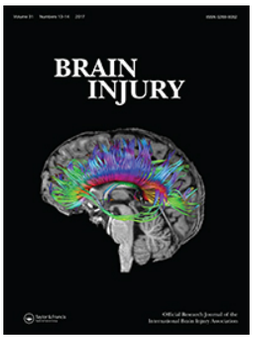

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# Language and cognitive communication disorder during post-traumatic amnesia: Profiles of recovery after TBI from three cases

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**ABSTRACT**

*Background*: There has been limited empirical speech–language pathology (SLP) study of language and cognitive communication during post-traumatic amnesia (PTA) and the early stages after TBI. The purpose of the current research was to explore the potential means and utility of assessing cognitive communication during PTA and the post-acute recovery period.

*Method*: This research used a longitudinal mixed methods design to describe language and cognitive communication assessment and recovery profiles of three patients with TBI. Cognitive communication was assessed with repeated standardised and non-standardised methods during PTA (rated with Westmead PTA Scale) and at follow-up 3 months after PTA emergence.

*Results*: All participants demonstrated a profile of language and cognitive communication strengths and weaknesses during PTA and the post-acute period, also evident at follow-up. Improvement occurred gradually throughout PTA, although with individual fluctuation across test occasions. There was no marked change in communication function immediately before and after PTA emergence, indicating that cognitive communication ability and those functions measured on the Westmead PTA Scale (memory and orientation) did not recover at the same rate.

*Conclusion*: It was feasible to assess language and cognitive communication throughout PTA and the post-acute period, and early assessment results were relevant to the patient's ongoing communicative function. It is suggested that early and repeated SLP assessment may contribute to the prediction of persisting cognitive communication issues.

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Cognitive communication; post-traumatic amnesia; speech-language pathology; traumatic brain injury; assessment

## Introduction

Language and cognitive communication (CC) disorders are common after traumatic brain injury (TBI) and may have long-term effects on work and social functioning (1,2). There is limited information about communication presentation in the early period after injury (3), particularly relating to post-traumatic amnesia (PTA). PTA is a transient stage of recovery after TBI characterised by disruption of behaviour and cognition (4), including impairment of language and CC (5), with duration lasting from minutes after mild injury to weeks or months after severe injury (6). For hospitalised patients during the acute and post-acute period, there may also be fluctuating medical status, delirium and varying levels of alertness (7). These issues make speech language pathology (SLP) assessment of language and CC problematic, and there is little professional guidance available on this stage of recovery. Recent INCOG multidisciplinary guidelines for professionals working with patients during PTA included the following recommendations: to minimise environmental distraction, reduce agitation, and for team members to facilitate function (8). While this guide suggested that cognitive assessment and therapy is unlikely to be of benefit during PTA, there was no specific reference to assessment of language and CC. These recommendations are based on expert consensus, with limited empirical research or published SLP-based literature available on early management of CC impairments during PTA. For many people with severe TBI, there may be a prolonged stage of PTA spanning the time of acute hospital admission and inpatient rehabilitation, and these patients may spend a large proportion of their inpatient rehabilitation with little participation in active multidisciplinary team assessment and intervention (9).

### *Speech–language pathology practice during PTA*

General SLP guidelines exist for CC assessment after TBI (10–12), although these do not contain information about timing or type of assessment that could be undertaken during PTA. Recommendations for SLP assessment of CC include using a combination of standardised and non-standardised assessment methods (10,11,13) and incorporating consideration of context, environment, history, needs and communication partner as part of evaluating the person's level of functioning (12). The feasibility of conducting assessment using these methods during PTA has not been reported. Despite the lack of SLP professional guidelines for this period of recovery, it is known SLPs conduct CC assessment during PTA (14,15). Survey results and interviews with SLPs on their practice and perspectives on CC assessment during PTA

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revealed that SLPs undertake mainly informal assessment using non-standardised tools during PTA. Furthermore, they commence formal assessment at the point of PTA emergence and use standardised measures at this time for multiple purposes (14,15). SLPs reported (a) lacking suitable measures to measure communication recovery during PTA, often relying on self-made or facility-made informal screening measures; and (b) concerns about the scant literature and evidence-base on CC during PTA on which to base their decisions. In the absence of research reports delineating types and course of recovery of communication impairments during PTA, the SLPs were unsure of how representative CC presentation during PTA was of ongoing disorder after PTA emergence. Also lacking literature to guide practice, SLPs working in acute hospital settings explained their organisations' practice of placing patients who were in PTA at a low prioritisation on the SLP caseload (15). These patients were reported often to enter rehabilitation settings with no evaluation of communication having been undertaken.

### Language and cognitive communication

Cognitive and behavioural disruption have been well documented as characteristic features of the syndrome of PTA, also referred to as post-traumatic confusional state (16). Less literature has reported on language and CC ability during PTA. The term 'confused language' commonly appears in descriptions of a patient's clinical presentation during PTA and the post-acute period (see Steel et al., 2015 for review) (5). Types of communication impairments reported during PTA, the acute period after TBI, or during Rancho Levels of Cognitive Function (17) associated with PTA include: aphasia, naming and word-finding difficulty (18–20), auditory comprehension, verbal fluency, syntax (21), discourse production (22) and language of confusion (23,24). There are issues with conceptualising cognitive communication disorder (CCD) after TBI, particularly in relation to aphasia, which is understood as linguistic impairment. Current thinking (see 18,25,26) is that CCD after TBI stems from generalised cognitive disruption (e.g., of attention, memory, executive function), which has a resultant impact on all communicative functions. Togher, McDonald, and Code (1999) also described a 'complex interplay of cognitive, linguistic, physical, behavioural and organic psychosocial factors' (27, p. 2) after TBI that has an impact on the ability to communicate. The relationship between these factors has been widely discussed (see Body and Perkins, 2006) (28), particularly regarding the relationship between language and cognition, which Kennedy and DeRuyter described as an 'integral–reciprocal relationship' (29, p. 124). Linguistic disorders, including anomia, paraphasias, and syntactic errors, similar to that seen after left hemisphere stroke, may also contribute to the clinical picture after TBI even without left focal injury (20). The term 'aphasia' has been used to encompass a variety of language- and cognition-related communication difficulties after TBI, including aspects of confused language evident during the acute period after TBI (24). In this paper, the term language is taken to refer to primarily linguistic functions, the broader term CCD as referring to the interaction of multiple processes underpinned by cognition, and social communication as the outcome of communicative factors between communication partners. The course of recovery of language impairment has been reported as differing after stroke and TBI (30). The impact of PTA, which is characterised by cognitive dysfunction, on communication ability has not been examined and represents a substantial gap in knowledge in relation to CC.

### Cognitive recovery during PTA

As reported by Elbourn et al. (3), there are no published studies on CC recovery during the initial 3 months post TBI, and therefore little is known about type or course of recovery of CC ability, or how SLP services might benefit a patient's language and CC recovery. The limited SLP research that has reported on communication during the post-acute period after TBI has mainly focused on recovery during the minimally conscious state (MCS) (31–33), ending at emergence from MCS into PTA. Studies originating from occupational therapy and neuropsychology have indicated that there is valuable information that may be collected during PTA. Neuropsychological testing of patients in PTA has been found to be feasible (34), predictive of global outcome (35) and long-term productivity (36), with qualitative aspects of testability also relevant (35). Presence and level of confusion have been found to be predictive factors for early functional outcome and later productivity status (36,37). Boake et al. suggested that verbal and comprehension impairments on resolution of PTA were predictive of impairments in these areas over the long term (36). These authors found that neuropsychological test results had value in directing the clinical decision-making process during early rehabilitation admission, even when testing was conducted at the point of PTA emergence (36). Weir et al. found that participants were able to learn functional tasks while still in PTA (9). These studies potentially have implications for SLP practice during PTA. Identification of CC strengths and weaknesses during the acute and inpatient rehabilitation settings could assist with SLP planning of services and potentially with prognostic information on CC for patients and families.

The CC impairments observable during PTA may be dependent on symptoms of PTA and acute medical issues or be predictive of lasting sequelae of cognitive injury requiring ongoing long-term rehabilitation. No previous SLP research has investigated the course of resolution of CC impairments demonstrated in PTA, and it is therefore unknown whether SLP assessment during this stage is feasible or yields useful information.

## Aim

Because of the paucity of research on CCD during PTA and the need already identified by SLPs for increased knowledge on PTA communication (15), the aim of this case study research was to improve knowledge of the nature of language and CC impairment during PTA, by determining (i) the feasibility and utility of assessing language and CC with patients in PTA, (ii) whether assessment during PTA would yield clinically useful information to help guide SLPs in their work, and (iii) the relationship of language and CC performance during PTA to performance at 3 months after PTA emergence.

## Methods

The research used a multiple case study methodology, with an embedded mixed-methods design. Descriptive case studies were used in order to examine assessment methods and individual factors that were relevant to performance on these measures, in addition to scores on standardised and non-standardised measures. Qualitative and quantitative data collection was integrated in a quantitative protocol (38). Ethics clearance was obtained from the relevant research bodies. Consent was gained for the patient to participate in the study from the person responsible for decision making during PTA and subsequently confirmed formally with the patient at follow-up.

This study documents the language and CC recovery profiles of three patients during PTA (as measured by the Westmead PTA Scale (WPTAS)) and at 3 months after PTA resolution. The three cases outlined were selected purposively from a cohort who had participated in research on CC recovery during and after PTA (see 39). Of the larger group of six, one participant had English as a second language, one did not emerge from PTA and one had a PTA duration of 24 hours. Therefore, the three cases presented in this study were selected as providing the most detailed results and being most illustrative of the aims of the current study. Patients who met the following eligibility criteria were recruited to the larger study on admission to an inpatient rehabilitation setting: (i) in PTA (indicated by the WPTAS) on inpatient admission; (ii) recent TBI (<6 months post injury); (iii) aged between 18 and 65 years; (iv) able to participate in PTA testing, as indicated on WPTAS and by rehabilitation team consensus; (v) no significant history of mental illness before the injury as documented in medical file. Participants were not excluded if they had a history of alcohol or substance abuse or previous TBI.

Details of participants selected for this study are shown in Table 1. Alphabetical initials were assigned to the cases to preserve confidentiality and anonymity. The three participants were recruited at inpatient rehabilitation admission and engaged in multiple assessment sessions throughout PTA and at follow-up. While audiometric hearing testing was not carried out for this research, there was no evidence from medical records, or patient, carer, or family report that suggested hearing was an issue affecting communication for any of the cases. None of the three participants presented with motor speech disorder following injury (as diagnosed by treating SLP), and only CD experienced visuospatial impairment after injury.

**Table 1.** Participant information and injury description.

| ID | Age (gender) | Injury cause | PTA duration | Initial GCS | Injury type | Assessments during PTA + follow-up |
|---|---|---|---|---|---|---|
| AB | 50 (F) | Fall | 28 days | 6 | R frontal SDH | 2 + follow-up |
| CD | 32 (F) | Horse-riding accident | 20 days | 6 | SAH, R basal ganglia | 2 + follow-up |
| EF | 47 (M) | Transport accident | 70 days | 4 | Diffuse bifrontal SAH | 9 + follow-up |

GCS = Glasgow Coma Scale; F = female; M = male; R = right hemisphere; SDH = subdural hematoma; SAH = subarachnoid haemorrhage

## Procedure

Information was extracted from medical files for each participant on demographics and social history, injury description, SLP management and PTA status. Cognitive communication was assessed using the protocol shown in Table 2. The assessment protocol involved using repeated measures up to three times a week while the patient was in PTA, and then at approximately 3 months after PTA emergence. Assessment sessions took between 10 and 40 minutes, depending on the patient's function. Sessions were recorded on an Olympus WS-832 digital recorder and were orthographically transcribed following sessions. Alternative versions of test components were used for repeated testing to avoid the effects of overfamiliarity with the material, with comparable stimulus tasks alternated over test occasions during PTA.

## Measures

The assessment battery was designed with reference to previous research protocols used with people with TBI (48,49) and conforming with CC assessment practice guidelines and texts (e.g.,

**Table 2.** Assessment battery used during PTA and at follow-up.

| Area assessed/Source | Reference |
|---|---|
| **Verbal expression** | |
| Discourse tasks: personal narrative, picture description, spontaneous conversation: Talkbank | Talkbank TBI protocol (2007); https://talkbank.org/TBIBank/ |
| Sentence repetition: Modified AphasiaBank Repetition Test | Talkbank TBI protocol (2007) |
| Picture naming: BNT short forms; MCLA | Kaplan et al. (1983); Del Toro et al. (2011); Graves et al. (2004) (40–42) |
| **Auditory comprehension** | |
| 10 yes/no questions, from simple concrete to more complex: MAST | Nakase-Thompson (2004) (39) |
| 6 complex questions: Complex Ideational Material (BDAE); selected Wiig Semel Test of Linguistic Concepts questions (passive and temporal) | Goodglass & Kaplan (1983) (43)<br>Wiig & Semel (1974) (44) |
| Following instructions: MAST | Nakase-Thompson (2004) (39) |
| Auditory paragraph comprehension: BDAE, CLQT, MCLA | Goodglass & Kaplan (1983); Helm-Estabrooks, (2001); Ellmo, et al. (1995) (43,45,46) |
| Story recall: MCLA | |
| **Higher-level communication function** | |
| Verbal fluency (phonemic and semantic): MCLA | Ellmo, et al. (1995) (45) |
| Figurative language comprehension (e.g. idioms, quotations): TLC-E, MCLA | Ellmo, et al. (1995); Wiig & Secord (1989) (45,47) |
| Divergent thinking: Caulfield Language for Cognition Screening Assessment | Willinck (1996) (92) |
| Divergent naming: MCLA | Ellmo et al. (1995) (45) |

BDAE = Boston Diagnostic Aphasia Examination; BNT = Boston Naming Test; CLQT = Cognitive-Linguistic Quick Test; MAST = Mississippi Aphasia Screening Test; MCLA = Measure of Cognitive-Linguistic Ability; TLC-E = Test of Linguistic Concepts – Expanded.

INCOG and ANCDS) (10,12,43). Assessment therefore incorporated standardised and non-standardised measures (including discourse measures) (see Table 2), with a focus in this paper on language and CC ability. Additional measures were taken of social communication ability (i.e., communicative aspects of social interaction with others such as turn-taking, topic maintenance, level of contribution to conversation) during and after PTA. These measures were collected from the perspectives of the person with TBI, friends/family members and the researchers, using standardised tools and qualitative observations, and have been reported elsewhere (see 50). Qualitative data on communication ability were collected by the first author. This information included observations of functional communicative ability observed during assessment sessions and information on communication that was reported by treating multidisciplinary staff in medical notes. Details have been included within case descriptions.

In addition to basic language and CC function (e.g., naming, auditory comprehension), the battery aimed to evaluate more complex cognitive and linguistic function (e.g., verbal fluency, understanding of non-literal language, complex ideational material), termed 'higher-level' communication function.

### *Published tools used in the battery*

Questions from the Mississippi Aphasia Screening Test (MAST) (51) were used in the protocol, including 10 simple and more complex yes/no questions and following instructions to test for basic auditory comprehension. The MAST was designed for repeated use over time with people with severe communication impairment associated with conditions including TBI (44) and has been reported to have good psychometric properties (52). More challenging questions were sourced from the Complex Ideational Material (CIM) subtest of the Boston Diagnostic Aphasia Examination (BDAE) (45), previously used extensively for testing people with aphasia and right hemisphere communication disorders (40), and TBI (31), and used within cognitive and delirium tests during PTA (53). Further testing of complex question comprehension (e.g., passive structures) used the Wiig Semel Test of Linguistic Concepts (WSTLC) (41), a popular clinical tool (42) which has been used in research on TBI (48,54). Understanding of non-literal language was tested with simple well-known idioms, and those in the Measure of Cognitive-Linguistic Ability (MCLA) Verbal Reasoning subtest (55). The MCLA was designed for use after TBI, is used clinically with patients with TBI and has been reported in use in SLP case study research and TBI literature (56,57). Subtests of the MCLA were used where appropriate on PTA emergence, or by the treating clinician during PTA. Naming ability was tested using The Boston Naming Test (BNT) (58), a confrontational naming measure used with people with aphasia and with TBI (59). The current research used short forms (15 items) as described in recent literature (60,61).

## Discourse procedure and analysis

Discourse elicitation tasks used were based on the TBI Talkbank protocol, available on the TBIBank website (http://talkbank.org/TBIBank/), and included: (i) Spontaneous conversation; (ii) Personal event narrative (important event, injury/recovery story); and (iii) Picture Description Narrative (Flowerpot Incident/Broken Window/Cat Rescue). The focus of interest in the current research was on the quantity and fluency of the person's verbal output and the quality and organisation of their discourse. Therefore, discourse was examined for within-sentence measures (productivity) and with story grammar measures (content). For the purpose of productivity analysis, transcribed utterances were segmented into communication units, or C-units (62), defined as a clausal unit with all associated subordinate clauses (63). Transcripts were entered into Systematic Analysis of Language Transcripts (SALT) discourse analysis software (64).

Story grammar has been used with people with TBI (65–68) and with other groups with communication difficulties (e.g., 69). In this study, story grammar analysis was conducted with the 'Flowerpot Incident' (70) stimulus, a six frame picture sequence narrative, which has been reported in a number of studies of discourse after TBI (see 65,67,71). Narratives were scored for the inclusion of story grammar elements as specified by Stein and Glenn (72) and rated for completeness using the seven story grammar elements (setting, initiating event, internal response, plan, attempt, consequence and reaction) presented in Snow and Powell (69). Percentage was rated as number of elements present as a percentage of those expected in the story. Discourse analyses and measures are shown in Table 3.

**Table 3.** Discourse analysis measures.

| |
|---|
| **Productivity (SALT)** |
| Words per C-unit |
| Mean length of utterance, or average number of words per C-unit (excludes mazes) |
| Maze words as a percentage of total words |
| Ratio of maze words to total words |
| Errors |
| Number of errors (including omitted words, omitted bound morphemes, semantic and phonemic paraphasias) as a percentage of total words |
| **Content** |
| Percentage of correct story grammar elements (scored according to Snow and Powell (2002) (92) scoring schema) |
| Qualitative description/observation on content of sample produced |

SALT = Systematic Analysis of Language Transcripts (58); C-unit = communication unit.

## Validity and reliability

The first author conducted all research protocol assessments on multiple sessions, and tests were administered according to the protocol and/or standardised procedures. Transcription accuracy, C-unit division and formatting for SALT analysis were confirmed by co-authors throughout analysis. An additional reliability check of story grammar was established by ratings of an SLP not involved in the study but experienced with narrative analysis on a random sample of 45% of total story grammar samples. Agreement was above 85% on all reliability checks, reaching 100% agreement after discussion.

## Statistical analysis

Where appropriate, descriptive statistics (i.e., frequencies, means and standard deviations) were used to report on individual participants' performance on test measures.

## Results

Assessment results are presented for two of the participants (AB and CD) for three test occasions: (i) while in PTA; (ii) around PTA emergence; and (iii) at follow-up approximately 3 months after PTA emergence. The third participant (EF) described in this study had a more complex CC presentation and longer PTA duration, and results are shown from nine test occasions during PTA and once at follow-up.

## Participant AB

Participant AB was a 50-year-old woman who sustained a severe TBI in a fall. She completed the test protocol on Test 1 (T1) 24 days post-injury (WPTAS score of 11/12); and Test 2 (T2) at PTA emergence 30 days post-injury (WPTAS 12/12 day three); and at follow-up 4 months after PTA emergence (T4MP; approximately 5 months after injury). Additional results from standardised measures taken by treating SLP are also included: selected subtests from the MCLA at 21 days post-injury (WPTAS scores 8/12) and at 49 days post-injury (21 days after PTA emergence). At follow-up, AB was living independently at home and had been discharged from SLP services although had not returned to her previous work in retail.

From informal observations, AB appeared able to verbally communicate her functional needs adequately (e.g., make meal choices, ask for care items) during PTA. Early CC and social communication issues documented in medical notes by her multidisciplinary staff included comments on her 'tangential', 'distracted' and confabulatory communication. Perceptually, during test sessions she presented as easily distracted, with poor topic maintenance and reduced awareness of communication partner.

### *AB assessment protocol*

Selected results from AB's assessment are shown in Table 4. AB's sentence repetition scores were consistently high, with no meaningful change in performance across test occasions (scores 93%, 96%, 93% at T1, T2, and at T4MP, respectively), indicating relatively intact auditory memory for short and longer sentences. Errors on this task during PTA related to answering, rather than repeating, distractor sentences (e.g., 'Count to ten as fast as you can').

AB's scores for phonemic fluency (FAS) were below expected level when tested by treating SLP 21 days after PTA emergence, at T1, T2, and again by treating SLP at 21 days after PTA emergence, but were within normal limits at T4MP. Semantic fluency performance was variable and appeared affected by education level (i.e., countries category was scored lower than animals category), however, remained low throughout testing. AB performed poorly on the divergent naming subtest of the MCLA (generating names of things that can be closed) on all test occasions, with comparable scores during and after PTA.

With picture naming, AB scored more highly when tested with the MCLA naming task than with the BNT. Poor naming performance on the BNT short forms compared with the MCLA could be explained in part by AB's stated unfamiliarity with the BNT's low frequency items (e.g., *sphinx, muzzle* and *yoke*). However, at follow-up, AB reported significant ongoing word-retrieval problems in conversation, irrespective of high score on MCLA naming subtest.

AB scored all simple yes/no questions and instructions correctly at T1 and was therefore not retested on basic auditory comprehension on subsequent test occasions. When tested with the MCLA auditory paragraph comprehension at 21 days post-injury (PTA 8/12), AB scored 18/30, more than two standard deviations below the mean on this task ($M$ = 25/30; $SD$ = 1.7). On subsequent test occasions, AB scored 28/30 three weeks after PTA emergence when tested by SLP, and 12/20 (discontinued at AB's request) at T4MP respectively. AB declined continuing with this task at follow-up as she reported feeling too distracted to concentrate. At several points of testing, AB referred to her poor recall of auditory information.

AB demonstrated impaired ability to understand figurative language. Although able to explain some well-known idioms during PTA, she consistently took a literal meaning for idioms in the MCLA verbal reasoning subtest, at three weeks after PTA emergence and at T4MP. Her performance on this task was well below average for age and education. She also scored poorly on passive question comprehension on all test occasions but was able to complete divergent thinking tasks relatively well (e.g., 'name three reasons why you would wear gloves'), and odd-one-out tasks, both while in PTA and at follow-up.

**Table 4.** AB assessment scores on test occasions.

| Task | 21 days post- injury (PTA 8/12) | T1 (PTA 11/12) | T2 (PTA emergence) | 3 weeks after PTA emergence | T4MP |
|---|---|---|---|---|---|
| PHON.FL. | 17* (FAS) | 4 (F) | 8(A) | 22* (FAS) | 29 (FAS) |
| SEM.FL. | 4* (countries) | 11 (animals) | 16 (food) | 3* (countries) | 4*(countries) |
| DIV.THINKING | | 3/3 | 2/3 | | |
| DIV.NAMING | 5*(MCLA) | | | 5*(MCLA) | 4*(MCLA) |
| BNT | | 8/15* (53%) | 13/15 (87%) | | 23/30* (77%) |
| MCLA NAMING | 44/48 (92%) | | | 48/48 (100%) | |
| PARA. COMP. | 18/30* (60%) | | | 28/30 (93%) | 12/20 (60%) |
| IDIOMS | 0/10 (MCLA) | 4/4 | 2/4 | 2/10* (MCLA) | 2/10* (MCLA) |
| WSTLC COMP./CIM | 6/6 | 6/6 | 6/6 | | |
| WSTLC PASSIVE | 1/3 | 1/3 | 2/4 | | 3/6 |
| ODD ONE OUT | 1/1 | 1/1 | 4/4 | | 2/2 |
| WORD DEF. | 1/1 | 1/1 | 3/4 | | |

PHON.FL = Phonemic fluency; SEM. FL. = Semantic fluency; DIV. = Divergent; BNT. = Boston Naming Test; MCLA = Measure of Cognitive Linguistic Abilities; PARA COMP. = Auditory paragraph comprehension; WSTLC Y/N = Wiig Semel Test of Linguistic Concepts Yes/No questions; CIM = BDAE Complex Ideational Material subtest; DIV. = Divergent; WORD DEF. = word definition; T = Test occasion; T4MP = Test occasion 4 months post PTA emergence

Note.* = below average. MCLA norms for FAS verbal fluency (M = 39, SD = 13); semantic fluency (countries) (M = 15, SD = 5.1).

Table 5. AB average scores across elicitation tasks for test occasions.

| | Test occasion | | |
|---|---|---|---|
| Discourse measure | T1 | T2 | T4MP |
| C-unit length (words) | 7.3 | 9 | 11 |
| % Maze content | 8.5% | 3% | 5.8% |

T = Test occasion; T4MP = Test occasion 4 months post PTA emergence

### AB discourse analysis

During conversation, AB's discourse while in PTA was characterised by social communication impairments and content-related difficulties, including tangentiality, repetition and poor awareness of communication partner. On SALT analysis, AB's ability on discourse tasks was observed to be similar on T1 and T2, with improved performance at follow-up. AB's average scores across tasks for each test time are presented in Table 5. Her improvement in productivity at follow-up was indicated by an increase in average length of C-unit and with a reduction in maze percentage. Productivity performance was variable across discourse stimulus tasks. For example, while there were improved scores on SALT measures for the Broken Window narrative task at 4 month follow-up (i.e., increased C-unit length and decreased maze production), the opposite was found in AB's measures for the Flowerpot Incident.

Story grammar analysis was undertaken twice for the Flowerpot Incident narratives. Score at T2 was 5/14 (35.7%) and at follow-up 7/14 (50%). See Appendix A for story grammar examples. At T2, AB misinterpreted a component of the stimulus picture, and although at follow-up she again made this error, on later testing she attempted to make sense of the narrative based on her error. AB failed to identify the main points of the story at T2, reporting on the content of each frame sequentially without integrating subsequent picture to get a sense of the narrative. Her production at T4MP remained incomplete but was more logically organised and contained more detail than her previous attempt.

## Participant CD

CD was a 32-year-old woman injured in a horse riding accident, transferred to inpatient rehabilitation 15 days post injury. CD had a tertiary-level education and had previously been self-employed in a role requiring highly advanced language skills. She was tested three times with the research protocol: Test 1 (T1) at 18 days post injury (PTA 11/12); at Test 2 (T2) 22 days after her injury, on third consecutive day of PTA score 12/12; and at 3 months after PTA emergence (T3MP). She was also tested by treating SLP on the MCLA at one week after PTA emergence. CD had returned home to live with her partner by follow-up and was working part-time in self-employment. She reported continuing difficulties with her vision and some mild cognitive difficulties.

During PTA, CD was observed to be cooperative and compliant, with few overt language difficulties. However, in medical file documentation, multidisciplinary staff had noted that CD complained of feeling fatigued, was 'restless', and 'reluctant to engage' in nursing and physiotherapy activities, and SLPs documented her 'word-finding difficulty', 'confused speech' and occasional confabulation. CD's partner reported 'confused speech and jumbled words' in the first two weeks after the injury which had mostly resolved by inpatient rehabilitation admission. During testing at T1, there were instances of misunderstanding (e.g., responses did not directly correspond with researcher's questions) and reduced turn-taking ability (e.g., overlapping utterances), and CD self-reported word-finding difficulty. Perceptually, at T1, CD was observed to communicate with slow, careful speech, and with precise vocabulary. Socially, she presented with a lack of initiation, insight and interest in her surroundings.

### CD assessment protocol

CD was able to complete the majority of test protocol tasks correctly at T1, T2 and T3MP, with the exception of comprehension of complex yes/no questions (passive structures) and verbal fluency tasks during PTA (see Table 6). She had significant difficulties generating items in both phonemic and semantic fluency tasks at T1, T2, and 1 week after PTA emergence, when FAS scores were nearly two standard deviations below average for age and education, although by T3MP, both phonemic and semantic fluency scores were at the lower end of being within normal limits. At one week after PTA emergence divergent naming (i.e., of things that can be closed) was below expected level, and this remained at more than 1SD below mean at T3MP.

CD had no difficulty understanding instructions or short paragraphs during or after PTA, and scored 100% for all simple tasks at initial testing and at follow-up. At T3MP, CD's score on the MCLA auditory comprehension subtest

Table 6. CD assessment scores on test occasions.

| Task | T1 | T2 | T1WP | T3MP |
|---|---|---|---|---|
| PHON.FL. | 5 (F) | 5 (A) | 25* (FAS) | 36 (FAS) |
| SEM.FL. | 10 (animals) | 9* (countries) | 18 (countries) | 26 (countries) |
| DIV.THINKING | 3/3 | 3/3 | | |
| DIV.NAMING | | | 7 (MCLA) | 9 (MCLA) |
| IDIOMS | 3/4 | 3/4 | 8 | 10 |
| WSTLC COMPARATIVE | 5/6 | 9/10 | | 8/8 |
| WSTLC PASSIVE | 4/6 | 5/6 | | 5/6 |
| STORY RECALL | | | 38/44 (MCLA) | 35/44 (MCLA) |
| PARA COMP | 6/6 | 3/4 | 28/30 (MCLA) | 26/30 (MCLA) |

PHON.FL = Phonemic fluency; SEM.FL. = Semantic fluency; DIV. = divergent; WSTLC = Wiig Semel Test of Linguistic Concepts; PARA COMP. = Auditory paragraph comprehension; T = test time; 1WP = one week post emergence from PTA; 3MP = three months post emergence from PTA; MCLA = Measure of Cognitive-Linguistic Abilities; MCLA norms for FAS verbal fluency: (M = 46, SD = 12), MCLA norms for countries: (M = 19, SD = 7.1); MCLA norms for auditory paragraph comprehension (M = 28, SD = 2.6)

Table 7. CD average scores across elicitation tasks for test occasions.

| | Test occasion | | |
|---|---|---|---|
| Discourse measure | T1 | T2 | T3MP |
| C-unit length (words) | 9.8 | 12.6 | 13.1 |
| % Maze content | 6% | 9% | 6% |

T = Test occasion; T3MP = Test occasion 3 months post PTA emergence

was in the lower range of average at 26/30 ($M$ = 28, $SD$ = 2.6). Story recall of short passages was above average at one week after PTA and at T3MP. CD demonstrated mild difficulty with comprehension of passive sentences that remained unchanged at T3MP. She reached ceiling level on higher-level subtests on early test occasions and was therefore not retested with these tests at three-month follow-up, with the exception of the MCLA verbal reasoning (idiom explanation) component. By follow-up, CD's mild difficulty with figurative language comprehension had resolved.

### CD discourse analysis

SALT analysis was conducted at T1, T2 and at follow-up (T3MP). CD's average scores for C-unit length and percentage of maze content across tasks on each test occasion are shown in Table 7. Mean scores for C-unit length on the three different test occasions increased.

CD's responses contained more maze content in emotive narratives (e.g., Injury/Recovery stories (T1: 12%, T2: 11%, T3MP: 7%), Important Event (T2: 11%, T3MP: 8%), rather than with picture description tasks (Flowerpot Incident: T1: 3%; T3MP: 6%). Picture description tasks potentially provide a more structured format than a personal narrative, and CD's responses were shorter on these narratives. CD's fluency improved in unstructured discourse tasks such as the Injury/Recovery/Important Event tasks over test times, from the first time of testing through to follow-up testing.

CD occasionally made errors in her discourse (plural morpheme errors, verb errors, pronoun and verb agreement and word errors) that were conspicuous in her otherwise careful speech. Although errors were infrequent (three errors in Test 1, five in Test 2), CD continued to make these word- and sentence-level errors at follow-up (five errors in T3MP).

Performance on story grammar improved from T1 (PTA 11/12) to follow-up (T3MP) (i.e., Test 1: 43%, follow-up: 86%), with second production of this narrative more organised and complete.

## Participant EF

EF was a 47-year-old man injured in a transport accident, who was transferred from the acute setting to inpatient rehabilitation five weeks after his TBI (PTA 8/12). He was tested nine times during PTA with the test protocol (T1-T9), and at follow-up 3 months after PTA emergence (T3MP). He presented initially with fluent severe aphasic-type language disorder, including a high level of jargon and disorganised conversation. Due to his language disorder, it was difficult for communication partners to understand his meaning in conversation, but EF demonstrated little awareness of errors. Socially, he was amenable and cooperative throughout all interactions during PTA, but lacked insight into the severity of his TBI and communication disorder, and frequently expressed his wish to leave hospital and return home.

EF's performance on the assessment battery fluctuated throughout his PTA; however, his 'islands of memory' (and/or higher PTA scores) did not correspond with higher scores on CC and discourse measures. Although variable from day to day, EF's CC improved over the course of his PTA, from initial testing to PTA emergence. At follow-up, EF was preparing to return to work (skilled trade) despite persisting language and CC impairments.

### EF assessment protocol

Selected scores for EF's performance on the test protocol are shown in Table 8.

Sentence repetition was problematic for EF, and he was initially unable to produce a response, despite promptings. Errors on subsequent test occasions included answering

Table 8. EF assessment scores on test occasions.

| Task | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T5DP | T3MP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WPTAS | 9/12 | 8/12 | 9/12 | 9/12 | 8/12 | 8/12 | 9/12 | 9/12 | 10/12 | | |
| SENT.REP. | NT | 17/73 | 6/88 | 63/88 | 31/88 | 54/88 | 33/88 | 85/88 | 48/88 | NT | 78/88 |
| PHON.FL. | 3 | 2 | 1 | 3 | 2 | 7 | 4 | 7 | 3 | 20* (FAS) | 28 (FAS) |
| SEM.FL. | 3 | 2 | 3 | 8 | 4 | 12 | 13 | 12 | 4 | 9* | 11 |
| DIV.NAM. | | | | | | | | | | 4* | 7* |
| DIV.THINK | 1/3 | 2/3 | 2/3 | 2/3 | 3/3 | 3/3 | 2/3 | 1/3 | 2/3 | | 2/3 |
| CONV.NAM. | 0 | 1/3 | | 0/3 | | 2/3 | | 0/3 | 1/3 | | 2/3 |
| BNT | 3/15 | 2/15 | 2/15 | 5/15 | 7/15 | 5/15 | 11/15 | 6/15 | 6/15 | NT | 22/30* |
| WSTLC COMPARATIVE | 4/6 | 4/6 | 4/6 | 5/6 | 4/6 | 5/6 | 6/6 | 5/6 | | | 7/8 |
| WSTLC PASSIVE | 3/6 | 4/6 | 3/6 | 2/6 | 2/6 | 4/6 | 4/6 | 3/6 | 3/6 | | 6/6 |
| PARA.COMP. | | 3/6 | 4/4 | 2/6 | 4/4 | 3/6 | 4/5 | 5/5 | 4/4 | 24/30 (MCLA) | 26/30 (MCLA) |
| MULT.DEF | 0/2 | 0/2 | 1/2 | 0/2 | | 0/1 | | 0/2 | | | 0/2 |
| ODD ONE OUT | 1/4 | 1/4 | 3/4 | | 1/4 | | 0/4 | | | | 1/2 |
| WORD DEF. | | 0/2 | 1/2 | 0/2 | 2/2 | | | | | | |

WPTAS = Westmead PTA Scale; T = test time; DP = days post emergence from PTA; MP = months post emergence from PTA MCLA = Measure of Cognitive Linguistic Abilities; SENT.REP. = Sentence repetition; PHON.FL. = Phonemic fluency; SEM.FL. = Semantic fluency; DIV.NAM. = Divergent naming; DIV.THINK = divergent thinking; CONV.NAM. = convergent naming; BNT.NAM = Boston naming test (short form); WSTLC = Wiig Semel Test of Linguistic Concepts; PARA.COMP. = paragraph comprehension; MULT.DEF = multiple definitions; DEF. = definitions.

MCLA norms for FAS verbal fluency (M = 39, SD = 13); semantic fluency (countries) (M = 15, SD = 5.1); * = > 1SD below expected level (MCLA)

BNT short form: <11/15 = cut off for impaired (42)(<25 cut off for 30 item test)

Table 9. EF average scores across elicitation tasks for test occasions.

| | Test occasion | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Discourse measure | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T3MP |
| C-unit length (words) | 10.9 | 9.3 | 9.5 | 12 | 9.5 | 9.6 | 10.7 | 11 | 10.9 | 11.1 |
| % Maze content | 17.5 | 21% | 17.7% | 27.0% | 28.0% | 12.3 | 15 | 8 | 10 | 10.6 |
| %Errors/total words | 5.5% | 6.6% | 21.0% | 5.1% | 6.6% | 7.1% | 5.1% | 4.9% | 4.5% | 1.3% |

T = Test occasion; T3MP = Test occasion 3 months post PTA emergence

stimulus questions rather than repeat as per task requirement, which occurred again at follow-up. Verbal fluency was significantly below average for age and education level during PTA and at five days after PTA emergence but was within normal limits (at the lower end) at T3MP.

During PTA, EF's performance appeared affected by attention, and he had difficulty staying on topic even during the 60-second verbal fluency task. See Excerpts 1 and 2 for comparison between performance at T2 and T3MP.

### Excerpt 1. EF's EF verbal fluency: (countries) at T2 (2 items correct)

> Probably be Germany, an that, ah, we had Scania, or whatever it was, Spain, or that sort of thing, we've done a few colours and countries for them sort of thing, um, Toyotas, Toyota or four-wheel drive or your Mazdas and all that sort of thing, or more Toyota, or your Holden, or pretty well, it was more called your escaline, Subaru, or the little, ah one of those little um, sawsaws ones, the little alfia ones I think they're called alfia, you had your little um, nadal one, Toyota, they was always same sort of thing, they was always mixed after another one sort of thing.

### Excerpt 2. EF verbal fluency (letter f) at 3MP (12 items correct)

> Flirt, fix, forgive, faces, functions, fertiliser for the garden, feed all the chooks in the chook yard, freezer in the kitchen, frozen esky, fresh meat, use the frypan, use the forks. [Note: 'Chook' and 'esky' are Australian slang terms for chicken and portable cooler respectively].

There was impaired ability with picture naming throughout PTA and in the weeks following PTA emergence. Despite fluctuations, EF's naming ability improved over the course of PTA. While BNT scores remained low towards the end of PTA (e.g. 6/15 at T8), the types of errors he made as his confusion cleared were qualitatively different from earlier responses. Responses were highly unrelated to the target on early testing, but became more semantically or phonemically related to the correct response over time, and there was evidence of his increasing insight into his word-finding difficulty towards the end of PTA (see Appendix B). His BNT score at three-month follow-up remained classified as impaired (61).

EF was able to answer basic yes/no questions and short instructions correctly from the first test session and during conversation, and therefore was not tested with these subtests after T1. He consistently demonstrated difficulty understanding more complex questions while he was in PTA, particularly with passive questions forms. His understanding of short auditory paragraphs while in PTA improved relatively steadily, and he scored within normal limits on the MCLA auditory comprehension subtest at five days after PTA emergence and at T3MP.

EF had difficulties with many higher-level tasks during PTA (e.g., multiple definitions, odd-one-out words) and impairments remained at follow-up. For example, he had difficulty with figurative language comprehension during PTA, and at T3MP scored 2/10 on the MCLA verbal reasoning idiom explanation subtest, making literal interpretations of four of the five idioms.

### *EF discourse analysis*

EF's discourse during PTA was affected not only by confusion, memory and disorientation but by severe expressive and receptive language impairment. Discourse was characterised by frequent jargon, restarts and neologisms, and conversation-level impairments including tangentiality and verbosity. There was also a high level of mazes and fillers, such as 'know what I mean' and 'sort of thing'. He had a relative strength in social communication skills such as his cooperative manner and willingness in sessions.

Mean scores from SALT analysis were calculated for discourse across elicitation tasks on all ten test occasions (see Table 9). Although fluctuating, average C-unit length across tasks improved over test times, and average maze percentage reduced, indicating improvement in productivity over time. There was a marked reduction in average number of word errors per discourse task.

Picture description tasks were problematic for EF, and on initial test occasions, he was unable to identify the correct sequence of the pictures and missed the salient points of the story in all stimulus tasks. EF's story grammar scores on the Flowerpot Incident task were T2: 3/14 = 21.4%; T5: 3/14 = 21.4%; T3MP: 9/14 = 64.3%. At T3MP, EF was able to construct a narrative that included at least partial inclusion of the essential elements of the story. In his later production, he demonstrated ability to identify cause and effect in the story, after self-correction. See Appendix A for EF's productions for the Flowerpot Incident.

## Discussion

This study describes language and CC assessment and recovery for three patients during late PTA and the post-acute period after TBI, using a protocol encompassing standardised and non-standardised measures. Although these methods are recommended for SLP assessment practice (10,11) after TBI, they have not been previously reported in use with patients during PTA. It was found to be feasible and useful to conduct repeated CC assessment sessions with all three participants in order to monitor improvement on measures over time.

### Ongoing profile of impairment and gradual course of recovery

Participants in this study demonstrated an observable profile of language and CC strengths and weaknesses during PTA that persisted at follow-up, but with decreased severity. Previous neuropsychological research has reported on identifying cognitive strengths and weaknesses while the patient is still in PTA (34,73). Commencing assessment during PTA enabled the process of building a picture of communication function to begin earlier rather than waiting until PTA emergence. This is relevant at a time when there is pressure to decrease length of stay, and discharge may occur on emergence from PTA.

In this study, there was no marked delineation of CC function immediately before and after PTA emergence, indicating that CC recovery did not directly correspond with recovery of memory and orientation functions measured on the WPTAS. This aligns with research on recovery of other cognitive and behavioural abilities over the course of PTA (9,53,74). Studies have reported on the difficulties identifying the point of transition from MCS into PTA (33,75,76), or of emergence from PTA into full consciousness (4,74). The lack of differentiation in CC scores at, and soon after, the WPTAS final score indicates that PTA emergence is a complex and multifactorial process, within which communication cannot be easily categorised into 'in' and 'out' states. Accordingly, using the end point of PTA to signal the start of active SLP assessment and intervention may not optimum timing for SLP practice. Delaying CC assessment until the person has emerged from PTA may mean omission of valuable information on rate of recovery and on early indicators of persisting CCD. It is suggested that early and repeated SLP assessment may contribute to prediction of persisting CC issues.

### Language and cognitive communication during PTA and the post-acute period

Participants in the current study performed more poorly on language and CC assessment measures during earlier test sessions, including during PTA, than at follow-up. Previous research on neuropsychological testing during PTA found that participants in PTA performed worse on cognitive measures than those not in PTA (34,74,76). The current research extends these findings with description of the type and incidence of various impairments that are present during PTA, the first from an SLP perspective.

Our results add to previous research on occurrence of language and CCD in the acute setting or early Rancho Levels (77–81). Participants in the current study demonstrated naming difficulties, decreased ability with verbal fluency, discourse impairments and social communication impairment while in PTA and the post-acute period, and increased difficulty with more complex CC functions, such as comprehension of passive sentences and idiom explanation. Naming and word-finding difficulties are some of the most widely reported communication impairments after TBI (23,25), and difficulty with complex language functions (e.g., metaphor comprehension) has been previously found to be affected over the course of the post-acute stage after injury (26). These impairments have various multifactorial contributors, including impairment of working and semantic memory, attention, visual perception, information processing and other cognitive, linguistic and behavioural factors (82). Despite a number of studies reporting on the presence of these cognitive impairments during PTA (53,74,83), there has been no investigation of the relationship of specific cognitive functions to naming and other CC areas at this stage of recovery. This would be of interest in future research.

Few studies have tracked the recovery of language function during the acute and post-acute period. This study has provided preliminary information about the resolution of early disorder of naming and paraphasias during their early recovery, in the absence of significant focal left hemisphere brain injury. Additionally, the finding that all participants demonstrated naming difficulty or paraphasic errors at this time supports previous research finding that language disturbance is a key feature of the post-traumatic state (e.g., 20,81,84). For one participant, EF, it was possible to monitor the course of recovery of severe aphasic language disorder over the early stage after injury. Aphasia after TBI is commonly reported as an issue that resolves over the early months after injury (85), but there are few studies investigating how language disorder resolves or for whom. It may be difficult to determine which of those people who present with linguistic disturbance during PTA go on to have persisting anomia or naming difficulties that require ongoing SLP services. Further research on the variables involved in the course of recovery of language disorder would be of benefit with a larger sample. This may help to establish which patients are likely to require ongoing SLP intervention services and assist with informing patients and families on likely communication prognosis.

### Language of confusion

As well as a persisting profile of CC strengths and weaknesses (i.e., evident throughout PTA and afterwards), there were features of CC during PTA that had resolved by emergence that appeared directly related to the state of confusion. It was possible to quantify these functions using standardised and non-standardised assessment approaches. Confused language demonstrated during PTA included disorganised, confabulatory, perseverative and irrelevant content, and this corresponded with previous literature on confusion during the post-acute period (18,23,86). Indeed, language disruption is described synonymously with confusion in much reporting on this stage of recovery. While confabulation commonly appears in the literature as a feature of PTA (4,19), it can be ambiguously labelled in social and pragmatic behaviour rating scales and is challenging to monitor. There may also be limited scope on measures for expressing the extent of the fabrication, the unrelatedness to reality, or how frequently the behaviour presents. These features were monitored in the current study with use of discourse analysis and qualitative measures, in addition to the standardised social communication measures reported elsewhere (50). Narrative discourse analysis using story grammar used in this study was of benefit to monitor improvement over time of discourse organisation and salience. Use of discourse analysis and descriptive, qualitative

reporting of incidence and extent of disorganised and confabulatory communication would appear to be of benefit in monitoring cognitive and communication recovery in the early stages after injury.

### Assessment method and purpose of testing

The use of a formal test protocol (including standardised measures, for example, the BNT), in addition to informal, conversational methods, was of benefit to provide both a structure and quantitative measures on which to base qualitative observations of change. These methods were used to monitor recovery and measure change, rather than to diagnose disorder or identify difference from normal. As stated by SLPs in our previous research, there would be limited rationale for diagnosing a CCD during PTA or establishing a baseline of function during this time of fluctuating status. This research has been one of the first to report on combining standardised and non-standardised measures to systematically monitor CC recovery, methods with limited previous SLP attention. Currently available standardised tools for use by SLPs are either not designed for repeated use, not suitable for use in the acute stage or are not sensitive enough for more complex language and CC presentations.

Use of standardised SLP assessment for monitoring purposes has been reported previously, although not in recent SLP literature (18,29). A growing body of literature from neuropsychology has reported on the rationales for repeated brief evaluations during the early stages after TBI (73–75). The serial use of behavioural measures has been reported during minimally conscious states (32,33,50,87,88) up to the point of PTA emergence. In addition, there are some aspects of communication, such as auditory comprehension and presence of repetitive verbal behaviour, that are included in the Confusion Assessment Protocol, which is designed for repeated use during the post-traumatic confusional state (53). As stated, early strengths and weaknesses were identifiable even while the patient was in PTA. Our results suggested that both standardised and non-standardised assessments were suitable to use from early contact with the patient in order to monitor recovery and begin the process of determining presence of a disorder. This is supported by neuropsychological literature on timing of cognitive testing that has recommended early investigation of cognitive function (9,36,89), even while the patient is still in PTA (35,83). For clinicians working with adults with TBI, assessment of CC has previously been reported as a challenging area (90) at any stage, and presence of PTA brings added complexity to decision making. With an absence of specific recommendation on timing and methods of assessment, and a scarcity of empirical SLP research on CC during PTA, further empirical research on language and CC recovery is needed.

### Limitations

While contributing new knowledge to the field of CC during PTA and the early recovery period, and enabling depth in the descriptive cases reported, this case study research has a number of limitations. A general limitation to wider application of the results of the current study was that a descriptive methodology was used in order to evaluate each individual's performance as rated by one examiner. The small sample size prevents generalisation to a larger population. However, the study was designed to be an exploratory, descriptive investigation of CC assessment during PTA and early recovery and was not intended to investigate prognostic factors. It would not have been possible to present the level of descriptive detail within individual cases with a large cohort.

The small number of test occasions is acknowledged for two of the three participants presented. These participants emerged from PTA within one week of recruitment to the study (i.e., following admission to inpatient rehabilitation). Therefore, it is unknown if multiple test occasions throughout a larger proportion of their PTA would have been feasible. However, the sample in this study was taken from a larger cohort of six, five of whom remained agreeable to undertaking repeated assessments using the language and CC protocol. In future studies, recruitment of participants prior to admission to inpatient rehabilitation would provide increased opportunities for data collection and information on feasibility of repeated testing of patients who are in PTA.

The possibility of practice effects from testing is also acknowledged for EF, who participated in multiple sessions during PTA. Practice effects during the early stage of recovery, including during PTA, have been reported by Wilson et al. (91), and it has been established that types of learning can be achieved during PTA (9,46,47). Measures were taken to counter this possibility, such as alternate versions used on consequent sessions where available. There may have been an effect of familiarity of task materials and of test session format, and it is unknown to what extent familiarity with communication partner (i.e., the examiner) had on discourse production tasks over repeated contact on test occasions. These factors and their relationship to test performance during PTA would require focused study.

Although cognitive performance as it is related to communication was a focus of the study, measures of cognitive performance (i.e., from neuropsychological testing) were not included in the research. Since formal cognitive assessment was not undertaken, inferences made about underlying cognitive processes of language dysfunction in this study, while from an informed clinical perspective, must be considered speculative. It would be of interest in future research to determine the cognitive correlates of language and CC performance and recovery during PTA.

## Conclusion

This study is the first SLP description of language and CC assessment and recovery during PTA and the early stages after TBI. Cognitive communication strengths and weaknesses were identifiable even while the patient was in PTA. It was feasible to assess throughout PTA and the post-acute period. Potential benefits of this research are improved knowledge for SLPS on effective timing and methods of CC assessment with this population, which may assist in their provision of relevant information to the patient, family, carers and professionals involved as to management throughout the recovery process.

In this under-researched area, analysis of these cases provides important context for social communication results (50). The study also increases understanding of the nature of language and CC impairment after TBI during PTA. These form preliminary foundations for further research on the relationship of communication impairments to aspects of PTA.

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## Declaration of interest

The authors report no conflicts of interest.

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## Appendix A

## AB Responses to Flowerpot Incident stimulus pictures

**Flowerpot Incident, T2 (PTA emergence)**

So a man was walking the dog, well I don't know what that thing is. I couldn't tell you. And this tank thing, some water came out, and lost his hat. Getting his hat together and put it back on again, and got his dog and walked through the doorway. He got to the doorway and gave it a knock on the door, and there was this lady there, that patted the dog. And the man kissed the lady on the hand and the dog got a bone and ran down the steps.

**Flowerpot Incident, T4MP**

Man walking the dog. And um he might have heard a noise from the tank up the top and he gave it a whack with his stick and then he goes up the top. Something fell from the – something fell from up at the top, and then he eventually got the front door of his apartment, and then he got to the door and banged with his walking stick, and an elderly lady came out and said hello to the puppy dog, and the gentleman kissed the lady's hand and the lady gave the doggy a bone and off they go.

T = test, 4MP = 4 months after PTA emergence

## CD Flowerpot Incident

**Flowerpot Incident, T1 (PTA 11/12).**

So, it's showing that some guy's had a flowerpot dropped on his head. That's a a building. Basically it looks like he's got really upset about it, and then he went inside, and knocked on the door, and there was some nice [laugh] old lady who he decided to [unintelligible] round it.

**Flowerpot Incident (Test 3MP)**

Okay so there is a man walking down the street with his dog. Um, as he's walking a flowerpot drops from above his head, um, knock him on his head and knocking his hat off. Um the man gets very angry and starts waving his cane at the owner of the balcony, um, he promptly takes his dog and heads inside, marches up the stairs and bangs hardly on her door with his cane. Um, the nice old lady comes out, I think she's holding a bone, gives the dog a nice little pat, um and the man is quite taken by her, p, f- somehow, um and the dog grabs the bone and runs down the stairs, by the looks of it. And the man promptly gives the lady a kiss on the hand, so a possible romance is blooming, with um the lump on his head. So it seems to be very fortuitous occasion.

T = test, 3MP = 3 months after PTA emergence

## EF Responses to Flowerpot Incident picture stimulus

**Flowerpot Incident, T2 (PTA 8/12).**

Getting a stay at home, well, like, leave the dog outside and go inside, so he's out there bolting sort of thing, and now looks like he's here, here, he looks like he's barking sort of thing, ah, come out of here he's got the bone on it, sort of looks like it. So he's just taken away all areas different thingo here. [Starts again at frame 1] Well, there he's trying to get in sort of thing, and there he is, getting in, his mother's letting him in. She, he's got a bone for him, so ah, seems alright, like the bo- bog seems alright there sort of thing, doesn't seem that sort of harsh, you know what I mean sort of thing, everything seems to be going alright.

**Flowerpot Incident, T3MP**

Ah fellow's going home, as he's going home a- the top thingo, must have his hat in his hand, and, as he's walked past the whatever you call it, wh- what is it, verandah you know, where the pot plants grow, it's hit him on the head. He's woken up, with the dog barking, he's put his hat on, put his hands up in the air, and then next door he's gone down, inside, and left the pot plant out where it was, basically. In the third, w- ah, in the second row, must be, where he goes in, knocks on the lady's door, she gives the dog a bone. He must be going to thank her and then gives her hand a kiss goodbye sort of thing. But, not properly supposed to go like that, he's probably going to abuse her or something, if you know what I mean. Or is it the right house? Got a lots- load of, apartments, sort of thing, one of them things. He's alright when he's getting on the [unintelligible] stage, in the new photo, had the hat, walking stick for knocking on the door, she gives the dog a bone, dog goes out in front, happy. In the last feature I don't know where his walking stick is, that's gone missing.

T = test, 3MP = 3 months after PTA emergence

## Appendix B

## Example responses to BNT short forms

| Name | Responses T4, PTA score: 9/12, BNT score: 5/15 | T9, PTA 10/12, BNT score: 6/15 | Responses 3 month follow-up. BNT score 9/15 |
|---|---|---|---|
| Seahorse | Single seahorse | Salty horse | Seahorse |
| Dominos | Three diamonds | Dominoes | Dominos |
| Pelican | A pelican | Penguin | Pelican |
| Stethoscope | Ah, stephead, stepascope it's called | Typie tweet, you know what I mean | Doctor's stefastope, I think it is, stethastope |
| Unicorn | Albino is it? Albino | Unicorn | Unicorn |
| Noose | Zombie, ah, zombie bloke crusoe, so they can hang isselves | Hangmans noose | That's not hangman's noose because it's got more than twelve circles |
| Tripod | A Teflon creature with three legs | Aeroguard mat puts his paints on | Ah hold the telescopic thingo, I forget the name |
| Tongs | You got the nice white ties there, or seafood ties | Shicar, shicar tongs | Ice cubes, trying to pick up ice cubes |
| Sphinx | Ah, segrena, lady at work gave 'em them, ah, Eskimo [semantic cue] yep in Egypt, an Eskimo, sha been there for a fair while | Bvon from eypgyt | Ah, a, ah statue from Egypt, I forget his name |
| Palette | And then the paint's artist [semantic cue] ah just a sort of painter's sort of diaphram sort of thing | Painters map up thingo | Painter's paint holder, with brushes to find the right colour |

BNT = Boston Naming Test Short Forms
Note: Responses underlined scored as correct