NOVA

University of Newcastle Research Online

nova.newcastle.edu.au

Steel, Joanne; Ferguson, Alison; Spencer, Elizabeth; Togher, Leanne "Language and cognitive communication during post-traumatic amnesia: a critical synthesis". Originally published NeuroRehabilitation Vol. 37, Issue 2, p. 221-234 (2015)

Available from: <http://dx.doi.org/10.3233/NRE-151255>

Accessed from: <http://hdl.handle.net/1959.13/1327496>

Language and cognitive communication during PTA

Steel, J., Ferguson, A., Spencer, E., & Togher, L. (2015). Language and cognition during post-traumatic amnesia: A critical synthesis. *Neurorehabilitation*, 10, (online) - DOI: 10.3233/NRE-151255

(pre-print version)

Language and cognitive communication during post traumatic amnesia:

A critical synthesis

Steel, Joanne^{1*}, ³; Ferguson, Alison^{1, 3}; Spencer, Elizabeth¹; Togher, Leanne^{2, 3}

¹ Speech Pathology, The University of Newcastle, Newcastle, Australia

² Speech Pathology, The University of Sydney, Sydney, Australia

³ NHMRC Clinical Centre of Research Excellence in Aphasia Rehabilitation

*Corresponding author

Correspondence:

Dr Joanne Steel

School of Humanities and Social Science

School Office, 1st Floor, McMullin Building

The University of Newcastle

Callaghan Campus, 2308

NSW Australia

Phone: +61 2 4921 5155

Fax: +61 2 4921 6933

E-mail: Joanne.Steel@uon.edu.au

Abstract

BACKGROUND: There is minimal speech pathology literature on communication presentation during post-traumatic amnesia (PTA) and the early recovery period after traumatic brain injury. While a body of research reports on other cognitive and behavioural functions during PTA, language and/or cognitive communication are not routinely the primary focus of current research literature.

OBJECTIVE: This critical synthesis provides an overview of research to date on communication during PTA to inform speech pathology assessment practice and provision of information to the multidisciplinary team and family members.

METHODS: A search was conducted of studies reporting on language, cognition, and cognitive communication during the acute, inpatient and early recovery period after TBI. These were examined for relevance to speech pathology practice during PTA and acute confusional state.

RESULTS: Historic and recent literature has described types of language and communication impairment during PTA and early recovery after TBI. Recently, aspects of communication impairment during PTA have been found relevant for outcome prediction. Few studies were found originating from speech pathology on communication during PTA.

CONCLUSIONS: Communication disruption forms a key feature of PTA. Existing literature indicates that speech pathology monitoring of communication during PTA may be of benefit as part of multidisciplinary team management during early recovery.

Key words: Post-traumatic amnesia, traumatic brain injury, cognitive-communication, aphasia, acute, recovery.

1. Introduction

Speech pathology management of cognitive communication impairment during post-traumatic amnesia (PTA) remains an underreported area. Post-traumatic amnesia is a term used for the stage of confusion that occurs early in recovery after TBI. It is a transient period of disordered consciousness, characterised by cognitive and behavioural disturbance and confusion (Levin, O'Donnell, & Grossman, 1979; Sherer, Nakase-Thompson, Yablon, & Gontkovsky, 2005). This state of confusion may last from a few minutes duration to several months, and the pathophysiology, neuropsychology and process of emergence of PTA remain unclear (Ahmed, Bierley, Sheikh, & Date, 2000). While there has been previous reporting of impaired communication during very early recovery after TBI, including during PTA (Heilman, Safran, & Geschwind, 1971; Russell, 1932; Snow & Ponsford, 2013; Symonds, 1937), less is known about the course of recovery of these impairments, or of speech pathology assessment during the early stages after injury.

Early researchers investigating PTA included description of disturbed language evident in the stage of early recovery after TBI, in some cases referring to impaired communication as being a key marker of the confusional state (see Symonds, 1937). However, in later years there has been less reference to communication in the literature on PTA. Aspects of cognitive and behavioural function during PTA have been investigated from disciplines such as psychology (e.g. Hanks et al., 2008; Kalmar et al., 2008; Pastorek, Hannay, & Contant, 2004; Sherer, Yablon, & Nakase-Richardson, 2009) and occupational therapy (e.g. Nott, Chapparo, Heard, & Baguley, 2010; Weir, Doig, Fleming, Wiemers, & Zemljic, 2006). While these may include some aspects of communicative function, there has

Language and cognitive communication during PTA

been little recent research with a focus on language or cognitive communication during PTA.

Clinically, the endpoint of PTA is used to signal the patient's readiness for engagement in rehabilitation (Hanks et al., 2008; Weir et al., 2006), and multidisciplinary assessment generally begins once the person has emerged from PTA (Tate, Perdices, Pfaff, & Jurjevic, 2001; Tate, Pfaff, & Jurjevic, 2000). Standardised PTA measurement tools in use include the Galveston Orientation and Amnesia Test (GOAT) (Levin, O'Donnell, et al., 1979) and the Westmead PTA scale (WPTAS) (Marosszeky, Ryan, Shores, Batchelor, & Marosszeky, 1998; Shores et al., 1986). Features of PTA that are measured in these and other prospective measures include disorientation (for place, person and time), and anterograde amnesia (i.e. the inability to lay down new memories) (Jennett & Teasdale, 1981a). Screening of language functions is not included as a standard part of PTA scales used clinically (e.g. the GOAT or WPTAS) or in research, although a recently developed tool, the Confusion Assessment Protocol (Sherer et al., 2005), includes testing of yes/no question comprehension as part of cognitive testing.

Patients may be in PTA for an extended time during their acute and inpatient rehabilitation admission, and during this time may be interacting with family, friends, and rehabilitation team members (Valitchka & Turkstra, 2013; Weir et al., 2006). A recent multidisciplinary INCOG guideline has been published for patient management during PTA. Recommendations include: "to provide therapy to maximize physical recovery, communication, and functional independence and educate the family about the cognitive effects of TBI and their management during this phase" (Ponsford, Janzen, et al., 2014, p. 316). Thus, the speech pathologist has a clear role as part of the team managing the patient in PTA. However, there has been little published within speech pathology on the types of

Language and cognitive communication during PTA

communication disorder that may be present during PTA and the early stages after injury, or on how impairments may resolve after PTA emergence.

In our recent survey of speech pathology practice (citation deleted for blind review) we found that one of the most frequently reported activities by speech pathologists was education of family and the multidisciplinary team. There is a need for increased awareness of multidisciplinary team members and families of the types of communication disorders that are occurring during this stage of rehabilitation, to enable compensatory strategies to be employed and for clinicians to be able to provide information and education on the person's current and continuing communication profile. With this in mind, the present review aimed to synthesise the historical and current literature from various fields relating to communication presentation and recovery during PTA and the early stages following TBI.

2. Cognitive communication disorder and assessment

Impairment of cognitive and social communication ability may be one of the most commonly reported and persisting disabilities after TBI (Ponsford et al., 2013). Recommendations for assessment of cognitive communication after TBI include use of a combination of standardised and non-standardised methods, with consultation with family members and use of contextualised hypothesis testing in the assessment process (Coelho, Ylvisaker, & Turkstra, 2005; Turkstra et al., 2003; Turkstra et al., 2005). However, less information is available on the early recovery period after TBI and there is little guidance on how and when to commence speech pathology assessment during PTA.

Due to the relatively recent inclusion of cognitive communication disorder into speech pathology scope of practice, clinicians have a limited empirical evidence base on which to base their decision-making for practice after TBI, in comparison with more classic language disorders (e.g. child language disorder or aphasia following stroke). Cognitive function maps onto the domains of different rehabilitation professionals, and therefore

Language and cognitive communication during PTA

assessment is viewed as a multidisciplinary process, with specialist input from speech pathologists, neuropsychologists, occupational therapists, nursing staff and rehabilitation specialists, amongst others (Tate et al., 2014; Togher et al., 2014; Velikonja et al., 2014). Clinically, reasons for conducting cognitive communication assessment after TBI vary at different stages of recovery. In the acute stage, for example, a primary purpose of speech pathology assessment may be to identify impairments that potentially will require ongoing services (Blyth, Scott, Bond, & Paul, 2012), or to facilitate interactions on the ward (O'Halloran, Worrall, & Hickson, 2007). While these reasons apply during PTA, rationales for testing may also be affected by a clinician's understanding as to how transient communication impairments are during this stage. That is, clinical decision-making may be influenced by perceptions of whether communication impairments arise due to the memory and orientation disruption resulting from PTA only, or whether they are relevant early predictors of longer-term communication disorder. There are minimal formal speech pathology recommendations for communication assessment during PTA, although the INCOG PTA guideline includes general recommendations for rehabilitation team practice (Ponsford, Janzen, et al., 2014). In our recent survey of speech pathology practice during PTA, we found that the majority of participants stated their awareness of the lack of profession guidelines for practice with patients in early recovery after injury, and that formal assessment of language and cognitive communication ability are commonly delayed until PTA emergence (citation deleted for blind review). The present paper presents a critical synthesis of the available research literature in order to inform clinical practice decision-making in this area.

3. Method

The literature on PTA and early recovery after TBI encompasses a diverse body of empirical and theoretical work, originating from different disciplines. The review focused

Language and cognitive communication during PTA

on investigations or reports on adult cognitive communication during the early recovery period. As a construct, PTA is not always labelled in studies, which may more broadly examine the acute stage or use the Rancho Los Amigos Levels of Cognitive Functioning (Rancho Levels), rather than the classification system of PTA. Therefore studies were sought that referred to language, cognition, and cognitive communication during the acute, inpatient and early recovery period after TBI, and these were examined for relevance to PTA and acute confusional state. Research relating to coma and other disorders of consciousness (e.g. minimally conscious and vegetative state) were accessed but were not a focus of this review, as was literature relating to motor speech disorder and paediatric traumatic brain injury. Online search providers and databases from health and psychology that were accessed included CINAHL, EBSCO, EMBASE, Informa Healthcare, Medline, Proquest, PsycBITE, PsycINFO, PubMed, speechBITE, and Google Scholar. A number of key terms were searched up to November 2014, including combinations and variations of the following: ‘traumatic brain injury’, ‘head injury’, ‘closed head injury’, ‘brain injury’; ‘post-traumatic amnesia’ ‘post-traumatic confusional state’, ‘confusion’; ‘acute’, ‘recovery’, ‘rehabilitation’ ‘early recovery’; ‘communication’, ‘cognitive communication’, ‘language’, ‘aphasia’, non-aphasic’, ‘social communication’; and ‘speech pathology’, ‘speech-language pathology’, ‘speech-language therapy’. Forward and backward citation searches of all relevant sources also increased the range of the review. Only research published in English was included.

4. Critical synthesis

First, an overview of the current level of knowledge on PTA is provided. This is followed by a summary of historic reporting on communication during PTA, description of the ‘language of confusion’ reported in the literature, findings in the literature on assessment of specific communicative functions (e.g. naming, auditory comprehension) during PTA,

Language and cognitive communication during PTA

and finally a summary of research on the significance of language and cognitive communication impairment to later function.

4.1 Post-traumatic amnesia definition

The time of post-traumatic confusion and disorientation was described over a hundred years ago, but was first reported as a “state” in 1937, when Symonds described the features of stupor, memory impairment and confabulation as comprising a syndrome evident in the period after coma emergence. Levin and colleagues provided further delineation of three stages in recovery from severe TBI as consisting of a period of coma, followed by a stage classified as PTA, and then “gradual restoration of cognitive function and activities of daily living” (Levin et al., 1979, p. 675). Their definition of PTA as “an interval during which the patient is confused, amnesic for ongoing events, and likely to evidence behavioral disturbance” remains in common use (Levin et al., 1979, p. 675). Although progression through PTA is gradual, there can be “islands” of memory (Symonds & Russell, 1943, p. 7), and the condition is best described as fluctuating. Early descriptions of PTA used various labels including “post-traumatic confusional state”, “post-traumatic dementia” (Symonds, 1937), “post-traumatic amnesia” (Russell & Smith, 1961), “Korsakow psychosis” (Zangwill, 1945) or “amnesic confabulatory state” (Weinstein & Lyerly, 1968).

Existing explanations on the pathophysiology and mechanisms of PTA are primarily speculative and the state remains poorly understood (Ahmed et al., 2000). It is still unknown what causes the state, and, critically, how or why PTA comes to an end. A number of reviews of PTA from neuropsychology in the past decades have summarised the current state of knowledge. Ahmed and colleagues, who noted the lack of a universal definition of PTA, listed the involvement of the following “intellectual” disturbances: anterograde and retrograde memory and attention; and “behavioural” issues: restlessness, agitation, fatigue, confabulation (Ahmed et al., 2000, p.765). Marshman and colleagues (Marshman, Jakabek,

Language and cognitive communication during PTA

Hennessy, Quirk, & Guazzo, 2013) classified three areas of cognitive and behavioural dysfunction during PTA, listed in headings as “amnesia”; “confusion and agitation”; and “attention and executive function”. The authors’ description of “confusion and agitation” delineated confusion as including verbose, rambling, meaningless speech and perseveration, therefore indirectly including the presence of disturbed language.

The multifactorial aspect of PTA has been emphasised in the past 15 years by several researchers, with attempts to redefine and relabel the stage of confusion to reflect these factors (Nakase-Richardson, Sherer, Yablon, Nick, & Trzepacz, 2004; Stuss et al., 1999). Stuss and colleagues suggested use of the term “post-traumatic confusional state” as being more appropriately descriptive of the stage (Stuss et al., 1999). This is particularly relevant in view of the role of delirium and agitation for many patients during this time (Sherer et al., 2005). Impaired attention has increasingly been regarded as significant during PTA (Jakabek, 2012; Pfaff, 1996; Stuss et al., 1999), as is slowed processing (De Monte, Geffen, & Massavelli, 2006). Sherer and colleagues identified seven core symptoms of PTA as measured by the Confusion Assessment Protocol: disorientation, cognitive impairment, fluctuation of presentation, restlessness, night-time sleep disturbance, daytime decreased arousal, and psychotic-type symptoms (Sherer et al., 2005).

Historically, language disorder was described as a key component of the confusional state (Russell & Smith, 1961). In accounts of PTA, there are numerous references to disturbed language (including “dysphasia”) as part of the syndrome comprising confusion, disorientation, and attention, memory and behavioural disruption (Russell, 1932; Symonds, 1937; Weinstein, 1971). Gradually, focus narrowed down from this range of features to the orientation and anterograde memory issues that are universally present during the state (Russell & Smith, 1961; Wilson, Baddeley, Evans, & Shiel, 1994), which are the two functions commonly tested with PTA measurement tools today. However, the multiple

Language and cognitive communication during PTA

cognitive and behavioural disturbances listed as associated with PTA may all be viewed as likely to affect communication ability in some way.

4.2 Communication during early recovery

Impaired linguistic processes evident early after TBI have been described in several studies (Hagen, 1984; Heilman et al., 1971; Levin, Grossman, & Kelly, 1976; Weinstein & Keller, 1963). These were reported as resulting both from focal left hemisphere injury, and more generally from diffuse axonal injury or bilateral frontal injury (Hagen, 1984; Sarno, 1980, 1984; Sarno, Buonaguro, & Levita, 1986; Thomsen, 1975; Weinstein & Kahn, 1952; Weinstein & Keller, 1963). Lack of consensus around how to view, identify and label language issues after TBI has likely contributed to the wide range reported of incidence of aphasia resulting from TBI, varying from between 2% (Heilman et al., 1971) to nearly 50% (Levin et al., 1976). The variation in incidence figures may also be reflective of the finding that many word-finding issues after TBI have been found to resolve in the early stages after injury (Thomsen, 1975; Vukovic, Vuksanovic, & Vukovic, 2008).

While numerous studies have reported on cognitive assessment during PTA and the early recovery period, few have focused on communication. In existing studies, it can be hard to establish PTA status, as this is either not stated, or may only be inferred from descriptive terms such “amnesic state” (e.g. Weinstein & Lyerly, 1968), or “confusional state” (Zangwill, 1945). The term “post-traumatic confusional state” (e.g. Sherer et al., 2009; Stuss et al., 1999) may be qualitatively and measurably different from PTA. Other research has used the structure of the Rancho Levels, rather than the classification system of PTA, to describe the patient’s stage of early recovery. This scale delineates eight stages of recovery of function after TBI, from non-responsive to independent, and traditionally the middle stages of this scale (Stage IV, “confused agitated”, Stage V, “confused inappropriate”, and Stage VI, “confused appropriate”) are associated with PTA.

Language and cognitive communication during PTA

In his description of recovery after TBI, Russell (1932) provided one of the first detailed accounts of confused language after injury within his description of 200 cases of head injury. The course of communication recovery in the initial stages of PTA was described as developing from groans or shouts, to repeated words and phrases, then discourse with meaningless content, and finally return of social communication (Russell, 1932). Symonds described three patients in PTA and reported on confabulation, perseveration, “dysphasia” and disturbance of speech (1937). He suggested that this disruption (including dysphasia) was closely related to the “general mental disorder” and queried whether it would be possible to learn about the nature of the state by observation of communication (p. 37). However, this recommendation did not appear to prompt further focus on communication content in subsequent research of the cognitive disruption of PTA.

4.3 Language of confusion

While the *language of confusion* has been reported after TBI by a number of researchers, there has been some dissention over its nature (Groher, 1977), and a lack of specificity on what stage in recovery it occurs. Although a frequently listed feature of communication presentation in early recovery after TBI, “dysphasia/aphasia” is variously viewed as being additional to confused language or a prime manifestation of it. Halpern and colleagues differentiated between confused language (seen as a primarily memory-related deficit) and aphasia (a language disorder) in their review of communication disorders after neurological damage (Halpern, Darley, & Brown, 1973). The authors provided explanation of this difference, with aphasia described as:

... an impairment.... of the capacity to interpret and formulate language
symbols... is disproportionate to impairment of other intellectual functions...
and is manifested in reduced availability of vocabulary, reduced efficiency in

Language and cognitive communication during PTA

application of syntactic rules, reduced auditory retention span. (Halpern et al., 1973, p.163)

Confused language was defined as:

... an impairment associated with the neurological condition of confusion. This is often traumatically induced and is characterized by reduced recognition and understanding of and responsiveness to the environment, faulty short term memory, mistaken reasoning, disorientation in time and space, and behavior which is less adaptive and appropriate than normal. (Halpern et al., 1973, p. 163)

The view that both aphasia and confused language could present as separate disorders during early recovery was supported by Groher (1977). He reported that in the early stages of recovery patients demonstrated “both aphasic (a reduced capacity to interpret and formulate language symbols) and confused (faulty short-term memory, mistaken reasoning, inappropriate behavior, poor understanding of the environment, and disorientation) language skills” (Groher, 1977, p. 220). How to assess and differentiate between errors produced as a result of confused language, aphasia and/or cognitive communication impairment remains unreported.

4.4 Assessment issues and practices

4.4.1 Naming and language impairment during early recovery

Weinstein and Kahn (1952) and Weinstein and Keller (1963) examined the nature of naming impairment in their research into language disorder during early recovery after acquired neurological damage. In their early study, Weinstein and Kahn investigated the types of naming errors made by three groups of hospitalised patients with brain damage of varied aetiology (Weinstein & Kahn, 1952). The three groups were classified according to presence of (1) diffuse, deep-seated and bilateral lesions, (2) left hemisphere lesions, and (3)

Language and cognitive communication during PTA

right hemisphere injury. In addition to conducting language testing, the authors collected orientation data. Although there is no reference to injury severity or of PTA in this research, patients were described as being tested twice, once in the acute stage and later during the course of clinical recovery. The authors found differences in the types of naming errors that the groups of confused (i.e. disorientated) patients demonstrated that differed from a classic aphasia. This was perceived to be a type of metaphoric error, or “non-aphasic misnaming”, which the authors viewed as being associated with behaviour changes and mood. The authors therefore suggested an association between paraphasias and disorientation, delusions and behavioural factors in the confusional state. Although it is difficult to make inferences from this study due to the varied aetiologies studied and lack of delineation of PTA status, the study lends some support to the view of language demonstrated during early recovery as being qualitatively different from that of non-confused patients with TBI.

Heilman and colleagues reported on presentation of anomia and Wernicke’s aphasia following closed head injury, in the time of disorientation after TBI (Heilman et al., 1971). This study investigated communication of patients with aphasia admitted after closed head injury; that is, only those identified as having language impairment were described. Patients were screened once “alert and cooperative” with spontaneous speech, auditory and written comprehension, repetition, naming, and ability to write. If they were found to be impaired on screening tests, the patients then participated in full aphasia and cognitive testing. Of 750 patients screened during recruitment, 13 were found to have either anomia or Wernicke’s aphasia. Seven of the 13 patients with aphasia had right frontal lobe damage, four had damage in the left temporoparietal area, and two had no external evidence of trauma. However, in contrast, in their control group of 100 non-aphasic patients admitted over the same period, 27 patients with evidence of damage in corresponding regions of the brain had no recorded language impairment. Again, the authors did not directly refer to PTA, but it was reported that four of the nine patients with anomia had “post-traumatic

Language and cognitive communication during PTA

Korsakoff's syndrome", after which memory returned to normal. In contrast to the Weinstein and colleagues' studies (Weinstein & Kahn, 1952; Weinstein & Keller, 1963) Heilman and colleagues described the impairment in communication as resembling a "classic anomic aphasia", rather than a distinct type of misnaming. Although the authors reported difficulties with follow-up, they found that patient outcomes varied widely. One of the main findings of this study was the heterogeneity of presentation after injury, and seeming lack of relationship to injury site and lesion type. The authors stated:

It is not known for certain why trauma in the same area of the head produces an anomic aphasia in some patients, a Wernicke's aphasia in others, and in some it produces no aphasia. (Heilman et al., 1971, p. 269)

Paterson (1942) described the presence of "paraphasic" errors in the communication of patients with TBI in the confused state (p. 717). He attributed these observed naming errors as resulting from distortion of perception rather than of language dysfunction. For example, in one case he reported, a patient named a pencil "cigar" and subsequently tried to smoke it. Paterson explained the nature of this type of error as resulting from restricted identification of the semantic qualities of the pencil. That is, the patient was able to identify the qualities of "long and thin" but had restricted understanding of other semantic features of the object (Paterson, 1942). In further description of confused communication evident after TBI, Zangwill reported on the recovery of two patients who participated in Rorschach testing (Zangwill, 1945), cases taken from Paterson's 1942 study. Although focus of this research was personality factors, Zangwill provided response samples from three test occasions during the acute stage and some theoretical discussion on confused language demonstrated soon after injury. The two participants, with no focal injury, were reported as demonstrating dysphasia on object-naming tasks and in their conversation. Responses to Rorschach cards on first and second testing contained bizarre responses with highly unusual

Language and cognitive communication during PTA

content, although correct in “word choice and syntax”. Zangwill interpreted the “paraphasic and incoherent” (Zangwill, 1945, p. 333) responses from the earlier testing in PTA as being more than a formal language disorder but rather a “generalized disturbance of affect and thought” (p. 333) and noted the reduction in paraphasic content for both patients over consecutive testing.

Thomsen investigated the language disorder and outcome of 50 patients after TBI, by assessing once during early recovery and again at follow up (Thomsen, 1975). The study has no details of when the first assessment took place, or whether the participants were clear of the confusional state at first testing. The author described the presence of post-traumatic aphasia, labelled “amnesic aphasia and verbal paraphasia” (p. 714), in the majority of the 12 participants with language disorder, and reported difficulties with higher-level tasks such as synonyms, antonyms, and metaphors. Although the time frames of initial assessment and follow up varied for the participants, Thomsen found that language disruption resolved relatively well over time. These findings corresponded with other research reporting that confused, aphasic errors are a feature of the early stage after TBI which resolve during the initial recovery process (Paterson, 1942; Zangwill, 1945).

Levin and colleagues (Levin, Grossman, Sarwar, & Meyers, 1981) studied linguistic recovery of 21 patients from acute admission over the course of five to six months after TBI. They examined a cohort of patients who presented with aphasia on initial assessment while in the acute setting after severe TBI. Of the 800 admissions during the recruitment period, the authors found 21 patients with aphasia as determined by testing at initial hospitalisation. Of these, eight had primarily left hemisphere damage, four had mainly right hemisphere damage, two had bilateral damage, and diffuse damage was inferred in six patients. Patients were tested with the Multilingual Aphasia Examination (Benton, 1967). At follow up, of the 21 cases, the authors found that nine had recovered language skills, six had a specific

Language and cognitive communication during PTA

linguistic disturbance (i.e. only a single function was impaired) and six had generalised disturbance (both expressive and receptive abilities affected). Nearly half the sample that were identified as aphasic in the acute setting had anomie errors in confrontation naming at 5-6 month follow up, and one-fifth had reduced verbal fluency. These findings indicated a relative persistence of language disorder over the early months of recovery for patients who are initially identified with difficulties. The study does not refer to PTA, confusional state, or level of confusion, but authors described the participants as being at a “testable condition” in the acute stage of recovery. The relationship of early linguistic ability to confusion was not investigated. However, since the median coma duration was 13 days (range <1–39) it may be expected that some of the patients with injury of this severity would have been in PTA during initial testing. Supporting the findings of Heilman and colleagues (Heilman et al., 1971), the authors did not find an association between injury lateralisation, as identified by CT (Computerised Tomography) scan, and performance on language testing. That is, those with left hemisphere, right hemisphere and diffuse damage after TBI were not differentiated on naming or other language tests.

In one of the few specific investigations of language recovery early after injury, Groher (1977) investigated the pattern of language recovery for a group of 14 patients with TBI, as measured by the Porch Index of Communicative Ability (Porch, 1967) and the Wechsler Memory Scale (Wechsler, 1945). Although there is no reference to PTA in this research, patients “who demonstrated language or memory disorders after regaining consciousness” (1977, p. 213) were initially tested once conscious, then monthly for 120 days (i.e. five test occasions). Groher found that for these patients who initially presented with impaired memory and language ability, there was significant improvement at one month after regaining consciousness. The patients demonstrated “marked anomia” with paraphasias, which resolved by follow up at four months after initial testing. At follow up, Groher observed that while patients were considered by family and hospital staff as having

Language and cognitive communication during PTA

returned to normal, there were remaining functional difficulties with organisational and retention skills, which were apparent on only some formal test measures. This was one of the first reports to comment on the discrepancy between seemingly normal ability to communicate and functional disability. Groher recommended development of an additional battery of tests for patients with closed head injury to evaluate these areas of difficulty.

4.4.2 Comprehension

A number of studies have investigated comprehension during early recovery, using simple and more complex question structures with, for example, the Test of Complex Ideational Material (CIM) subtest of the Boston Diagnostic Aphasia Examination (BDAE) (Goodglass & Kaplan, 1983) (e.g. “Will a stone float on water?”) or the Mississippi Aphasia Screening Test (MAST). In an investigation of emergence from the minimally conscious state, Nakase-Richardson and colleagues reported on the ability of patients in the confused state with the questions from the CIM, administered as part of the Cognitive Test for Delirium (Hart et al., 1996; Nakase-Richardson, Yablon, Sherer, Evans, & Nick, 2008). The authors found that of 812 patients classified as confused, only 34% were able to consistently respond accurately to yes/no questions, and that accuracy was lower for those who had recently emerged from minimally conscious state than for those who had emerged by inpatient admission (Nakase-Richardson et al., 2008). Even patients who were not classified as confused had difficulty completing yes/no questions correctly during early recovery, indicating a continuum of recovery over time for this ability, and possibly reflecting the inherent difficulty of this task for patients with TBI. In further study with 144 participants in acute inpatient brain injury rehabilitation, Nakase-Richardson and colleagues found that confused patients had more difficulty with the MAST yes/no questions than non-confused patients (Nakase-Richardson, Yablon, Sherer, Nick, & Evans, 2009). Patients in the confused state had increased difficulty answering questions requiring judgements; for

Language and cognitive communication during PTA

example, “Does Monday come before Tuesday?” The authors speculated that many factors impacted on the ability to respond to auditory comprehension tasks in the early stages after injury, including impaired attention and language processing, as well as neurobehavioural factors such as motivation (Nakase-Richardson et al., 2008; Nakase-Richardson et al., 2009).

4.4.3 Verbal fluency

Verbal fluency ability has been examined with patients during PTA or at Rancho Levels IV-VI (Gruen, Frankle, & Schwartz, 1990; Hagen, Malkmus, & Durham, 1980; Hanks et al., 2008; Heilman et al., 1971; Wilson et al., 1999). Verbal fluency, while frequently included in neuropsychological batteries as a test of executive function and semantic memory, is also used as a test of verbal expression ability. Gruen and colleagues used verbal fluency measures with 218 patients in the acute phase (at Rancho Level IV and above) (Gruen et al., 1990). Of this cohort, 19% were at Rancho Levels IV and V, and 29% were at level VI, indicating a likelihood of being in PTA, and patients were tested with semantic and phonemic verbal fluency. There was a significant relationship between level of cognitive functioning and the number of words produced, with those in lower Rancho Levels producing significantly less responses, indicating an effect of the confused state on performance with this task. The authors speculated that patients used the same strategies of word retrieval, regardless of level of functioning, but confusion disrupted “effectiveness and speed” of using the selected strategy.

Wilson and colleagues included verbal fluency measures with other cognitive tests, including reaction time, comprehension speed and accuracy, prose recall, and backward digit span (Wilson et al., 1992) in their study of cognitive ability during PTA. This study comprised four groups of 12: patients in PTA; non-TBI amnesic patients; chronic memory impaired patients; and controls. The group in PTA performed more poorly on tests of, for

Language and cognitive communication during PTA

example, speed of comprehension (e.g. some tasks took up to four times longer for people in PTA), and accuracy, digit span, simple reaction time, and verbal fluency.

4.4.4 Cognitive communication

Wiig and colleagues conducted cognitive linguistic testing with the Test of Language Competence with patients in the Rancho Levels VI, VII, and VIII (Wiig, Alexander, & Secord, 1988). While PTA status was not included in this study, the authors do refer to duration of “coma and amnesia”, which ranged from none to 14 weeks. Time post injury was between two and 37 months, although the group at Rancho Levels VI were all less than 12 months post onset. All participants were screened for language ability, and as an inclusion criterion were required to have no aphasia as measured on BDAE subtests and the Boston Naming Test. Five of the 17 eligible participants were rated at Rancho Level VI: “confused and appropriate”. The authors found that interpretation of metaphors and matching ability differentiated the groups rated at VI and VII, indicating that abstract thinking was affected by cognitive functions and level of recovery. This group was also differentiated by the ability with these skills in complex sentences. The authors suggested this difficulty was related to planning, integration and synthesis of semantic, syntactic and pragmatic variables, which was suggestive of executive dysfunction. The groups were further differentiated by the ambiguities subtest, which requires flexibility. Patients rated as being VII and VIII scored around the average normal range (although this test is normed for 18 year olds), whereas those rated VI were clustered at the lower limits of normal range.

Other authors have included types of communication assessment as part of neuropsychological testing in the early recovery stages. Chabok and colleagues conducted language and cognitive testing while patients were in an acute trauma centre, using the Persian Aphasia Test (Nilipour, 1993), with one of the selection criteria being “existing post-traumatic amnesia (PTA) of 20 minutes or more” (Chabok, Kapourchali, Leili, Saberi,

& Mohtasham-Amiri, 2012, p. 1445). Patients were separated into two groups of aphasic ($N = 39$) and non-aphasic ($N = 21$) participants, based on scores on aphasia testing in the acute setting. The assessment protocol included verbal fluency, visual confrontation naming, auditory story comprehension, descriptive speech, and repetition. Cognition was measured with the Mini-Mental State Examination (MMSE). For patients with “post-traumatic linguistic disorder”, aspects of communication most affected were verbal fluency, story auditory comprehension and discourse efficiency. The authors found that patients in the aphasic group were more likely to have had post-injury neurosurgery, had higher level of cognitive impairment, and more severe injury, suggesting that post-traumatic cognitive deficits and linguistic disorder were related. It appeared that presence of aphasia was not related to lateralisation of damage. There were no significant differences in lesion location between groups classified aphasic and non-aphasic on whether injury was in the left or right hemispheres, or bilateral. The authors concluded that impaired linguistic processing after TBI was associated with executive dysfunction, and that impairment of declarative memory had a role in reduced performance on tests requiring lexical-semantic information encoding and retrieval. However, there were global differences between groups on injury severity, sample size, and length of time in the intensive care unit (ICU), and the study did not include information on timing of testing and the groups’ stage of recovery.

Vukovic and colleagues (Vukovic et al., 2008) examined language and cognition of patients after TBI and stroke in the acute setting and at six months follow up. Patients were divided into two groups based on aetiology, comprising a group of 37 post-TBI patients who demonstrated clinical features of a classic aphasia syndrome, and a group of 34 patients post stroke with aphasia. All patients were required to have left hemisphere damage, and TBI participants were selected as having language processing disorder. That is, they were required to demonstrate paraphasias, word-finding difficulty, syntactic deficits and production of meaningless words. The study does not refer to PTA status, or injury severity,

Language and cognitive communication during PTA

so it is unclear whether the participants in the acute setting had emerged from PTA, or if their injury severity was mild, moderate or severe, and time post injury of initial testing was not reported. When comparing the groups, the authors found that patients with TBI had a different recovery pattern to the stroke patients. Of the 37 patients with TBI who had aphasia, at follow up 12 had no aphasia (or other symptoms of language disorder), compared with only two participants with stroke making a recovery of language function. A limitation of this study was that the post-TBI group was significantly younger than the post stroke group, and younger age has been found to be a positive prognostic factor following brain injury (van Velzen, van Bennekom, Edelaar, Sluiter, & Frings-Dresen, 2009; Zasler, 1997).

Ellis and Peach (2009) reported on sentence planning ability with a group of patients in the acute phase of TBI, at the stage of the “confused language” (Ellis & Peach, 2009, p. 257) of Rancho Levels V (confused, inappropriate, non-agitated) and VI (confused, appropriate) (Ellis & Peach, 2009). Although the authors do not refer to PTA status in the study, these stages are associated with late PTA. Two groups were compared, comprising a group of seven patients rated as being in Rancho Levels V–VI, and a group of seven controls with no injury. Patients in the “confused” group were screened for significant aphasia, and all scored above cut-off for impairment. Testing consisted of repetition of sentences of increasing complexity (e.g. with passive and dative structures). The authors found that sentence production was disrupted during the confusional state. The “confused” group of patients demonstrated a larger number of pauses both between and within clauses than the controls, and the authors found a relationship between pauses and sentence complexity (i.e. there were more pauses with increasingly complex sentence structures). Ellis and Peach attributed these difficulties to linguistic planning impairment. Although the authors acknowledged the potential impact of impaired working memory, they stated that their use of matched pairs of sentences indicated that working memory alone was unlikely to

Language and cognitive communication during PTA

explain the fact that syntactically more complex sentences were more difficult for these patients.

In one of the only investigations of intelligence during PTA, Mandleberg (1975, 1976) found that non-verbal skills showed a distinct difference in stages of recovery, supporting the theory of PTA as a disparate state (Mandleberg, 1975, 1976). This finding was based on qualitative rather than quantitative differences in performance. Mandleberg tested 16 people with severe injury while still in PTA, between 21 days and 10 months post injury, with the Wechsler Adult Intelligence Scale (WAIS), including “Verbal subtests of Information”, “Comprehension”, “Arithmetic”, “Similarities”, “Digit Span” and “Vocabulary”. The author found that while the group in PTA performed significantly worse on measures when in PTA, the differences were more marked for Performance IQ than Verbal IQ. Mandleberg concluded that people in PTA were able to make appropriate and complex responses in PTA, and therefore he suggested that verbal abilities remain “relatively intact during PTA” (1975, p. 1,131).

4.5 Significance of communication impairment during PTA for outcome

In their study of conversational discourse ability during the acute stage of recovery after TBI, Le Blanc and colleagues used a discourse rating scale (the Protocole Montréal d'évaluation de la communication) (Joanette, Ska, & Côté, 2004), and tests of memory, mental flexibility, confrontation naming, and semantic and phonemic verbal fluency (LeBlanc et al., 2014a, 2014b). The authors did not include PTA status as a variable in the study; however, the patients were within three weeks post injury. It was found that discourse performance at this acute stage of recovery significantly predicted moderate and severe disability categories of the Glasgow Outcome Scale – Extended (GOS-E) (Teasdale, Pettigrew, Wilson, Murray, & Jennett, 1998) and the “probability of requiring rehabilitation” (LeBlanc et al., 2014b, p. 951). The more severely impaired conversational

Language and cognitive communication during PTA

discourse was associated with worse level of disability and global outcome. In a previous study, Le Blanc and colleagues (LeBlanc, de Guise, Feyz, & Lamoureux, 2006) found a relationship between injury severity (as measured by Glasgow Coma Scale score) and performance on confrontation naming, semantic verbal fluency, auditory comprehension and verbal reasoning, as demonstrated in the acute setting. The authors did not include PTA status in these studies.

The Confusion Assessment Protocol, which includes the CIM yes/no questions, has been used in several studies of recovery and outcome with patients in the early stages of recovery following TBI (Sherer et al., 2005; Sherer et al., 2009; Sherer, Yablon, Nakase-Richardson, & Nick, 2008). Sherer and colleagues found that level of confusion during the post-traumatic confusional state was predictive of outcome at rehabilitation discharge (Sherer et al., 2005). Hanks and colleagues (2008) found that including participants in PTA in their study of performance in a neuropsychological battery in acute stage had no effect on the predictive validity of early testing (i.e. testing was equally predictive for those in PTA) (Hanks, et al., 2008). Although originating from neuropsychology, some of the tests used in this study are also commonly used in speech pathology (e.g. phonemic and semantic word verbal fluency tasks and tests of reading). In a study of outcome prediction based on cognition during PTA, Pastorek and colleagues used measures of language comprehension and attention to determine which factors at one month post injury would predict global outcome at six months post TBI (Pastorek et al., 2004). In their study of 105 patients with TBI in the acute setting after TBI, they found results of testing (and testability) were predictive of global outcome, particularly performance on the CIM yes/no questions. In their study on the feasibility of conducting neuropsychological testing of people in PTA, Kalmar and colleagues found that approximately two-thirds of their sample of 218 patients in PTA were able to complete a battery of tests, with a test time mean duration of 66 minutes (Kalmar et al., 2008).

Language and cognitive communication during PTA

A prospective study by Nakase-Richardson and colleagues evaluated the contribution of measurements of level of confusion during PTA to prediction of employment outcome at one year after injury (Nakase-Richardson, et al., 2007). Confusion severity level was found to be even more predictive of outcome than PTA duration, and provided a distinct contribution to long-term outcome. Presence and level of confusion were found to be predictive factors for early functional outcome and later productivity status (Sherer et al., 2005; Sherer et al., 2008).

5. Discussion

Aspects of language, behaviour, testability, severity of symptoms and rate of recovery have been found to be factors of interest in the early stages of recovery after traumatic brain injury. Disordered language and cognitive communication form part of the clinical picture during PTA and the early recovery period, in addition to more widely documented impairments of attention, orientation and memory. Studies have reported on impairment of naming, word-finding, auditory comprehension, verbal fluency, syntax and discourse production. Confusion may be manifested in communication impairments such as confabulation, perseveration and disorganised discourse (Marshman et al., 2013; Symonds, 1937). These studies suggest that there may be useful and clinically relevant information observable during the time of PTA for prognostic, predictive and planning purposes. However, there has been little research, particularly from recent decades, reporting on the course of recovery of communication function in the early stages after injury, or on the relevance of early presentation to later communication disorder.

As delineated in profession position statements and guidelines, management of cognitive impairment and cognitive communication disorder is a multidisciplinary concern (American Speech-Language-Hearing Association, 2005; Katz et al., 2002; Ponsford, Bayley, et al., 2014; Togher et al., 2014). Focus of rehabilitation after TBI, often beginning

Language and cognitive communication during PTA

on PTA emergence, is on assisting the person to regain their previous roles as much as is possible (Khan et al. 2003), and professionals in the rehabilitation team ideally work together to help the patient with these goals (Cicerone et al., 2005). In the time of PTA and early recovery, when cognitive disruption is particularly marked, speech pathologists have a key role within the multidisciplinary team in educating the team and family members on the person's changing ability with cognition and interaction (citation deleted for blind review). While cognitive impairments are typically managed collaboratively during the patient's rehabilitation (as is recommended practice), during PTA and early recovery there is so little professional literature to support practice that speech pathologists may feel their role is more defined once the person has emerged from PTA (citation deleted for blind review).

Several areas relating to speech pathology practice are in need of future research, including questions on the impact of PTA-related cognitive and behavioural impairments on communication (relative to persisting communication disorder), optimal timing and methods of cognitive communication assessment during early recovery, and on the types of communication therapy that may be of benefit during PTA. Despite a small number of studies investigating therapeutic practice at this time (e.g. de Guise, Leblanc, Feyz, Thomas, & Gosselin, 2005; McGhee, Cornwell, Addis, & Jarman, 2006; Thomas et al., 2003) there has been no clear empirical evidence for any speech pathology practice during PTA (Ponsford, Janzen, et al., 2014). For patients with extended PTA of weeks or longer, a large proportion of inpatient rehabilitation admission may be spent waiting for emergence from PTA before active therapy begins (Weir et al., 2006). With increasing pressure to reduce hospital stays (Hanks et al., 2008) it is imperative to determine best evidence-based practice at this time in order to make the most of the time available.

6. Conclusion

Cognitive presentation and recovery in the post-acute stages have been investigated in research from other disciplines, and the lack of corresponding speech pathology literature is of concern. Despite the interest in language problems in historical accounts of PTA and common reference to confused language, aphasic/non-aphasic communication, and cognitive communication disturbance, in recent years this aspect of PTA and the confused state has become less reported. Future speech pathology research describing and systematically measuring cognitive communication presentation during the early recovery period would be of benefit. This literature review has highlighted the need for inclusion of language and communication monitoring and management during this early stage, which may contribute information for educational and predictive purposes.

Declaration of interest

The authors report no conflict of interest.

Ahmed, S., Bierley, R., Sheikh, J. I., & Date, E. S. (2000). Post-traumatic amnesia after closed head injury: A review of the literature and some suggestions for further research. *Brain Injury*, 14(9), 765-780. doi: 10.1080/026990500421886

American Speech-Language-Hearing Association. (2005). Roles of speech-language pathologists in the identification, diagnosis, and treatment of individuals with cognitive-communication disorders: Position statement. Retrieved from <http://www.asha.org/policy>

Blyth, T., Scott, A., Bond, A., & Paul, E. (2012). A comparison of two assessments of high level cognitive communication disorders in mild traumatic brain injury. *Brain Injury*, 26(3), 234-240. doi: 10.3109/02699052.2012.654587

Chabok, S. Y., Kapourchali, S. R., Leili, E. K., Saberi, A., & Mohtasham-Amiri, Z. (2012). Effective factors on linguistic disorder during acute phase following traumatic brain injury in adults. *Neuropsychologia*, 50(7), 1444-1450. doi: 10.1016/j.neuropsychologia.2012.02.029

Cicerone, K., D. , Dahlberg, C., Malec, J., F. , Langenbahn, D. M., Felicetti, T., Kneipp, T., . . . Catanese, J. (2005). Evidence-Based Cognitive Rehabilitation: Updated Review of the Literature From 1998 Through 2002. *Archives of physical medicine and rehabilitation*, 86(8), 1681-1692. doi: <http://dx.doi.org/10.1016/j.apmr.2005.03.024>

Coelho, C. A., Ylvisaker, M., & Turkstra, L. S. (2005). Nonstandardized assessment approaches for individuals with traumatic brain injuries. *Seminars in Speech and Language*, 26(4), 223-241. doi: 10.1055/s-2005-922102

de Guise, E., Leblanc, J., Feyz, M., Thomas, H., & Gosselin, N. (2005). Effect of an integrated reality orientation programme in acute care on post-traumatic amnesia in patients with traumatic brain injury. *Brain Injury*, 19(4), 263-269. doi: 10.1080/02699050400004971

Language and cognitive communication during PTA

- De Monte, V. E., Geffen, G. M., & Massavelli, B. M. (2006). The effects of post-traumatic amnesia on information processing following mild traumatic brain injury. *Brain Injury*, 20(13/14), 1345-1354. doi: 10.1080/02699050601082073
- Ellis, C., & Peach, R. K. (2009). Sentence planning following traumatic brain injury. *NeuroRehabilitation*, 24(3), 255-266. doi: 10.3233/nre-2009-0476
- Goodglass, H., & Kaplan, E. (1983). *Boston Diagnostic Aphasia Examination (BDAE)*. Philadelphia: Lea and Febiger.
- Groher, M. (1977). Language and memory disorders following closed head trauma. *Journal of Speech and Hearing Research*, 20(2), 212-223.
- Gruen, A. K., Frankle, B. C., & Schwartz, R. (1990). Word fluency generation skills of head-injured patients in an acute trauma center. *Journal of Communication Disorders*, 23(3), 163-170. doi: 10.1016/0021-9924(90)90020-Y
- Hagen, C. (1984). Language disorders in head trauma. In A. Holland (Ed.), *Language disorders in adults* (pp. 245-281). San Diego: College Hill Press.
- Hagen, C., Malkmus, D., & Durham, P. (1980). *Rancho Levels of Cognitive Functioning*. Downey, CA: Rancho Los Amigos Medical Centre, Adult Brain Injury Service.
- Halpern, H., Darley, F. L., & Brown, J. R. (1973). Differential language and neurologic characteristics in cerebral involvement. *Journal of Speech and Hearing Disorder*, 38(2), 162-173.
- Hanks, R. A., Millis, S. R., Ricker, J. H., Giacino, J. T., Nakese-Richardson, R., Frol, A. B., . . . Gordon, W. A. (2008). The predictive validity of a brief inpatient neuropsychologic battery for persons with traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 89(5), 950-957. doi: 10.1016/j.apmr.2008.01.011

Language and cognitive communication during PTA

Hart, R. P., Levenson, J. L., Sessler, C. N., Best, A. M., Schwartz, S. M., & Rutherford, L.

E. (1996). Validation of a cognitive test for delirium in medical ICU patients.

Psychosomatics, 37(6), 533-546. doi: 10.1016/s0033-3182(96)71517-7

Heilman, K. M., Safran, A., & Geschwind, N. (1971). Closed head trauma and aphasia.

Journal of Neurology, Neurosurgery & Psychiatry, 34, 265-269.

Jakabek, D. D. (2012). *The contribution of executive attention towards post-traumatic*

amnesia. Master of Psychology (Clinical), James Cook University, Townsville.

Joanette, Y., Ska, B., & Côté, H. (2004). *Protocole Montréal d'Évaluation de la*

Communication. Isbergues, France Ortho Édition.

Kalmar, K., Novack, T. A., Nakase-Richardson, R., Sherer, M., Frol, A. B., Gordon, W. A.,

. . . Ricker, J. H. (2008). Feasibility of a brief neuropsychologic test battery during

acute inpatient rehabilitation after traumatic brain injury. *Archives of Physical*

Medicine and Rehabilitation, 89(5), 942-949. doi: 10.1016/j.apmr.2008.01.008

Katz, R. C., Kennedy, M. R., Avery, J., Coelho, C., Sohlberg, M., Turkstra, L., & Ylvisaker,

M. (2002). Evidence-based practice guidelines for cognitive-communication

disorders after traumatic brain injury: Initial committee report. *Journal of Medical*

Speech-Language Pathology, 10(2), ix–xiii.

LeBlanc, J., de Guise, E., Champoux, M.-C., Couturier, C., Lamoureux, J., Marcoux, J., . . .

Feyz, M. (2014a). Acute evaluation of conversational discourse skills in traumatic

brain injury. *International Journal of Speech-Language Pathology*, 0(0), 1-12. doi:

10.3109/17549507.2013.871335

LeBlanc, J., de Guise, E., Champoux, M.-C., Couturier, C., Lamoureux, J., Marcoux, J., . . .

Feyz, M. (2014b). Early conversational discourse abilities following traumatic brain

injury: An acute predictive study. *Brain Injury, Early online*(0), 1-8. doi:

10.3109/02699052.2014.888760

LeBlanc, J., de Guise, E., Feyz, M., & Lamoureux, J. (2006). Early prediction of language impairment following traumatic brain injury. [Article]. *Brain Injury*, 20(13/14), 1391-1401. doi: 10.1080/02699050601081927

Levin, H. S., Grossman, R. G., & Kelly, P. J. (1976). Aphasic disorder in patients with closed head injury. *Journal of Neurology, Neurosurgery & Psychiatry*, 39, 1062-1070. doi: 10.1136/jnnp.39.11.1062

Levin, H. S., Grossman, R. G., Sarwar, M., & Meyers, C. A. (1981). Linguistic recovery after closed head injury. *Brain and Language*, 12(2), 360-374. doi: 10.1016/0093-934X(81)90025-0

Levin, H. S., O'Donnell, V. M., & Grossman, R. G. (1979). The Galveston Orientation and Amnesia Test. A practical scale to assess cognition after head injury. *Journal Of Nervous And Mental Disease*, 167(11), 675-684. doi: 10.1097/00005053-197911000-00004

Mandleberg, I. A. (1975). Cognitive recovery after severe head injury. 2. Wechsler Adult Intelligence Scale during post-traumatic amnesia. *Journal of Neurology, Neurosurgery & Psychiatry*, 38(11), 1127-1132. doi: 10.1136/jnnp.38.11.1127

Mandleberg, I. A. (1976). Cognitive recovery after severe head injury. 3. WAIS verbal and performance IQs as a function of post-traumatic amnesia duration and time from injury. *Journal of Neurology, Neurosurgery & Psychiatry*, 39(10), 1001-1007. doi: 10.1136/jnnp.39.10.1001

Marshman, L. A. G., Jakabek, D., Hennessy, M., Quirk, F., & Guazzo, E. P. (2013). Post-traumatic amnesia. *Journal of Clinical Neuroscience*, 20(11), 1475-1481. doi: 10.1016/j.jocn.2012.11.022

McGhee, H., Cornwell, P., Addis, P., & Jarman, C. (2006). Treating dysarthria following traumatic brain injury: Investigating the benefits of commencing treatment during

Language and cognitive communication during PTA

- post-traumatic amnesia in two participants. *Brain Injury*, 20(12), 1307-1319. doi: 10.1080/02699050601081851
- Nakase-Richardson, R., Sherer, M., Yablon, S. A., Nick, T. G., & Trzepacz, P. T. (2004). Acute confusion following traumatic brain injury. *Brain Injury*, 18(2), 131-142. doi: 10.1080/0269905031000149542
- Nakase-Richardson, R., Yablon, S. A., Sherer, M., Evans, C. C., & Nick, T. G. (2008). Serial yes/no reliability after traumatic brain injury: Implications regarding the operational criteria for emergence from the minimally conscious state. *Journal of Neurology, Neurosurgery & Psychiatry*, 79(2), 216-218. doi: 10.1136/jnnp.2007.127795
- Nakase-Richardson, R., Yablon, S. A., Sherer, M., Nick, T. G., & Evans, C. C. (2009). Emergence from minimally conscious state: Insights from evaluation of posttraumatic confusion. *Neurology*, 73(14), 1120-1126. doi: 10.1212/WNL.0b013e3181bacf34
- Nilipour, R. (1993). *Persian aphasia test* Tehran: Iran University of Medical Science.
- Nott, M. T., Chapparo, C., Heard, R., & Baguley, I. J. (2010). Patterns of agitated behaviour during acute brain injury rehabilitation. *Brain Injury*, 24(10), 1214-1221. doi: 10.3109/02699052.2010.506858
- O'Halloran, R., Worrall, L., & Hickson, L. (2007). Development of a measure of communication activity for the acute hospital setting: Part 1. Rationale and preliminary findings. *Journal of Medical Speech-Language Pathology*, 15(1), 39-50.
- Pastorek, N. J., Hannay, H. J., & Contant, C. S. (2004). Prediction of global outcome with acute neuropsychological testing following closed-head injury. *Journal of the International Neuropsychological Society*, 10(6), 807-817. doi: 10.1017/S1355617704106012

Language and cognitive communication during PTA

Paterson, A. (1942). Emotional and cognitive changes in the post-traumatic confusional state (Publication no. 10.1016/S0140-6736(00)57984-7). (0140-6736 <http://dx.doi.org/>).

Retrieved 12/19/

<http://www.sciencedirect.com/science/article/pii/S0140673600579847>

Pfaff, A. (1996). *Resolution of post-traumatic amnesia*. Master of Arts (Hons), Macquarie University, Sydney.

Ponsford, J., Bayley, M., Wiseman-Hakes, C., Togher, L., Velikonja, D., McIntyre, A., . . .

Tate, R. (2014). INCOG Recommendations for Management of Cognition Following Traumatic Brain Injury, Part II: Attention and Information Processing Speed.

Journal of Head Trauma Rehabilitation July/August, 29(4), 321-337.

Ponsford, J., Downing, M., Olver, J., Ponsford, M., Acher, R., Carty, M., & Spitz, G.

(2013). Longitudinal follow-up of patients with traumatic brain injury: Outcome at 2, 5, and 10-years post-injury. *Journal of Neurotrauma, 26, 26.* doi:

10.1089/neu.2013.2997

Ponsford, J., Janzen, S., McIntyre, A., Bayley, M., Velikonja, D., & Tate, R. (2014). INCOG

Recommendations for management of cognition following traumatic brain injury, Part I: Posttraumatic amnesia/delirium. *Journal of Head Trauma Rehabilitation,*

29(4), 307-320. doi: 10.1097/HTR.0000000000000074

Porch, B. E. (1967). *Porch index of communicative ability (adult)*. Palo Alto, CA.:

Consulting Psychologists Press.

Russell, W. R. (1932). Cerebral involvement in head injury. A study based on the examination of two hundred cases. *Brain, 55(549-603).*

Russell, W. R., & Smith, A. (1961). Post-traumatic amnesia in closed head injury. *Archives of Neurology, 5(1), 4-17.* doi: 10.1001/archneur.1961.00450130006002

- Sarno, M. T. (1980). The nature of verbal impairment after closed head injury. *Journal Of Nervous And Mental Disease*, 168(11), 685-692. doi: 10.1097/00005053-198011000-00008
- Sarno, M. T. (1984). Verbal impairment after closed head injury. Report of a replication study. *Journal Of Nervous And Mental Disease*, 172(8), 475-479. doi: 10.1097/00005053-198408000-00006
- Sarno, M. T., Buonaguro, A., & Levita, E. (1986). Characteristics of verbal impairment in closed head injured patients. *Archives of Physical Medicine and Rehabilitation*, 67(6), 400-405.
- Sherer, M., Nakase-Thompson, R., Yablon, S. A., & Gontkovsky, S. T. (2005). Multidimensional assessment of acute confusion after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 86(5), 896-904. doi: 10.1016/j.apmr.2004.09.029
- Sherer, M., Yablon, S. A., & Nakase-Richardson, R. (2009). Patterns of recovery of posttraumatic confusional state in neurorehabilitation admissions after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 90(10), 1749-1754. doi: 10.1016/j.apmr.2009.05.011
- Sherer, M., Yablon, S. A., Nakase-Richardson, R., & Nick, T. G. (2008). Effect of severity of post-traumatic confusion and its constituent symptoms on outcome after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 89(1), 42-47. doi: 10.1016/j.apmr.2007.08.128
- Snow, P., & Ponsford, J. (2013). Assessing and managing disorders of consciousness following TBI. In J. Ponsford, S. Sloan & P. Snow (Eds.), *Traumatic Brain Injury: Rehabilitation for Everyday Adaptive Living* (2nd ed.). Hove: Psychology Press.

Language and cognitive communication during PTA

- Stuss, D. T., Binns, M. A., Carruth, F. G., Levine, B., Brandys, C. E., Moulton, R. J., . . . L., S. M. (1999). The acute period of recovery from traumatic brain injury: Posttraumatic amnesia or posttraumatic confusional state? *Journal of Neurosurgery*, 90(4), 635-643. doi: 10.3171/jns.1999.90.4.0635
- Symonds, C. P. (1937). *Mental Disorder Following Head Injury*. Paper presented at the Proceedings of the Royal Society of Medicine.
- Symonds, C. P., & Russell, W. R. (1943). Accidental head injuries: Prognosis in service patients. *The Lancet*, 241(6227), 7-10. doi: 10.1016/S0140-6736(00)70687-8
- Tate, R. L., Perdices, M., Pfaff, A., & Jurjevic, L. (2001). Predicting duration of posttraumatic amnesia (PTA) from early PTA measurements. *The Journal of Head Trauma Rehabilitation*, 16(6), 525.
- Tate, R. L., Pfaff, A., & Jurjevic, L. (2000). Resolution of disorientation and amnesia during post-traumatic amnesia. *Journal of Neurology, Neurosurg Psychiatry*, 68(2), 178-185.
- Tate, R. P., Kennedy, M. P., Ponsford, J. P., Douglas, J. P., Velikonja, D. P., Bayley, M. M. D. F., & Stergiou-Kita, M. P. (2014). INCOG Recommendations for Management of Cognition Following Traumatic Brain Injury, Part III: Executive Function and Self-Awareness. *Journal of Head Trauma Rehabilitation* 29(4), 338-352.
- Teasdale, G. M., Pettigrew, L. E., Wilson, J. T., Murray, G., & Jennett, B. (1998). Analyzing outcome of treatment of severe head injury: a review and update on advancing the use of the Glasgow Outcome Scale. *Journal of Neurotrauma*, 15(8), 587-597.
- Thomas, H., Feyz, M., LeBlanc, J., Brosseau, J., Champoux, M.-C., Christopher, A., . . . Lin, H. (2003). North Star Project: Reality orientation in an acute care setting for

- patients with traumatic brain injuries. *Journal of Head Trauma Rehabilitation*, 18(3), 292-302. doi: 10.1097/00001199-200305000-00007
- Thomsen, I. V. (1975). Evaluation and outcome of aphasia in patients with severe closed head trauma. *Journal of Neurology, Neurosurgery & Psychiatry*, 38(7), 713-718. doi: 10.1136/jnnp.38.7.713
- Togher, L., Wiseman-Hakes, C., Douglas, J., Stergiou-Kita, M., Ponsford, J., Teasell, R., . . . Turkstra, L. S. (2014). INCOG Recommendations for Management of Cognition Following Traumatic Brain Injury, Part IV: Cognitive Communication. *Journal of Head Trauma Rehabilitation July/August*, 29(4), 353-368.
- Turkstra, L., Ylvisaker, M., Coelho, C., Kennedy, M., Moore Sohlberg, M., Avery, J., & Yorkston, K. (2003). Standardized assessment for persons with traumatic brain injury: Technical report: Academy of Neurologic Communication Disorders and Sciences (ANCDS).
- Turkstra, L., Ylvisaker, M., Coelho, C., Kennedy, M., Moore Sohlberg, M., Avery, J., & Yorkston, K. (2005). Practice guidelines for standardized assessment for persons with traumatic brain injury. *Journal of Medical Speech-Language Pathology*, 13(2), ix-xxviii.
- Valitchka, L., & Turkstra, L. S. (2013). Communicating with inpatients with memory impairments. *Seminars in Speech and Language*, 34(3), 142-153. doi: 10.1055/s-0033-1358371
- van Velzen, J. M., van Bennekom, C. A., Edelaar, M. J., Sluiter, J. K., & Frings-Dresen, M. H. (2009). Prognostic factors of return to work after acquired brain injury: a systematic review. *Brain Injury*, 23(5), 385-395. doi: 10.1080/02699050902838165

- Velikonja, D., Tate, R., Ponsford, J., McIntyre, A., Janzen, S., & Bayley, M. (2014). INCOG Recommendations for Management of Cognition Following Traumatic Brain Injury, Part V: Memory. *Journal of Head Trauma Rehabilitation*, 29(4), 369-386.
- Vukovic, M., Vuksanovic, J., & Vukovic, I. (2008). Comparison of the recovery patterns of language and cognitive functions in patients with post-traumatic language processing deficits and in patients with aphasia following a stroke. *Journal of Communication Disorders*, 41(6), 531-552. doi: 10.1016/j.jcomdis.2008.04.001
- Weinstein, E. A. (1971). Linguistic aspects of amnesia and confabulation. *Journal of Psychiatric Research*, 8(3), 439-444. doi: 10.1016/0022-3956(71)90036-7
- Weinstein, E. A., & Kahn, R. L. (1952). Non-aphasic misnaming (paraphasia) in organic brain disease. *AMA Archives of Neurology and Psychiatry*, 67(1), 72-79.
- Weinstein, E. A., & Keller, N. J. A. (1963). Linguistic patterns of misnaming in brain injury. *Neuropsychologia*, 1(2), 79-90. doi: 10.1016/0028-3932(63)90001-0
- Weinstein, E. A., & Lyerly, O. G. (1968). Confabulation following brain injury: Its analogues and sequelae. *Archives of General Psychiatry*, 18(3), 348-354. doi: 10.1001/archpsyc.1968.01740030092009
- Weir, N., Doig, E. J., Fleming, J. M., Wiemers, A., & Zemljic, C. (2006). Objective and behavioural assessment of the emergence from post-traumatic amnesia (PTA). *Brain Injury*, 20(9), 927-935. doi: 10.1080/02699050600832684
- Wiig, E. H., Alexander, E. W., & Secord, W. (1988). Linguistic competence and Level of Cognitive Functioning in adults with traumatic closed head injury. In H. A. Whitaker (Ed.), *Neuropsychological studies of nonfocal brain damage* (pp. 186-201). New York: Springer.

Language and cognitive communication during PTA

- Wilson, B. A., Baddeley, A., Evans, J. J., & Shiel, A. (1994). Errorless learning in the rehabilitation of memory impaired people. *Neuropsychological Rehabilitation*, 4(3), 307-326. doi: 10.1080/09602019408401463
- Wilson, B. A., Evans, J. J., Emslie, H., Balleny, H., Watson, P. C., & Baddeley, A. D. (1999). Measuring recovery from post traumatic amnesia. *Brain Injury*, 13(7), 505-520. doi: 10.1080/026990599121412
- Zangwill, O. L. (1945). Observations on the Rorschach Test in two cases of acute concussional head-injury. *The British Journal of Psychiatry*, 91(384), 322-336. doi: 10.1192/bjp.91.384.322
- Zasler, N. D. (1997). Prognostic indicators in medical rehabilitation of traumatic brain injury: A commentary and review. *Archives of physical medicine and rehabilitation*, 78(8, Supplement 4), S12-S16. doi: 10.1016/S0003-9993(97)90150-7