ-Emp-self, BAFQ-Emp-proxy), Role Resumption List (RRL), Quality of Life after Brain Injury (QOLIBRI satisfaction, QOLIBRI burden), Treatment Goal Attainment (TGA), Relationship Quality Scale (RQS-self, RQS-life partner).	1. For the primary outcome of TASIT-short, there was no significant improvements over time in either group and no significant differences between groups. 2. Significant Time x Group interactions from T0 to T1 were observed for FEEST (p=0.01), CT (p=0.02), RRL (p<0.01), and TGA (p<0.01). No significant interactions from T0 to T1 were observed for FP, DEX-Soc-self, DEX-Soc-proxy, BAFQ-SM-self, BAFQ-SM-proxy, BAFQ-Emp-self, BAFQ-Emp-proxy, QOLIBRI satisfaction, QOLIBRI burden, RQS-self, RQS-life partner, WAIS-III digit span, TMT A, TMT B/A, or TEA lottery. 3. Significant Time x Group interactions from T0 to T2 were observed for FEEST (p<0.01), CT (p=0.02), BAFQ-Emp-proxy (p=0.02), RRL (p<0.01), QOLIBRI burden (p=0.04), RQS-life partner (p=0.02), and TGA (p<0.01). No significant interactions from T0 to T2 were observed for FP, DEX-Soc-self, DEX-Soc-proxy, BAFQ-SM-self, BAFQ-SM-proxy, BAFQ-Emp-self, QOLIBRI satisfaction, RQS-self, WAIS-III digit span, TMT A, TMT B/A, or TEA lottery.

An RCT by Westerhof-Evers et al. (2017) compared the use of a social cognition and emotional regulation protocol (T-ScEmo) to a protocol for attention and general cognitive rehabilitation (Cogniplus) to evaluate how participants performed on emotion perception, social understanding, and social behavior. The T-ScEmo group had statistically significant improvements on emotion perception (facial affect recognition), theory of mind, proxy-rated empathic behavior, societal participation, and treatment goal attainment, when compared with the Cogniplus group (Westerhof-Evers et al., 2017). Participants in the T-ScEmo group also reported higher quality of life and their life partners rated relationship quality to be higher than those in the Cogniplus group. However, no significant differences were seen in either group on the Awareness of Social Inferences Test. Overall, there is moderate evidence to suggest that specific social cognitive retraining programs are effective for improving communication deficits post ABI.

Specifically, in line with the literature base, the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI (2015) recommend the following for the remediation of social communication:

Recommendations for the rehabilitation of social communication deficits (Section K2 from www.braininjuryguidelines.org)

- *Social skills training should be offered to address interpersonal and pragmatic conversational skills problems in individuals with traumatic brain injury.*
- *A cognitive communication rehabilitation program for individuals with traumatic brain injury should provide the opportunity to rehearse communication skills in situations appropriate to the context in which the person will live, work, study, and socialize.*
- *Interventions for social communication for individuals with traumatic brain injury should include role playing to improve a variety of social communication skills as well as self-concept and self-confidence in social communications.*

2.7.2 Non-Verbal Communication

Goals of treatment regarding non-verbal communication post ABI include initiating conversation with others, learning to understand the emotion presented in verbal language, the ability to respond appropriately, and to maintain conversation. In order to achieve these goals, the necessary strategies to be employed consist of environmental and behavioural modification, counselling and support, pragmatic skills trailing, and targeted speech and language therapy. Patients will require positive reinforcement of the appropriate responses, as well as auditory/visual feedback by others.

Key Study

Author/ Year/ Country/ Study Design/ N	Methods	Outcomes
Neumann et al. (2015) USA RCT PEDro=9 $N_{Initial}$=71, N_{Final}=60	**Population**: TBI; Faces (n=24): Mean Age=41 yr; Gender: Male=23, Female=1; Mean Time Post-Injury=10.5yr; Mean GCS=6.9; Stories (n=23): Mean Age=41.5 yr; Gender: Male=18, Female=5; Mean Time Post-Injury=10.9 yr; Mean GCS=4.4; Control (n=24): Mean Age=39.5 yr; Gender: Male=16, Female=8; Mean Time Post-Injury=9.8yr; Mean GCS=5.3. **Intervention:** Participants randomly assigned to one of three interventions for 1 hr sessions 3 days/wk for 3 wk. Faces intervention taught individuals to recognize emotions in facial expressions, whereas stories intervention taught individuals to recognize emotion within stories. Control	1. According to DANVA 2-AF, participants trained in the faces intervention had a significant improvement across all follow-up time points compared to controls (p=0.031). 2. No significant improvement for the stories intervention on DANVA 2-AF compared to controls (p=0.239). 3. No significant improvement on EIST for the stories intervention (p=0.167) and faces (p=0.349) compared to controls. 4. Across all post-treatments assessments, there was a main effect of time as performance decreased for the stories intervention on EIST compared to controls (p=0.001).

Author/ Year/ Country/ Study Design/ N	Methods	Outcomes
	group underwent cognitive training. Participants assessed at pre-treatment and post-treatment within 4 days, at 3 mo and 6 mo. **Outcome Measure:** Diagnostic Assessment of Nonverbal Accuracy 2-Adult Faces (DANVA 2-AF), Emotional Inference From Stories Test (EIST), Interpersonal Reactivity Index (IRI), Neuropsychiatric Inventory (NPI) Irritability and Aggression domain.	5. NPI irritability and aggression and IRI empathy were not significant for faces or story interventions compared to controls.

Overall, there is moderate evidence to suggest that interventions that focus on non-verbal cues such as facial expression and emotional prosody (tone) are effective at improving non-verbal communication post ABI. Aligning with best practices principles, in the key study above, participants who were trained on facial recognition during treatment sessions had higher carryover effects to real world situations of facial recognition compared to those who were not directly trained on the task (Neumann, Babbage, Zupan, & Willer, 2015).

2.7.3 Training Communication Partners

The success of communication interventions often relies on the understanding, compliance and competence of communication partners. Training of communication partners has become a central component of communication interventions with many populations. This development is consistent with the World Health Organization (2001) emphasis on *context* (environmental and attitudinal) as a determinant in health and disability outcomes. Training of communication partners has been shown to have a positive effect on communication effectiveness and reacquisition of communication skills in children with language disorders and developmental disabilities (Girolametto, Verbey, & Tannock, 1994), adults with aphasia (Kagan, Black, Duchan, Simmons-Mackie, & Square, 2001), adults with dementia (Ripich, Ziol, Fritsch, & Durand, 1999), and adults with ABI (Togher, McDonald, Code, & Grant, 2004).

It is not surprising that following an ABI, individuals have difficulty engaging in meaningful conversation with others. Training communication partners is particularly helpful in successfully facilitating communication with those with moderate to severe ABI. The strategies that are most useful in ensuring success of treatment include speaking in short, simple sentences, making and maintaining eye contact, and asking the patient to repeat the messages being conveyed (Figure2.8) (Behn, Togher, Power, & Heard, 2012). Also, asking patients to clarify they understand the information and repeating the information when necessary, while allowing adequate time to receive an answer. Presenting the information in written form can also elicit a positive outcome from patients (Behn et al., 2012). Eliminating environmental distractions will be a tremendous aid to allow proper focus and attention for optimal results. Communication partners should present choices to patients and clarify the intent of the message being delivered. Using a variety of modes of communication (e.g., nonverbal) can also be a useful strategy (Behn et al., 2012; Sim, Power, & Togher, 2013; Togher et al., 2004; Togher, McDonald, Tate, Power, & Rietdijk, 2013; Togher, McDonald, Tate, Rietdijk, & Power, 2016).

Key Study

Author/ Year/ Country/ Study Design/ N	Methods	Outcomes
Togher et al. (2016) Australia PCT $N_{Initial}$=44, N_{Final}=38	**Population:** TBI; Gender: Male=26, Female=18. *Control (n=15)*: Mean Age=38.1 yr; Mean Time Post-Injury=9.7 yr. *JOINT (n=14)*: Mean Age=30.3 yr; Mean Time Post-Injury=8yr; *TBI SOLO (n=15)*: Mean Age=39.7 yr; Mean Time Post-Injury=8.1 yr; **Intervention:** Participants were allocated to one of three groups: 1) control group, no training; 2) the JOINT group, attended all sessions together with their communication partner; or 3) the TBI SOLO group, attended sessions without their communication partner. The training was 2.5 hr/wk of group sessions and 1 hr/wk of individual sessions for 10 wk. Outcomes were assessed before and after treatment, and at 6 mo follow-up. **Outcome Measure:** La Trobe Communication Questionnaire (LCQ) - Self Report and Significant Other Report.	1. Post treatment, communication partners in JOINT reported greater overall improvements compared to TBI SOLO (p=0.05) and control (p<0.001). 2. Post treatment, individuals with TBI and their partners reported more positive change on LCQ in JOINT (p<0.001 for both) and TBI SOLO (p=.01; p=0.004) compared to controls, with only a significant difference on LCQ significant others reports between JOINT and TBI SOLO conditions (p=0.002). 3. At follow-up, individuals with TBI reported increase in positive change in communication skills in JOINT (p=0.01) and TBI SOLO (p=0.03) compared to controls, with no significant difference between JOINT and TBI SOLO. 4. At follow-up, more change was reported in communication partners in JOINT than TBI SOLO (p=0.01) and controls (p<0.001).

The evidence that exists suggests that the most efficacious way to improve communication between an individual with an ABI and their communication partner is to have them participate in training together (Togher et al., 2013; Togher et al., 2016). This also provides an opportunity to monitor the two-way interactions that take place and the facilitator or therapist can provide real-time feedback to improve communication strategies.

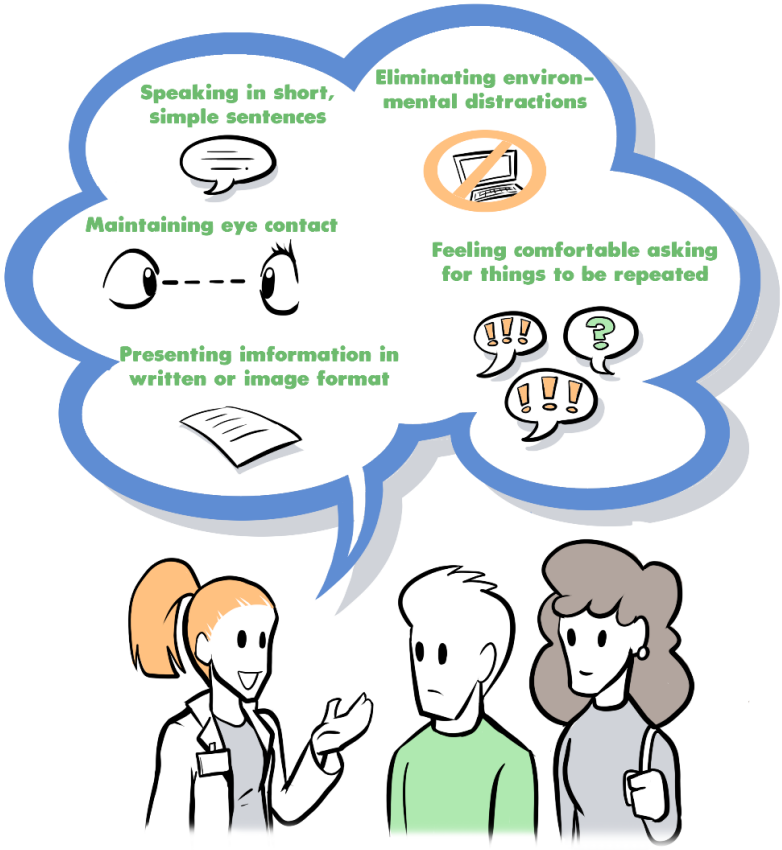

Figure 2.8 Potential communication strategies which can be used to increase communication efficacy between an individual with an ABI and their communication partner.

The Aphasia Institute provides a variety of communication strategies to improve communication between an individual and their communication partner through their Supported Conversation for Adults with Aphasia program (https://www.aphasia.ca/communicative-access-sca/). This program specifically includes the use of drawings, spoken and written words, body language and gestures, and detailed pictographs to facilitate conversation in the presence of a language impairment. The primary components of the program are listed below.

Components of the Aphasia Institute Communication Strategies Program for adults with communication deficits following neurologic insult.

- *Acknowledging the competence of the individual*
- *Revealing the competence by using different techniques to get the "message in" and "message out"*
- *Verifying the message*
- *How and when to use communication techniques*
- *Providing helpful materials and resources*

2.7.4 Alternative Communication Strategies

There are those individuals within the ABI population who benefit from the use of alternative or augmentative communication (AAC) strategies and tools when verbal communication may not be feasible (Bourgeois et al., 2001; Burke, Beukelman, & Hux, 2004; de Joode et al., 2012; Fager, Hux, Beukelman, & Karantounis, 2006; Johannsen-Horbach, Cegla, Mager, Schempp, & Wallesch, 1985).

In the AAC domain, there are divisions of complexity that include simple, low-tech options (e.g. alphabet boards, picture-based communication boards, memory books, conversation books, day planners) and high tech options that include Voice Output Communication Aids (e.g., Dynavox, McCaw, Message Mate, Big Mack, Voice Pal and Boardmaker) (Fager et al., 2006). Notably, both low-tech and high-tech solutions to communication difficulties may have access that is either direct (i.e. touching/ pointing) or indirect (i.e. switch access or partner-assisted scanning).

Glossary from ASHA on different cognitive communication devices and strategies.
https://www.asha.org/public/speech/disorders/AAC-Glossary/

2.8 Case Study (Part 2)

Remember Mr. YY…
He's a 27 year-old male who was assaulted and kicked repeatedly sustaining a temporal bone fracture, subdural hemorrhage, diffuse sub-arachnoid hemorrhage with mid-line shift, and left carotid canal involvement.
Mr. YY completed your inpatient rehabilitation Program for ABI and was an inpatient for a total of 4 weeks.
Lifestyle Factors: Mr. YY has a history of alcohol abuse, no post-secondary education, is currently employed, and has a parental support system in the home.
Medical History: Mr. YY had an initial GCS of 4, and a left sided decompressive craniectomy to evacuate a subdural hematoma. He is presently not on any medications.
Signs & Symptoms: Upon admission Mr. YY had PTA, difficulty following instructions, difficulty reading, and had reduced attention. It was observed that he benefitted from having instructions repeated multiple times. Although his speech was functional for communicating basic needs, anomia was present, and he was aware of this deficit. At no time did Mr. YY exhibit inappropriate behavior towards staff or family.
Inpatient Discharge: Upon discharge Mr. YY was able to communicate socially, PTA had resolved, and he had demonstrated the ability to learn and retain new information.

Now that Mr. YY is receiving outpatient therapy, what skills does he need to keep improving? Where is he struggling?

From your notes, discharge assessment, and conversations with Mr. YY and his family you identify that he is still having difficulties with insight, and executive function (problem-solving and planning).

Executive Function

Q1. What tests can you use to better assess and identify areas of executive dysfunction?

1. Woodcock Johnson Test of Achievement (WJTA)
2. Functional Assessment of Verbal Reasoning (FAVRES)
3. Scales of Cognitive Ability for Traumatic Brain Injury (SCATBI)

You conduct the WJTA and the FAVRES to better encapsulate the potential different areas of Mr. YY's executive dysfunction. Results are presented below.

WJTA Subtest	Description	SS	Classification
Applied Problems	Listen to a problem, recognize the procedure to be followed, and then perform relatively simple calculations.	75	Low
Calculation	Arithmetic computation with paper and pencil.	58	Very Low

FAVRES	Description	Cutoff
1. Planning an Event	Choose an event given scheduling and budgeting parameters and provide rationale.	Met
2. Scheduling	Organize a schedule given a list of tasks and time frames and provide rationale.	Not Met
3. Making a Decision	Read a passage and decide which provided gift idea is most appropriate to give and provide rationale.	Not Met
4. Building a Case	Read a passage and plan a response that will support an argument.	Not Met

Q2. Based on Mr. YY's scores, what can you conclude?

1. You conclude that based on the WJTA Mr. YY currently has below average executive functioning.
2. Based on the FAVRES you determine that Mr. YY has not met the cut-off points for scheduling, decision making, and creating arguments.
3. Overall, you determine that Mr. YY has moderate to severe impairment in executive functioning, specifically when it comes to organizational tasks.

Q3. Based on your conclusions regarding the status of Mr. YY's executive functioning skills, what interventions can you recommend to him?

1. Group-based problem-solving therapy
2. Goal-Management Training
3. Environmental modification
4. Expanding the use of smart technology (such as smartphones and organizers)

*Remember there are no recommended pharmacological interventions for the treatment of executive dysfunction.

Based on the level of executive dysfunction you recommend that Mr. YY attend group-based problem-solving therapy, receive goal management training, leverage technology via a smartphone, and that his home environment be modified to support organization and planning.

Therapy Breakdown

Group-based problem-solving therapy → Group therapy sessions focused on helping individuals identify which stressors triggered negative emotions, supported individuals in becoming more hopeful about achieving their goals, and sharing strategies on how to be more systematic and intentional when developing plans to solve problems.

Goal-Management Training → Mr. YY received GMT one-on-one with a therapist to identify and address specific goals twice a week. Sessions focused on organization, planning, flexibility, action, and self-evaluation.

Environmental Modification → A therapist came into Mr. YY's home to help determine appropriate environmental modifications such as placing a schedule on the refrigerator, organizing frequently used items such as car keys, notepads, and other rehabilitation materials efficiently and in predictable locations, and limiting distractions in the home.

Now that you've provided therapy to address Mr. YY's last concern, what is your long-term treatment plan for Mr. YY?

Mr. YY's cognitive status should be periodically assessed and monitored. As he continues to improve his treatments should be adjusted to an appropriate frequency and intensity as determined by his care team.

As you continue to support and evaluate Mr. YY through his recovery don't forget to point him in the direction of any additional useful community resources. Your local health unit, colleagues, and rehabilitation facilities are good resources to learn more about programs in the community. Examples of programs available are library services, YMCA/gym, peer-mentoring programs, and others run by regional brain injury groups.

Clinical Tip!

As personal insight improves mood disorders can start to present or become more apparent, so here's another good time to screen for mental health or mood disorders.

2.9 References

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