Thesis submitted in partial fulfilment of the degree of

Doctor of Clinical Psychology (DClinPsych)

Lawson Falshaw

1405202

Harris Manchester College

May 2023

Word Counts

Critical Review of the Literature (CRL): 7043

Service Improvement Project (SIP): 5213

Theory-Driven (Main) Research Project (TDRP): 5029

Executive Summary: 998

Connecting Narrative: 943

Table of Contents

Abstracts

Critical Review of the Literature

Approximately one third of stroke survivors experience difficulties with understanding language (fluent aphasia), or producing language (non-fluent aphasia). Although copious research has been conducted assessing the language abilities of individuals with post-stroke aphasia, fewer studies have been conducted applying neuropsychological tests to assess the non-linguistic neuropsychological functioning of individuals with post-stroke aphasia. This review aimed to learn more about measures which may be used in neurorehabilitation to assess memory, executive functioning, attention, visuospatial skills, social cognition, and intellectual functioning of stroke survivors with fluent or non-fluent aphasia. The systematic review resulted in 17 quantitative papers published since 2013 involving the non-linguistic cognitive assessment of individuals with fluent or non-fluent aphasia after stroke across eight countries. The use of assessments by clinicians in multidisciplinary neurorehabilitation services has been considered. Findings have implications for how neurorehabilitation clinicians assess non-linguistic cognitive functioning in post-stroke aphasia.

Service Improvement Project

Study Design: Mixed methods service improvement project. Retrospective analysis of clinical documentation and focus group with clinicians.

Objectives: Although traumatic brain injury (TBI) and spinal cord injury (SCI) often co-occur, many barriers have been found to identifying TBI in SCI rehabilitation and adapting treatment accordingly. This study aimed to compare the number of TBIs detected at the UK National Spinal Injury Centre to figures found in previous research, and understand the barriers to adapting SCI rehabilitation in the presence of TBI.

Setting: United Kingdom inpatient spinal cord injury rehabilitation unit.

Methods: This mixed methods study assessed the documentation at each stage of 88 patients' treatment where a TBI could be detected and used to inform rehabilitation, and subsequently, a focus group was conducted with staff to explore the barriers to detecting TBI and adapting SCI rehabilitation.

Results: Results suggested that data related to TBI were inconsistently recorded, the number of TBIs at the Centre was lower than previous research, and several barriers were interpreted from the focus group.

Conclusions: TBI in SCI populations may be an invisible unmet need. Several barriers may exist which prevent clinicians from detecting TBI in this population and adapting rehabilitation accordingly. Findings have implications for rehabilitation for individuals with TBI and SCI admitted to the service.

Theory-Driven (Main) Research Project

Although an acquired brain injury (ABI) may bring some couples closer together, for other couples, an ABI may pose challenges to their relationship. Recent research has suggested that social cognition is the strongest predictor of continuity in couples' relationships after one partner experiences an ABI. The current study aimed to examine the role of social cognition in relationship satisfaction and continuity after ABI. Sixty-four participants who were in a relationship with someone who had experienced an ABI completed measures of their partner's social cognition, their relationship satisfaction before and after injury, and a measure of relational continuity after ABI. It was found that the participants' relationship satisfaction significantly decreased after injury, and that the average social cognition score for the group reporting a high change in relationship satisfaction was significantly poorer than the group reporting a low change in relationship satisfaction. Regression analysis suggested that overall social cognition could predict the continuity in relationships after injury, although no single content area on a measure of social cognition could predict relational continuity. Findings have implications for the impact of ABI on couples' relationships and support to provide to couples following ABI.

Critical Review of the Literature

A Systematic Review of Assessments of Non-Linguistic Cognitive Functioning in Adults with Post-Stroke Fluent and Non-Fluent Aphasia

Lawson Falshaw

lawson.falshaw@hmc.ox.ac.uk

The Oxford Institute of Clinical Psychology Training and Research

University of Oxford

Internal Supervisor: Dr Reena Vohora, The Oxford Institute of Clinical Psychology Training and Research

External Supervisor: Dr Bronwen Bonfield, Buckinghamshire Healthcare NHS Trust

External Supervisor: Dr Sam Waterman, Buckinghamshire Healthcare NHS Trust

Proposed Journal: Disability and Rehabilitation

Rationale: This journal has chosen because it is an international multidisciplinary journal which aims to promote rehabilitation practice, including assessment procedures.

Word Count: 7043

May 2023

Abstract

Approximately one third of stroke survivors also experiences difficulties with understanding language (fluent aphasia), or producing language (non-fluent aphasia). Although copious research has been conducted assessing the language abilities of individuals with post-stroke aphasia, fewer studies have been conducted applying neuropsychological tests to the non-linguistic neuropsychological functioning of individuals with post-stroke aphasia. This review aimed to learn more about measures which may be used in neurorehabilitation to assess memory, executive functioning, attention, visuospatial skills, social cognition, and intellectual functioning of stroke survivors with fluent or non-fluent aphasia. The systematic review resulted in 17 quantitative papers published since 2013 involving the non-linguistic cognitive assessment of individuals with fluent or non-fluent aphasia after stroke across eight countries. The use of assessments by clinicians in multidisciplinary neurorehabilitation services has been considered. Findings have implications for how neurorehabilitation clinicians assess non-linguistic cognitive functioning in post-stroke aphasia.

Keywords: Stroke, Fluent Aphasia, Non-Fluent Aphasia, Cognitive functioning

A Systematic Review of Assessments of Non-Linguistic Cognitive Functioning in Adults with Post-Stroke Fluent and Non-Fluent Aphasia

A stroke is a cerebrovascular accident whereby the blood supply to a brain area is cut off, damaging brain cells. It is one of the most common neurological conditions, affecting 100,000 people each year in the UK alone (Stroke Association, 2021). A stroke is also a major, and often traumatic life event which can impact the mental health of the survivor as well as causing a 'ripple effect' on families as the survivor and those around them adjust to life after injury (Villa & Riley, 2017; Bowen et al., 2009; Temkin et al., 2009).

People who experience a stroke are affected in different ways, depending on the area in which it occurs and its severity. For example, a stroke may impact someone's physical mobility. Sometimes, a stroke may also result in several 'invisible disabilities', including cognitive impairments in problem-solving abilities, attention, learning, memory, and language (Fonseca et al., 2019). Understanding the mechanism behind how stroke impacts people's functioning in different ways is key to successful rehabilitation (Cipolotti & Warrington, 1995).

One theoretical framework to understand how an individual is impacted after stroke is the theory of functional specialisation (Mahon & Cantlon, 2011). This theory suggests that different areas of the brain represent different abilities or 'functions' which enable people to navigate daily life. Therefore, if a certain region of the brain is damaged, this may lead to an impairment in functioning for which that part of the brain is responsible (Cipolotti & Warrington, 1995).

Functional specialisation theory has since been supported by more recent stroke research which has illustrated the relationships between certain brain areas and specific cognitive functions. Moore and Demeyere (2022) examined associations between impairment on the Oxford Cognitive Screen (OCS; Demeyere, et al., 2015) and stroke location in 573 patients using

voxel-based lesion-symptom mapping through brain scans. The researchers found that lesions in certain areas of the brain caused by stroke were associated with different cognitive impairments on the OCS. This finding supports the functional specialisation perspective that a stroke in a specific area of the brain impairs an individual's ability to perform certain cognitive tasks.

Post-Stroke Aphasia

One of the most common and debilitating areas of cognitive functioning to be affected by stroke is language, and this condition is called 'aphasia' (Manning et al., 2020; Hilari, 2011). One third of stroke survivors experiences this condition, equating to 350,000 people living with language difficulties after stroke in the UK (Stroke Association, 2020). Aphasia is an umbrella term for many types of language difficulties, and, in line with the theory of functional specialisation, studies have found that certain neural pathways in the left fronto-temporal areas are related to various language deficits after stroke (Moore & Demeyere, 2022).

The classical theory of language representation in the brain suggested that damage to Broca's area leads to difficulties producing language (non-fluent aphasia), and lesions to Wernicke's area relate to impairments in understanding language or 'fluent aphasia' (Geschwind, 1965a; 1965b). Although these areas are important in speech production and comprehension, recent research has suggested that rather than single regions, there are certain networks spanning the left temporal lobe which are responsible for these functions (Døli et al., 2021). However, in the cognitive assessment literature, the dichotomy between fluent and non-fluent aphasia remains (Gordon, 2020; Vukovic et al., 2021). Both of these types of aphasia individually, or together (global aphasia) may pose unique challenges for survivors and their families, both in the early stages of care (Pringle et al., 2010), and in the long-term (Kitzmüller et al., 2012; Kincheloe et al., 2022).

Research has demonstrated that individuals with post-stroke aphasia (PSA) may also have impairments in other areas of other cognitive functioning (Moore & Demeyere, 2022; Weaver et al., 2021). The language areas of the brain are close to regions involved in other cognitive functions and the devastating and cascading nature of stroke means damage may occur in multiple brain areas, and thus, cognitive abilities (Fonseca et al., 2017). For example, survivors with aphasia may also have difficulties with memory and attention (Potagas, et al., 2011), which are involved in almost all activities of daily life. These 'invisible disabilities' may cause additional distress for survivors and their carers (Barrett et al., 2021; Gialanella et al., 2011).

Cognitive rehabilitation theory identifies testing cognitive abilities as one of the first stages in rehabilitation (Cipolotti & Warrington, 1995, Caramazza & Hillis, 1993). Before treatment, it is important to ascertain how cognitive functioning has been affected, and to gather information on the degree and severity of the impairment considering an individual's premorbid functioning. Resulting relative strengths and weaknesses may be used to understand a patient's cognitive profile as a whole, and adaptations may be made to support patients and their carers to adjust better to life after stroke.

Assessing Non-Linguistic Cognitive Functioning

Although there are many speech and language therapy-specific ways to test the language ability of people with aphasia (Salter et al., 2006), less research has been conducted into how psychologists in multidisciplinary neurorehabilitation teams may examine other cognitive functions in people whose language skills are impaired after stroke. These difficulties are harder to identify, as many cognitive assessments rely on intact language skills which are difficult for patients with PSA to complete. This means patients with PSA may have other cognitive

impairments which may be missed, meaning rehabilitation cannot be tailored to these ‘invisible disabilities’ (Barrett et al., 2021).

Some assessments result in a ‘cognitive profile’ of people after stroke and rely much less on language (Demeyere et al., 2015). However, these tools are novel and the research needs to be synthesised to provide guidance for fast-paced multidisciplinary neurorehabilitation services. Additionally, there are gaps in previous research. Fonseca et al. (2016) reviewed the cognitive profile of this population and the tools to assess non-linguistic cognition in people with aphasia after stroke until 2015. However, some papers were missed due to the study’s less detailed search strategy (Yu, Jiang, Bi & Li et al., 2013; Yu, Jiang, Li & Bi et al., 2013), they did not assess the quality of the studies included, and since their review, there has been a flurry of research papers published in this area. Also, Salis and colleagues (2021) conducted a review of memory measures post-stroke, however this only collated measures for memory.

The Current Review

The primary aim of the present study was to systematically review and evaluate papers focusing on the assessment of non-linguistic cognitive functioning of adults with post-stroke fluent or non-fluent aphasia published since 2013, as this was the year of the first paper not included in the Fonseca et al. (2016) review. It was hoped that the results would provide helpful guidance for non-linguistic cognitive assessments that can be used by psychologists, alongside those used by speech and language therapists, to have a greater multidisciplinary understanding of the needs of stroke survivors to support patients and their carers to adjust to life after stroke.

Method

This review was conducted in accordance with the guidelines for reporting systematic reviews, updated in 2020 (PRISMA; Page et al., 2021), and was registered with PROSPERO (CRD42021251162).

Search Strategy

Search terms related to stroke, fluent and non-fluent aphasia, neuropsychological assessment, and non-linguistic cognitive functions were used (see Appendix B) to systematically search the following databases on 3rd of April 2023: EMBASE, MEDLINE, and APA PsychInfo via Ovid, and Scopus. Search results were restricted to studies in the English language and a secondary hand-search of relevant reference lists was also completed. Discussions with research supervisors identified any recently published (or in press) studies and clarified eligibility questions.

Identified studies were imported into EndNote, and duplicates were removed. Subsequently, through the software Rayyan (Ouzzani et al., 2016), the titles and abstracts of the resulting papers were screened against the inclusion criteria by the primary researcher. Selected full texts were then screened against the inclusion criteria by the primary (LF) and secondary (RU) researcher. Inter-rater reliability was calculated using Cohen's kappa statistic to ascertain the scoring agreement between these researchers. The researchers initially agreed on 93% of the 126 papers (κ = .75). The two researchers then met to discuss the remaining papers, and agreement increased to 100%. The rest of the research team were consulted regarding two papers that the primary and secondary researchers both agreed they were unsure whether should be included. Seventeen papers were included in the final review (Figure 1).

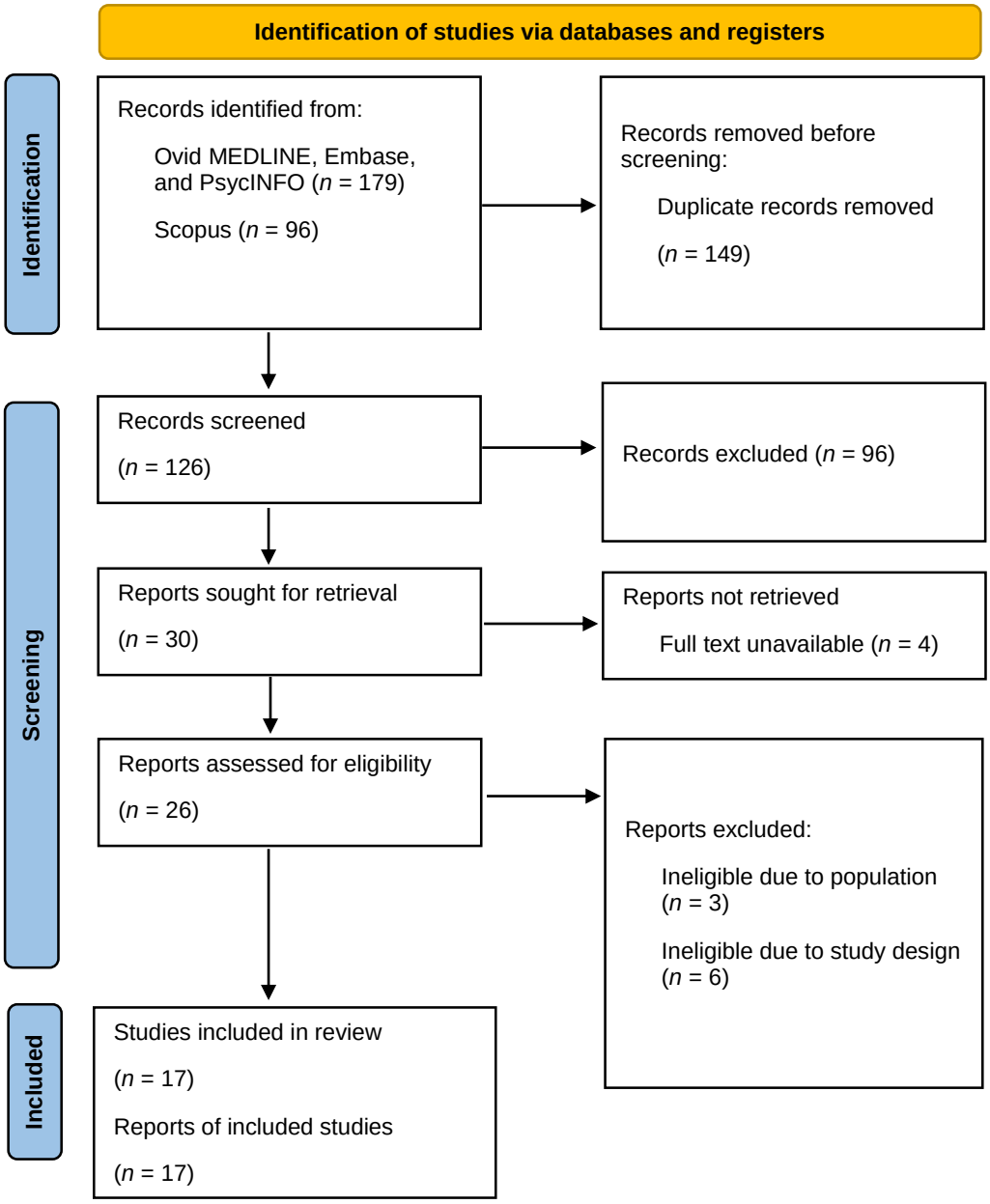
Inclusion and Exclusion Criteria

Studies were included if they met the following criteria: original peer-reviewed research articles, published in English, published in or after 2013, adopted a quantitative methodology, and administered a non-linguistic cognitive assessment. Studies included a sample of adults over 18 years of age with fluent or non-fluent aphasia after having incurred any of the three types of stroke: ischaemic stroke, haemorrhagic stroke, or a transient ischaemic attack.

Papers were excluded from the review if they involved a population of participants with non-vascular conditions. For example, papers incorporating a sample of stroke survivors alongside a sample of people with other acquired brain injuries such as traumatic brain injury, were excluded. Papers were also excluded if they were conference abstracts, primarily aimed to explore linguistic cognitive functioning, or the sample had non-impaired language abilities.

Figure 1

PRISMA Diagram



Data Synthesis

A data extraction plan was created, informed by the Cochrane data extraction and assessment form template. This was used to extract the key information from each paper which

was relevant to the current review, including participant demographics, type of stroke, type of aphasia, cognitive functions assessed, and tests used. Neuropsychological assessments were grouped by the cognitive functions they were used to assess in each paper.

Quality Assessment

The quality of each resulting study was assessed in accordance with the checklist for assessing the quality of quantitative studies from Kmet and colleagues' (2004) standard quality assessment criteria for evaluating primary research papers from a variety of fields (see Appendix B). The quality assessment was carried out independently by two researchers. Inter-rater reliability was calculated using Cohen's kappa statistic to ascertain the scoring agreement (κ = .92).

Results

Study Characteristics

Studies were mostly cross-sectional, although two were quantitative single case studies (Puvanendran et al., 2016; Woods et al., 2017), two were validation papers for assessment measures (Demeyere et al., 2015; Rodrigues et al., 2019), and one validated a treatment protocol as part of a wider RCT (Kaur et al., 2020) assessing the impact of a rehabilitation programme on non-linguistic cognitive functioning. Of the 17 studies included, 16 aimed to specifically explore the non-verbal cognitive functioning of participants (Bonini & Radanovic, 2015; Demeyere et al., 2015; Fonseca et al., 2019; Lee & Pyun, 2014; Lee et al., 2020; Puvanendran et al., 2016; Rodrigues et al., 2019; Schumacher et al., 2019; 2022; Thomson et al., 2015; Woods et al., 2017; Yao, Liu & Liu et al., 2020; Yao, Liu & Lu et al., 2020; Yu, Jiang, Bi & Li et al., 2013; Yu, Jiang, Li & Bi et al., 2013; Yan et al., 2022). Twelve studies involved only individuals who had

experienced a stroke (Bonini & Radanovic, 2015; Fonseca et al., 2019; Lee & Pyun, 2014; Lee et al., 2020; Schumacher et al., 2019; 2022; Thomson et al., 2015; Woods et al., 2017; Yao, Liu & Liu et al., 2020, Yu, Jiang, Bi & Li et al., 2013; Yu, Jiang, Li & Bi et al., 2013; Yan et al., 2022), and five studies included a neurologically healthy control group alongside stroke survivors (Demeyere et al., 2015; Kaur et al., 2020; Puvanendran et al., 2016; Rodrigues et al., 2019; Yao, Liu & Lu et al., 2020). Where studies reported multiple groups of participants (Bonini & Radanovic, 2015; Demeyere et al., 2015; Fonseca et al., 2019; Kaur et al., 2020; Lee & Pyun, 2014; Lee et al., 2020; Puvanendran et al., 2016; Rodrigues et al., 2019; Yao, Liu & Liu et al., 2020; Yao, Liu & Lu et al., 2020; Yan et al., 2022), the sample characteristics are reported separately. Table 1 represents the methodological information extracted from each paper.

Whilst all of the studies were published in English, the studies were conducted in 10 countries, with eight originating in Asia (Kaur et al., 2020; Lee & Pyun, 2014; Woods et al., 2017; Yao, Liu & Liu et al., 2020; Yao, Liu & Lu et al., 2020; Yu, Jiang, Bi & Li et al., 2013; Yu, Jiang, Li & Bi et al., 2013; Yan et al., 2022) six in Europe (Demeyere et al., 2015; Fonseca et al., 2019; Puvanendran et al., 2016; Schumacher et al., 2019; 2022; Thomson et al., 2015), two in South America (Bonini & Radanovic, 2015; Rodrigues et al., 2019), and one in North America (Lee et al., 2020). Most studies recruited outpatient samples, apart from five studies which recruited inpatient participants (Demeyere et al., 2015; Lee & Pyun, 2014; Yao, Liu & Liu et al., 2020; Yao, Liu & Lu et al., 2020; Yan et al., 2022), and two studies which included both (Yu, Jiang, Bi & Li et al., 2013; Yu, Jiang, Li & Bi et al., 2013). Sample sizes ranged from one to 352. All of the studies included participants with fluent or non-fluent aphasia. Two single case studies reported participants purely with non-fluent aphasia (Puvanendran et al., 2016; Woods et al., 2017). Although most studies used comorbid physical and mental health conditions as exclusion

criteria, information regarding participants' comorbid mental health status was gathered in seven studies (Fonseca et al., 2019; Kaur et al., 2020; Rodrigues et al., 2019; Woods et al., 2017; Yao, Liu & Liu et al., 2020; Yao, Liu & Lu et al., 2020; Yu, Jiang, Bi & Li et al., 2013).

All 17 studies assessed the non-verbal cognitive functioning of participants. Most studies also assessed the relationship between language deficits and non-verbal cognitive functioning (Bonini & Radanovic, 2015; Fonseca et al., 2019; Lee et al., 2020; Rodrigues et al., 2019; Schumacher et al., 2019; 2022; Thomson et al., 2015; Yao, Liu & Liu et al., 2020; Yu, Jiang, Bi & Li et al., 2013; Yu, Jiang, Li & Bi et al., 2013; Yan et al., 2022). Sixteen papers used a battery of standardised neuropsychological assessments to explore non-verbal cognitive functioning in PSA (Bonini & Radanovic, 2015; Demeyere et al., 2015; Lee & Pyun, 2014; Lee et al., 2020; Puvanendran et al., 2016; Rodrigues et al., 2019; Schumacher et al., 2019; 2022; Thomson et al., 2015; Woods et al., 2017; Yao, Liu & Liu et al., 2020; Yao, Liu & Lu et al., 2020; Yu, Jiang, Bi & Li et al., 2013; Yu, Jiang, Li & Bi et al., 2013; Yan et al., 2022).

Table 1

Study Characteristics and Key

Key

Term	Meaning	Reference
NA	Not applicable	-
NR	Not reported	-
HC	Healthy controls	-
SS	Stroke survivors	-
Aph	Aphasia	-
NAph	Non-aphasia	-
FA	Fluent aphasia	-
NFA	Non-fluent aphasia	-
Subs	Substance misuse	-
NeuroHis	Previous history of neurological conditions	-
PsychHis	Previous history of mental health conditions	-
SensImp	Sensory impairment impacting participation	-
RP	Research participant in another research project into cognition	-
LH	Left-handed	-
LHem	Left-hemisphere	-
RH	Right-handed	-
RHem	Right-hemisphere	-
BCB-Edu	Brief Cognitive Battery-Edu	Nitrini et al. (2007)
BCoS	BCoS: Birmingham Cognitive Screen	Humphreys et al. (2012)
BIT	Behavioural Inattention Test	Wilson et al. (1987)
BLAD	Battery of Lisbon for the Assessment of Dementia	Garcia (1984).
CAT	Cognitive Abilities Test	Lohman et al. (2008)
CDT	Clock Drawing Test	Freedman et al. (1994)
CERAD	Consortium to Establish a Registry for Alzheimer's Disease Constructional Praxis Task	Fillenbaum et al. (2011)

Term	Meaning	Reference
CNT	Computerised Neuropsychological Test Version 4.0	MaxMedica, Inc., Seoul, South Korea
CPT-II	Conners' Continuous Performance Test – Second Edition	Conners (2004)
D-KEFS	Delis-Kaplan Executive Function System	Delis et al. (2001).
LOTCA	The Loewenstein Occupational Therapy Cognitive Assessment	Katz et al. (1989)
MOCA	Montreal Cognitive Assessment	Nasreddine et al. (2005)
MMSE	Mini-Mental State Examination	Folstein et al. (1975)
NART	National Adult Reading Test	Nelson & Willison (1991)
NEUPSILIN-Af	Brief Neuropsychological Assessment Battery NEUPSILIN for patients with expressive aphasia	Rodrigues et al. (2019)
NLCA	The Non-Language-Based Cognitive Assessment	Wu et al. (2013)
OCS	Oxford Cognitive Screen	Demeyere et al. (2015)
RCF	Rey Complex Figure task	Osterreith (1944)
R(C)PM	Raven's (Coloured) Progressive Matrices	Raven & Raven (2003)
TAP	The Test of Attentional Performance	Zimmerman & Fimm (2002)
TEA	The Test of Everyday Attention	Robertson et al. (1996)
TMT	Trail Making Test	Retain (1958)
TOPF	Test of Premorbid Functioning	Wechsler (2011)
VOSP	The Visual Object and Space Perception Battery	Warrington & James (1991)
WAIS-IV	Wechsler Adult Intelligence Scale – Fourth Edition	Wechsler (2008)
WASI-II	Wechsler Abbreviated Scale of Intelligence, Second Edition	Wechsler (2011)
WCST	Wisconsin Card Sorting Test	Grant & Berg (1948)
WMS-IV	Wechsler Memory Scale –Fourth Edition	Wechsler (2009)
WMS-III	Wechsler Memory Scale – Third Edition	Wechsler (1997)
WMS-R	Wechsler Memory Scale – Revised Edition	Wechsler (1987)
WTAR	Wechsler Test of Adult Reading	Holdnack (2001)
-	The Test of Derived Fact Strategies	Dowker (1998)

Term	Meaning	Reference
-	The Five Objects Test	Papageorgiou et al. (2014)
-	The Camel and Cactus Test	Bozeat et al. (2000)
-	The Tower of Hanoi	Simon (1975)
-	The Kramer Test	Balzer et al. (2011)
-	Tower of London test	Shallice (1982)
-	The Brixton Test	Burgess & Shallice (1997).

Study Characteristics

Study	Country	Type(s) of PSA	Exclusion criteria	Sample size; Setting	Average Age (SD); Average Years of Education (SD)	Area(s) of Cognition Tested	Measure(s)/Task(s) Used	Study Quality
Yu, Jiang, Bi & Li et al. (2013)	China	Global, fluent, and non-fluent aphasia	PsychHis, NeuroHis,	63; Inpatient and outpatient	56 (12); 11 (2)	Orientation, visuospatial perception, intellectual functioning, executive functioning, and attention.	LOTCA – Chinese Version	19/22
Yu, Jiang, Li & Bi et al. (2013)	China	Global, fluent, and non-fluent aphasia	PsychHis, NeuroHis,	59; Inpatient and outpatient	56 (13); 11 (3)	Orientation, visuospatial perception, intellectual functioning, executive	LOTCA – Chinese Version	17/22

Study	Country	Type(s) of PSA	Exclusion criteria	Sample size; Setting	Average Age (SD); Average Years of Education (SD)	Area(s) of Cognition Tested	Measure(s)/Task(s) Used	Study Quality
						functioning, and attention.		
Lee & Pyun (2014)	Korea	Global, fluent, and non-fluent aphasia	NeuroHis, PsychHis	94; RHem = 36 NAph LHem = 32, Aph LHem = 26; Inpatient	RHem = 59.2 (12.3), NAph LHem = 61.2 (11.8), Aph LHem = 54.7 (12); RHem = 11.8 (4.6), NAph LHem = 9.6 (3.0), Aph LHem = 10.4 (4.2)	Memory, attention, praxis, executive functioning, intellectual functioning	CNT including: Digit span test forward (DST-F) and backward (DST-B), visual span test forward (VST-F) and backward (VST-B), visual and auditory continuous performance test (VCPT and ACPT), TMT, WCST, and RCPM.	20/22
Bonini & Radanovic (2015)	Brazil	Global, fluent, and non-fluent aphasia	Subs NeuroHis, PsychHis, SensImp	47 (Aph = 21), Outpatient	Aph = 59.2, (12.5), NAph LHem = 62.7, (13), NAph RHem = 59.5 (12.6). Aph = 7 (NR), NAph L = 6 (NR), NAph RHem = 8.2 (NR)	Attention, memory, executive functioning, visuospatial skills and praxis	TMT (A and B), Visual Cancellation Test, Word List Memory, Word List Recall, Word List Recognition, Praxis and Constructional Praxis Recall (CERAD), WMS-R Digit Span (forward and backwards),	20/22

Study	Country	Type(s) of PSA	Exclusion criteria	Sample size; Setting	Average Age (SD); Average Years of Education (SD)	Area(s) of Cognition Tested	Measure(s)/Task(s) Used	Study Quality
							Visual Memory (BCB-Edu), CDT	
Thomson et al. (2015)	UK	Non-fluent and fluent aphasia	Time of stroke onset beyond one year	21; Outpatient	FA = 68.25 (5.19), NFA = 65.77 (12.41); FA = 11.38 (.99), NFA = 11.83 (.8)	Memory, intellectual functioning, visuospatial functioning, attention, executive functioning	WMS-R Digit span, RCPM, VOSP, Elevator Counting with and without distraction from the TEA, the Brixton test	15/22
Demeyere et al. (2015)	UK	Global, fluent, and non-fluent aphasia	Time of stroke onset beyond three weeks, unable to concentrate for beyond 15 mins, unable to consent	348 (208 SS, 140 HC); Inpatient	71.1 (14.5); 11.5 (2.7)	Attention (executive and spatial functioning), memory, number, and praxis	OCS, validated against the MoCA, CAT calculations page, BIT star cancellation, BCoS imitation task, WMS-IV delayed memory story recall task	21/22

Study	Country	Type(s) of PSA	Exclusion criteria	Sample size; Setting	Average Age (SD); Average Years of Education (SD)	Area(s) of Cognition Tested	Measure(s)/Task(s) Used	Study Quality
Puvanendran et al. (2016)	UK	Non-fluent aphasia	NA	17 (1 SS, 16 HC); Outpatient	SS = 32, HC = 31 (2.08); University degrees	Attention (executive and spatial functioning), memory, number, and praxis, intellectual functioning	OCS, BCoS, RPM, Panamath task, Dowker's (1998) test of derived fact strategies	12/12
Woods et al. (2017)	Thailand	Non-fluent aphasia	NA	1; Outpatient	86 (NA); 11 (NA)	Intellectual functioning; memory; visuospatial functioning; executive functioning	Non-verbal subtests of the WAIS-IV and WMS-IV, RCF delayed recall task, TMT (letter-number switch subtest from the D-KEFS) and the WCST	14/14
Fonseca et al. (2019)	Portugal	Global, fluent, and non-fluent aphasia	Subs NeuroHis, PsychHis,	80 (Aph = 48; NAph = 32), Outpatient	Aph: 64.1, (10.8) NAph: 66.3 (7.2); Aph: 9.3 (5.4), NAph: 10.2 (5.6)	Memory, executive functions, and attention and speed processing.	5 Objects Memory Test, Spatial Span of WMS-III, Memory of faces both immediate and delayed recall (WMS-R); Camel and Cactus Test, Tower of Hanoi, Matrix reasoning from the WASI-II, Clock	21/22

Study	Country	Type(s) of PSA	Exclusion criteria	Sample size; Setting	Average Age (SD); Average Years of Education (SD)	Area(s) of Cognition Tested	Measure(s)/Task(s) Used	Study Quality
							drawing and Motor initiative of the BLAD, Symbol Search of WAIS-IV, and the Letter Cancellation Task of BLAD.	
Rodrigues et al. (2019)	Brazil	Non-fluent aphasia	NeuroHis, PsychHis	94 adults (49 SS and 45 HC); Outpatient	HC = 56.13 (9.95), RHem = 52.45 (9.65), LHem = 60.24 (10.23); HC = 9.56 (SD = 4.36), RHem = 9.45, SD = 3.33), LHem = 8.32 (SD = 4.68)	Orientation, visual perception, memory, praxis, executive functioning, and academic achievement (written language and arithmetic)	NEUPSILIN-Af	20/22
Schumacher et al. (2019)	UK	Global, fluent, non-fluent aphasia	NeuroHis, LH, SensImp	38; Community	64 years (11.9); NR	Attention and executive functioning	Alertness, GoNoGo, Divided Attention, and Distractibility from the TAP; the subtests Design Fluency and TMT (parts 2–4) from	18/22

Study	Country	Type(s) of PSA	Exclusion criteria	Sample size; Setting	Average Age (SD); Average Years of Education (SD)	Area(s) of Cognition Tested	Measure(s)/Task(s) Used	Study Quality
							the D-KEFS; a computerised version of the Tower of London, a visuospatial planning task; the Kramer test; RCPM; the Brixton test	
Kaur et al. (2020)	India	Global, fluent, and non-fluent aphasia	Subs NeuroHis, PsychHis, RP	55 (15 SS, 40 HCs); Outpatient	NR	Mathematical ability, memory, executive functioning	Handling cash, setting up a clock, playing cards, mazes, colouring	17/22
Lee et al. (2020)	USA	Fluent and non-fluent aphasia	LH, Non-English speakers SensImp	114; Outpatient	56.5 (12.3); 15.1 (2.5)	Attention	CPT-II	20/22
Yao, Liu & Liu et al. (2020)	China	Fluent and non-	NeuroHis, PsychHis	86; Inpatient	Aph = 57.71 (10.77), NAph =	Orientation, visuospatial perception, intellectual	LOTCA – Chinese Version	22/22

Study	Country	Type(s) of PSA	Exclusion criteria	Sample size; Setting	Average Age (SD); Average Years of Education (SD)	Area(s) of Cognition Tested	Measure(s)/Task(s) Used	Study Quality
		fluent aphasia			55.39 (11.67); Aph = 12.24, (3.64), NAph = 11.24 (3.24)	functioning, executive functioning, and attention.		
Yao, Liu & Lu et al. (2020)	China	Global, fluent, and non-fluent aphasia	PsychHis, NeuroHis, SensImp	27 (Aph = 10, HC = 17); Inpatient	Aph = 54.90 (12.58), HC = 54.00 (15.26); Aph = 11.40 (3.60), HC = 14.29 (4.96)	Orientation, visuospatial perception, intellectual functioning, executive functioning, and attention.	LOTCA – Chinese Version	21/22
Schumacher et al., (2022)	UK	Fluent and non-fluent aphasia	PsychHis, NeuroHis, SensImp	32	61.6 (11.4); 12.6 (2.7)	Attention	TEA (Robertson et al., 1994) Elevator Counting with and without distraction subtests.	19/22
Yan et al. (2022)	China	Fluent and non-	PsychHis, NeuroHis, SensImp	NA = 21, FA = 26, and NFA = 45	NA = 55.86 (15.048), FA = 57.19 (14.92), NFA	Visuospatial functioning, attention, memory,	MOCA, MMSE, and NLCA.	22/22

Study	Country	Type(s) of PSA	Exclusion criteria	Sample size; Setting	Average Age (SD); Average Years of Education (SD)	Area(s) of Cognition Tested	Measure(s)/Task(s) Used	Study Quality
		fluent aphasia			= 59.93 (12.52)	logical reasoning ability, executive functioning, and orientation.		

Table 2

Tests administered categorised by the area of cognitive functioning they were used to assess and frequency of use across the 17 papers

Cognitive Domain	Task/Test Used	Frequency
Global Cognitive Functioning	LOTCA	4
	OCS	2
	MOCA	2
	NEUPSLIN	1
	CNT	1
	MMSE	1
	NLCA	1
Memory	WMS-R: Digit Span	2
	All non-verbal subtests from the WMS-IV	1
	WMS-III: Spatial Span	1
	WMS-R: Memory of faces both immediate and delayed recall	1
	WMS-IV: Story recall	1
	CERAD: Word List Memory	1
	CERAD: Word List Recall	1
	CERAD: Word List Recognition	1
	CERAD: Praxis and Constructional Praxis Recall	1
	BCB-Edu: Visual Memory	1
	The Five Objects Memory Test	1
	Camel and Cactus Test	1
	RCF delayed recall	1
	Playing cards task	1
Attention	Visual cancellation	3
	TMT	2
	TEA: Elevator Counting with and without distraction)	2
	WAIS-IV: Symbol Search	1
	CPT-II	1
	TAP: Alertness	1
	TAP: GoNoGo	1
	TAP: Divided Attention	1
	TAP: Distractibility	1
Executive Functioning	The Brixton Test	2
	Tower Task (London/Hanoi)	2
	CDT	1

Cognitive Domain	Task/Test Used	Frequency
	WASI-II: Matrix reasoning	1
	BLAD: Motor initiative subtest	1
	D-KEFS: Design Fluency	1
	D-KEFS: Trail Making Test (number sequencing, letter sequencing, number-letter switching)	1
	The Kramer Test	1
	Raven's Progressive Matrices	1
Visuospatial Functioning	CDT	2
	VOSP	1
	RCF	1
Intellectual Functioning	Non-verbal subtests of WAIS-IV	1
	RPM	1
Social Cognition	-	0

Note: Frequency refers to the number of studies which administered the test. Since some tasks/tests may assess multiple cognitive areas simultaneously, the category tests were put under was informed by the articles. Although it has recently been suggested that the Tower of Hanoi and Tower of London tasks explore different underlying abilities, they were grouped together as authors used these to assess overall executive functioning (Fonseca et al., 2019; Schumacher et al., 2019).

Global Measures

Over half the studies involved the use of single measures which captured multiple domains of cognitive functioning. The global measures of cognitive functioning used in the studies included were: the LOTCA, NEUPSILIN-Af, OCS, BCoS, MOCA, MMSE, NLCA and CNT.

The most commonly used global measure was the LOTCA, which was used in four Chinese studies to assess orientation, visuospatial functioning, intellectual functioning, executive functioning, and attention, in individuals with post-stroke global, fluent, and non-fluent aphasia.

Although this is an occupational therapy screening tool, it may be an option for occupational therapists within multidisciplinary neurorehabilitation services.

The next most commonly used global measure was the OCS, specifically designed for those with PSA, to measure five domains: language deficits, numerical skills, memory, attention (including executive functioning and visuospatial abilities), and praxis. Demeyere et al. (2015) reported the development and validation of the OCS in 140 neurologically healthy individuals and 208 acute patients within three weeks of stroke. They reported that the OCS had robust validity, reliability, sensitivity and specificity. Demeyere et al. (2015) validated the OCS against the BCoS, which assessed similar domains using similar tasks with good psychometric properties, although takes around an hour to administer, whereas the OCS can be completed in 15-20 minutes.

Rodrigues et al. (2019) reported the validation of the NEUPSILIN-Af in a pilot of the measure involving 94 participants (49 post-stroke and 45 neurologically healthy). This measure was designed to test orientation, perception, memory, praxis, executive functions, oral language, and academic achievement (written language and arithmetic). Whilst they found that the orientation and executive functions tasks were essential components the results indicated that only the orientation, oral language, academic achievement, and executive function dimensions could be used to differentiate between the clinical and healthy groups.

Additionally, Yan et al. (2022) used the MOCA, MMSE, and NLCA, and Lee & Pyun (2014) explored the cognitive functioning of individuals with PSA compared to stroke survivors without aphasia, as well as the relationship between cognitive deficits and aphasia severity. The CNT was used, which assesses memory, attention, praxis, executive functioning, and intellectual functioning.

Individual Domains

Memory

Memory was one of the most frequently tested areas of non-verbal cognition, being investigated by 10 out of 17 papers. The tests used to assess memory in PSA largely originated from the Wechsler memory scales. Woods et al. (2017) used the WMS-IV to assess memory by using all of the non-verbal subtests alongside the Rey Complex Figure delayed recall task. Similarly, Thomson et al. (2015) used the digit span subtests from the WMS-R to test whether semantic 'access' impairment is a common problem for comprehension impaired people with stroke Wernicke's aphasia. Around a similar time, Bonini et al. (2015) applied the digit span from the WMS-R and word list tasks from the CERAD to test individuals with PSA, although they removed the time limit for the digit span tasks due to the verbal element. Nonetheless, the 47 individuals with aphasia still scored lower compared to stroke survivors without aphasia. Furthermore, Fonseca et al. (2019) aimed to explore the non-verbal cognitive functioning of people with PSA. They administered the immediate and delayed memory of faces from the WMS-II and the spatial span test from the WMS-III, alongside the five objects memory test and the camel and cactus test to capture non-verbal memory abilities in PSA. Lastly, Demeyere et al. (2015) used the story recall subtest when validating the OCS, although it is worth noting that the OCS is designed to also assess language alongside other non-verbal cognitive domains.

Besides studies including the Wechsler scales, Kaur et al. (2020) reported the development and validation of a comprehensive, home-based, caregiver delivered neuropsychological and language rehabilitation programme for stroke survivors. In their study, they used playing cards to test the memory of individuals with PSA after the rehabilitation programme.

Attention

Attention was tested in 14 out of 17 studies included. The most commonly used task to assess attention in individuals with fluent and non-fluent aphasia was visual cancellation, which was used in three studies. For example, Demeyere et al. (2015) used the BIT star cancellation task in their paper validating the OCS, which itself includes a task involving cancelling small heart symbols. Likewise, in their study specifically analysing the non-verbal cognitive functioning of 21 stroke survivors with aphasia and 26 without aphasia, Bonini et al. (2015) used a visual cancellation task, alongside trail making tests, to assess attention. Next, Fonseca et al. (2019) used a visual cancellation task to explore the non-verbal cognitive abilities of individuals with PSA. Although they reported using tests which were not strictly dependent on intact language abilities, they chose a letter cancellation task, and used this in combination with the symbol search subtest from the WAIS-IV (Wechsler, 2008).

Similarly, Schumacher et al. (2022) used the Elevator Counting test (with and without distraction) from the TEA, as did Thomson et al. (2015) in their study of semantic access deficits in individuals with PSA. Instead, in 2019, Schumacher et al. used the Alertness, GoNoGo, Divided Attention, and Distractibility subtests from the TAP (Mobility version 1.3.1; Zimmermann & Fimm, 1995), as well as the trail making tasks. Finally, Lee et al. (2020) recently conducted a study specifically into the attention deficits of 25 stroke survivors with fluent aphasia, and 89 with non-fluent aphasia. They used the Conners' Continuous Performance Test-II (CPT-II; Conners, 2000), a computerised test consisting of respondents pressing the space bar when any letter except the target letter "X" appears.

Executive Functioning

The domain of executive functioning was independently assessed in 13 of the 17 studies, and the most frequently administered task in this area was the clock drawing task, followed by the Brixton test and tower tasks (including the Tower of London task and the Tower of Hanoi task). Bonini et al. (2015) used the clock drawing task to specifically compare the executive functioning abilities of 21 individuals with PSA. Similarly, Fonseca et al. (2019) used the clock drawing task, although they also added the Tower of Hanoi (a measure of planning and problem solving; Shallice, 1982), the Matrix reasoning subtest of the WASI-II (which evaluates abstract reasoning), and the motor initiative task from the BLAD (a graphical patterns switching test; Garcia, 1984). Although Kaur et al. (2020) described the development and validation of a home-based, caregiver rehabilitation programme, they also used the clock drawing task to measure executive functioning in 15 stroke survivors with aphasia and 40 neurologically healthy controls.

Alternatively, Schumacher et al. (2019) used subtests from the D-KEFS, including the Design Fluency and Trail Making (parts 2–4) tasks (Delis et al., 2001), the former assessing non-verbal idea generation by requiring participants to draw as many different figures as possible (connecting dots with lines), and the latter assessing visuospatial attention, processing speed and flexibility by requiring participants to connect numbers (part 2), letters (part 3) or alternatingly both (part 4) in ascending order. They also administered a visuospatial planning task under executive functioning; the Kramer test (Balzer et al., 2011), a categorisation task requiring participants to find ways of sorting eight cards into two groups; the Raven's Coloured Progressive Matrices (Raven, 1962), assessing reasoning abilities; and the Brixton test (Burgess and Shallice, 1997), assessing visuospatial rule detection. Next, they also gave participants a computerised version of the Tower of London (TOL-F by Schuhfried; Kaller et al., 2011). This

was similar to Woods et al.'s (2017) case study, which involved measuring executive functioning of an 86-year-old man with non-fluent aphasia complaining of memory difficulties. They gave the participant the Trail Making Test (TMT) letter-number switch subtest from the D-KEFS, and the Wisconsin Card Sorting Test (WCST; Heaton, 1981).

Visuospatial Functioning

Including studies using global measures, visuospatial functioning was tested as an independent domain in 10 studies out of 17. Four of these included visuospatial tasks under the executive functioning or attention domains. The individual tasks and batteries used in the studies to assess visuospatial abilities in PSA included the VOSP, which was used by Thomson et al. (2015) in their case series into semantic access deficits in 21 stroke survivors with aphasia. Bonini et al. (2015) used tasks such as the clock drawing task to assess visuospatial skills. In Woods et al.'s (2017) single case study of an 86-year old man with PSA and memory difficulties, they asked the participant to complete a Rey Complex Figure copy task.

Intellectual Functioning

Although intellectual functioning has been suggested to relate to multiple areas of cognitive functioning (Wechsler, 2008), 2 out of 17 studies applied tests to focus specifically on overall intellectual ability to gain an understanding of 'intelligence' in PSA. Both were single case studies. Since many tools estimating premorbid intelligence rely on intact language difficulties, Puvanendran et al. (2016) used Raven's progressive matrices to estimate the non-verbal intelligence quotient of 32-year-old man without a phonological loop when comparing him to controls on numerical abilities. Similarly, Woods et al. (2017) tested the general intellectual abilities of the 86-year-old man in their case study who was experiencing memory difficulties via the nonverbal subtests from the WAIS-IV (Wechsler, 2008).

Social Cognition

Although social cognition is increasingly recognised as a separate domain of cognitive functioning with a ripple effect on systems around survivors of stroke, none of the studies included tasks specifically designed to test social cognition in individuals with PSA.

Study Quality

No study was excluded based on methodological quality. The quality ratings for each study are detailed in Appendix C (Table C.1). The ratings were used to assess the risk of bias and internal validity of each study given the nature of the current review was to explore which measures may be used to assess non-verbal cognitive functioning in PSA.

Overall, the quality of the studies included was good. The quality ratings ranged from 77% to 100%. All studies included a clear question or objective sufficiently described apart from one (Thomson et al., 2015). Most studies were cross-sectional in nature, which may limit the causal conclusions that can be drawn from the studies, however this did not impact the current review which aimed to systematically review the assessments used to measure non-verbal cognitive functioning in this population. The studies included key information about the characteristics of the sample, including age, gender, years of education, and time since onset of stroke. However, in some studies, detailed information about how participants were recruited was lacking (Lee et al. 2020; Schumacher et al., 2019; 2022; Thomson et al., 2015). In most studies, information about how the measures were administered beyond stating the assessments used was unavailable, which makes it difficult to know which adaptations need to be made to accommodate PSA.

None of the studies were interventional. One study described the development and validation of a treatment programme (Kaur et al. 2020). None of the studies included a power

analysis to determine the adequacy of the size of the sample, however, some studies did comment on the size of the sample by either referring to previous studies (Demeyere et al., 2015), or referring to chance logarithm units (Rodrigues et al., 2019).

The level of control over potential confounding variables was mixed. Most studies gathered information about age, gender, years of education, time since stroke, handedness, and multilingualism. Some studies also measured participants' mood (Fonseca et al., 2019; Kaur et al., 2020; Rodrigues et al., 2019; Woods, et al., 2017, Yao et al., 2020; Yao et al., 2020), which is increasingly recognised as a factor influencing cognitive functioning (Milan et al., 2012).

All studies gave clear and sufficient explanations of the results, apart from two, which were also rated as having weaker conclusions (Kaur et al., 2020; Yu et al., 2013).

Discussion

This review aimed to systematically review papers written since 2013 focusing on the assessment of non-linguistic cognitive functioning of adults with post-stroke fluent or non-fluent aphasia, to provide recommendations of assessment tools for clinicians to measure non-linguistic cognitive functions in this population.

Global Measures

Although Yu et al. (2013; 2013) and Yao et al. (2020; 2020) found the Chinese version of the LOTCA suitable to be used in clinical settings with this population, the relatively low sample sizes limit conclusions about the clinical utility of the LOTCA in UK neurorehabilitation settings. Moreover, Lee & Pyun (2014) used the CNT with a small sample of 26 individuals with aphasia in Korea, but did not comment on the measure's psychometric properties. Since the study also did not control for confounding variables, this is an important threat to validity.

Additionally, the CNT was not specifically designed for stroke survivors with aphasia, and factor analysis has previously shown it does not capture language abilities or sensorimotor coordination (Kim et al., 2001). These drawbacks limit its applicability to assess other stroke survivors with aphasia undergoing neurorehabilitation.

Rodrigues et al. (2019) piloted the NEUPSILIN to assess a range of cognitive functions, however they found that only the orientation, oral language, academic achievement and executive function dimensions could be used to differentiate between the 49 stroke survivors and 45 healthy controls. For neurorehabilitation teams, this suggests the measure may not capture the full range of non-linguistic cognitive impairments which individuals with which PSA may present.

Lastly, Yan et al. (2022) used the MOCA, MMSE, and the NLCA, however, these tools were not developed specifically for people with PSA. Instead, the Demeyere et al., (2015) and Puvanendran et al., (2016) papers described the validation and application of the OCS. This short screening measure was specifically designed for stroke survivors with communication difficulties and was used in the acute and long-term phases of rehabilitation. Although Puvanendran et al.'s (2016) study adopted a single case design, Demeyere et al. (2015) recruited a large sample of 140 healthy controls and 208 acute stroke patients, with results indicating it has strong reliability, validity, specificity and sensitivity. The OCS is also available in other languages and has recently been adapted to be administered online (Demeyere et al., 2021). This may be valuable in post-pandemic neurorehabilitation where telehealth is likely to be more prominent, as well as increasing accessibility for patients who have physical mobility difficulties preventing access to clinics. Uniquely, the researchers presented results with a visual snapshot of patient's strengths and relative difficulties. The OCS also has specific adaptions for individuals

with PSA (e.g. patients may point to names of towns instead of say them). Thus, the robust psychometric properties found by Demeyere et al. (2015), combined with the large UK sample, underline that the OCS is a valuable option for psychologists in acute and outpatient multidisciplinary neurorehabilitation services.

Individual Cognitive Domains

Memory

Thomson et al. (2015) and Bonini & Radanovic (2015) used subtests from the WMS-R to assess memory in individuals with PSA. Although, a major limitation of these studies is that the reliability and validity of the WMS-R in this population were not reported. Indeed, Murray et al. (2018) reviewed the use of subtests from the Wechsler memory scales (e.g., digit span), and found that many subtests rely on intact language or numerical abilities; even though people with PSA may struggle to understand the lengthy verbal instructions from the Wechsler memory scales. Woods et al. (2017) conducted a single case study which may not be generalisable to all people with PSA, nonetheless they specifically chose to use the non-verbal WMS-IV subtests. Similarly, Fonseca et al. (2019) used the spatial span from the WMS-III and memory of faces from the WMS-R. Using non-verbal tests improved these studies' quality as it reduced the confounding effect of aphasia on memory tests e.g., story recall, digit span, and word recall tasks in the Wechsler memory scales, and thus demonstrate the value of non-verbal tests for cognitive assessment in neurorehabilitation.

Attention

The review suggested that there are a variety of measures of attention available, including visual cancellation and trail making. However, the visual attention tests in Schumacher et al.'s (2019; 2022) studies relied on letters and numbers. This is a drawback of these studies, as

participants' language ability may limit their ability to read letters and numbers in these tests. It is therefore difficult to say that these studies validly measure attention. Instead, Fonseca et al. (2019) complemented the letter cancellation with a symbol search task which overcame this confounding variable. Despite this study's relatively low sample, such symbol searches may be a more valid option for assessing attention in this population.

Most recently, Lee et al. (2020) purely tested attention in PSA by using the CPT-II. This study used the test in a large sample of 114 individuals and they noted that it avoids other linguistically demanding tests of attention. This is in line with research suggesting it has good specificity and sensitivity and is feasible for individuals with aphasia (Lee and Sohlberg, 2013), making it a valuable option for neurorehabilitation clinicians.

Executive Functioning

Executive functioning was tested in most studies and this was mainly done via the Brixton test and the Tower tasks. Importantly, Wall et al. (2017) suggested that even with visual executive tasks, auditory comprehension may explain up to 53% of the variance. The researchers reported instructions for executive tests are lengthy, and repetition of instructions may be helpful for those with PSA. Additionally, answers to the Brixton test must be given verbally. This is important because Thomson et al.'s (2015) relied solely on the Brixton test, their study lacked a clear research question, the researchers did not control well for confounds nor offer an estimate of the variance, and there were few participants due to its case series design. Similarly, Schumacher et al.'s (2019) paper lacked a large sample to imply applicability to stroke survivors with PSA, however, in addition to Fonseca et al. (2019), the researchers complimented these tasks with simpler visual tasks such as the RPM and clock drawing, which may be useful adjunct to assess executive functioning in the wider population.

Visuospatial Functioning

One major drawback of the studies included was that some researchers categorised visuospatial tasks within a separate category, and some under executive functioning, which makes it difficult to develop clear recommendations as to which tasks should be used for which cognitive domain in neurorehabilitation.

Bonini et al. (2015) used the clock drawing task to assess visuospatial skills, however the clock drawing test has been critiqued for having questionable validity (Adunsky et al., 2002) and poor interrater reliability in scoring. In Woods et al.'s (2017) single case study of an 86-year old man with PSA and memory difficulties, they asked the participant to complete a Rey Complex Figure task. One drawback of this study was its single case design limiting its applicability to other stroke survivors with aphasia. However, the RCF visual tasks rely less on language and numerical abilities, which supports the validity of the assessment of visuospatial abilities in this study. However, such tasks combine several aspects of visual processing, as well as motor functions, making it difficult to single out visual perceptual disorders in PSA (Annegarn, 2017).

Despite the drawbacks of a case series design, Thomson et al. (2015) used the VOSP to assess semantic 'access' deficits in 21 stroke survivors with aphasia. The VOSP is a test battery intended to evaluate visual perception problems in stroke survivors, relatively independently of other cognitive and motor processes required by the CDT and Rey Complex Figure used in other studies in this review. Recently, Annegarn (2017) tested the validity of the VOSP for stroke survivors. The factor analysis, with a larger sample than Thomson et al.'s (2015) case series, supported this assessment's validity for assessing stroke survivors. The VOSP also has individual subtests that can be used independently, which further supports its usefulness for neurorehabilitations teams (Annegarn, 2017).

Intellectual Functioning

Interestingly, many measures used post-stroke to capture premorbid intellectual functioning, such as the NART, WTAR, and TOPF, rely heavily on intact language abilities, which is a major threat to validity for assessing individuals with PSA. Within this review, Puvanendran et al., (2016) used Raven's progressive matrices, and Woods et al. (2017) used all of the non-verbal subtests of the WAIS-IV. Despite the low generalisability of these single case studies, the application of non-verbal assessments was more valid in these studies, and thus may be a valuable way for clinicians to explore this area in neurorehabilitation. This is in line with literature suggesting verbal tasks such as those on the WAIS-IV may not be appropriate for this population (Fucetola et al., 2009). Nonetheless, few studies in this review aimed to capture intelligence, therefore the use of non-verbal measures to capture intellectual functioning in stroke populations warrants further investigation before solid conclusions may be drawn for neurorehabilitation services.

Social Cognition

One major finding from the current review was the distinct lack of tests for social cognition difficulties in individuals with PSA. This is surprising because relationships have been found to be important for stroke survivors (Setyoadi et al., 2019), and may be affected by a variety of verbal and non-verbal cognitive abilities. Since social cognition deficits may have a ripple effect on individuals and whole family systems (Yasmin & Riley, 2021), future research is urgently needed into which tools may be helpful in assessing social cognition difficulties in people with PSA and guide support for individuals and families to maintain healthy relationships in the face of language difficulties after injury.

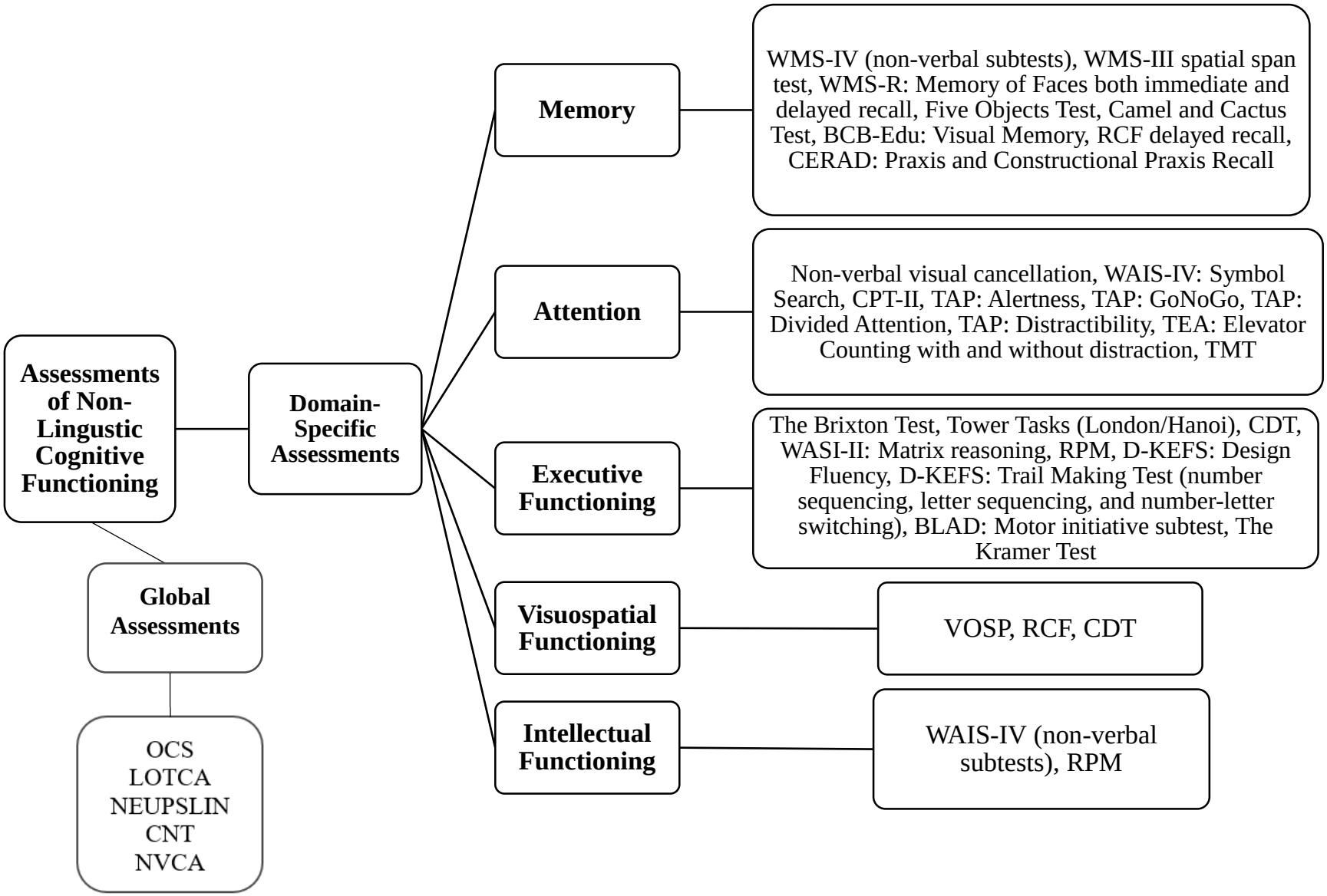
Implications

Although further research is needed into existing measures as well as post-stroke specific cognitive assessments (Abzhandadze et al., 2021; Salis et al., 2015), the measures identified in the present review could be valuable options for rehabilitation clinicians to assess the non-linguistic cognitive functioning of individuals with fluent and non-fluent aphasia post-stroke. Clinicians in fast-paced NHS neurorehabilitation services may draw upon the range of measures captured in this review based on the clinical setting, the areas of cognition they may need to assess, and the time taken to administer the measures.

Since many studies took place in other countries, this underlines the importance of cultural sensitivity when applying measures of non-linguistic cognitive functioning to diverse populations in UK neurorehabilitation services. There may have been sources of biases due to the studies having been conducted in different countries, such as differences between standardisation samples, examiner and language bias, and differing social and educational opportunities. Moreover, concepts and cognitive patterns may not be universal across languages and cultures, therefore issues with directly translating assessments might have been present. Thus, there is an increasing need for tests and norms in different languages and cultures, and there may be clinical applications for adopting an individualised approach to assessment, such as using interpreters trained in cognitive assessment and measures validated in patients' culture of origin to assess their cognitive functioning whilst minimising the risk of cultural bias. The assessments that were found in the papers which can be used for each area of non-linguistic cognitive functioning in PSA are represented visually for neurorehabilitation teams in Figure 3.

Figure 3

A Summary of Recommended Assessments to Measure Various Non-linguistic Cognitive Functions in PSA



Strengths and Limitations

This study is the first to conduct a comprehensive systematic review of multiple databases spanning the past ten years of studies into assessments of non-linguistic cognitive functioning for individuals with PSA. It included a detailed quality appraisal process absent from previous reviews, and provides a clear overview of the cognitive assessments used in PSA over the past ten years with helpful recommendations for fast-paced multidisciplinary teams. It includes papers from several different countries, summarising a wide variety of online/in person, short screens versus longer batteries for inpatient and outpatient settings.

However, there was some inconsistency in how the papers used the same test to assess different areas of cognitive functioning. This makes it challenging to make clear guidelines for clinicians about which tests should be used in which situation. Moreover, many studies used different versions of measures e.g., subtests of the WMS-R versus WMS-III, making it difficult to compare across studies and many of the reported measures have been replaced by more up-to-date versions in neurorehabilitation services.

Although most of the studies used standardised measures, the primary aim of most studies was to describe the cognitive functioning of individuals with post-stroke fluent and non-fluent aphasia. Since most studies, apart from the validation papers, did not focus on the assessment tools used, the studies lacked key information about the psychometric properties of the tools the researchers chose, and adaptations made for patients. Therefore, it is difficult to draw conclusions about the clinical utility of the measures used, including the validity, reliability, specificity, and sensitivity of the assessments for stroke survivors with aphasia. Combined with the limited sample sizes in most of the papers, this also limits the generalisability of the findings to the wider population and suggests the need for further large-scale studies in this area.

Conclusions

This study aimed to systematically review and evaluate papers written since 2013 focusing on the assessment of non-linguistic cognitive functioning of adults with post-stroke fluent or non-fluent aphasia. This was to provide recommendations regarding assessment tools for neurorehabilitation clinicians to measure non-linguistic cognitive functions in these individuals. Although no measure is without limitations, and further research is needed in light of a lack of assessments designed for people with PSA (Wall et al., 2017), this review brings together the assessments used over the past ten years to assess key areas of non-linguistic cognitive functioning in individuals with communication difficulties following stroke, including global measures, as well as individual tests of memory, attention, executive functioning, visuospatial abilities, and intellectual functioning. These tools may allow clinicians to understand patients' cognitive profiles and identify strengths and relative difficulties to guide rehabilitation, and illustrate that in neurorehabilitation settings, 'It's not what you do, but how you measure it' (Hesketh & Hopcutt, 1997).

References

Abzhandadze, T., Buvarp, D., Lundgren-Nilsson, Å., & Sunnerhagen, K. S. (2021). Barriers to cognitive screening in acute stroke units. *Scientific Reports*, *11*(1), 1-9.

Adunsky, A., Fleissig, Y., Levenkrohn, S., Arad, M., Nov, S. (2002). Clock drawing task, mini-mental state examination and cognitive-functional independence measure: relation to functional outcome of stroke patients. *Arch Gerontol Geriatr*, *35*(2), 153-60.

Annegarn, F.J. (2017) Validity of the Visual Object and Space Perception battery (VOSP) in stroke patients with posterior brain lesions. The University of Amsterdam.

Balzer C, Berger JM, Caprez G, Gonser A, Gutbrod K, Keller M. Materialien und Normwerte fuer die neuropsychologische Diagnostik (MNND). Rheinfelden, Switzerland: Verlag Normdaten; 2011.

Barrett, A. M. (2021). Spatial neglect and anosognosia after right brain stroke. *Continuum (Minneapolis, Minn.)*, *27*(6), 1624.

Bonini, M. V., & Radanovic, M. (2015). Cognitive deficits in post-stroke aphasia. *Arquivos de Neuro-psiquiatria*, *73*, 840-847.

Bowen, C., Hall, T., Newby, G., Walsh, B., Weatherhead, S., & Yeates, G. (2009). The impact of brain injury on relationships across the lifespan and across school, family and work contexts. Human Systems: *The Journal of Consultation and Training*, *20*, 65-80.

Bozeat S, Lambon Ralph MA, Patterson K, Garrard P, Hodges JR. Non-verbal semantic impairment in semantic dementia. *Neuropsychologia 2000; 38*: 1207–15.

Burgess, P. W., & Shallice, T. (1997). The Hayling and Brixton tests.

Caramazza, A., & Hillis, A. (1993). For a theory of remediation of cognitive deficits. *Neuropsychological Rehabilitation*, *3*(3), 217-234.

Cipolotti, L., & Warrington, E. K. (1995). Neuropsychological assessment. *Journal of Neurology, Neurosurgery, and Psychiatry*, *58*(6), 655.

Conners, K. C., & Staff, M. H. S. (2004). Conners' Continuous Performance Test II. CPT II. North Tonawanda, NY: Multi-Health Systems.

Demeyere, N., Riddoch, M. J., Slavkova, E. D., Bickerton, W. L., & Humphreys, G. W. (2015). The Oxford Cognitive Screen (OCS): validation of a stroke-specific short cognitive screening tool. *Psychological Assessment*, *27*(3), 883.

Demeyere, N., Haupt, M., Webb, S. S., Strobel, L., Milosevich, E. T., Moore, M. J., ... & Duta, M. D. (2021). Introducing the tablet-based Oxford Cognitive Screen-Plus (OCS-Plus) as an assessment tool for subtle cognitive impairments. *Scientific Reports*, *11*(1), 1-14.

Døli, H., Andersen Helland, W., Helland, T., & Specht, K. (2021). Associations between lesion size, lesion location and aphasia in acute stroke. *Aphasiology*, *35*(6), 745-763.

Dowker, A. (1998). “Individual differences in arithmetical development,” in The Development of Mathematical Skills, ed C. Donlan (London: Taylor and Francis),

Fillenbaum, G. G., Burchett, B. M., Unverzagt, F. W., Rexroth, D. F., & Welsh-Bohmer, K. (2011). Norms for CERAD constructional praxis recall. *The Clinical Neuropsychologist*, *25*(8), 1345-1358.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-Mental State Examination (MMS, MMSE) [Database record]. APA PsycTests.

Fonseca, J., Ferreira, J. J., & Martins, I. P. (2016). Cognitive performance in aphasia due to stroke: a systematic review. *International Journal on Disability and Human Development*, *16*(2), 127-139.

Fonseca, J., Raposo, A., & Martins, I. P. (2018). Cognitive functioning in chronic post-stroke aphasia. *Applied Neuropsychology: Adult*.

Fucetola, R., Connor, L. T., Strube, M. J., & Corbetta, M. (2009). Unravelling nonverbal cognitive performance in acquired aphasia. *Aphasiology*, *23*(12), 1418-1426.

Garcia, C. (1984). A Doença de Alzheimer: problemas do diagnóstico clínico (Doctoral dissertation, Universidade de Lisboa (Portugal)).

Geschwind, N. (1965a). Disconnexion syndromes in animals and man. I. *Brain*, *88*, 237–294.

Geschwind, N. (1965b). Disconnexion syndromes in animals and man. II. *Brain*, *88*, 585–644.

Gialanella, B., Bertolinelli, M., Lissi, M., & Prometti, P. (2011). Predicting outcome after stroke: the role of aphasia. *Disability and Rehabilitation*, *33*(2), 122-129.

Gordon, J. K. (2020). Factor Analysis of Spontaneous Speech in Aphasia. *Journal of Speech,*

Language, and Hearing Research, *63*(12), 4127-4147.

Grant, D. A., & Berg, E. (1948). A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card-sorting problem. *Journal of Experimental Psychology*, *38*(4), 404–411.

Hesketh, A., & Hopcutt, B. (1997). Outcome measures for aphasia therapy: It's not what you do, it's the way that you measure it. *European Journal of Disorders of Communication*, *32*(sup1), 189-202.

Hilari, K. (2011). The impact of stroke: are people with aphasia different to those without? *Disability and Rehabilitation*, 33(3), 211 - 218.

Humphreys, G. W., Bickerton, W. L., Samson, D., & Riddoch, M. J. (2012). BCoS cognitive screen.

Katz, N., Itzkovich, M., Averbuch, S., & Elazar, B. (1989). Loewenstein Occupational Therapy Cognitive Assessment (LOTCA) battery for brain-injured patients: reliability and validity. *The American Journal of Occupational Therapy*, *43*(3), 184-192.

Kaur, H., Nehra, A., Chopra, S., Sati, H., Bhatia, R., Kumaran, S. S., ... & Srivastava, M. P. (2020). Development and validation of a comprehensive neuropsychological and language rehabilitation for stroke survivors: A home-based caregiver-delivered intervention program. *Annals of Indian Academy of Neurology*, *23*(Suppl 2), S116.

Kim, Y. H., Shin, S. H., Park, S. H., & Ko, M. H. (2001). Cognitive assessment for patient with brain injury by computerized neuropsychological test. *Journal of the Korean*

Academy of Rehabilitation Medicine, 209-216.

Kincheloe, H., Off, C., Murphy, M., Griffin-Musick, J., Murray, K., & Jakober, D. (2022). "We all have coping and communication problems". Experiences of stroke survivors living with aphasia and graduate student clinicians who participated in a telehealth interprofessional psychoeducation and wellness group. *Aphasiology*, 1-24.

Kitzmüller, G., Asplund, K., & Häggström, T. (2012). The long-term experience of family life after stroke. *Journal of Neuroscience Nursing*, *44*(1), E1-E13.

Kmet, L. M., Cook, L. S., & Lee, R. C. (2004). Standard quality assessment criteria for evaluating primary research papers from a variety of fields.

Lee, J. B., Kocherginsky, M., & Cherney, L. R. (2020). Attention in individuals with aphasia: Performance on the Conners' Continuous Performance Test–2nd edition. *Neuropsychological Rehabilitation*, *30*(2), 249-265.

Lee, B., & Pyun, S. B. (2014). Characteristics of cognitive impairment in patients with post-stroke aphasia. *Annals of Rehabilitation Medicine*, *38*(6), 759-765.

Lohman, D. F., Korb, K., & Lakin, J. (2008). Identifying academically gifted English language learners using nonverbal tests: A comparison of the Raven, NNAT, and CogAT. *Gifted Child Quarterly*, *52*, 275-296.

Mahon, B. Z., & Cantlon, J. F. (2011). The specialization of function: Cognitive and neural perspectives. *Cognitive Neuropsychology*, *28*(3-4), 147-155.

Manning, M., MacFarlane, A., Hickey, A., Galvin, R., & Franklin, S. (2020). The relevance

of stroke care for living well with post-stroke aphasia: a qualitative interview study with working-aged adults. *Disability and Rehabilitation*, 1-13.

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., ... & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society*, *53*(4), 695-699.

Nitrini, R., Caramelli, P., Porto, C. S., Charchat-Fichman, H., Formigoni, A. P., Carthery-Goulart, M. T., ... & Prandini, J. C. (2007). Brief cognitive battery in the diagnosis of mild Alzheimer's disease in subjects with medium and high levels of education. *Dementia & Neuropsychologia*, *1*, 32-36.

Rey, A., & Osterrieth, P. A. (1941). Rey-Osterrieth Complex Figure Copying Test [Database record]. APA PsycTests.

Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan -a web and mobile app for systematic reviews. *Systematic Reviews*, *5*, 210.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *International Journal of Surgery*, *88*, 105906.

Papageorgiou, S. G., Economou, A., & Routsis, C. (2014). The 5 Objects Test: a novel, minimal-language, memory screening test. *Journal of Neurology*, *261*(2), 422-431.

Moore, M. J., & Demeyere, N. (2022). Lesion symptom mapping of domain-specific

cognitive impairments using routine imaging in stroke. *Neuropsychologia*, 108159.

Potagas, C., Kasselimis, D., & Evdokimidis, I. (2011). Short-term and working memory impairments in aphasia. *Neuropsychologia*, *49*(10), 2874-2878.

Pringle, J., Hendry, C., McLafferty, E., & Drummond, J. (2010). Stroke survivors with aphasia: personal experiences of coming home. *British Journal of Community Nursing*, *15*(5), 241-247.

Puvanendran, K., Dowker, A., & Demeyere, N. (2016). Compensating arithmetic ability with derived fact strategies in Broca's aphasia: a case report. *Neurocase*, *22*(2), 205-214.

Raven, J., & Raven, J. (2003). Raven Progressive Matrices. In R. S. McCallum (Ed.), Handbook of nonverbal assessment (pp. 223–237). Kluwer Academic/Plenum Publishers.

Robertson, I. H., Ward, T., Ridgeway, V., & Nimmo-Smith, I. (1996). Structure of normal human attention: The Test of Everyday Attention. *Journal of the International Neuropsychological Society*, *2*(6), 525–534.

Rodrigues, J. D. C., Machado, W. D. L., da Fontoura, D. R., Almeida, A. G., Brondani, R., Martins, S. O., ... & Salles, J. F. D. (2019). What neuropsychological functions best discriminate performance in adults post-stroke? *Applied Neuropsychology: Adult*, *26*(5), 452-464.

Salis, C., Kelly, H., & Code, C. (2015). Assessment and treatment of short-term and working memory impairments in stroke aphasia: a practical tutorial. *International*

Journal of Language & Communication Disorders, *50*(6), 721-736.

Salis, C., Murray, L., & Vonk, J. M. (2021). Systematic review of subjective memory measures to inform assessing memory limitations after stroke and stroke-related aphasia. *Disability and Rehabilitation*, *43*(11), 1488-1506.

Salter, K., Jutai, J., Foley, N., Hellings, C., & Teasell, R. (2006). Identification of aphasia post stroke: a review of screening assessment tools. *Brain Injury*, *20*(6), 559-568.

Schumacher, R., Halai, A. D., & Lambon Ralph, M. A. (2019). Assessing and mapping language, attention and executive multidimensional deficits in stroke aphasia. *Brain*, *142*(10), 3202-3216.

Schumacher, R., Halai, A. D., & Ralph, M. A. L. (2022). Attention to attention in aphasia–elucidating impairment patterns, modality differences and neural correlates. *Neuropsychologia*, *177*, 108413.

Setyoadi, S., Nasution, T. H., & Kardinasari, A. (2019). Family Support in Improving Independence of Stroke Patients. *Jurnal Ilmu Keperawatan: Journal of Nursing Science*, *6*(1), 96-107.

Simon, H. A. (1975). The functional equivalence of problem solving skills. *Cognitive Psychology*, *7*(2), 268-288.

Thompson, H. E., Robson, H., Lambon Ralph, M. A., & Jefferies, E. (2015). Varieties of semantic 'access' deficit in Wernicke's aphasia and semantic aphasia. *Brain*, *138*(12), 3776-3792.

Villa, D., & Riley, G. A. (2017). Partners' experiences of relationship continuity in acquired brain injury. *Cogent Psychology*, *4*(1), 1380891.

Vukovic, M., Milovanovic, T., & Miller, N. (2021). Assessing oral word reading ability in Serbian speakers with acquired aphasia. *Journal of Neurolinguistics*, *59*, 101003.

Warrington, E. K., & James, M. (1991). The visual object and space perception battery.

Weaver, N. A., Kancheva, A. K., Lim, J. S., Biesbroek, J. M., Wajer, I. M. H., Kang, Y., ... & Bae, H. J. (2021). Post-stroke cognitive impairment on the Mini-Mental State Examination primarily relates to left middle cerebral artery infarcts. *International Journal of Stroke*, 1747493020984552.

Wechsler, D. (1987). *Wechsler memory scale-revised manual*. San Antonio, TX: The Psychological Corporation.

Wechsler, D. (1997). *Wechsler memory scale-third edition administration and scoring manual*. San Antonio, TX: Pearson Assessments.

Wechsler, D. (2008). *Wechsler Adult Intelligence Scale--Fourth Edition (WAIS-IV)* [Database record]. APA PsycTests.

Wechsler, D. (2009). *Wechsler Memory Scale--Fourth Edition (WMS-IV)* [Database record]. APA PsycTests.

Wechsler, D. (2011). *Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II)*. San Antonio, TX: NCS Pearson.

Wilson, B., Cockburn, J., & Halligan, P. (1987). Development of a behavioral test of

visuospatial neglect. *Archives of Physical Medicine and Rehabilitation*, *68*(2), 98-102.

Wilson, B. (1991). Theory, assessment, and treatment in neuropsychological rehabilitation. *Neuropsychology*, *5*(4), 281.

Woods, D., Sirirat, S., Pattara-Angkoon, S., & Rattanajan, J. (2017). Neuropsychological assessment of 86-year-old man with Broca's aphasia complaining of memory difficulties. *Applied Neuropsychology: Adult*, *24*(6), 577-586.

Wu, J., Liu, X., Wu, X., & Wang, Q. (2013). Validation of the non-language-based cognitive assessment. *International Journal of Cerebrovascular Diseases*, 282-287.

Yao, J., Liu, X., Liu, Q., Wang, J., Ye, N., Lu, X., ... & Zhang, Y. (2020). Characteristics of non-linguistic cognitive impairment in post-stroke aphasia patients. *Frontiers in Neurology*, *11*, 1038.

Yao, J., Liu, X., Lu, X., Xu, C., Chen, H., & Zhang, Y. (2020). Changes in white matter microstructure related to non-linguistic cognitive impairment in post-stroke aphasia. *Neurological Research*, *42*(8), 640-648.

Yan, Z., Xu, S., Wei, D., He, X., Li, C., Zhang, Y., ... & Jia, J. (2022). Comparison of three cognitive assessment methods in post-stroke aphasia patients. *Frontiers in Psychology*, *13*.

Yasmin, N., & Riley, G. A. (2021). Are spousal partner perceptions of continuity and discontinuity within the relationship linked to the symptoms of acquired brain injury? *Disability and Rehabilitation*, 1-8.

Yu, Z. Z., Jiang, S. J., Bi, S., Li, J., Lei, D., & Sun, L. L. (2013). Relationship between linguistic functions and cognitive functions in a clinical study of Chinese patients with post-stroke aphasia. *Chinese Medical Journal*, *126*(07), 1252-1256.

Yu, Z. Z., Jiang, S. J., Li, J., Bi, S., Li, F., Xie, T., ... & Zhang, X. T. (2013). Clinical application of loewenstein occupational therapy cognitive assessment battery-in evaluating of cognitive function of Chinese patients with post-stroke aphasia. *Chinese Medical Sciences Journal*, *28*(3), 167-171.

Zimmermann, P. & Fimm, B. "A Test Battery for Attentional Performance," *Applied Neuropsychology of Attention*, *20*, No. 2, 2002, pp. 110-151.

Service Improvement Project

Improving the Rehabilitation of Individuals Admitted to the National Spinal Injuries Centre with Traumatic Brain Injury

Lawson Falshaw

lawson.falshaw@hmc.ox.ac.uk

The Oxford Institute of Clinical Psychology Training and Research

University of Oxford

Internal Supervisor: Dr Nigel King, The Oxford Institute of Clinical Psychology Training and Research

External Supervisor: Dr Imogen Cotter, Buckinghamshire Healthcare NHS Trust

Proposed Journal: Spinal Cord

Rationale: This journal has been chosen because it is a specialised, international, and multidisciplinary journal that publishes spinal cord related manuscripts, including spinal cord anatomy, physiology, management of injury and disease, and the quality of life and life circumstances of people with a spinal cord injury.

Word Count: 5213

May 2023

Abstract

Study Design: Mixed methods service improvement project. Retrospective analysis of clinical documentation and qualitative focus group with clinicians.

Objectives: Although traumatic brain injury (TBI) and spinal cord injury (SCI) often co-occur, many barriers have been found to identifying TBI in SCI rehabilitation and adapting treatment accordingly. This study aimed to compare the number of TBIs detected at the UK National Spinal Injury Centre to figures found in previous research, and understand the barriers to adapting SCI rehabilitation in the presence of TBI.

Setting: United Kingdom inpatient spinal cord injury rehabilitation unit.

Methods: This mixed methods study assessed the documentation at each stage of 88 patients' treatment where a TBI could be detected and used to inform rehabilitation, and subsequently, a focus group was conducted with staff to explore the barriers to detecting TBI and adapting SCI rehabilitation.

Results: Results suggested that data related to TBI were inconsistently recorded, the number of TBIs at the Centre was lower than previous research, and several barriers were interpreted from the focus group.

Conclusions: TBI in SCI populations may be an invisible unmet need. Several barriers may exist which prevent clinicians from detecting TBI in this population and adapting rehabilitation accordingly. Findings have implications for rehabilitation for individuals with TBI and SCI admitted to the service.

Improving the Rehabilitation of Individuals Admitted to the National Spinal Injuries Centre with Traumatic Brain Injury

Recent NHS data suggest that 50,000 people in the UK alone are living with a Spinal Cord Injury (SCI; SIA, 2021). These conditions can be life changing for the person directly involved, as well as having a ripple effect on loved ones around them, and wider economic impacts on society (McDaid, et al., 2019). Although traditionally investigated separately (Badhiwala et al., 2019; James et al., 2019), one of the most commonly co-occurring conditions when someone suffers an SCI is Traumatic Brain Injury (TBI). Some research indicates that between 20% to 60% of people with a SCI will also have at least a mild TBI, particularly in those who acquire a traumatic SCI through motor collisions and falls (Budisin et al., 2019; Macciocchi, et al., 2008; Melo Neto et al., 2014).

Research suggests that having both an SCI and TBI poses unique rehabilitation challenges compared to having either condition alone. Firstly, individuals with both conditions may require additional adjustments during SCI rehabilitation, such as a longer stay in inpatient settings (Vova et al., 2020). These individuals may also need early discharge planning and rehabilitation professionals and carers may need additional training to ensure more time and personalised support is provided so that the individual can safely return home (Nott et al., 2014). Those with both conditions may also face the potential cognitive difficulties of a TBI. Processing speed, memory, problem solving and language skills may be impaired by a TBI, all of which are key in the learning involved in all aspects of the SCI rehabilitation process (Macciocchi, et al., 2012). Depending on the severity of the injury, patients may suffer major cognitive impairments impacting their SCI rehabilitation. Some patients, however, may acquire milder cognitive impairments associated with mild TBI, and there is therefore a risk that these difficulties will be missed by rehabilitation professionals, thus limiting the therapeutic gains which can be made through rehabilitation (Bradbury et al.,

2008). Moreover, although most with a mild TBI will make a full recovery, a minority will still be recovering at 3-6 months and a smaller minority will have long-term or permanent deficits which can impact on rehabilitation. Suffering a TBI in addition to a SCI may also have a greater emotional and relational impact on the survivor and their families as they adapt to life with both conditions (VanDerwerke et al., 2019).

Due to these difficulties associated with TBI often being 'hidden', theories around 'invisible disabilities' after TBI provide the theoretical framework for the current study. The theory suggests that people with invisible disabilities may not 'pass' as having a disabled identity, as their difficulties are not represented visually. Since their difficulties are not 'seen', they are not 'read' as disabled, which may lead to other people developing negative beliefs about people with hidden disabilities 'looking well', and their additional needs may not be recognised as the external appearance does not match internal reality (Hendry et al., 2022). Applied to TBI, invisible disability theory may predict that invisible disabilities associated with TBI may not be 'seen' by clinicians working in a spinal injury context where disability is typically marked through visual cues. Thus, patients may be labelled rather than invisible disabilities being identified which are attributed to a potential underlying TBI. This may thus mean that TBI may be under-detected, and the additional needs of someone with a TBI in addition to an SCI may not be fully met.

Despite the high concurrence of SCI and TBI and the additional barriers faced by those with a dual diagnosis and their families, TBI in those with a spinal injury remains poorly detected. Previous literature has highlighted many barriers to spinal injury services in detecting and tailoring rehabilitation to patients with a TBI. For example, TBI often is not considered by rehabilitation professionals, is poorly documented, and cognitive screens may not be administered (Sikka et al., 2019; Mohamed et al., 2017). One recent study by Sharma and colleagues (2014) found that more than half of patients referred to acute settings for

traumatic SCI rehabilitation had TBIs which had been missed, with more TBIs being missed in falls and assaults compared to motor accidents. Therefore, the researchers suggested rehabilitation professionals may have varying perceptions about how often TBI occurs based on the mechanism of injury. Nonetheless, recent guidelines state that SCI rehabilitation services should be screening for TBIs in this population; the clinical reference group, who set standards for the UK SCI rehabilitation centres has agreed, for the first time, for pre-screening of psychological needs associated with TBI to be part of their core recommendations.

Service Context

This project aims to assess and improve the detection and consideration of TBIs in those undergoing rehabilitation at the National Spinal Injuries Centre (NSIC) in Stoke Mandeville Hospital in Buckinghamshire, a 114 bed rehabilitation unit for people adjusting to life after a SCI. Although the NSIC is specialised in spinal injury rehabilitation rather than brain injury, due to the nature of SCIs, research suggests many individuals admitted to NSIC with SCIs may also experience at least a mild-moderate TBI (Craig et al., 2017). Furthermore, despite the clinical reference group's new guidance, initial discussions with outreach and inpatient staff suggested TBIs are often not detected at NSIC or not recorded prior to referral, and are often not routinely screened for upon admission.

The Current Study

Thus, this service improvement project aims to address the following questions emerging from the existing literature and the service needs at the NSIC: Firstly, is the number of patients reported to have TBI by the NSIC in line with national figures suggested by existing research? Next, what are the barriers to identifying and considering TBI during rehabilitation according to clinicians? The project subsequently aims to improve the NSIC's detection and response to TBI in patients admitted for SCI rehabilitation.

Phase One

The project was designed and divided into three phases based on consultation with senior NSIC clinicians and expert by experience involvement at the NSIC. Phase one consisted of auditing the number of TBIs detected by the NSIC and comparing this figure with previous research.

Participants

The records for 88 patients, newly admitted between June 2020 to July 2021 were screened. 65 patients were male (73.86%), 23 were female (26.14%), and patients' ages ranged from 18 to 83 (M = 57.27 years, SD = 17.32). The most common type of SCI in the sample was traumatic SCI, affecting 51 patients (58%), and the most common mechanism of injury was falls, which was the case for 40 patients (45%).

Design and Materials

A quantitative, between-groups design was used to compare the number of TBIs recorded by the NSIC to previous research. All documents were screened through electronic health records accessed through Trust computers. This study received ethical approval from Buckinghamshire Healthcare NHS Trust as a quality improvement project.

Procedure

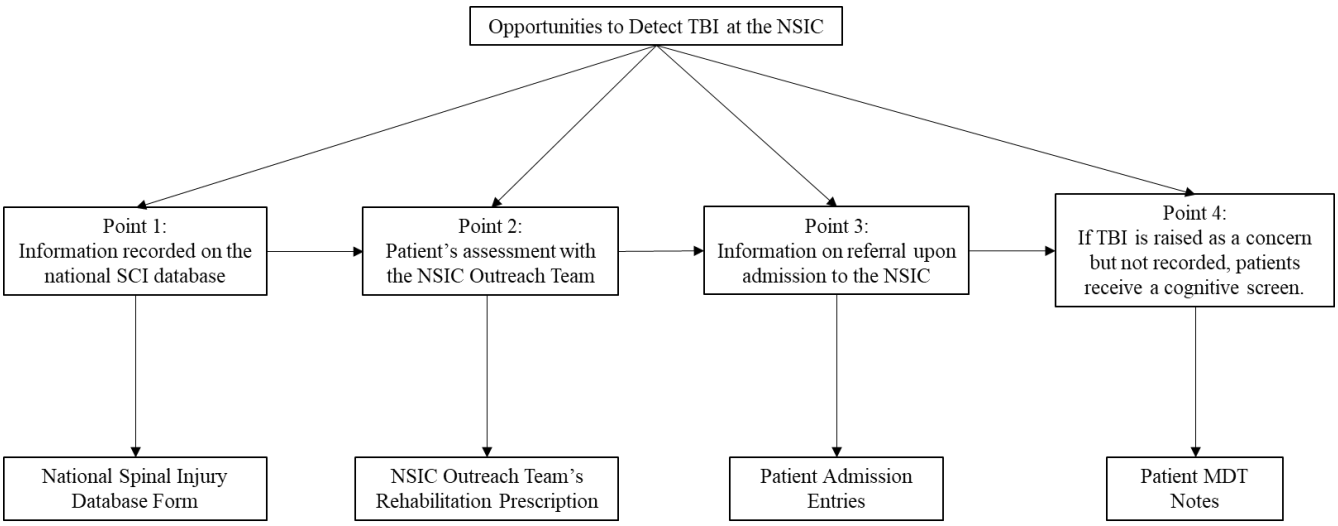
The patient records were screened with reference to the four different opportunities that clinicians have to detect TBI throughout a patient's journey at the NSIC. These stages are represented in Figure 1 below. Firstly, the referral forms from the national spinal injury database were screened, as this is where all information related to spinal injury is recorded and then sent to the NSIC. Secondly, the rehabilitation prescriptions, records for each patient's assessment by the NSIC outreach team, were screened as these documents are passed on to the NSIC clinicians upon admission. Next, the admission entry for each patient was assessed, as this represents information about patients' health at the time of entering the

inpatient service. Finally, all of the MDT notes for each patient were screened, as were the goal-planning meeting sheets for patients with a recorded TBI, since these documents contained information about patients' physical health and neuropsychological status throughout their admission, and how this informed their rehabilitation.

The criteria for assessing whether a patient was deemed to have a TBI were pre-determined through the National Institute for Health and Care Excellence guidelines on the assessment of traumatic brain injury (NICE, 2013), and previous studies into TBI and SCI comorbidity (Macciocchi, et al., 2008). A mild-moderate TBI was considered as a blow to the head resulting in post-traumatic amnesia (PTA) for under 24 hours, a Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) score between 9-15, and/or loss of consciousness (LOC) of fewer than 15 minutes. A severe/very severe TBI was considered present if PTA was more than 24 hrs, a patient had a GCS score of below 9, there was LOC for more than 15 minutes, and/or there were positive results identified on a brain scan. Additionally, specific mention of TBI and/or cognitive difficulties was recorded.

Figure 1

The Different Points at Which TBI May Be Detected at the NSIC, and the Corresponding Documents Screened.



Analysis

The number of TBIs detected by the NSIC was compared with figures suggested by recent research in another major spinal injury centre (Craig et al., 2017a). This was done by conducting a one sample proportions test in SPSS. This study was chosen as a comparator because it is the most recent large scale study exploring the number of TBIs in patients admitted for SCI rehabilitation across three SCI rehabilitation centres. It assessed patients throughout rehabilitation, and it assessed TBI comorbidity across all types of SCI.

Results

Regarding the pre-determined search criteria for TBI, the relevant data were recorded inconsistently. According to patient records, zero patients had brain scan results indicative of TBI. GCS scores from the national database referral forms were available for 70 patients, with 61 patients scoring 15, eight scoring 14, one patient scoring three, and 18 patients not having any recorded GCS scores. PTA was recorded for two patients but the duration was not given. Six patients had been recorded as losing consciousness upon injury, although the duration of amnesia was not recorded.

Qualitatively, 11 patients had a TBI diagnosis stated in their records (13.6%), which is significantly fewer than even the lowest proportions found in previous research (z = -2.6, p = .009). 10 of the 11 patients with a recorded TBI diagnosis had goal planning sheets available, none of which included reference to TBI, and only two of which stated cognitive difficulties which may or may not have been associated with TBI. For the 11 patients with a TBI, one person's was noted in the national database referral form, five TBIs were recorded in the outreach team's rehabilitation prescriptions, six admission entries mentioned a TBI diagnosis, and two patients' MDT notes mentioned TBI.

28 patients were reported to have cognitive difficulties, three of whom had confirmed TBI diagnoses. One had epilepsy, one had multiple sclerosis, one had long COVID and

delirium, one had ASD, psychosis, OCD, and a history of substance misuse, one had Guillain-Barré syndrome, one had ADHD, and one had encephalitis. One had a historic hypoxic brain injury unrelated to the current injury, and five were referred for further assessment for dementia.

Phase Two

Phase two involved conducting a focus group with NSIC clinicians to identify barriers to assessing for TBI and tailoring SCI rehabilitation accordingly, thus highlighting areas for service improvement.

Participants

Contact was made with the lead of each discipline to identify outreach and inpatient clinicians from different disciplines and grades to be invited to the focus group. A total of five out of nine invited clinicians attended the focus group, including one outreach clinician (a physiotherapist), and four inpatient clinicians, including one clinical psychologist, one medical doctor, one occupational therapist, and one physiotherapist.

Design and Materials

The structure of the focus group was informed by Krueger's (2002) guidance on designing and conducting focus group interviews. The clinicians met via Microsoft Teams for the focus group, through which the meeting was recorded and transcribed.

Procedure

The focus group was semi-structured, and following discussion with staff and an expert by experience, the interview was structured around the following topics: key factors clinicians would consider when assessing patients with and without a TBI, service expectations regarding TBI, how the NSIC's processes meet the needs of people admitted

with a SCI and TBI, the barriers to assessing and providing SCI rehabilitation for someone with a TBI, and what might overcome these barriers.

Analysis

The data from the focus group was analysed in line with Braun and Clarke's (2006) thematic analysis methodology. This exploratory approach was chosen to allow the researchers to create meaning through NSIC clinicians' comments, and to identify, analyse and report themes in the data to understand clinicians' perspectives on TBI in SCI rehabilitation at the centre, and to understand the meanings of clinicians' experiences within the wider social context of the service (Braun & Clarke, 2006).

Results

Barriers to Identifying TBI in SCI Patients at the NSIC

Systemic Factors. Staff voiced pressures on the service which limit the extent to which clinicians can assess comorbidities: "*There's something about …the system that we're in and it being already under pressure and then, whether actually it's fair for staff to flex their skills*." Moreover, one clinician reported: "*With a TBI… I think on the stats that ends up looking like: 'oh this patient's stay's been extended by two months' and that's seen as a bit of a failure rather than a really good example of how we've tailored our resources to fit that individual's need*."

Brief Referral Information Provided to Outreach. Outreach staff mentioned the brief referral information they receive and the need to gather a lot of information: "*When we first get referrals, they're usually ever so brief in every regard*."

Subjectivity. Clinicians also reported that rehabilitation in the context of TBI was subjective, reporting: '*I find it a wee bit subjective as to who with a cognitive impairment of a variety of diagnosis would and would not benefit'*, and '*I think that's a wee bit subjective 'cause what number on a MOCA can we meet?*'

Delayed Detection. Clinicians also noted that TBIs are not queried until later in rehabilitation: '*Patients in the adult population that have come with TBI as a diagnosis, it might be that it's something becomes a bit more apparent later down the line during their rehab because it's more mild.*'

Lack of TBI Understanding. Clinicians reported that they did not know how someone with a TBI attending the NSIC may present: "*The main areas which someone with TBI might be presenting with… I don't know what all of them would be*."

Variety of TBI Presentations. Additionally, clinicians spoke about brain injuries impacting patients in different ways: "*for someone with a TBI… each presentation is different*."

Clinicians' Current Rehabilitation for Individuals with TBI and SCI

Appropriateness for Rehabilitation. Clinicians' views conveyed a sense of confliction about providing rehabilitation for patients with TBI: "*They would not be appropriate to engage with intense rehab, because… there's an element of whether they'll be able to understand and follow the instructions, and how much we can offer, and how much they will gain from us*." Although equally, clinicians asked the question: "*If not us, then who?... is it better for people to get a little bit of what we have on offer even if it might not be the full package?"*

Patients Missing Out. Clinicians voiced concerns about patients' rehabilitation needs being met, stating: "*the other concern I have as well is the patient getting the right care and support and not missing out*", and "*If you add in TBI… how you then cater that program and have to backtrack to either give them more time or fit them in with how the rest of our population are working*." Additionally, they reported: '*Let's go to neurological rehab' may be the decision… I think that presumption there is that that service would be able to rehab their physical and their cognitive needs. I'm not overly aware as to how experienced in spinal cord*

injury rehab [neurorehabilitation] services are… but I hope that somebody can rehab them as a whole… 'cause I'd hate them to be failed by one of two diagnoses"

Staff Perceptions of Patients with TBI. Staff also reflected upon labels they may hold about patients with TBI and SCI: "*there is a risk for those with a mild TBI that they get early on labelled or experienced, as someone just unpleasant person or someone who just doesn't listen."*

The Importance of Goal-Planning. Clinicians noted the importance of the goal planning process: "*The goal planning process I think is very valuable… it might be that it's hard to communicate how we set goals based on the TBI because that's something we're not familiar with*." Similarly, another clinician noted: "*With the goal planning… maybe it's about that there should be some guidelines for people with complexities or multiple diagnoses and difficulties, including TBI*."

Limited Opportunities for MDT Working. However, staff also stated there were few chances to come together and discuss patients' care: "*I think there's a big value in the actual team working with that person to have a chance to talk together about that person, and I think there's a bit of a gap in our system… it's very rare you get much time where the professionals are there and the patient isn't... you miss the opportunity for the MDT discussion*."

Impact of Discharge Process. NSIC staff also reported the additional challenges of discharge for patients admitted with TBI and SCI: "*For someone with a brain injury [discharge] can be very daunting and quite complex, and I've found that sometimes here we're not overly good at communicating that, and I think having a brain injury on top can be can cause quite a lot of anxiety… So it isn't just the day-to-day rehab, it's as you approach discharge as well."*

Improving SCI rehabilitation for TBI

Need for TBI Education. Clinicians reported that they would benefit from some education around TBI in SCI: "*I guess from an education point of view… the main areas which someone with TBI might be presenting with… I think knowing what to look out for to start with might be might be needed*." Another clinician agreed, mentioning: "*I think [TBI] is not as well understood. Certainly not for me, but, you know, across our whole team."*

Need for Guidelines for Rehabilitation. Clinicians were in agreement about the need for guidelines when working with someone with a suspected TBI: "*I think the most important thing is to have something in hand to recognise the signs pointing toward TBI."*

Importance of Family. The clinicians also stated the impact of TBI and SCI on families and how the systems around the person can be a valuable source of information for TBI assessment and throughout rehabilitation: "*The guidelines should include something about how to engage family fully in someone's rehab, but whether in the case of the query TBI, whether that might need to be particularly emphasised or more of an active decision amongst the team about who's included in decision making at an early stage and why.*"

Earlier Adaptation of Rehabilitation. Finally, the clinicians reported the importance of adapting rehabilitation earlier in a patient's journey in the presence of a suspected TBI: "*Like [Psychologist] said to follow the guideline to if it's expected… rather than waiting for the diagnosis. By that time, it may be really late… it's better to have set guidelines and implement them before you have a specific diagnosis for that patient.*"

Phase Three

The final phase consisted of feeding back the findings of the audit and focus group to the service, and giving recommendations for service improvement. The recommendations were decided upon based on gaps identified in the reporting of TBI-related information in the

audit, and the themes raised by clinicians in the focus group. The service's feedback on these recommendations was gathered, and lastly, a training package was developed for the NSIC based on the study findings and the service's feedback on the recommendations.

Feedback

The findings of the audit and focus group, as well as subsequent recommendations, were delivered to the service at the NSIC's monthly audit meeting in June 2022. A presentation was delivered by the research team to the service, which was transcribed and recorded. For phase one (audit), the key recommendations were: noting comorbidities on rehab prescription, completing all parts of admission entry, and expanding on TBI info in MDT notes, Add TBI (or cognition) to goal planning sheet. For phase two (focus group), the recommendations were: a training package incorporating the perspective of someone with lived experience of rehab for TBI and SCI at the NSIC, a checklist to know what to look out for and what each professional should do, creating a space early on for professionals to discuss how TBI may impact goals, areas of risk, and discharge, and lastly, greater family involvement during assessment where TBI is queried.

The service's feedback on the project and recommendations was positive - that the project had been helpful and will better equip clinicians to work with TBI. One piece of feedback was that there were concerns that TBI may be over diagnosed as a result of the findings of the project, and it would be important to upskill the clinical team on other factors which may result in the cognitive deficits which may lead clinicians to query TBI.

Service Improvement

Since education and understanding were key themes of potential improvement resulting from the focus group, a training package was delivered for the clinicians at the NSIC, which has been integrated into the NSIC staff induction. This was done in collaboration with an expert by experience. The training began with the expert by experience

sharing their story and giving clinicians an exercise to hypothesise the resulting difficulties. Subsequently, the training covered the following topics: firstly, the ways in which TBI in addition to an SCI may impact an individual and their family, secondly, what to look out for, guidance around how TBI may impact the patient across healthcare disciplines, the expert by experience's feedback of care and how it could be improved. Additionally, a TBI summary checklist was provided summarising these points, and finally, information was provided regarding other factors which may impact cognition, following the NSIC's feedback on the project at the audit meeting.

The training was recorded and included a pre-training questionnaire and post-training questionnaire, measuring clinicians' knowledge of and confidence working with TBI in SCI, as well as how useful the training had been. This has been handed over to the NSIC to allow the package to be evaluated once it has been implemented.

Discussion

This project aimed to compare the incidence of TBI at the NSIC to figures found in previous research, and to understand the barriers to identifying and considering TBI during rehabilitation at the NSIC. Finally, the project aimed to improve the NSIC's detection and response to TBI in patients admitted for SCI rehabilitation.

The results from phase one of the project suggested that the proportion of TBIs in the NSIC sample was significantly lower than even the lowest proportions identified in previous research. Data required to inform a TBI assessment was not reliably recorded, although the TBIs detected tended to be recorded in the outreach team's rehabilitation prescription and inpatient admission entries. However, the TBIs recorded were not reflected in the documents throughout rehabilitation. For example, no patients with a TBI had their TBI mentioned in their goal planning sheets. The low number of TBIs detected at the NSIC may reflect

previous research which found that TBI is often under detected in SCI services, often due to the diagnostic criteria of TBI not being recognised (Tolonen et al., 2007). For example, a recent meta-analysis with 92,780 patients has suggested the prevalence of concomitant TBI in SCI patients is 32.5% (Pandrich & Demetriades, 2020). As well as potential difficulties in recognising, for example, LOC, and PTA, in the NSIC sample the information related to TBI was not consistently screened and recorded. Inconsistent screening and varying documentation of TBI diagnostic criteria has also been found in other research throughout patients' SCI rehabilitation (Sikka et al., 2019), and may limit clinicians' ability to identify TBI and modify SCI rehabilitation accordingly.

The results from phase two suggested that there may be several factors involved in detecting TBI at the NSIC and tailoring patients' treatment accordingly. These were interpreted as: service pressures, staff perceptions, lack of understanding of how TBI may impact SCI rehabilitation, few opportunities for MDT discussion, subjectivity and a variety of TBI presentations, and a need for guidelines. These barriers are supported by Sharma et al.'s (2014) research which also found that rehabilitation professionals' perceptions about how SCI may result in TBI may influence the detection of TBI in SCI rehabilitation. Similar themes related to the importance of staff in considering TBI have been reported by Sommer & Witkiewicz (2004), who noted that staff need basic education about the impact of TBI on patients with SCI. Similar to the NSIC clinicians' views, they reported greater emphasis is needed on staff knowing and assessing the cognitive, social and behavioural impacts of having both conditions on patients' ability to engage in rehabilitation offered by different professionals in multidisciplinary SCI teams.

Implications and Recommendations

In terms of the theoretical framework of the study, the themes interpreted from the focus group such as 'lack of TBI understanding', 'staff perceptions', 'delayed detection', and

‘patients missing out’ support the theory of invisible disabilities. Since clinicians reported not understanding all of the invisible symptoms of TBI, this may support the prediction that clinicians’ external perceptions of patients may not have matched the internal experience of patients (Hendry et al., 2022). A low proportion of TBIs was detected, which could have been because their difficulties may not have been seen through the lens of TBI. Moreover, as the theory predicts, clinicians reported patients may be labelled as ‘someone unpleasant or who does not listen’. Therefore, this study’s findings support the predictions that theory of hidden disabilities may make about clinicians holding beliefs that patients’ disabilities may only be perceived visually. This may prevent patients from being perceived as potentially having a TBI and limiting the extent to which these patients’ needs may be fully met in rehabilitation.

Based on the study’s findings, it is recommended that the NSIC standardise the way that TBI is screened and documented. This includes adapting the documentation at each stage to incorporate TBI, and encouraging clinicians to consistently report information which may be relevant to assessing TBI. This could be done by adding comorbidities to the rehabilitation prescription, by ensuring clinicians complete all areas of the admission entry, and by adding TBI and cognition to the goal planning sheet template.

Moreover, given the lack of understanding of TBI noted in the focus groups, education is recommended at a team level to increase clinicians’ knowledge of what TBI looks like in patients at the NSIC, and to be equipped to address the additional challenges that TBI may pose for SCI rehabilitation. This may be achieved through training, such as the package created for the NSIC being integrated into the staff induction. This could be accompanied by a ‘checklist’ which was suggested by clinicians, which may support staff to more thoroughly assess for TBI symptoms. Next, given the lack of space for discussion solely between professionals, it is recommended to create a space early in the patient journey to discuss how TBI may impact rehabilitation, adjustments required, risk, and discharge.

Finally, the clinicians underlined the importance of the family in working with TBI in SCI rehabilitation, therefore the family should be at the heart of rehabilitation early on in assessment and throughout treatment.

These recommendations will be implemented by the NSIC in several ways. A meeting was held with the service to deliver the recommendations and offer ideas for implementation, such as editing the service's documentation to ensure that information related to TBI is recorded for each patient throughout their rehabilitation in the NSIC. The training package has been integrated into the staff induction. Finally, a report was written which was given to the service which outlined the findings and underlined resulting recommendations for the service.

Strengths and Limitations

One strength of this project is that it adopted a comprehensive and systematic approach to comparing the number of TBIs detected by the NSIC to previous research. This was achieved by assessing the records which reflect each stage at which a patient at the NSIC may be assessed for TBI. This was triangulated with the focus group, which was useful in exploring the views of various clinicians and identifying areas for improvement 'on the ground'. It also resulted in key recommendations and training for the service, addressing a common comorbidity treated by the service.

Limitations of this study include that the identification of TBI relied on patient records, which may not accurately reflect the clinical activity at the NSIC. Furthermore, there could have been a confounding impact of the COVID-19 pandemic, since the 88 patients in the NSIC sample were admitted from June 2020 to July 2021. Since many people's daily lives were changed, this may have had a confounding effect on the patients' circumstances of injury, and their rehabilitation before and after they were admitted. This may mean that the 88 patients selected were not representative of the usual patients admitted to the NSIC, which

could have influenced the number of TBIs recorded. Moreover, although the focus group captured the views of clinicians from the outreach and inpatient teams, the small sample of five clinicians from the centre may not have represented all of the perspectives of the wider multidisciplinary team, which may have affected the qualitative views which were analysed in thematic analysis, which methodologically involves subjective interpretation. Lastly, since the project was aimed at supporting clinicians at the NSIC, this limits the generalisability of the findings to other spinal injury services. As a result, future research could compare the incidence of TBIs with a larger sample, without COVID-19 restrictions, and an explore a larger pool of clinicians' views. This may be done at different centres so that potential conclusions may be drawn across spinal injury services, which may confirm the representativeness of the findings at the NSIC to other centres.

References

Badhiwala, J. H., Wilson, J. R., & Fehlings, M. G. (2019). Global burden of traumatic brain and spinal cord injury. *The Lancet Neurology*, *18*(1), 24-25.

Bradbury, C. L., Wodchis, W. P., Mikulis, D. J., Pano, E. G., Hitzig, S. L., McGillivray, C. F., ... & Green, R. E. (2008). Traumatic brain injury in patients with traumatic spinal cord injury: clinical and economic consequences. *Archives of Physical Medicine and Rehabilitation*, *89*(12), S77-S84.

Budisin, B., Bradbury, C. C., Sharma, B., Hitzig, S. L., Mikulis, D., Craven, C., ... & Green, R. E. (2016). Traumatic brain injury in spinal cord injury: frequency and risk factors. *Journal of Head Trauma Rehabilitation*, *31*(4), E33-E42.

Craig, A., Guest, R., Tran, Y., & Middleton, J. (2017). Cognitive impairment and mood states after spinal cord injury. *Journal of Neurotrauma*, *34*(6), 1156-1163.

Hendry, G., Wilson, C., Orr, M., & Scullion, R. (2022). "I Just Stay in the House So I Don't Need to Explain": A Qualitative Investigation of Persons with Invisible Disabilities. *Disabilities*, *2*(1), 145-163.

James, S. L., Theadom, A., Ellenbogen, R. G., Bannick, M. S., Montjoy-Venning, W., Lucchesi, L. R., ... & Karch, A. (2019). Global, regional, and national burden of traumatic brain injury and spinal cord injury, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Neurology*, *18*(1), 56-87.

Krueger, R. A., & Casey, M. A. (2002). Designing and conducting focus group interviews (Vol. 18). University of Minnesota.

Macciocchi, S., Seel, R. T., Thompson, N., Byams, R., & Bowman, B. (2008). Spinal cord injury and co-occurring traumatic brain injury: assessment and incidence. *Archives of Physical Medicine and Rehabilitation*, *89*(7), 1350-1357.

Macciocchi, S., Seel, R. T., Warshowsky, A., Thompson, N., & Barlow, K. (2012). Co-

occurring traumatic brain injury and acute spinal cord injury rehabilitation outcomes. *Archives of Physical Medicine and Rehabilitation*, *93*(10), 1788-1794.

McDaid, D., Park, A. L., Gall, A., Purcell, M., & Bacon, M. (2019). Understanding and modelling the economic impact of spinal cord injuries in the United Kingdom. *Spinal Cord*, 57(9), 778-788.

Melo Neto, J. S. D., Tognola, W. A., Spotti, A. R., & Morais, D. F. D. (2014). Analysis of patients with spinal cord trauma associated with traumatic brain injury. *Coluna/Columna*, *13*(4), 302-305.

Mohamed, H. E., Dominick, E., & Valles, J. (2017). Under Diagnosed Traumatic Brain Injury in Traumatic Spinal Cord Injury Patients Admitted to Acute Rehab. *Archives of Physical Medicine and Rehabilitation*, *98*(10), e125.

National Institute for Health and Care Excellence. (2019). Head injury: assessment and early management [Clinical guideline [CG176]].

Nott, M., Baguley, I., Heriseanu, R., Weber, G., Middleton, J., Meares, S., ... & Chilko, S. (2014). Effects of concomitant spinal cord injury and brain injury on medical and functional outcomes and community participation. *Topics in Spinal Cord Injury Rehabilitation*, *20*(3), 225-235.

Pandrich, M. J., & Demetriades, A. K. (2020). Prevalence of concomitant traumatic cranio-spinal injury: a systematic review and meta-analysis. *Neurosurgical Review*, *43*(1), 69-77.

Sharma, B., Bradbury, C., Mikulis, D., & Green, R. (2014). Missed diagnosis of traumatic brain injury in patients with traumatic spinal cord injury. *Journal of Rehabilitation Medicine*, *46*(4), 370-373.

Sommer, J. L., & Witkiewicz, P. M. (2004). The therapeutic challenges of dual diagnosis: TBI/SCI. *Brain Injury*, *18*(12), 1297-1308.

SIA, 2021. Spinal cord injury paralyses someone every four hours, new estimates reveal. [online] Spinal Injuries Association. Available at: <https://www.spinal.co.uk/news/spinal-cord-injury-paralyses-someone-every-four-hours-new-estimates-reveal/> [Accessed 10 March 2021].

Sikka, S., Vrooman, A., Callender, L., Salisbury, D., Bennett, M., Hamilton, R., & Driver, S. (2019). Inconsistencies with screening for traumatic brain injury in spinal cord injury across the continuum of care. *The Journal of Spinal Cord Medicine*, *42*(1), 51-56.

Teasdale, G., & Jennett, B. (1974). Assessment of coma and impaired consciousness: a practical scale. *The Lancet*, *304*(7872), 81-84.

VanDerwerker, C., Gregory, C., & Simpson, K. (2019). Dual Spinal Cord Injury and Traumatic Brain Injury Index Diagnosis: Associations With Depression Post-Injury. *Archives of Physical Medicine and Rehabilitation*, *100*(12), e174-e175.

Vova, J., Palma, P. & McClanahan, E. (2020) Dual diagnosis: the prevalence of brain injury and spinal cord injury in the pediatric population and its impact on length of stay. *Int Phys Med Rehab J.*, *5*(1), 30–37.

Theory-Driven (Main) Research Project

Exploring the Role of Social Cognition in Couples' Relationship Satisfaction and Continuity After Acquired Brain Injury

Lawson Falshaw

lawson.falshaw@hmc.ox.ac.uk

The Oxford Institute of Clinical Psychology Training and Research

University of Oxford

Internal and External Supervisor: Dr Nigel King, The Oxford Institute of Clinical Psychology Training and Research, Buckinghamshire Healthcare NHS Trust

Proposed Journal: Neuropsychological Rehabilitation

Rationale: This journal has been chosen because it is aimed at clinicians who wish to inform their practice in the light of the latest scientific research; at researchers in neurorehabilitation; and finally at researchers in cognitive neuroscience and related fields interested in the mechanisms of recovery and rehabilitation.

Word Count: 5029

May 2023

Abstract

Although an acquired brain injury (ABI) may bring some couples closer together, for other couples, an ABI may pose challenges to their relationship. Recent research has suggested that social cognition is the strongest predictor of continuity in couples' relationships after one partner experiences an ABI. The current study aimed to examine the role of social cognition in relationship satisfaction and continuity after ABI. Sixty-four participants who were in a relationship with someone who had experienced an ABI completed measures of their partner's social cognition, their relationship satisfaction before and after injury, and a measure of relational continuity after ABI. It was found that the participants' relationship satisfaction significantly decreased after injury, and that the average social cognition score for the group reporting a high change in relationship satisfaction was significantly poorer than the group reporting a low change in relationship satisfaction. Regression analysis suggested that overall social cognition could predict the continuity in relationships after injury, although no single content area on a measure of social cognition could predict relational continuity. Findings have implications for the impact of ABI on couples' relationships and support to provide to couples following ABI.

Keywords: Acquired Brain Injury, Social Cognition, Relationship Satisfaction, Relational Continuity

Exploring the Role of Social Cognition in Couples' Relationship Satisfaction and Continuity After Acquired Brain Injury

For some couples, an acquired brain injury (ABI) may bring partners closer together (Abendschein et al., 2021; Stevens et al., 2017). For other couples, however, an ABI may pose significant challenges to their relationship. Couples where one partner has experienced an ABI may face twice the divorce rate seven years post-injury compared to the general population (Tyerman & King, 2009, p. 436). Moreover, a Headway survey found that 40% of couples' relationships may be challenged after one partner experiences an acquired brain injury (ABI). Partners reported: "My wife left me as my personality changed." and "[I was] heartbroken my husband left me saying I'd changed" (Headway, 2018). Such challenges of an ABI on relationships have been reported in several studies (Villa & Riley, 2017; Bowen et al., 2009; Temkin et al., 2009). These findings are an example of the 'ripple effect' of ABI on the survivor and subsequently the people around them.

Social Cognition

Since brain injuries affect people in different ways, there are many reasons why relationships may change after ABI. The emotional, behavioural, physical and cognitive effects of ABI can all impact existing and future relationships. Nonetheless, recent research has found that the strongest predictor of continuity in couples' relationships after ABI is 'social cognition' (Yasmin & Riley, 2022).

Social cognition is a broad umbrella term for the various psychological processes that enable individuals to take advantage of being part of a social group (Frith & Frith, 2012). Examples include reading social cues such as facial expressions, as well as seeing the world from another person's perspective. In doing so, one needs to appreciate that other people can think and feel in different ways to predict their behaviour. These aspects of social cognition

underpin the ability to make decisions in social settings, and thus play a pivotal role in forming and maintaining effective social relationships (Lee & Harris, 2013).

One of the most well-known aspects of social cognition is 'Theory of Mind' (ToM; Wellman, 1992). ToM is the ability to understand that other people have thoughts and feelings different to one's own (Korkmaz, 2011). This theory posits that during childhood, through interactions with others such as playing and pretending with peers, one gradually develops the ability to recognise that other people think and feel differently to oneself. According to the theory, this ability is key to social relationships because effective social interactions rely on this skill to recognise other people's 'agency' – to recognise that people can have different ideas and emotions to one's own, and infer these from the social context, enabling predictions about another person's behaviour, ultimately allowing an individual to navigate the social world (Gallagher & Frith, 2003).

Difficulties with ToM and the impact on relationships have been well documented in the autism literature (Velikonja et al., 2019). ToM deficits are a defining feature of autistic spectrum conditions, which may make it difficult to know what other people think and feel in social situations and respond accordingly. This can lead to difficulties in forming social relationships because people with autism may have misunderstandings or make unintentionally hurtful or inappropriate comments (Baron-Cohen et al., 1985).

Social Cognition After Brain Injury

Injury to the ventromedial prefrontal cortex, thought to be involved in social cognition, may occur following ABI, which in turn can impact an individual's ability to infer other people's thoughts and feelings (Yu et al., 2020). Channon and Crawford (2010) found that 20 people with ABI had greater difficulty in detecting the awkward elements of social situations, and in selecting appropriate solutions from a range of behavioural responses compared to 20 controls, suggestive of ToM deficits. However, this study involved a small

sample, limiting conclusions about the relationship between brain injury and social cognition deficits. Moreover, Martín-Rodríguez and León-Carrión, J. (2010) conducted a systemic review into quantitative studies of ToM deficits after brain injury. They found that individuals with ABI experienced severe deficits in understanding indirect speech and a ToM deficit known as a social 'faux pas' – where ''a speaker says something without considering if it is something that the listener might not want to hear or know, and which typically has negative consequences that the speaker never intended'' (Baron-Cohen et al. 1999, p. 408).

The Impact on Couples' Relationships

The components of social cognition, such as theory of mind, are thus a key overarching theoretical framework to the current study, since if someone with a brain injury struggles to correctly interpret the thoughts and emotions of their partner, the theory would predict misunderstandings or unintentionally harmful comments towards partners after injury, which may lead to changes in couples' relationships (Yasmin & Riley, 2022). People with ABI may struggle to interpret how their partner feels, which qualitative studies have found leads to feelings of being with a 'different person' or a 'stranger' after an ABI, leading to changed roles, disruption to 'couplehood', and feelings of having lost the person they originally fell in love with (Stiekema et al., 2020; Bodley-Scott & Riley, 2015; Leach et al., 1994). Quantitatively, Yeates (2012) studied seventy couples where one partner had an ABI, finding a range of predictive relationships between neuropsychological impairments and relationship outcomes. These included a positive relationship between survivors' emotion recognition ability and partners' rated interconnectedness in the relationship. Similarly, one review has suggested tentative links between ToM deficits and misattunement of intentions and motives in couples after brain injury, such as survivors incorrectly attributing their partner's behaviours as malevolent, and also potentially interpreting partners' facial expressions as negative, leading to conflict (Yeates, 2013). Moreover, a recent systematic

review found that that social cognition difficulties in the injured partner may affect the relationship satisfaction reported by the uninjured partner (van den Broek et al., 2022). Thus, if social cognition, including theory of mind, plays a key role in the continuity of relationships following ABI, then the theory would predict that there would be a significant difference in social cognition scores between individuals who report a high change in relationship satisfaction after their partner's ABI compared to those who report a relatively low change in relationship satisfaction. However, the research in this area has been largely correlational, and has involved measures which are not suitable or psychometrically robust specifically for individuals in a relationship with someone who has experienced an ABI. This limits the extent to which conclusions may be drawn about the causal impact social cognition deficits may have on couples' relationships following ABI. Moreover, previous studies have investigated relationship status at a single time point after injury, without data about how the couple related to each other beforehand.

Relational Continuity after ABI

More recent research has suggested that change in couples' relationships after ABI may occur as a process over a period of time (Villa & Riley, 2017; Riley et al., 2020; Ghosh-Cannell et al., 2022), leading to the concept of 'relational continuity/discontinuity' after ABI. This framework derives from research on spousal relationships following ABI which found that some caregiving partners experience their relationship as a continuation or strengthening of the loving relationship they shared before the onset of the injury, whereas for others the pre-injury relationship has been lost and replaced with something very different (Yasmin et al., 2020). Yasmin and Riley (2022) conducted a study to understand which symptoms of ABI may relate to discontinuity in couples' relationships after injury, by testing the correlations between various ABI symptoms and relational discontinuity. The researchers found that consequence of ABI which was most strongly associated with relational discontinuity was

social cognition difficulties. However, the researchers did not explore whether certain aspects of social cognition difficulties related to relational continuity. Moreover, due to the correlational nature of the study design, it is difficult to make conclusions about to what extent social cognition may cause relational discontinuity.

The Current Study

Therefore, the present study aimed to further explore the effect of social cognition on relational continuity after ABI, by studying relationship satisfaction of the partners of people with ABI before and after injury, as well as the effect of social cognition difficulties on changes in relationship satisfaction pre and post-injury. Additionally, the current study aimed to explore whether any specific social cognition difficulties could predict discontinuity in certain aspects of couples' relationships after injury.

Aims and Hypotheses

It is firstly hypothesised that there will be a significant reduction in participants' total relationship satisfaction scores before and after injury on the Relationship Assessment Scale (RAS; Hendrick, 1988). Secondly, it is hypothesised that there will be a significant difference between overall social cognition scores on the Brain Injury Rehabilitation Trust Social Cognition Questionnaire (BSCQ; Cattran et al., 2018) between participants who report a high change in relationship satisfaction after their partner's ABI compared to participants who report a low change in relationship satisfaction based on pre and post-injury RAS scores. Lastly, this study aims to explore whether specific aspects of social cognition functioning scores on the BSCQ may predict the discontinuity in relationships after injury reported by partners on the Birmingham Relational Continuity Measure for ABI (BRCM-ABI; Yasmin et al., 2020).

If there is a significant difference in social cognition functioning after ABI between partners who rate their relationship satisfaction as relatively the same versus having changed,

this may suggest that social cognition may play a more direct role in changes in relationship satisfaction after ABI, and social cognition difficulties may be targeted in rehabilitation. Moreover, if specific areas of social cognition predict discontinuity in couples' relationships after ABI, these areas may be targeted in rehabilitation.

Method

Participants

Participants were eligible if they were in a relationship with someone who had experienced an ABI at least six months prior to taking part. This included traumatic brain injury, stroke, brain haemorrhage, brain aneurysm, brain tumour, hypoxic brain injury, hydrocephalus, meningitis, or encephalitis. Participants must also have been in a relationship since one month before the injury, and they had to be capable of completing the questionnaires which were in English.

Seventy-four participants took part, of whom 64 met the eligibility criteria. Participants' full demographic information may be found in Appendix I (Table I.1). The average total length of the relationships was 24.65 years (*SD* = 12.67), the average time since injury was 3.65 years (*SD* = 3.58), and the average length of relationships pre-injury was 20.72 years (*SD* = 12.57). A minimum of 64 participants (32 each in the high and low change in relationship satisfaction groups) was needed to adequately power the study at a medium effect size ($p = .05$), according to power analysis with G*Power.

Design and Materials

The study adopted a quantitative between-subjects design, which involved delivering a survey to a cross-section of adults in a relationship with an individual with an ABI. The views of a partner in a relationship with someone with an ABI were sought in designing the

study, and the research was registered on the Open Science Framework before data collection (https://osf.io/pxagu/).

Measures

The following measures were used in the study and may be found in Appendix H.

The Brain Injury Rehabilitation Trust Social Cognition Questionnaire (BSCQ; Cattran et al., 2018). The relative version of this 28-item measure of social cognition was used, which measures the largest range of aspects of social cognition, such as: sensitivity to social cues; complex language; empathy; processing complex information; social interaction (the largest domain, which includes ToM); and social anxiety. This measure has been validated based on existing standardised neuropsychological assessments of social cognition such as The Awareness of Social Inference Test (TASIT; McDonald et al., 2003). The BSCQ demonstrates good psychometric properties, including high test-retest (.94) and split-half (.92) reliability, high internal consistency (α = .92), and good concurrent validity, and is appropriate for clinical settings (Cattran et al., 2018). Higher scores indicate greater social cognition difficulties.

The Relationship Assessment Scale (RAS; Hendrick, 1988). The RAS is a 7-item measure of general relationship satisfaction. It has previously been applied to couples adapting to brain injury to obtain ratings of the satisfaction experienced by the partners of people with ABI retrospectively before injury and after injury (e.g., Yasmin, Keeble & Riley, 2020). It has high internal consistency and test-retest reliability (both at α = .96) and robust construct validity (Hendrick et al., 1998). Higher scores indicate greater relationship satisfaction, and total scores below 24.5 suggest substantial relationship dissatisfaction and potential separation (Hendrick, 1988; Hendrick et al., 1998).

The Birmingham Relational Continuity Measure for ABI (BRCM-ABI; Yasmin et al., 2020). To capture a couple's relationship continuity after injury, the newly developed

BRCM-ABI was used. This measure was used because the measure captures a range of relational dimensions such as loss, couplehood, redefinition of relationship, same or different feelings, and same or different person, all of which could theoretically be impacted by social cognition abilities after ABI. The measure has high internal consistency (α = .96), test-retest reliability, and discriminative power, with good construct validity (Yasmin et al., 2020). Higher scores indicate a greater sense of relational continuity.

Procedure

The research received ethical approval from an NHS Research Ethics Committee (22/NE/0176). To recruit participants online, a study advertisement was posted on social media platforms, including social media groups for individuals and family members affected by ABI. The advertisement was also shared by Headway, the Stroke Association, and the Encephalitis Society via these organisations' social media pages and websites. Participants who were recruited online via social media platforms took part by clicking on the link in the study advertisement which directed them to the Qualtrics online survey platform. Participants recruited via an NHS community ABI service were identified by systematically screening the clients recently discharged. Starting with the most recent discharge, a member of the clinical team screened 17 clients, two of which had a partner who met the criteria to take part and these individuals were emailed the link to the online survey. Participants subsequently read the participant information sheet and anonymously completed the questionnaires. All items required a response to ensure questions were not missed, and it was stated that participants' answers must have been their own. Participants' responses were subsequently exported to SPSS statistical software for data analysis on an encrypted computer.

Data Analysis

To address the first hypothesis, the participants' satisfaction scores before and after injury on the RAS were used to test for a significant difference in relationship satisfaction pre

and post-injury. Secondly, a median split was conducted on the difference between participants RAS scores before and after injury to divide the participants into two groups based on whether they reported a high change in relationship satisfaction before and after injury or a low change (DeCoster et al., 2011). Subsequently, an independent samples *t*-test was completed to examine whether there was a significant difference in social cognition scores measured by the BSCQ across these two groups.

Additionally, to explore whether social cognition functioning could predict the continuity in relationships after injury, regression analyses were conducted on the BSCQ scores and the scores on the BRCM-ABI, to understand how much variance in the continuity of relationships after ABI can be explained by deficits in different domains of social cognition.

Results

Descriptive Statistics

The mean, median, standard deviation, minimum, and maximum scores for each measure and their subscales may be found in Appendix I (Table I.2). In terms of social cognition according to the BSCQ, the average score of the participants was 66.95 out of a possible 112 (*SD* = 13.5). With regards to relationship satisfaction according to the RAS, the average score for the participants' relationship satisfaction before injury was 30.66 (*SD* = 4.38), suggesting high relationship satisfaction. This differed to the average relationship satisfaction post-injury which was 22.5 (*SD* = 7.59), which is within the range of substantial relationship dissatisfaction. The participants' average relational continuity score was 70.23 out of a total 115 (*SD* = 23.93). Chi-squared tests were conducted to test for significant differences in relationship satisfaction change based on different demographic variables

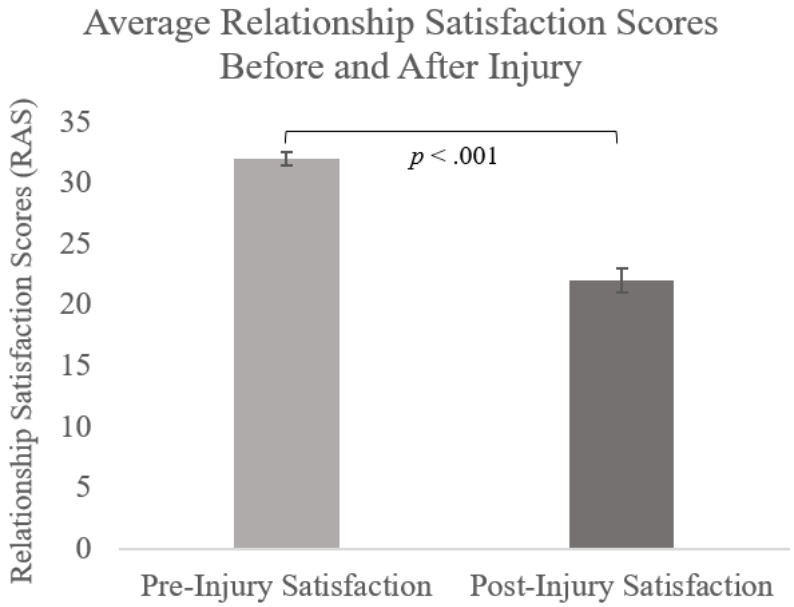
(Appendix I, Table I.3). Demographic variables which were significant were physical difficulties post-injury and social support across the high and low satisfaction groups.

Relationship Satisfaction Before and After Injury

To address the first hypothesis that there would be changes in participants' relationship satisfaction scores on the RAS before and after injury, a Wilcoxon matched-pairs signed rank test was completed, because whilst participants' post-injury relationship satisfaction scores were normally distributed ($W(64) = .97$, $p = .12$), participants' pre-injury satisfaction ratings were skewed towards high relationship satisfaction ($W(64) = .871$, $p < .001$). Fifty-six participants' satisfaction scores decreased after injury, three participants' remained the same, and five participants' satisfaction increased post-injury. There was a significant negative change in participants' relationship satisfaction before ($MD = 32$, $SD = 4.38$, $n = 64$) and after ($MD = 22$, $SD = 7.59$, $n = 64$) injury according to scores on the RAS ($z = -6.473$, $p = <.001$), with a large effect size ($r = .57$)

Figure 1

A Bar Chart of the Relationship Satisfaction Scores Reported by the Participants Before and After Their Partner's ABI



Note: Error bars refer to standard error.

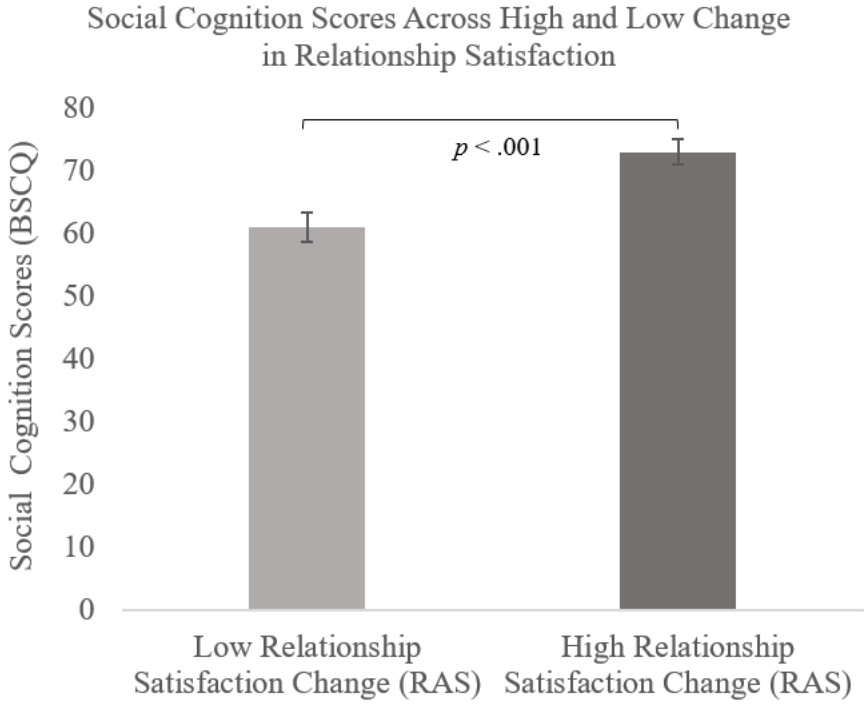
Social Cognition and Relationship Satisfaction

To address the second hypothesis that there would be a significant difference in social cognition scores between participants who report a high reduction in relationship satisfaction after their partner's ABI compared to participants who report a low reduction in their relationship satisfaction, an independent samples t-test was conducted to compare the means of the two groups (see Figure 2). The social cognition scores met the assumption of normality according the Shapiro Wilk test ($W(64) = .98$, $p = .29$), and homogeneity of variances according to Levene's test ($F(62) = .58$, $p = .45$). The average social cognition score for the group reporting a high change in relationship satisfaction ($M = 72.91$, $SD = 11.41$) was poorer than the group reporting a low change in relationship satisfaction ($M = 61$, $SD = 12.93$). This

difference between the social cognition scores across both groups was significant ($t(62) = 2.17$, $p < 0.001$, $d = -.98$).

Figure 2

A Bar Chart of the Social Cognition Scores Reported by the Participants Who Experienced a High Change in Relationship Satisfaction After Their Partner's ABI Versus a Low Change



Note: Error bars refer to standard error.

Social Cognition and Relational Continuity

To explore whether social cognition functioning could predict continuity in relationships after injury, regression analyses were conducted on the BSCQ scores and the scores on the BRCM-ABI. Initially, linear regression was conducted on the overall total on the BSCQ and the BRCM-ABI, to explore whether overall scores of social cognition functioning could predict the overall level of relational continuity in participants' relationships after ABI.

The results of the regression suggested that social cognition difficulties after ABI explained 28% of the variance (R^2 = .28, $F(1, 62) = 24.58$, $p < .001$). Social cognition functioning significantly predicted the continuity of relationships after ABI (β = -.94, t = 44.96, $p < .001$).

Next, to explore whether certain aspects of social cognition could predict relational continuity, multiple linear regression was conducted on the content areas of the BSCQ and the total scores on the BRCM-ABI. The tolerance and variance inflation factors (see Appendix I, Table I.4) did not indicate multicollinearity, and a Durbin-Watson statistic suggested that the values of the residuals were independent (1.5). A scatterplot indicated homoscedasticity, and a P-P plot suggested that the residuals were normally distributed (Appendix E, Figure I.1). Cook's distance values were below one, indicating that no influential cases were biasing the model. The results of the regression indicated the content areas of the BSCQ explained 33% of the variance (R^2 =.33, $F(6, 57) = 4.77$, $p < .001$), however none of the content areas of the BSCQ on their own significantly predicted relational continuity.

Discussion

This research aimed to explore the role of social cognition in relationship satisfaction and continuity after ABI. Specifically, it firstly aimed to assess whether there would be a significant difference in participants' relationship satisfaction scores before and after injury. Secondly, it aimed to examine whether there would be a difference between social cognition scores between participants who report a high reduction in relationship satisfaction after their partner's ABI compared to participants who report a low reduction in relationship satisfaction. Lastly, this study aimed to explore whether social cognition functioning may predict the continuity in relationships after injury.

In terms of the hypothesised change in relationship satisfaction reported by the participants before and after their partner's ABI, the results supported the hypothesis; although five participants' relationship satisfaction increased post-injury, overall the satisfaction participants reported in their relationship significantly decreased after injury, with a large effect size. This is in line with existing literature which has found that the partners of people with an ABI report that their satisfaction in the relationship has decreased since injury (Burridge et al., 2007).

The second hypothesis was that there would be a difference between social cognition scores between participants who report a high change in relationship satisfaction after their partner's ABI compared to participants who report a low change in relationship satisfaction. The results supported this hypothesis, since the average social cognition score for the group reporting a high change in relationship satisfaction was significantly lower than the group reporting a low change in relationship satisfaction. This finding is corroborated by a recent systematic review of studies exploring the factors related to the quality and stability of couples' relationships after traumatic brain injury, which found that specifically social cognition may play a role in non-injured partners' decreased relationship satisfaction following injury (van den Broek et al., 2022).

Lastly, in relation to whether social cognition functioning may predict the continuity in the relationship after injury, participants' overall ratings of their partner's social cognition functioning after injury significantly predicted their total scores for relational continuity on the BRCM. This is in line with Yasmin and Riley's (2022) study which found that social cognition difficulties could predict relational continuity reported by the uninjured partner after ABI. However, the scores on the individual content areas of the BSCQ in isolation could not predict relational continuity. Additionally, the finding that no one aspect of social cognition alone could predict relational continuity reported by participants is in agreement

with a recent systematic review which found that multiple factors related to social cognition post-injury could influence couples' relationships over time before and after ABI (van den Broek et al., 2022). These included the injured partner being able to notice when their partner needed emotional support, the level of emotional 'bluntness' of the injured partner (versus them providing emotional connection and warmth), empathy, theory of mind, and considering their partner's perspective.

Implications

The findings of the current study may have implications regarding our understanding of what contributes to changes in relationship satisfaction and continuity of relationships post-injury, and what support may be provided to couples during community neurorehabilitation. Firstly, the findings reinforce the role which social cognition plays in the ways partners respond to ABI. Whilst Yasmin and Riley (2022) found that amongst ABI symptoms social cognition difficulties are strongest predictor of changes in relationships, the between-subjects design of this study furthers our understanding the role social cognition plays in relationship satisfaction after injury. Clinically, the findings suggest that individuals in a relationship with someone who has experienced an ABI may report a decrease in relationship satisfaction post-injury. Furthermore, social cognition difficulties may contribute to a decrease in relationship satisfaction experienced by individuals in a relationship with someone who has an ABI. Thus, this implies that support for couples could be important for those who were in a relationship before the injury. In particular, social cognition could be targeted during neurorehabilitation to support couples adjusting to life after injury to minimise the impacts of the ABI on relationship satisfaction and continuity. The findings may suggest that social cognition impairments are complex and multifaceted, and thus multiple factors of social cognition together may contribute to relational continuity rather than specific aspects on their own. Thus, a holistic approach taking into consideration multiple aspects

related to social cognition difficulties may be needed to be targeted to support couples after injury.

Strengths, Limitations, and Future Research

Much of the research into relationship satisfaction after ABI has adopted a qualitative methodology involving small numbers of participants. However, the quantitative studies which have taken place have tended to compare the satisfaction experienced by those in a relationship with someone with an ABI with those in a relationship with other conditions or healthy controls (e.g., Burridge et al., 2007), or focused on capturing relationship satisfaction at a single time point post-injury. One strength of this study was that it employed a quantitative methodology which examined the *change* in relationship satisfaction felt by an adequately powered sample of participants. This provides a stronger empirical basis for the theoretical role which social cognition difficulties after ABI may play in relationship satisfaction and continuity.

One limitation of the current study was that data regarding certain other factors which may have had an impact on the relationship difficulties experienced by the participants was not collected. For example, it is possible that factors overlapping with social cognition such as insight and awareness may have contributed to the results, however since this data was not collected, it is difficult to understand whether these factors played a confounding role in this study's findings. Moreover, the mood and psychological adjustment of the participants was not measured, although these factors may have influenced the satisfaction which the participants reported in their relationships. Additionally, this study lacked a control or comparison group. Therefore, it is difficult to draw conclusions about how the sample's relationships compared to individuals in a relationship where neither of the partners has an ABI and potential social cognition difficulties. Future research could explore the factors which were not captured in the current study, such as insight and awareness difficulties, as

well as the mood and psychological adjustment of partners, and include a control or comparison group which could be obtained, for instance, through census data. This may further our understanding of the role of these factors alongside social cognition, and understand the unique influence these variables may have in comparison to partners in a relationship with someone who does not have an ABI and potential social cognition difficulties.

A further limitation of this study is that a standardised neuropsychological assessment data was not collected. Although the BSCQ was validated against the TASIT (McDonald et al., 2003) during its development, future research could use standardised neuropsychological assessment data to explore relationship satisfaction and continuity after injury, to build upon the findings of the current study with more objective neuropsychological data. Moreover, although this study used regression analyses in an exploratory way to assess whether certain aspects of social cognition may predict couples' relational continuity after ABI, it could be that the sample was not large enough to detect significant contributions made by specific aspects of social cognition on the BSCQ. Thus, further research with larger samples and standardised assessments may highlight the role of certain aspects of social cognition on relational continuity post-injury.

Furthermore, although exploring the views of those in a relationship with some who had experienced an ABI meant that the effects of injured partners' insight and awareness difficulties could be avoided, the participants' responses may have been affected by cognitive biases in their attitudes towards how their relationships were before injury. Participants may have had more positive, nostalgic perceptions of how their relationships were pre-injury, which may have impacted their pre-injury scores on the BSCQ, and subsequently the change in relationship satisfaction and continuity reported. Additionally, physical difficulties and social support were significantly different across the high and low satisfaction groups. This

may suggest that these variables had confounding effects on the change in satisfaction reported by the partners.

Since the current study did not recruit the injured partners, the findings of this study are limited to the experiences of the non-injured partner in the relationship. Future research could explore the relationship satisfaction and continuity from the perspective of the injured partner, to ensure a 360-degree appreciation of the impact of ABI on couples.

Conclusion

In short, this study suggests that the relationship satisfaction experienced by the partner of someone with an ABI often decreases after injury. Moreover, the average social cognition score for the group reporting a high change in relationship satisfaction was significantly lower than the group reporting a low change in relationship satisfaction. Thus, social cognition appears to play a key role in changes in relationship satisfaction after ABI. Social cognition difficulties may also be helpful in predicting the continuity in couples' relationships after injury. Moreover, social cognition after ABI may be multifaceted, with multiple elements relating to continuity in relationships post-injury, including theory of mind, empathy, and sensitivity to social cues. Further research is necessary with larger samples and standardised neuropsychological assessment data, perhaps exploring the perspective of the injured partner in the relationship. Nevertheless, this study demonstrates that relationship satisfaction experienced by those in a relationship with someone with an ABI often reduces after injury, and social cognition may play a role in changes in relationship satisfaction post-injury. These findings may encourage neurorehabilitation services to offer routine relationship assessment and support to couples who are adjusting to life after ABI, and suggests that social cognition may be a key target in maximising relationship satisfaction and continuity in such circumstances.

References

Abendschein, B., Basinger, E. D., & Wehrman, E. C. (2021). Struggling Together: Examining the Narratives of Interdependence and Healing Within Romantic Relationships After Stroke. *Qualitative Health Research*, *31*(7), 1275-1289.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition*, *21*(1), 37-46.

Baron-Cohen, S., O' Riordan, M., Stone, V., Jones, R., & Plaisted, K. (1999). Recognition of faux pas by normally developing children and children with Asperger syndrome or high-functioning autism. *Journal of Autism and Developmental Disorders*, *29*, 407-418.

Bodley-Scott, S. E., & Riley, G. A. (2015). How partners experience personality change after traumatic brain injury–its impact on their emotions and their relationship. *Brain Impairment*, *16*(3), 205-220.

Bowen, C., Hall, T., Newby, G., Walsh, B., Weatherhead, S., & Yeates, G. (2009). The impact of brain injury on relationships across the lifespan and across school, family and work contexts. *Human Systems: The Journal of Consultation and Training*, *20*, 65-80.

Burridge, A. C., Huw Williams, W., Yates, P. J., Harris, A., & Ward, C. (2007). Spousal relationship satisfaction following acquired brain injury: The role of insight and socio-emotional skill. *Neuropsychological Rehabilitation*, *17*(1), 95-105.

Cattran, C., Oddy, M., Ramos, S. D. S., Goodson, A., & Wood, R. (2018). The development of a measure of social cognition following acquired brain injury. *Neuropsychological Rehabilitation*, *28*(4), 633-648.

Channon, S., & Crawford, S. (2010). Mentalising and social problem-solving after brain injury. *Neuropsychological Rehabilitation*, *20*(5), 739-759.

DeCoster, J., Gallucci, M., & Iselin, A. M. R. (2011). Best practices for using median splits,

artificial categorization, and their continuous alternatives. *Journal of Experimental Psychopathology*, *2*(2), 197-209.

Frith, C. D., & Frith, U. (2012). Mechanisms of social cognition. *Annual Review of Psychology*, *63*, 287-313.

Gallagher, H. L., & Frith, C. D. (2003). Functional imaging of 'theory of mind'. *Trends in Cognitive Sciences*, *7*(2), 77-83.

Ghosh-Cannell, C., Fisher, P., Ajayi, J., & Gracey, F. (2022). The experiences of wives following acquired brain injury (ABI). A qualitative analysis exploring realisations of change following the ABI of a "loved one.". *Neuropsychological Rehabilitation*, 1-22.

Headway. (2018). You, me and brain injury: Relationship changes after brain injury.

Hendrick, S. S. (1988). A generic measure of relationship satisfaction. *Journal of Marriage and the Family*, 93-98.

Hendrick, S. S., Dicke, A., & Hendrick, C. (1998). The relationship assessment scale. *Journal of Social and Personal Relationships*, *15*(1), 137-142.

Korkmaz, B. (2011). Theory of mind and neurodevelopmental disorders of childhood. *Pediatric Research*, *69*(8), 101-108.

Leach, L. R., Frank, R. G., Bouman, D. E., & Farmer, J. (1994). Family functioning, social support and depression after traumatic brain injury. *Brain Injury*, *8*(7), 599-606.

Lee, V., & Harris, L. (2013). How social cognition can inform social decision making. *Frontiers in Neuroscience*, *7*, 259.

Martín-Rodríguez, J. F., & León-Carrión, J. (2010). Theory of mind deficits in patients with acquired brain injury: A quantitative review. *Neuropsychologia*, *48*(5), 1181-1191.

McDonald, S., Flanagan, S., Rollins, J., & Kinch, J. (2003). TASIT: A new clinical tool for assessing social perception after traumatic brain injury. *The Journal of Head Trauma Rehabilitation*, *18*(3), 219-238.

Riley, G. A., Keeble, H. S., Yasmin, N., & Hagger, B. F. (2020). Relationship continuity and person-centred care: an exploratory mixed-methods investigation of spousal partners' responses to the challenging care needs of those with acquired brain injury. *Neuropsychological Rehabilitation*, *30*(6), 1169-1189.

Stevens, L. F., Lapis, Y., Tang, X., Sander, A. M., Dreer, L. E., Hammond, F. M., ... & Nakase-Richardson, R. (2017). Relationship stability after traumatic brain injury among veterans and service members: a VA TBI Model Systems study. *The Journal of Head Trauma Rehabilitation*, *32*(4), 234.

Stiekema, A. P., Winkens, I., Ponds, R., De Vugt, M. E., & Van Heugten, C. M. (2020). Finding a new balance in life: a qualitative study on perceived long-term needs of people with acquired brain injury and partners. *Brain Injury*, *34*(3), 421-429.

Temkin, N. R., Corrigan, J. D., Dikmen, S. S., & Machamer, J. (2009). Social functioning after traumatic brain injury. *The Journal of Head Trauma Rehabilitation*, *24*(6), 460-467.

Tyerman, A., & King, N. S. (Eds.). (2009). *Psychological approaches to rehabilitation after traumatic brain injury*. John Wiley & Sons.

Velikonja, T., Fett, A. K., & Velthorst, E. (2019). Patterns of nonsocial and social cognitive functioning in adults with autism spectrum disorder: A systematic review and meta-analysis. *JAMA Psychiatry*, *76*(2), 135-151.

van den Broek, B., Rijnen, S., Stiekema, A., Van Heugten, C., & Bus, B. (2022). Factors related to the quality and stability of partner relationships after traumatic brain injury: a systematic literature review. *Archives of Physical Medicine and Rehabilitation*, *103*(11), 2219-223.

Villa, D., & Riley, G. A. (2017). Partners' experiences of relationship continuity in acquired brain injury. *Cogent Psychology*, *4*(1), 1380891.

Wellman, H. M. (1992). The child's theory of mind. The MIT Press.

Yasmin, N., Keeble, H. S., & Riley, G. A. (2020). Development and psychometric evaluation of the Birmingham Relationship Continuity Measure for acquired brain injury. *Brain Injury*, *34*(8), 1089-1099.

Yasmin, N., & Riley, G. A. (2022). Are spousal partner perceptions of continuity and discontinuity within the relationship linked to the symptoms of acquired brain injury? *Disability and Rehabilitation*, *44*(16), 4249-4256.

Yeates, G. N., McMillan, T., Weddell, R., Eley, D., Zapiain Creamer, N., Mahadevan, M., Goshawk, M., Rowberry, M., Dunn, S., Gracey, F., & Bateman, A. (2012). Social cognition and psychosocial predictors of couple relationship outcomes following acquired brain injury. Paper Presented at the 9th International Brain Injury Association Conference, Edinburgh.

Yeates, G. N. (2013). Towards the neuropsychological foundations for couples therapy following acquired brain injury (ABI): a review of empirical evidence and relevant concepts. *Neuro-Disability & Psychotherapy*, *1*(1): 108–150.

Yu, L. Q., Kan, I. P., & Kable, J. W. (2020). Beyond a rod through the skull: A systematic review of lesion studies of the human ventromedial frontal lobe. *Cognitive Neuropsychology*, *37*(1-2), 97-141.

Executive Summary

Introduction

For some couples, an acquired brain injury (ABI) may bring partners closer together. For other couples, however, an ABI may pose significant challenges to their relationship. These findings are an example of the 'ripple effect' of ABI on the survivor and subsequently the people around them. Since brain injuries affect people in different ways, there are many reasons why relationships may change after ABI. The emotional, behavioural, physical and cognitive effects of ABI can all impact existing and future relationships. Nonetheless, recent research has found that the strongest predictor of continuity in couples' relationships after ABI is 'social cognition'.

'Theory of Mind' is the ability to understand that other people have thoughts and feelings different to one's own. According to this theory, this ability is key to social relationships because effective social interactions rely on this skill to recognise that other people can have different ideas and emotions. Injury to certain areas of the brain thought to be involved in social cognition may occur following ABI, which in turn can impact an individual's ability to infer other people's thoughts and feelings, affecting their relationships with their partner. Therefore, this study aimed to further explore the effect of social cognition on relational continuity after ABI, by studying relationship satisfaction of the partners of people with ABI before and after injury, as well as the effect of social cognition difficulties on changes in relationship satisfaction pre and post-injury. Additionally, the current study aimed to explore whether any specific social cognition difficulties could predict discontinuity in certain aspects of couples' relationships after injury.

Research Questions

Firstly, this study aimed to answer whether there would be a significant reduction in participants' relationship satisfaction before versus after their partner's injury according to a questionnaire measuring relationship satisfaction. Secondly, the research aimed to address the question of whether there would be a significant difference in overall scores of social cognition between participants who report a high change in relationship satisfaction after their partner's ABI compared to participants who report a low change in relationship satisfaction based on pre and post-injury scores on the relationship satisfaction questionnaire. Lastly, this study aimed to explore whether certain aspects of social cognition functioning may predict the discontinuity in relationships after injury reported by partners on a questionnaire measuring continuity in couples' relationships after one partner experiences an ABI.

Method

The views of a partner in a relationship with someone with an ABI were sought in designing the study and the study received ethical approval from the NHS and an independent research ethics committee. Individuals were invited to participate if they were in a relationship with someone who had experienced an ABI at least six months prior to taking part. This included traumatic brain injury, stroke, brain haemorrhage, brain aneurysm, brain tumour, hypoxic brain injury, hydrocephalus, meningitis, or encephalitis. Participants must also have been in a relationship since one month before the injury, and they had to be capable of completing the questionnaires which were in English.

The study involved delivering a survey to a group of adults in a relationship with an individual with an ABI. To recruit participants online, a study advertisement was posted on social media platforms, including social media groups for individuals and family members

affected by ABI. The advertisement was also shared by Headway, the Stroke Association, and the Encephalitis Society via these organisations' social media pages and websites. Participants who were recruited online via social media platforms took part by clicking on the link in the study advertisement which directed them to the Qualtrics online survey platform. Participants recruited via an NHS community ABI service were identified by systematically screening the clients recently discharged. Starting with the most recent discharge, a member of the clinical team screened 17 clients, two of which had a partner who met the criteria to take part and these individuals were emailed the link to the online survey. Participants subsequently read the participant information sheet and anonymously completed the questionnaires.

Key Findings

Seventy-four participants completed the survey, of whom 64 were eligible for the study. It was found that there was a significant negative change in participants' relationship satisfaction before and after their partner's injury. Moreover, the average social cognition score for the group reporting a high change in relationship satisfaction was poorer than the group reporting a low change in relationship satisfaction. Lastly, all of the different aspects of social cognition on the social cognition questionnaire significantly predicted discontinuity in the participants' relationships after injury, however none of specific aspects of social cognition on their own could predict relational discontinuity.

Limitations and Future Research

One limitation of this study is that a standardised social cognition assessment was not used. Additionally, since the study involved participants reflecting on their relationships before injury retrospectively, this may mean that the reports of relationship satisfaction before the ABI were not completely accurate. It was also found that physical difficulties after

injury as well as social support influenced were different between the participants who reported a large versus small reduction in their relationship satisfaction, so these factors may have played a role alongside social cognition and should be researched further. Lastly, this study did not explore the views of the injured partners. Future research could use cognitive assessments to assess social cognition functioning and relationship satisfaction and continuity experienced by partners with an ABI.

Conclusion

Overall, this study suggests that the relationship satisfaction experienced by the partner of someone with an ABI often decreases after injury. Moreover, the average social cognition score for the group reporting a high change in relationship satisfaction was significantly lower than the group reporting a low change in relationship satisfaction. Thus, social cognition appears to play a key role in changes in relationship satisfaction after ABI. Social cognition difficulties may also be helpful in predicting the continuity in couples' relationships after injury. These findings may encourage neurorehabilitation services to offer routine relationship assessment and support to couples who are adjusting to life after ABI.

Connecting/Reflective Narrative

Although I had worked in neuropsychology prior to training, I started the course with the intention of not being committed to a particular specialism in psychology. Nonetheless, as I progressed through training, I was still drawn to the field of clinical neuropsychology, although also developed interests in clinical health psychology. Therefore, I saw the three research projects as opportunities to explore these areas. A theme cutting across the three projects was the focus on systemic factors, be that the ripple effect of acquired brain injury on partners, or how healthcare professionals might be able to support individuals who have experienced an acquired brain injury.

Critical Review of the Literature

I developed an interest in the interface between linguistic and non-linguistic cognitive functioning during my integrated master's degree in psychology and language sciences. Whilst completing this qualification, and working in a community neurorehabilitation service, I noticed how there appeared to be a wealth of assessments of linguistic cognitive functioning in people with post-stroke aphasia, however a challenge for the team was how to assess the non-linguistic cognitive functioning of these individuals. Therefore, this project was an ideal opportunity to explore this area further and conduct a project with concrete implications for multidisciplinary neurorehabilitation teams.

A brief scoping search suggested that indeed a wealth of papers had explored language abilities in this population, however fewer papers had explored the non-linguistic thinking skills of people with post-stroke aphasia. Nonetheless, this was an area which appeared to be gathering more interest, therefore the recent papers in this area needed to be synthesised and evaluated for fast-paced NHS neurorehabilitation teams.

Although the process of conducting a systematic review was time consuming, it was valuable as I learnt more about this area. I also enjoyed working alongside a peer reviewer; having someone else's critical viewpoint and discussing the process with them was helpful. I found the results interesting and one of the things I valued most was considering how to present the results in a way which would be most clinically helpful to those working in busy neurorehabilitation teams. Learning to not just list the assessments in the studies, but to evaluate them and using a figure to create a visual tool to guide clinicians' decision making was an extremely valuable experience in disseminating research in the most helpful way to inform its audience and their clinical practice.

Service Improvement Project

During training, I have reflected on how neuropsychology is often treated as a separate stream to clinical health psychology. However, on placement, I observed that even in mental health services, comorbidity is the norm. This prompted me to consider whether there could be some overlap in these areas. Therefore, this was an opportunity to combine my experience with neuropsychology with another clinical health context to benefit multiple stakeholders, in this case, traumatic brain injury and spinal cord injury, whilst also developing my skills in qualitative research.

It was challenging to conduct a service improvement project in a service where I was not based, since I was concerned about being perceived as a 'critical outsider'. However, after getting started, I felt that my positioning gave me a valuable external viewpoint. I have often wondered whether this actually made it easier to capture the honest views of the clinicians and expert by experience in the process, and in fact, all stakeholders felt that traumatic brain injury was an invisible need not captured by the service.

I thoroughly enjoyed completing this service-related piece of work, as I gained experience of an inpatient physical health setting. Although, perhaps most importantly, this work felt meaningful. Working with the expert by experience to deliver the training package was highly rewarding in not just ensuring that all voices where heard, but placing patients' personal experiences at the heart of service development. I look forward to completing further service improvement work in my qualified role.

Theory-Driven (Main) Research Project

In line with my other projects, I was interested in exploring how physical health conditions may influence other individuals around the person with my theory-driven project. I distinctly remember the concept that health conditions have a ripple effect on not just individuals, but whole families. Therefore, through my TDRP, I was curious to learn more about the 'invisible patients' that may not be seen or heard by services.

Through initial discussions with supervisors, I became interested in the experiences of partners of people with acquired brain injury, due to the close nature of the relationship to patients, and thus the potential for partners to be impacted. Upon looking at the recent research and by being on a specialist placement in a community head injury service, I reflected that the couples' relationships can go through enormous changes over time due to brain injury as they adjust to life alongside these conditions. Additionally, I have noticed that social cognition is not always considered in neurorehabilitation. Yet, since recent research had suggested that it was strongly correlated with changes in couples' relationships, I was determined to explore this area further to understand how to support couples after injury.

Although I had completed NHS research during my master's degree, recruiting partners for this project was an exciting challenge, since I had to be creative in order to reach these 'invisible patients'. I enjoyed thinking flexibly to consider potential sources of

participants, such as social media, charitable organisations' websites, online groups, and was fortunate to be able to recruit via my specialist placement service. Completing this project has made me passionate about maintaining a flexible and creative stance to research to ensure that multiple voices are heard in NHS services, a value and experience which I will treasure moving forwards.

Acknowledgements

Firstly, I would like to acknowledge all those who took the time to take part in my research. Without you, this thesis would not have been possible. I hope that this work goes some way towards improving the experiences of people attending mental and physical health services in hospital and the community. I am also grateful for the support given to me by my research supervisors and course tutor over the past three years. Your advice and encouragement have been invaluable. I would also like to give my heartfelt thanks to my family and friends for your love throughout training. Thank you for always believing in me and supporting me, celebrating my achievements and being there when things have been tough. I will never forget everything you have done to listen and help me, and you always being there to encourage me when I have doubted myself.

Appendices

Appendix A

Instructions for Authors: Critical Review of the Literature

About the journal

Disability and Rehabilitation is an international, peer reviewed journal, publishing high-quality, original research. Please see the journal's Aims & Scope for information about its focus and peer-review policy.

From 2018, this journal will be online only, and will no longer provide print copies.

Please note that this journal only publishes manuscripts in English.

Disability and Rehabilitation accepts the following types of article: Reviews, Research Papers, Case Studies, Perspectives on Rehabilitation, Reports on Rehabilitation in Practice, Education and Training, and Correspondence. Systematic Reviews including meta-syntheses of qualitative research should be submitted as Reviews. All other types of Reviews will normally be considered as Perspectives in Rehabilitation.

Special Issues and specific sections on contemporary themes of interest to the Journal's readership are published. Please contact the Editor for more information.

Open Access

You have the option to publish open access in this journal via our Open Select publishing program. Publishing open access means that your article will be free to access online immediately on publication, increasing the visibility, readership and impact of your research. Articles published Open Select with Taylor & Francis typically receive 95% more citations* and over 7 times as many downloads** compared to those that are not published Open Select.

Your research funder or your institution may require you to publish your article open access. Visit our Author Services website to find out more about open access policies and how you can comply with these.

You will be asked to pay an article publishing charge (APC) to make your article open access and this cost can often be covered by your institution or funder. Use our APC finder to view the APC for this journal.

Please visit our Author Services website if you would like more information about our Open Select Program.

*Citations received up to 9th June 2021 for articles published in 2016-2020 in journals listed in Web of Science®. Data obtained on 9th June 2021, from Digital Science's Dimensions platform, available at https://app.dimensions.ai
**Usage in 2018-2020 for articles published in 2016-2020.

Peer review

Taylor & Francis is committed to peer-review integrity and upholding the highest standards of review. For submissions to *Disability and Rehabilitation* authors are given the option to remain anonymous during the peer-review process. Authors will be able to indicate whether their paper is 'Anonymous' or 'Not Anonymous' during submission, and should pay particular attention to the below:

- Authors who wish to remain anonymous should prepare a complete text with information identifying the author(s) removed. Authors should upload their files using the 'double anonymous peer review' article types during submission. A separate title page should be included providing the full affiliations of all authors. Any acknowledgements and the Declaration of Interest statement must be included but should be worded mindful that these sections will be made available to referees.
- Authors who wish to be identified should include the name(s) and affiliation(s) of author(s) on the first page of the manuscript. Authors should upload their files using the 'authors made known to the reviewers' article types during submission.

Once your paper has been assessed for suitability by the editor, it will be peer-reviewed by independent, anonymous expert referees. If you have shared an earlier version of your Author's Original Manuscript on a preprint server, please be aware that anonymity cannot be guaranteed. Further information on our preprints policy and citation requirements can be found on our Preprints Author Services page. Find out more about what to expect during peer review and read our guidance on publishing ethics.

Preparing your paper

All authors submitting to medicine, biomedicine, health sciences, allied and public health journals should conform to the Uniform Requirements for Manuscripts Submitted to Biomedical Journals, prepared by the International Committee of Medical Journal Editors (ICMJE).

We also refer authors to the community standards explicit in the American Psychological Association's (APA) Ethical Principles of Psychologists and Code of Conduct.

We encourage authors to be aware of standardised reporting guidelines below when preparing their manuscripts:

- Case reports - CARE
- Diagnostic accuracy - STARD
- Observational studies - STROBE
- Randomized controlled trial - CONSORT
- Systematic reviews, meta-analyses - PRISMA

Whilst the use of such guidelines is supported, due to the multi-disciplinary nature of the Journal, it is not compulsory.

Structure

Your paper should be compiled in the following order: title page; abstract; keywords; main text, introduction, materials and methods, results, discussion; acknowledgments; declaration of interest statement; references; appendices (as appropriate); table(s) with caption(s); figures; figure captions (as a list).

In the main text, an introductory section should state the purpose of the paper and give a brief account of previous work. New techniques and modifications should be described concisely but in sufficient detail to permit their evaluation. Standard methods should simply be referenced. Experimental results should be presented in the most appropriate form, with sufficient explanation to assist their interpretation; their discussion should form a distinct section.

Tables and figures should be referred to in text as follows: figure 1, table 1, i.e. lower case. The place at which a table or figure is to be inserted in the printed text should be indicated clearly on a manuscript. Each table and/or figure must have a title that explains its purpose without reference to the text.

The title page should include the full names and affiliations of all authors involved in the preparation of the manuscript. The corresponding author should be clearly designated, with full contact information provided for this person.

Word count

Please include a word count for your paper. There is no word limit for papers submitted to this journal, but succinct and well-constructed papers are preferred.

Style guidelines

Please refer to these style guidelines when preparing your paper, rather than any published articles or a sample copy.

Please use any spelling consistently throughout your manuscript.

Please use double quotation marks, except where "a quotation is 'within' a quotation". Please note that long quotations should be indented without quotation marks.

For tables and figures, the usual statistical conventions should be used.

Drugs should be referred to by generic names. Trade names of substances, their sources, and details of manufacturers of scientific instruments should be given only if the information is important to the evaluation of the experimental data.

Alt Text

This journal is now including Alt Text (alternative text), a short piece of text that can be attached to your figure to convey to readers the nature or contents of the image. It is typically used by systems such as pronouncing screen readers to make the object accessible to people that cannot read or see the object, due to a visual impairment or print disability. Alt text will

also be displayed in place of an image, if said image file cannot be loaded. Alt Text can also provide better image context/descriptions to search engine crawlers, helping them to index an image properly. To include Alt Text in your article, please follow our Guidelines.

Formatting and templates

Papers may be submitted in any standard format, including Word and LaTeX. Figures should be saved separately from the text. To assist you in preparing your paper, we provide formatting template(s).

Word templates are available for this journal. Please save the template to your hard drive, ready for use.

A LaTeX template is available for this journal. Please save the template to your hard drive, ready for use.

If you are not able to use the templates via the links (or if you have any other template queries) please contact us here.

References

Please use this reference guide when preparing your paper. An EndNote output style is also available to assist you.

Taylor & Francis Editing Services

To help you improve your manuscript and prepare it for submission, Taylor & Francis provides a range of editing services. Choose from options such as English Language Editing, which will ensure that your article is free of spelling and grammar errors, Translation, and Artwork Preparation. For more information, including pricing, visit this website.

Checklist: what to include

1. **Author details**. Please ensure everyone meeting the International Committee of Medical Journal Editors (ICJME) requirements for authorship is included as an author of your paper. Please ensure all listed authors meet the Taylor & Francis authorship criteria. All authors of a manuscript should include their full name and affiliation on the cover page of the manuscript. Where available, please also include ORCiDs and social media handles (Facebook, Twitter or LinkedIn). One author will need to be identified as the corresponding author, with their email address normally displayed in the article PDF (depending on the journal) and the online article. Authors' affiliations are the affiliations where the research was conducted. If any of the named co-authors moves affiliation during the peer-review process, the new affiliation can be given as a footnote. Please note that no changes to affiliation can be made after your paper is accepted. Read more on authorship.
2. A structured **abstract** of no more than 200 words. A structured abstract should cover (in the following order): the *purpose* of the article, its *materials and methods* (the design and methodological procedures used), the *results* and conclusions (including their relevance to the study of disability and rehabilitation). Read tips on writing your abstract.

3. You can opt to include a **video abstract** with your article. Find out how these can help your work reach a wider audience, and what to think about when filming.
4. 5-8 **keywords**. Read making your article more discoverable, including information on choosing a title and search engine optimization.
5. A feature of this journal is a boxed insert on **Implications for Rehabilitation**. This should include between two to four main bullet points drawing out the implications for rehabilitation for your paper. This should be uploaded as a separate document. Below are examples:
   Example 1: Leprosy
   - Leprosy is a disabling disease which not only impacts physically but restricts quality of life often through stigmatisation.
   - Reconstructive surgery is a technique available to this group.
   - In a relatively small sample this study shows participation and social functioning improved after surgery.

   Example 2: Multiple Sclerosis

   - Exercise is an effective means of improving health and well-being experienced by people with multiple sclerosis (MS).
   - People with MS have complex reasons for choosing to exercise or not.
   - Individual structured programmes are most likely to be successful in encouraging exercise in this cohort.
6. **Acknowledgement**. Please supply all details required by your funding and grant-awarding bodies as follows: *For single agency grants*: This work was supported by the under Grant . *For multiple agency grants*: This work was supported by the under Grant ; under Grant ; and under Grant .
7. **Declaration of Interest**. This is to acknowledge any financial or non-financial interest that has arisen from the direct applications of your research. If there are no relevant competing interests to declare please state this within the article, for example: *The authors report there are no competing interests to declare.* Further guidance on what is a conflict of interest and how to disclose it.
8. **Data availability statement.** If there is a data set associated with the paper, please provide information about where the data supporting the results or analyses presented in the paper can be found. Where applicable, this should include the hyperlink, DOI or other persistent identifier associated with the data set(s). Templates are also available to support authors.
9. **Data deposition.** If you choose to share or make the data underlying the study open, please deposit your data in a recognized data repository prior to or at the time of submission. You will be asked to provide the DOI, pre-reserved DOI, or other persistent identifier for the data set.
10. **Supplemental online material.** Supplemental material can be a video, dataset, fileset, sound file or anything which supports (and is pertinent to) your paper. We publish supplemental material online via Figshare. Find out more about supplemental material and how to submit it with your article.
11. **Figures.** Figures should be high quality (1200 dpi for line art, 600 dpi for grayscale and 300 dpi for colour). Figures should be saved as TIFF, PostScript or EPS files.
12. **Tables.** Tables should present new information rather than duplicating what is in the text. Readers should be able to interpret the table without reference to the text. Please supply editable files.
13. **Equations**. If you are submitting your manuscript as a Word document, please ensure that equations are editable. More information about mathematical symbols and equations.
14. **Units.** Please use SI units (non-italicized).

Using third-party material in your paper

You must obtain the necessary permission to reuse third-party material in your article. The use of short extracts of text and some other types of material is usually permitted, on a limited basis, for the purposes of criticism and review without securing formal permission. If you wish to include any material in your paper for which you do not hold copyright, and which is not covered by this informal agreement, you will need to obtain written permission from the copyright owner prior to submission. More information on requesting permission to reproduce work(s) under copyright.

Declaration of Interest Statement

Please include a declaration of interest statement, using the subheading "Declaration of interest." If you have no interests to declare, please state this (suggested wording: *The authors report no conflicts of interest*). For all NIH/Wellcome-funded papers, the grant number(s) must be included in the disclosure of interest statement. Read more on declaring conflicts of interest.

Clinical Trials Registry

In order to be published in Disability and Rehabilitation , all clinical trials must have been registered in a public repository, ideally at the beginning of the research process (prior to participant recruitment). Trial registration numbers should be included in the abstract, with full details in the methods section. Clinical trials should be registered prospectively – i.e. before participant recruitment. The clinical trial registry should be publicly accessible (at no charge), open to all prospective registrants, and managed by a not-for-profit organization. For a list of registries that meet these requirements, please visit the WHO International Clinical Trials Registry Platform (ICTRP). The registration of all clinical trials facilitates the sharing of information among clinicians, researchers, and patients, enhances public confidence in research, and is in accordance with the ICMJE guidelines.

Complying with ethics of experimentation

Please ensure that all research reported in submitted papers has been conducted in an ethical and responsible manner, and is in full compliance with all relevant codes of experimentation and legislation. All papers which report *in vivo* experiments or clinical trials on humans or animals must include a written statement in the Methods section. This should explain that all work was conducted with the formal approval of the local human subject or animal care committees (institutional and national), and that clinical trials have been registered as legislation requires. Authors who do not have formal ethics review committees should include a statement that their study follows the principles of the Declaration of Helsinki.

Please ensure that all research reported in submitted papers has been conducted in an ethical and responsible manner, and is in full compliance with all relevant codes of experimentation and legislation. All original research papers involving humans, animals, plants, biological material, protected or non-public datasets, collections or sites, must include a written statement in the Methods section, confirming ethical approval has been obtained from the appropriate local ethics committee or Institutional Review Board and that where relevant, informed consent has been obtained. For animal studies, approval must have been obtained

from the local or institutional animal use and care committee. All research studies on humans (individuals, samples, or data) must have been performed in accordance with the principles stated in the Declaration of Helsinki. In settings where ethics approval for non-interventional studies (e.g. surveys) is not required, authors must include a statement to explain this. In settings where there are no ethics committees in place to provide ethical approval, authors are advised to contact the Editor to discuss further. Detailed guidance on ethics considerations and mandatory declarations can be found in our Editorial Policies section on Research Ethics.

Consent

All authors are required to follow the ICMJE requirements and Taylor & Francis Editorial Policies on privacy and informed consent from patients and study participants. Authors must include a statement to confirm that any patient, service user, or participant (or that person's parent or legal guardian) in any type of qualitative or quantitative research, has given informed consent to participate in the research. For submissions where patients or participants can be potentially identified (e.g. a clinical case report detailing their medical history, identifiable images or media content, etc), authors must include a statement to confirm that they have obtained written informed consent to publish the details from the affected individual (or their parents/guardians if the participant in not an adult or unable to give informed consent; or next of kin if the participant is deceased). The process of obtaining consent to publish should include sharing the article with the individual (or whoever is consenting on their behalf), so that they are fully aware of the content of the article before it is published. Authors should familiarise themselves with our policy on participant/patient privacy and informed consent. They may also use the Consent to Publish Form, which can be downloaded from the same Author Services page.

Health and safety

Please confirm that all mandatory laboratory health and safety procedures have been complied with in the course of conducting any experimental work reported in your paper. Please ensure your paper contains all appropriate warnings on any hazards that may be involved in carrying out the experiments or procedures you have described, or that may be involved in instructions, materials, or formulae.

Please include all relevant safety precautions; and cite any accepted standard or code of practice. Authors working in animal science may find it useful to consult the International Association of Veterinary Editors' Consensus Author Guidelines on Animal Ethics and Welfare and Guidelines for the Treatment of Animals in Behavioural Research and Teaching. When a product has not yet been approved by an appropriate regulatory body for the use described in your paper, please specify this, or that the product is still investigational.

Submitting your paper

This journal uses Taylor & Francis' Submission Portal to manage the submission process. The Submission Portal allows you to see your submissions across Taylor & Francis' journal portfolio in one place. To submit your manuscript please click here.

By submitting your paper to *Disability and Rehabilitation* you are agreeing to originality checks during the peer-review and production processes.

The Editor of *Disability and Rehabilitation* will respond to appeals from authors relating to papers which have been rejected. The author(s) should email the Editor outlining their concerns and making a case for why their paper should not have been rejected. The Editor may choose to accept the appeal and secure a further review, or to not uphold the appeal. In case of the latter, the Editor of *Disability and Rehabilitation: Assistive Technology* will be consulted.

On acceptance, we recommend that you keep a copy of your Accepted Manuscript. Find out more about sharing your work.

Data Sharing Policy

This journal applies the Taylor & Francis Basic Data Sharing Policy. Authors are encouraged to share or make open the data supporting the results or analyses presented in their paper where this does not violate the protection of human subjects or other valid privacy or security concerns.

Authors are encouraged to deposit the dataset(s) in a recognized data repository that can mint a persistent digital identifier, preferably a digital object identifier (DOI) and recognizes a long-term preservation plan. If you are uncertain about where to deposit your data, please see this information regarding repositories.

Authors are further encouraged to cite any data sets referenced in the article and provide a Data Availability Statement.

At the point of submission, you will be asked if there is a data set associated with the paper. If you reply yes, you will be asked to provide the DOI, pre-registered DOI, hyperlink, or other persistent identifier associated with the data set(s). If you have selected to provide a pre-registered DOI, please be prepared to share the reviewer URL associated with your data deposit, upon request by reviewers.

Where one or multiple data sets are associated with a manuscript, these are not formally peer reviewed as a part of the journal submission process. It is the author's responsibility to ensure the soundness of data. Any errors in the data rest solely with the producers of the data set(s).

Publication charges

There are no submission fees, publication fees or page charges for this journal.

Color figures will be reproduced in color in your online article free of charge.

Copyright options

Copyright allows you to protect your original material, and stop others from using your work without your permission. Taylor & Francis offers a number of different license and reuse options, including Creative Commons licenses when publishing open access. Read more on publishing agreements.

Complying with funding agencies

We will deposit all National Institutes of Health or Wellcome Trust-funded papers into PubMedCentral on behalf of authors, meeting the requirements of their respective open access (OA) policies. If this applies to you, please tell our production team when you receive your article proofs, so we can do this for you. Check funders' OA policy mandates here. Find out more about sharing your work.

My Authored Works

On publication, you will be able to view, download and check your article's metrics (downloads, citations and Altmetric data) via My Authored Works on Taylor & Francis Online. This is where you can access every article you have published with us, as well as your free eprints link, so you can quickly and easily share your work with friends and colleagues.

We are committed to promoting and increasing the visibility of your article. Here are some tips and ideas on how you can work with us to promote your research.

Queries

Should you have any queries, please visit our Author Services website or contact us here.

Updated 12-11-2021

Appendix B

Critical Review of the Literature Search Terms

"Broca's aphasi*" OR "expressive aphasi*" OR "non-fluent aphasi*" OR "Wernicke's aphasi*" OR "receptive aphasi*" OR "fluent aphasi*" OR "post-stroke aphasi*" OR "word deafness" OR "agrammatism"

AND

"cognition" OR "cognitive function*" OR "executive function*" OR "learning" OR "memory" OR "attention" OR "complex attention" OR "social cognition" OR "Theory of Mind" or "ToM" OR "mentali*" OR "cognitive abilit*" OR "cognitive health" OR "intellectual function*" OR "visuospatial abilit*" OR "cognitive flexibilit*" OR "metacognition" OR "metacognitive function*" OR "problem-solving" OR "problem solving" OR "concentration"

AND

"cognitive assessment*" OR "cognitive screen*" OR "cognitive test*" OR "cognitive evaluation" OR "neuropsychological assessment*" OR "neuropsychological screen*" OR "neuropsychological test*" OR "neuropsychological evaluation"

AND

"stroke" OR "brain haemorrhage" OR "brain hemorrhage" OR "cerebrovascular accident*" OR "CVA" OR "apoplexy" OR "transient ischaemic attack" OR "transient ischemic attack" OR "brain ischaemia" OR "brain ischemia" OR "cerebral ischaemia" OR "cerebral ischemia" OR "intracerebral haemorrhage" OR "intracerebral hemorrhage" OR "ICH"

Appendix C

Table C.1

The Checklist for Assessing the Quality of Quantitative Studies from Kmet et al.'s (2004) Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields, and Subsequent Ratings for the Studies Included in This Review.

Item Number	Question
1	Question/objective sufficiently described?
2	Study design evident and appropriate?
3	Method of subject/comparison group selection or source of information/input variables described and appropriate?
4	Subject (and comparison group, if applicable) characteristics sufficiently described?
5	If interventional and random allocation was possible, was it described?
6	If interventional and blinding of investigators was possible, was it reported?
7	If interventional and blinding of subjects was possible, was it reported?
8	Outcome and (if applicable) exposure measure(s) well defined and robust to measurement/misclassification bias? Means of assessment reported?
9	Sample size appropriate?
10	Analytic methods described/justified and appropriate?
11	Some estimate of variance is reported for the main results?
12	Controlled for confounding?
13	Results reported in sufficient detail?
14	Conclusions supported by the results?

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Total Score	%
Yu, Jiang, Bi & Li et al. (2013)	2	2	2	2	NA	NA	NA	2	1	2	1	1	2	2	19/22	86%
Yu, Jiang, Li & Bi et al. (2013)	2	2	2	2	NA	NA	NA	2	1	2	0	2	1	1	17/22	77%
Lee & Pyun (2014)	2	2	2	2	NA	NA	NA	2	1	2	2	1	2	2	20/22	91%
Bonini & Radanovic (2015)	2	2	2	2	NA	NA	NA	2	1	2	2	2	2	2	21/22	95%

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Total Score	%
Thomson et al. (2015)	1	2	1	2	NA	NA	NA	2	1	1	0	1	2	2	15/22	68%
Demeyere et al. (2015)	2	2	2	2	NA	NA	NA	2	2	2	2	1	2	2	21/22	96%
Puvanendran et al. (2016)	2	2	NA	2	NA	NA	NA	2	NA	NA	NA	NA	2	2	12/12	100%
Woods et al. (2017)	2	2	NA	2	NA	NA	NA	2	NA	NA	NA	2	2	2	14/14	100%

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Total Score	%
Rodrigues et al. (2019)	2	1	2	2	NA	NA	NA	2	2	2	2	1	2	2	20/22	91%
Schumacher et al. (2019)	2	2	1	2	NA	NA	NA	2	1	2	1	1	2	2	18/22	82%
Fonseca et al. (2019)	2	2	2	2	NA	NA	NA	2	1	2	2	2	2	2	21/22	96%
Kaur et al. (2020)	2	2	2	2	NA	NA	NA	2	1	1	1	2	1	1	17/22	77%

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Total Score	%
Lee et al. (2020)	2	2	1	2	NA	NA	NA	2	2	2	2	1	2	2	20/22	91%
Yao, Liu & Liu et al. (2020)	2	2	2	2	NA	NA	NA	2	2	2	2	2	2	2	22/22	100%
Yao, Liu & Lu et al. (2020)	2	2	2	2	NA	NA	NA	2	1	2	2	2	2	2	21/22	96%
Scumacher et al. (2022)	2	2	1	2	NA	NA	NA	2	1	2	2	1	2	2	19/22	86%

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Total Score	%
Yan et al. (2022)	2	2	2	2	NA	NA	NA	2	2	2	2	2	2	2	22	100%

Appendix D

Instructions for Authors: Service Improvement Project

Guide to Authors

To download our complete Guide to Authors as a pdf, please click here. We require you to comply with the instructions in the attached when submitting, as the below is only an overview and thus does not cover everything.

Spinal Cord and Springer Nature are pleased to share detailed online Author Tutorials - including interactive quizzes - which cover the following topics:

- Writing a journal manuscript
- Submitting a journal and peer review
- Writing in English
- Open Access

You can also watch a brief video giving an overview of the tutorials here.

Article Type Specifications

Article (presenting primary data): *Spinal Cord* prioritises original research that contains prospectively collected data driven by clear a priori hypothesis. This includes but isn't limited to: randomised and non-randomised clinical trials; diagnostic studies; cohort studies; case-control studies; psychometric studies; basic cellular studies; animal studies; qualitative studies; explanatory or mechanistic studies; economic evaluation studies

The following studies are low publication priority: retrospective chart audits; studies of the demographics of patients of a single hospital presenting with new SCI; studies that are only of a regional interest; studies examining the reliability of outcome measures translated into a non-English language; surveys of small and non-representative samples.

Exceptions will be made if the authors can demonstrate that the study is particularly novel and would be of wide interest to an international readership.

Specifications: Structured Abstract (Study Design; Objectives; Setting; Methods; Results; Conclusions; Sponsorship) max. 250 words; Main body of text (excluding abstract, tables/figures and references) not to exceed 3,500 words; Max. 4 tables and 3 figures; Max. 30 references*

Review Article: *Spinal Cord* prioritises systematic reviews about treatment effectiveness which have clearly stated Population-Intervention-Comparate-Outcomes (PICO) elements with results presented in forest plots including meta-analyses as appropriate. Systematic reviews examining incidence or prevelance of SCI or of a secondary condition will also be prioritised.

Narrative reviews will be considered but only if the topic is of wide interest to readers. The topics of both narrative and systematic reviews should not have already been extensively reviewed, or the authors can demonstrate that the review adds new insights to a previous review on the topic. Authors are encourage to seek feedback about suitability for publication of narrative reviews from the Editorial Office before submitting.

Specifications: Structured Abstract of max. 250 words; Main body of text (excluding abstract, tables/figures, and references) not to exceed 4,500 words; Max. of 2 tables and 3 figures; Max. 30 references (references of the studies extracted can go in supplementary files)*

Protocol (when submitting please select manuscript type 'Article)': Protocol of large cohort studies or clinical trials may be published from time-to-time. However, the studies need to be of high importance (e.g. answering a key clinical question, or offering methodologic innovation) with a strong likelihood of completion (evident by sufficient funding).
The headings for the Structured Abstract and within the article text should be the same as for Articles as outlined in the complete Guide to Authors document with the following exception: the Results and Discussion sections should be replaced with one section titled 'Ethics and Dissemination'. Additional subheadings within the sections are allowed.
Specifications: Structured Abstract of max. 250 words; Main body of text (excluding abstract, tables/figures, and references) not to exceed 2,500 words; Max. of 1 table and 2 figures; Max. of 30 references*

Correspondence: Correspondences will be considered if they relate to a previously published manuscript in *Spinal Cord* or a current controversial issue. Correspondences that highlight an important weakness with the methodology or interpretation of the results of a published paper will be prioritised.
Specifications: No abstract or subheadings required; Main body of text (excluding tables/figures, references) not to exceed 800 words; No tables or figures unless essential; Max. 5 references

Perspective: Any type of scholarly paper that requires less than 1,500 words and 10 references. This may include summaries of Cochrane Reviewers (provided by the Cochrane Rehabilitation Group), summaries of well-recognised clinical practise guidelines, summaries of position or consensus statements by Societies and organisations affiliated with ISCoS, summaries of important strategic planning meetings, summaries of medical or research procedures or new assessment tools, or short narratives on controversial topics. Perspectives need to be balanced but can be more opinionated than original research. They should stimulate discussion or provide an accessible summary of content that would be of interest to the readers of *Spinal Cord.*
Specifications: Unstructured abstract/brief overview of maximum 150 words; Main body of text (excluding tables/figures, references) not to exceed 1,500 words; Max. 1 table and/or figures[+]; Max. 10 references

*Unless the restrictions prevent authors from conveying key messages. If these restrictions are exceeded then authors need to provide an explanation in their covering letter and be aware that they may be asked to reduce the number of Tables, Figures, References and/or length of the manuscript. Authors can put extensive descriptions of particular methods of statistical techniques, and extra Figures or Tables in Supplementary Files.

[+]Additional Tables and Figures can be included as Supplementary Files.

Please note: all submissions should include a Title Page and a Conflict of Interest Statement. More information can be found below.

Prior Registrations
Clinical Trials
Important message: Mandatory requirements starting 1st January 2018
From 2018: All clinical trials starting on or after 1st January 2018 **MUST** be registered **BEFORE** the first participant is randomised to be accepted for publication in *Spinal Cord*. A clinical trial is any study in which participants are allocated to a treatment. Most registries allow registration of non-interventional studies, and we encourage researchers to register their observational studies. Trials commenced before 2018 must be retrospectively registered.
Read here and see the Clinical Trial section in the Guide to Authors PDF for more details.

Systematic Reviews
Systematic reviews can be registered in PROSPERO (https://www.crd.yourk.ac.uk/PROSPERO) and *Spinal Cord* will at some point in the future start requiring such pre-registration.

Preparation of Articles
House Style: Authors should adhere to the following formatting guidelines

- We accept UK English or American English, however authors should be consistent of their use of either within the manuscript.
- Text should be double spaced with margins of between 1cm and 3cm wide.
- All pages and lines are to be numbered continuously.
- Do not make rules thinner than 1pt (0.36mm).
- Use a coarse hatching pattern rather than shading for tints in graphs.
- Colour should be distinct when being used as an identifying tool.
- Commas, not spaces should be used to separate thousands. Decimal values should be proceeded by a dot, not a comma.
- At first mention of a manufacturer, the town (and state if USA) and country should be provided.
- Normally distributed data should be expressed as mean (SD). Skewed data should be expressed as median (25% and 75% percentiles).
- Sole reliance on statistically significance (and p values) is discouraged. Instead, we encourage reporting of effect sizes preferably in the units of the original scale. See Author Guide for more details and examples of this.
- Units**:** Use metric units (SI units) as fully as possible. Preferably give measurements of energy in kiloJoules or megaJoules with kilocalories in parentheses (1 kcal = 4.186kJ). Use % throughout.
- Express all 95% confidence intervals in this format - "95% CI, xx to xx"
- Express all means and standard deviations in this format - "the mean (SD) was xx (xx)"
- Use person centred terminology throughout e.g. "people with tetraplegia" not "tetraplegics"
- Use the term "tetraplegia" (not quadripligea)

- Use the words "person/s", "people" or "individual/s" where ever possible (rather than patient/s) unless this distracts from the readability or meaning
- Use the word "participant/s" not "subject/s"
- Avoid spurious precision. As a general rule, report numbers between 0 and 1 to 2 decimal places, between 1 and 10 to 1 decimal place, and above 10 with no decimal place

Please note Articles must contain the below components. More details on this can also be found in the Guide to Authors PDF.

Cover Letter: Authors should provide a cover letter that includes the affiliation and contact information for the corresponding author. Authors should briefly discuss the importance of the work and explain why it is considered appropriate for the diverse readership of the journal. The cover letter should confirm the material is original research, has not been previously published and has not been/will not be submitted for publication elsewhere while under consideration. If the manuscript has been previously considered for publication in another journal, please include the previous reviewer comments, to help expedite the decision by the Editorial team.

Title Page: The title page should contain:

- Title of the paper - brief, informative, of 150 characters or less and should not make a statement or conclusion. See Author Guide for more details and examples.
- Full first and last names of all authors along with initials for any middle names. Also provide the affiliations of all authors, as well as the e-mail address of the corresponding author (postal addresses are no longer required). If authors regard it as essential to indicate that two or more co-authors are equal in status, they may be identified by an asterisk symbol with the caption ‘These authors contributed equally to this work’ immediately under the address list.
- Consortia: please see Author Guide for full details on this.

Large Language Models (LLMs), such as ChatGPT, do not currently satisfy our authorship criteria. Notably an attribution of authorship carries with it accountability for the work, which cannot be effectively applied to LLMs. Use of an LLM should be properly documented in the Methods section (and if a Methods section is not available, in a suitable alternative part) of the manuscript.

Structured Abstract: Articles must be prepared with a structured abstract designed to summarise the essential features of the paper in a logical and concise sequence under the following mandatory headings. Authors can also apply this layout to Review Articles if they wish to do so. (Structured abstracts must be used for systematic reviews but unstructured abstracts may be used for narrative reviews)

- **Study Design** e.g. Cohort Study; clinical trial; Narrative Review; Systematic Review - see "Article Description" for other examples
- **Objectives**

- **Setting** e.g. Hospital in Gothenburg, Sweden; University-based laboratory in Chicago, USA. (Narrative and systematice reviews do not need to include this heading)
- **Methods**
- **Results**
- **Conclusions:** Framed with respect to the objectives and primary results
- **Sponsorship** (this is only relevant if a commercial company has sponsored the study)

Graphical Abstracts (optional): A graphical abstract, which summarizes the manuscript in a visual way, is designed to attract the attention of readers in the table of contents of the journal. Graphical abstracts are published in the table of contents and in the article html. The graphic should be submitted as a single file using a standard file format (.tiff, .eps, .jpg, .bmp, .doc, or .pdf.), it should be 9 cm wide x 5 cm high when printed at full scale and a minimum of 300 dpi. All graphical abstracts should be submitted with a white background and imagery should fill the available width, whenever possible. Colour graphical abstracts are encouraged and will be published at no additional charge. Textual statements should be kept to a minimum.

Introduction: The Introduction should assume that the reader is knowledgeable in the field and should therefore be as brief as possible but, can include a short historical review where desirable. Please refrain from commencing with statements such as "Spinal cord injuries are devastating injuries" or similar

Methods: This section should contain sufficient detail, so that all experimental procedures can be reproduced by a knowledgeable scientist, and include references. Methods that have been published in detail elsewhere should not be described in detail. Authors should provide the name of the manufacturer and their location for any specifically named medical equipment and instruments, and all drugs should be identified by their pharmaceutical names, and by their trade name if relevant.

Results: The Results section should briefly present the experimental data in text, tables and/or figures. Tables and figures should not be described extensively in the text, but the text should refer to key findings/observations in Tables and Figures e.g. "As shown in Table 2, males are taller than females with a mean (SD) difference of 1.2 (0.3)cm". All results comparing groups should be presented as point estimates with measures of precision (eg. mean between-group differences, odds ratios or hazard ratios with 95% confidence intervals).

Discussion: The Discussion should focus on the interpretation and the significance of the findings with concise objective comments that describe their relation to other work in the area. It should not repeat information in the results. The final paragraph should highlight the main conclusion(s) and clinical implications, and provide some indication of the direction future research should take.

Data Availability Statement: Please include a statement at the end of your paper that tells readers where the data generated or analysed during this study can be found e.g. within the published article and its supplementary files, within a recognised repository, with a link to the data in said repository, or if additional data are available from the corresponding author on

reasonable request.
Please see the Data Availability and Policy page for more information.

References: Only papers directly related to the article should be cited. Exhaustive lists should be avoided - see the limitations on number of references under Article Type Specifications above. References should follow the Vancouver format. In the text they should appear as numbers (starting at one) in square brackets before punctuations. Example "...the scale maintains adequate construct validity and measures the attributes it purports to measure [15,16]".
The full details of the References should appear at the end of the paper (double-spaced) in numerical order corresponding to the order of citation in the text. If you use a reference manager such as Endnote or RefWorks, make sure you check the results for completeness and proper capitalization of author names, Journal names, titles, and year/volume/issue/page information. The doi, PMCID and similar numbers should not be included unless the Reference is only available in electronic format. Please ensure the links to Endnote are removed prior to submission.

All authors should be listed for papers with up to six authors; for papers with more than six authors, the first six only should be listed, followed by *et al.* Abbreviations for titles of medical periodicals should conform to those used in the NCBI database. The first and last page numbers for each reference should be provided. Abstracts and letters must be identified as such. Papers in press may be included in the list of references.
Personal communications can be allocated a number and included in the list of references in the usual way or simply referred to in the text e.g. "William Jones, personal communication, 2 June 2018". In either case authors must obtain permission from the individual concerned to quote his/her unpublished work.

Examples:

Journal article:
Neidlein, S, Wirth, R, Pourhassan, M. Iron deficiency, fatigue and muscle strength and function in older hospitalized patients. Eur J Clin Nutr. 2020; 75:456–463.
Journal article by DOI:
Kurotani K, Shinsugi C, Takimoto H. Diet quality and household income level among students: 2014 National Health and Nutrition Survey Japan. Eur J Clin Nutr. 2020; https://doi.org/10.1038/s41430-020-00794-1.
Journal article, in press:
Gallardo RL, Juneja HS, Gardner FH. Normal human marrow stromal cells induce clonal growth of human malignant T-lymphoblasts. Int. J Cell Cloning (in press).
Complete book:
Atkinson K, Champlin R, Ritz J, Fibbe W, Ljungman P, Brenner MK (eds). Clinical Bone Marrow and Blood Stem Cell Transplantation. 3rd ed. Cambridge University Press, Cambridge, 2004.
Chapter in book:
Coccia PF. Hematopoietic cell transplantation for osteopetrosis. In: Blume KG, Forman SJ, Appelbaum FR (eds). Thomas' Hematopoietic Cell Transplantation. 3rd ed. Blackwell Publishing Ltd, Malden, 2004. pp 1443–1454.
Abstract:

Abstracts from the 2020 Annual Scientific Meeting of the British and Irish Hypertension Society (BIHS). J Hum Hypertens 34; 2020; 1–20
Website:
Kassambara A. rstatix: pipe-friendly framework for basic statistical tests. 2020. https://rpkgs.datanovia.com/rstatix/.
Online Document:
Doe J. Title of subordinate document. In: The dictionary of substances and their effects. Royal Society of Chemistry. 1999. http://www.rsc.org/dose/title of subordinate document. Accessed 15 Jan 1999.

Acknowledgements: These should be brief, and should include sources of technical assistance, critical advice or other assistance, which contributed to the final manuscript.

Author Contributions: Authors must include a statement about the contribution of each author to the manuscript (see section on Authorship). The initials of each author may be used. Please see example in the Guide to Authors document.

Funding: The funding section is mandatory. Authors must declare sources of study funding including sponsorship (e.g. university, charity, commercial organization) and sources of material (e.g. novel drugs) not available commercially. If no financial assistance was received in support of the study, please include a statement to this fact here.

Ethical Approval
Authors must provide a statement regarding ethical approval (see information on Human and Other Animal Experiments in the Editorial Policy section for further details). If ethical approval was not required, authors must provide an explanation of why it was not needed.

Competing Interests: Authors must declare whether or not there are any competing financial interests in relation to the work described. This information must be included at this stage and will be published as part of the paper. Please see the Competing Interests section under Editorial Policies for detailed information.

Patient consent for images or information used in a manuscript: If a patient or participant of a study can be identified in any way through images or information presented in a paper, the patient or participant provide written and signed consent for this identification. The consent needs to be emailed to the editorial office. Alternatively, please indicate where a photograph can be cropped to remove identifiable features. If consent has not been obtained, then any recognizable features must be masked so that the individual is 'officially unrecognizable'.

Figure Legends: These should appear on a separate manuscript page after the References section. Each Figure should have a brief title and may have a short footnote.

Tables: Tables should only be used to present essential data; they should not duplicate what is written in the text. Use lower case letters starting with 'a' to reference Table footnotes. Tables should consist of at least two columns; columns should always have headings. Ensure

each Table is cited within the text and in the correct order, e.g. (Table 3). All measures of variability should be defined either within the table title or footnote. **It is imperative that tables are editable** and ideally submitted in Excel format although Word format is acceptable. **If uploading in Excel, each table must be uploaded as a separate workbook with a title or caption and be clearly labelled, sequentially**. Files for Tables need to be saved with one of the following extensions: .xls / .xlsx / .ods / or .doc or .docx. Please ensure that you provide a 'flat' file, with single values in each cell with no macros or links to other workbooks or worksheets and no calculations or functions.

Figures: Figures and images should be labelled sequentially and cited in the text (e.g. Fig1.). **Figures should not be embedded within the text but uploaded as separate files**. The use of three-dimensional histograms is strongly discouraged unless the addition of the third dimension is important for conveying the results. All parts of a figure should be grouped together. Where possible large figures and tables should be included as supplementary material.
Detailed guidelines for submitting artwork can be found by downloading our Artwork Guidelines. Using the guidelines, please submit production quality artwork with your initial online submission. If you have followed the guidelines, we will not require the artwork to be resubmitted following the peer-review process, if your paper is accepted for publication.

Colour Charges
There is a charge if authors choose to publish their figures in colour in print publication (which includes the online PDF). VAT or local taxes will be added where applicable. Colour charges will not apply to authors who wish to have their figures in colour online only (HTML version of the article but NOT the PDF).
Colour charges will NOT apply to authors who choose to pay an article processing charge to make their paper Open Access.

Number of colour illustrations		1	2	3	4	5	6	7+
Cost:	Rest of world	£573	£852	£1,132	£1,303	£1,473	£1,619	£146
	USA	$883	$1,313	$1,745	$2,007	$2,270	$2,496	$226
								per figure

Standard Abbreviations: Abbreviations should be defined in full at their first usage in the Abstract, and again at their first usage in the body of the manuscript. So on first use of an abbreviation, place it in parentheses after the full item. Do this separately for the abstract and the full texts). Note these abbreviations: gram **g**; litre **l**; milligram **mg**; kilogram **kg**; kilojoule **kj**; megajoule **mj**; weight **wt**; seconds **s**; minutes **m**; hours **h**. Do not add s for plural units. Terms used less than four times should not be abbreviated. It is not advised to use more than five abbreviations in total unless they are extremely common abbreviations.

Reporting of demographic and neurological details: Demographic data should be reported as mean and standard deviation, or median and interquartile range depending on whether the data are skewed or not. If data are to be grouped, authors are encouraged to follow the recommendations of Biering-Sørensen *et al*.[1] Age should be grouped in 15 year increments:

0–15, 16–30, 31–45… to 76+. Reporting on the paediatric SCI population should use age groups 0–5, 6–12, 13–14, 15-17 and 18–21. When time since injury is grouped, 5 year increments should be used: <1 year, 1–5 years, 6–10 years, and 5-year increments thereafter. Calendar time (years during which the study is conducted) should be grouped by either 5 or 10 year increments with years ending in 4 or 9. The severity of injury should be grouped as C1-4 ASIA Impairment Scale grade (AIS) A, B, or C; C5-8 AIS A, B, or C; T1-S5 AIS A, B, or C; AIS D at any injury level; Ventilator-dependent at any injury level or AIS grade. If data are limited, the above groups can be collapsed. If data are limited, the above groups can be collapsed.

[1] Biering-Sorensen F, DeVivo MJ, Charlifue S, Chen Y, New PW, Noonan V. et al. International Spinal Cord Injury Core Data Set (version 2.0) including standardization of reporting. Spinal Cord 2017; 55: 759-764.

Supplementary Information: Supplementary information is material directly relevant to the Methods, Results, Discussion and/or Conclusion of an article that cannot be included in the printed version owing to space or format constraints. The article must be complete and self-explanatory for the average reader without the Supplementary Information, which is posted on the journal's website and linked to the article. Supplementary Information may consist of data files, graphics, movies or extensive tables. Please see our Artwork Guidelines for information on accepted file types.
Authors should submit supplementary information files in the FINAL format as they are not edited, typeset or changed, and will appear online exactly as submitted. Ideally all Supplementary Information files should be merged into one PDF document, unless the file contains Data, Software, Movie or Audio files, in which case these should be submitted as separate documents/files in the appropriate format (e.g. Excel files, *.dat files, *.mov files, etc.). Please upload supplementary material as file type 'Supplementary Material - seen by all'. When submitting Supplementary Information, authors are required to:

- Include a text summary (no more than 50 words) to describe the contents of each file within the supplementary materials as the legends. These need to be placed in the Supplementary File (not at the back of the manuscript). If you are unable to include the legends for Supplementary Materials within the file, please upload your legends for supplementary materials in a separate file. Please also ensure that all data files include a codebook explaining each variable. It is important that all Supplementary Files are referred to within the main text of the manuscript. For example - "(see Supplementary Appendix 1 for participant-level data)".
- Identify the types of files (file formats) submitted.

Please submit supplementary figures, small tables and text as a single combined PDF document. Tables longer than one page should be provided as an Excel or similar file type. For optimal quality video files please use H.264 encoding, the standard aspect ratio of 16:9 (4:3 is second best) and do not compress the video. Supplementary information is not copyedited, so please ensure that it is clearly and succinctly presented, and that the style and terminology conform to the rest of the manuscript, with any tracked-changes or Review mark-ups removed.

Please note: We do not allow the resupplying of Supplementary Information files for style reasons after a paper has been exported in production, unless there is a serious error that affects the science which would lead to a formal correction once the paper has been published. In these cases we would make an exception and replace the file; however there are very few instances where a Supplementary Information file would be corrected post publication.

Appendix E

Service Improvement Project Lay Summary

Research suggests that when someone suffers a spinal cord injury (SCI), there is also a possibility that they will acquire a traumatic brain injury. Having a TBI on top of a SCI may mean additional barriers to recovery than having either condition alone. This study aimed to compare the number of TBIs detected at the UK National Spinal Injury Centre to figures found in previous research, and understand what makes it hard for clinicians to adapt SCI rehabilitation in the presence of TBI. This was done by assessing the documents representing 88 patients' journeys through treatment where a TBI could be detected and used to adapt treatment. Next, staff were interviewed to explore the barriers to detecting TBI and adapting SCI rehabilitation. Results suggested that data related to TBI were inconsistently recorded, the number of TBI at the Centre was lower than previous research, and several barriers were interpreted from the interview with staff. The findings are important in helping the clinicians assess for traumatic brain injuries and making changes to patients' SCI treatment, such as by adapting the documents clinicians use to examine patients, and training the clinicians on how TBI may affect individuals with SCI and their families.

Appendix F

Service Improvement Project Approval Letter

Safe & compassionate care, every time

NHS
Buckinghamshire Healthcare
NHS Trust

Lawson Falshaw
Trainee Clinical Psychologist
The Oxford Institute of Clinical Psychology
Training and Research
The Oxford Centre for Psychological Health

Stoke Mandeville Hospital
Mandeville Road
Aylesbury
Buckinghamshire
HP21 8AL
Tel: 01296 315000
Direct Dial: 01296 418124

www.buckshealthcare.nhs.uk

05 May 2021

Dear Lawson

Project title: **Assessing and Improving the Detection of TBI in Patients Undergoing Rehabilitation for A Spinal Cord Injury: A Service Improvement Project.**
Date of Submission to Project Classification Group: **04 May 2021**

Project Classification Group Reference: **PCG041**

The Buckinghamshire Healthcare NHS Trust Project Classification Group has reviewed the above project and has determined that it is a **Quality Improvement project.** A member of the Quality Improvement team at Buckinghamshire Healthcare NHS Trust will be in touch with you shortly.

If, for any reason, the project changes after the date of this letter please inform the Research and Innovation Department

To allow us to monitor project output please can you send the Research and Innovation Department a summary of the results within 90 days of the project completion.

Best wishes

James Cooper

Signed on behalf of the Buckinghamshire Healthcare NHS Trust Project Classification Group

Cc. Debbie Begent,
Imogen Cotter

Appendix G

Instructions for Authors: Theory-Driven (Main) Research Project

About the Journal

Neuropsychological Rehabilitation is an international, peer-reviewed journal publishing high-quality, original research. Please see the journal's Aims & Scope for information about its focus and peer-review policy.

Please note that this journal only publishes manuscripts in English.

Neuropsychological Rehabilitation accepts the following types of article: original articles, scholarly reviews, book reviews.

Open Access

You have the option to publish open access in this journal via our Open Select publishing program. Publishing open access means that your article will be free to access online immediately on publication, increasing the visibility, readership and impact of your research. Articles published Open Select with Taylor & Francis typically receive 32% more citations* and over 6 times as many downloads** compared to those that are not published Open Select.

Your research funder or your institution may require you to publish your article open access. Visit our Author Services website to find out more about open access policies and how you can comply with these.

You will be asked to pay an article publishing charge (APC) to make your article open access and this cost can often be covered by your institution or funder. Use our APC finder to view the APC for this journal.

Please visit our Author Services website or contact openaccess@tandf.co.uk if you would like more information about our Open Select Program.

*Citations received up to Jan 31st 2020 for articles published in 2015-2019 in journals listed in Web of Science®.
**Usage in 2017-2019 for articles published in 2015-2019.

Peer Review and Ethics

Taylor & Francis is committed to peer-review integrity and upholding the highest standards of review. Once your paper has been assessed for suitability by the editor, it will then be single blind peer reviewed by independent, anonymous expert referees. Find out more about what to expect during peer review and read our guidance on publishing ethics.

Preparing Your Paper

All authors submitting to medicine, biomedicine, health sciences, allied and public health journals should conform to the Uniform Requirements for Manuscripts Submitted to Biomedical Journals, prepared by the International Committee of Medical Journal Editors (ICMJE).

Clinical trials: must conform to the Consort guidelines http://www.consort-statement.org. Submitted papers should include a checklist confirming that all of the Consort requirements have been met, together with the corresponding page number of the manuscript where the information is located. In addition, trials must be pre-registered on a site such as clinicaltrials.gov or equivalent, and the manuscript should include the reference number to the relevant pre-registration.

Systematic reviews: submitted papers should follow PRISMA http://www.prisma-statement.org/ guidelines and submission should also be accompanied by a completed PRISMA checklist, together with the corresponding page number of the manuscript where the information is located.

Single-case studies: submitted papers should follow SCRIBE guidelines (http://psycnet.apa.org/fulltext/2016-17384-001.html) and include a completed SCRIBE checklist together with the corresponding page number of the manuscript where the information is located.

Observational studies: submitted papers should follow the STROBE guidelines (https://www.strobe-statement.org/index.php?id=strobe-home) and also include a completed checklist of compliance, together with the corresponding page number of the manuscript where the information is located.

Qualitative studies: should follow the COREQ guidelines (http://www.equator-network.org/reporting-guidelines/coreq/) and be accompanied by a completed COREQ checklist of compliance, together with the corresponding page number of the manuscript where the information is located.

The EQUATOR Network (Enhancing the Quality and Transparency of Health Research) website provides further information on available guidelines.

Structure

Your paper should be compiled in the following order: title page; abstract; keywords; main text introduction, materials and methods, results, discussion; acknowledgments; declaration of interest statement; references; appendices (as appropriate); table(s) with caption(s) (on individual pages); figures; figure captions (as a list).

Word Limits

Please include a word count for your paper. There are no word limits for papers in this journal.

Style Guidelines

Please refer to these quick style guidelines when preparing your paper, rather than any published articles or a sample copy.

Please use American spelling style consistently throughout your manuscript. Please use single quotation marks, except where 'a quotation is "within" a quotation'. Please note that long quotations should be indented without quotation marks.

Alt Text

This journal is now including Alt Text (alternative text), a short piece of text that can be attached to your figure to convey to readers the nature or contents of the image. It is typically used by systems such as pronouncing screen readers to make the object accessible to people that cannot read or see the object, due to a visual impairment or print disability. Alt text will also be displayed in place of an image, if said image file cannot be loaded. Alt Text can also provide better image context/descriptions to search engine crawlers, helping them to index an image properly. To include Alt Text in your article, please follow our Guidelines

Format-Free Submission

Authors may submit their paper in any scholarly format or layout. Manuscripts may be supplied as single or multiple files. These can be Word, rich text format (rtf), open document format (odt), or PDF files. Figures and tables can be placed within the text or submitted as separate documents. Figures should be of sufficient resolution to enable refereeing.

- There are no strict formatting requirements, but all manuscripts must contain the essential elements needed to evaluate a manuscript: abstract, author affiliation, figures, tables, funder information, and references. Further details may be requested upon acceptance.
- References can be in any style or format, so long as a consistent scholarly citation format is applied. Author name(s), journal or book title, article or chapter title, year of publication, volume and issue (where appropriate) and page numbers are essential. All bibliographic entries must contain a corresponding in-text citation. The addition of DOI (Digital Object Identifier) numbers is recommended but not essential.
- The journal reference style will be applied to the paper post-acceptance by Taylor & Francis.
- Spelling can be US or UK English so long as usage is consistent.

Note that, regardless of the file format of the original submission, an editable version of the article must be supplied at the revision stage.

Taylor & Francis Editing Services

To help you improve your manuscript and prepare it for submission, Taylor & Francis provides a range of editing services. Choose from options such as English Language Editing, which will ensure that your article is free of spelling and grammar errors, Translation, and Artwork Preparation. For more information, including pricing, visit this website.

Checklist: What to Include

1. **Author details.** Please ensure everyone meeting the International Committee of Medical Journal Editors (ICMJE) requirements for authorship is included as an author of your paper. All authors of a manuscript should include their full name and affiliation on the cover page of the manuscript. Where available, please also include ORCiDs and social media handles (Facebook, Twitter or LinkedIn). One author will need to be identified as the corresponding author, with their email address normally displayed in the article PDF (depending on the journal) and the online article. Authors' affiliations are the affiliations where the research was conducted. If any of the named co-authors moves affiliation during the peer-review process, the new affiliation can be given as a footnote. Please note that no changes to affiliation can be made after your paper is accepted. Read more on authorship.
2. Should contain an unstructured abstract of 200 words.
3. You can opt to include a **video abstract** with your article. Find out how these can help your work reach a wider audience, and what to think about when filming.
4. Between 5 and 5 **keywords**. Read making your article more discoverable, including information on choosing a title and search engine optimization.
5. **Funding details.** Please supply all details required by your funding and grant-awarding bodies as follows:
   For single agency grants
   This work was supported by the [Funding Agency] under Grant [number xxxx].
   For multiple agency grants
   This work was supported by the [Funding Agency #1] under Grant [number xxxx]; [Funding Agency #2] under Grant [number xxxx]; and [Funding Agency #3] under Grant [number xxxx].
6. **Disclosure statement.** This is to acknowledge any financial interest or benefit that has arisen from the direct applications of your research. Further guidance on what is a conflict of interest and how to disclose it.
7. **Data availability statement.** If there is a data set associated with the paper, please provide information about where the data supporting the results or analyses presented in the paper can be found. Where applicable, this should include the hyperlink, DOI or other persistent identifier associated with the data set(s). Templates are also available to support authors.
8. **Data deposition.** If you choose to share or make the data underlying the study open, please deposit your data in a recognized data repository prior to or at the time of submission. You will be asked to provide the DOI, pre-reserved DOI, or other persistent identifier for the data set.
9. **Geolocation information.** Submitting a geolocation information section, as a separate paragraph before your acknowledgements, means we can index your paper's study area accurately in JournalMap's geographic literature database and make your article more discoverable to others. More information.
10. **Supplemental online material.** Supplemental material can be a video, dataset, fileset, sound file or anything which supports (and is pertinent to) your paper. We publish supplemental material online via Figshare. Find out more about supplemental material and how to submit it with your article.
11. **Figures.** Figures should be high quality (1200 dpi for line art, 600 dpi for grayscale and 300 dpi for colour, at the correct size). Figures should be supplied in one of our preferred file formats: EPS, PS, JPEG, TIFF, or Microsoft Word (DOC or DOCX) files are acceptable for figures that have been drawn in Word. For information relating to other file types, please consult our Submission of electronic artwork document.

12. **Tables.** Tables should present new information rather than duplicating what is in the text. Readers should be able to interpret the table without reference to the text. Please supply editable files.
13. **Equations.** If you are submitting your manuscript as a Word document, please ensure that equations are editable. More information about mathematical symbols and equations.
14. **Units.** Please use SI units (non-italicized).

Using Third-Party Material in your Paper

You must obtain the necessary permission to reuse third-party material in your article. The use of short extracts of text and some other types of material is usually permitted, on a limited basis, for the purposes of criticism and review without securing formal permission. If you wish to include any material in your paper for which you do not hold copyright, and which is not covered by this informal agreement, you will need to obtain written permission from the copyright owner prior to submission. More information on requesting permission to reproduce work(s) under copyright.

Disclosure Statement

Please include a disclosure statement, using the subheading "Disclosure of interest." If you have no interests to declare, please state this (suggested wording: *The authors report no conflict of interest*). For all NIH/Wellcome-funded papers, the grant number(s) must be included in the declaration of interest statement. Read more on declaring conflicts of interest.

Clinical Trials Registry

In order to be published in a Taylor & Francis journal, all clinical trials must have been registered in a public repository at the beginning of the research process (prior to patient enrolment). Trial registration numbers should be included in the abstract, with full details in the methods section. The registry should be publicly accessible (at no charge), open to all prospective registrants, and managed by a not-for-profit organization. For a list of registries that meet these requirements, please visit the WHO International Clinical Trials Registry Platform (ICTRP). The registration of all clinical trials facilitates the sharing of information among clinicians, researchers, and patients, enhances public confidence in research, and is in accordance with the ICMJE guidelines.

Complying With Ethics of Experimentation

Please ensure that all research reported in submitted papers has been conducted in an ethical and responsible manner, and is in full compliance with all relevant codes of experimentation and legislation. All papers which report in vivo experiments or clinical trials on humans or animals must include a written statement in the Methods section. This should explain that all work was conducted with the formal approval of the local human subject or animal care committees (institutional and national), and that clinical trials have been registered as legislation requires. Authors who do not have formal ethics review committees should include a statement that their study follows the principles of the Declaration of Helsinki.

Consent

All authors are required to follow the ICMJE requirements on privacy and informed consent from patients and study participants. Please confirm that any patient, service user, or participant (or that person's parent or legal guardian) in any research, experiment, or clinical trial described in your paper has given written consent to the inclusion of material pertaining to themselves, that they acknowledge that they cannot be identified via the paper; and that you have fully anonymized them. Where someone is deceased, please ensure you have written consent from the family or estate. Authors may use this Patient Consent Form, which should be completed, saved, and sent to the journal if requested.

Health and Safety

Please confirm that all mandatory laboratory health and safety procedures have been complied with in the course of conducting any experimental work reported in your paper. Please ensure your paper contains all appropriate warnings on any hazards that may be involved in carrying out the experiments or procedures you have described, or that may be involved in instructions, materials, or formulae.

Please include all relevant safety precautions; and cite any accepted standard or code of practice. Authors working in animal science may find it useful to consult the International Association of Veterinary Editors' Consensus Author Guidelines on Animal Ethics and Welfare and Guidelines for the Treatment of Animals in Behavioural Research and Teaching. When a product has not yet been approved by an appropriate regulatory body for the use described in your paper, please specify this, or that the product is still investigational.

Submitting Your Paper

This journal uses ScholarOne Manuscripts to manage the peer-review process. If you haven't submitted a paper to this journal before, you will need to create an account in ScholarOne. Please read the guidelines above and then submit your paper in the relevant Author Centre, where you will find user guides and a helpdesk.

Please note that *Neuropsychological Rehabilitation* uses Crossref™ to screen papers for unoriginal material. By submitting your paper to *Neuropsychological Rehabilitation* you are agreeing to originality checks during the peer-review and production processes.

On acceptance, we recommend that you keep a copy of your Accepted Manuscript. Find out more about sharing your work.

Data Sharing Policy

This journal applies the Taylor & Francis Basic Data Sharing Policy. Authors are encouraged to share or make open the data supporting the results or analyses presented in their paper where this does not violate the protection of human subjects or other valid privacy or security concerns.

Authors are encouraged to deposit the dataset(s) in a recognized data repository that can mint a persistent digital identifier, preferably a digital object identifier (DOI) and recognizes a

long-term preservation plan. If you are uncertain about where to deposit your data, please see this information regarding repositories.

Authors are further encouraged to cite any data sets referenced in the article and provide a Data Availability Statement.

At the point of submission, you will be asked if there is a data set associated with the paper. If you reply yes, you will be asked to provide the DOI, pre-registered DOI, hyperlink, or other persistent identifier associated with the data set(s). If you have selected to provide a pre-registered DOI, please be prepared to share the reviewer URL associated with your data deposit, upon request by reviewers.

Where one or multiple data sets are associated with a manuscript, these are not formally peer reviewed as a part of the journal submission process. It is the author's responsibility to ensure the soundness of data. Any errors in the data rest solely with the producers of the data set(s).

Publication Charges

There are no submission fees, publication fees or page charges for this journal.

Colour figures will be reproduced in colour in your online article free of charge. If it is necessary for the figures to be reproduced in colour in the print version, a charge will apply.

Charges for colour figures in print are £300 per figure ($400 US Dollars; $500 Australian Dollars; €350). For more than 4 colour figures, figures 5 and above will be charged at £50 per figure ($75 US Dollars; $100 Australian Dollars; €65). Depending on your location, these charges may be subject to local taxes.

Copyright Options

Copyright allows you to protect your original material, and stop others from using your work without your permission. Taylor & Francis offers a number of different license and reuse options, including Creative Commons licenses when publishing open access. Read more on publishing agreements.

Complying with Funding Agencies

We will deposit all National Institutes of Health or Wellcome Trust-funded papers into PubMedCentral on behalf of authors, meeting the requirements of their respective open access policies. If this applies to you, please tell our production team when you receive your article proofs, so we can do this for you. Check funders' open access policy mandates here. Find out more about sharing your work.

My Authored Works

On publication, you will be able to view, download and check your article's metrics (downloads, citations and Altmetric data) via My Authored Works on Taylor & Francis Online. This is where you can access every article you have published with us, as well as your free eprints link, so you can quickly and easily share your work with friends and colleagues.

We are committed to promoting and increasing the visibility of your article. Here are some tips and ideas on how you can work with us to promote your research.

Article Reprints

You will be sent a link to order article reprints via your account in our production system. For enquiries about reprints, please contact the Taylor & Francis Author Services team at reprints@tandf.co.uk. You can also order print copies of the journal issue in which your article appears.

Queries

Should you have any queries, please visit our Author Services website or contact us here.

Updated 30-09-2022

Appendix H

Measures used in the Theory-Driven (Main) Research Project

The Relationship Assessment Scale (Pre-Injury RAS; Hendrick, 1988).

RELATIONSHIP ASSESSMENT SCALE – PRE-INJURY

Please mark on the answer sheet the letter for each item which best answers that item for ***before the brain injury.***

How well did your partner meet your needs?

A	B	C	D	E
Poorly		Average		Extremely well

In general, how satisfied were you with your relationship?

A	B	C	D	E
Unsatisfied		Average		Extremely satisfied

How good was your relationship compared to most?

A	B	C	D	E
Poor		Average		Excellent

How often did you wish you hadn't gotten in this relationship?

A	B	C	D	E
Never		Average		Very often

To what extent had your relationship met your original expectations:

A	B	C	D	E
Hardly at all		Average		Completely

How much did you love your partner?

A	B	C	D	E
Not much		Average		Very much

How many problems were there in your relationship?

A	B	C	D	E
Very few		Average		Very many

NOTE: Items 4 and 7 are reverse scored. A=1, B=2, C=3, D=4, E=5.

The Relationship Assessment Scale (Post-Injury RAS; Hendrick, 1988).

RELATIONSHIP ASSESSMENT SCALE – POST-INJURY

Please mark on the answer sheet the letter for each item which best answers that item for you ***now.***

How well does your partner meet your needs?

A	B	C	D	E
Poorly		Average		Extremely well

In general, how satisfied are you with your relationship?

A	B	C	D	E
Unsatisfied		Average		Extremely satisfied

How good is your relationship compared to most?

A	B	C	D	E
Poor		Average		Excellent

How often do you wish you hadn't gotten in this relationship?

A	B	C	D	E
Never		Average		Very often

To what extent has your relationship met your original expectations:

A	B	C	D	E
Hardly at all		Average		Completely

How much do you love your partner?

A	B	C	D	E
Not much		Average		Very much

How many problems are there in your relationship?

A	B	C	D	E
Very few		Average		Very many

NOTE: Items 4 and 7 are reverse scored. A=1, B=2, C=3, D=4, E=5.

The Brain Injury Rehabilitation Trust Social Cognition Questionnaire (BSCQ; Cattran et al., 2018).

The Birmingham Relational Continuity Measure for ABI (BRCM-ABI; Yasmin et al., 2020)

Appendix I

Additional Data for the Theory-Driven (Main) Research Project

Table I.1

Demographic Information of the Participants

Participant Demographics		Count	Column N %
Age Category	25-34 years old	9	14.06%
	35-44 years old	12	18.75%
	45-54 years old	14	21.88%
	55-64 years old	22	34.38%
	65+ years old	7	10.94%
Gender Identity	Female	52	81.25%
	Male	12	18.75%
Ethnicity	Asian/Asian British	1	1.56%
	Caucasian	62	96.88%
	Travelling Community	1	1.56%
Religion	Christian	27	42.19%
	Hindu	1	1.56%
	No religion	36	56.25%
Sexual Orientation	Bisexual	1	1.56%
	Heterosexual	61	95.31%
	Homosexual	2	3.13%
Education	Secondary School	11	17.19%
	College/Sixth Form	7	10.94%
	Bachelor’s degree	20	31.25%

	Master's degree	7	10.94%
	Post-Grad	1	1.56%
	Doctorate degree	1	1.56%
	Vocational training	16	25.00%
	Prefer not to say	1	1.56%
Household Income	£1 to £9,999	2	3.13%
	£10, 000 to £24,999	13	20.31%
	£25, 000 to £49,999	14	21.88%
	£50, 000 to £74,999	17	26.56%
	£75, 000 to £99,999	4	6.25%
	£100,000 or more	6	9.38%
	Prefer not to say	8	12.50%
Cohabiting	No	1	1.56%
	Yes	63	98.44%
Partner's Type of ABI	Brain Aneurysm	4	6.25%
	Brain haemorrhage	13	20.31%
	Brain Tumour	5	7.81%
	Encephalitis	3	4.69%
	Hypoxic brain injury	1	1.56%
	Stroke	28	43.75%
	Traumatic Brain Injury (TBI)/Head injury	9	14.06%
	Other	1	1.56%
Physical Difficulties Impacting Relationship	No	11	17.19%
	Yes	53	82.81%

Social Support Impacting	No	31	48.44%
Relationship	Prefer not to say	1	1.56%
	Yes	32	50%

Note: Numbers are rounded to two decimal places.

Table I.2

Descriptive Statistics

Measure/Subscale	Mean	Median	Std. Deviation	Minimum	Maximum
BSCQ Overall	66.95	69	13.5	39	98
BSCQ 'Sensitivity to Social Cues'	10.58	11	2.87	5	18
BSCQ 'Complex Language'	12.02	11.5	3.41	6	20
BSCQ 'Empathy'	4.84	5	1.65	2	8
BSCQ 'Processing Complex Information'	4.68	5	1.35	2	8
BSCQ 'Social Interaction'	22.19	23	4.52	11	32
BSCQ 'Social Anxiety'	12.66	13	2.75	6	19
Pre-Injury RAS	30.66	32	4.38	19	35
Post-Injury RAS	22.5	22	7.59	7	35
Change in RAS Scores Pre-Post Injury	8.16	8	6.7	-3	25
BRCM-ABI Overall	70.23	64	23.93	26	114
BRCM-ABI 'Relationship Redefined'	11.42	10	5.1	4	20
BRCM-ABI 'Same Different Person'	18.75	18	6.55	6	30
BRCM-ABI 'Same Different Feelings'	22.78	22.5	8.2	8	35
BRCM-ABI 'Couplehood'	12.81	12	3.87	5	20
BRCM-ABI 'Loss'	7.41	6.5	3.83	3	15

Note: BSCQ = BIRT Social Cognition Questionnaire – Relative Version (Cattran et al., 2018). RAS = Relationship Satisfaction Scale (Hendrick, 1988). BRCM-ABI = Birmingham Relational Continuity Measure for Acquired Brain Injury (Yasmin, Keeble & Riley, 2020). Numbers are rounded to two decimal places.

Table I.3

Tables Showing the Analysis of Differences Between High and Low Change in Satisfaction Groups Based on Demographic Variables Using a Chi-Squared or T-Test Analysis

Demographic Information	$\chi 2$	*p*	Low Satisfaction Change	High Satisfaction Change
Age Category (L)	4.1	.39		
25-34 years old			7	2
35-44 years old			6	6
45-54 years old			6	8
55-64 years old			9	13
65+ years old			4	3
Gender Identity (C)	2.56	.11		
Female			23	29
Male			9	3
Ethnicity (L)	2.77	.25		
Caucasian			31	31
Asian			0	1
Travelling Community			1	0
Religion (L)	2.17	.34		
Christian			12	15
Hindu			0	1

Demographic Information	$\chi 2$	*p*	Low Satisfaction Change	High Satisfaction Change
Atheist			20	16
Sexual Orientation (L)	3.02	.12		
Heterosexual			30	31
Homosexual			2	0
Bisexual			0	1
Education (L)	6.26	.51		
Secondary school			7	4
Sixth Form/College			3	4
Bachelor's degree			10	10
Master's degree			3	4
Doctorate			1	0
Post-graduate degree			1	0
Vocational training			6	10
Prefer not to say			1	0
Household Income (L)	.14	1		
£1 - £9,999			1	1
£10,000 - £24,999			6	7
£25,000 - £49,999			7	7
£50,000 - £74,999			9	8
£75,000 - £99,999			2	2
£100,000 or more			3	3
Relationship Status (L)	4.68	.32		
Civil Partnership			1	0
Cohabiting			7	5

Demographic Information	$\chi 2$	*p*	Low Satisfaction Change	High Satisfaction Change
Divorced			1	0
Married			23	26
Prefer not to say			0	1
Cohabiting (Y)	.000	1		
No			0	1
Yes			32	31
Type of ABI (L)	12.52	.09		
Brain Aneurysm			2	2
Brain Haemorrhage			10	3
Brain Tumour			2	3
Encephalitis			0	3
Hypoxic Brain Injury			1	0
Other			1	0
Stroke			11	17
Traumatic Brain Injury/Head Injury			5	4
Physical Difficulties Impacting on Relationship	5.38	.02		
No			9	2
Yes			23	30
Social Support Impacting on Relationship	6.06	.048		
No			20	11
Yes			12	20

Demographic Information	$\chi 2$	*p*	Low Satisfaction Change	High Satisfaction Change
Prefer not to say			0	1

Demographic Information	*t*	*df*	*p*
Total Relationship Length (months)	-1.7	62	.1
Time Since Injury	-.15	62	.88
Relationship Length Pre-Injury (months)	-1.47	62	.73

Note: Yates continuity correction (C) and likelihood ratios (L) were used where the number of participants did not meet the assumptions for the Pearson $\chi 2$. Numbers are rounded to two decimal places.

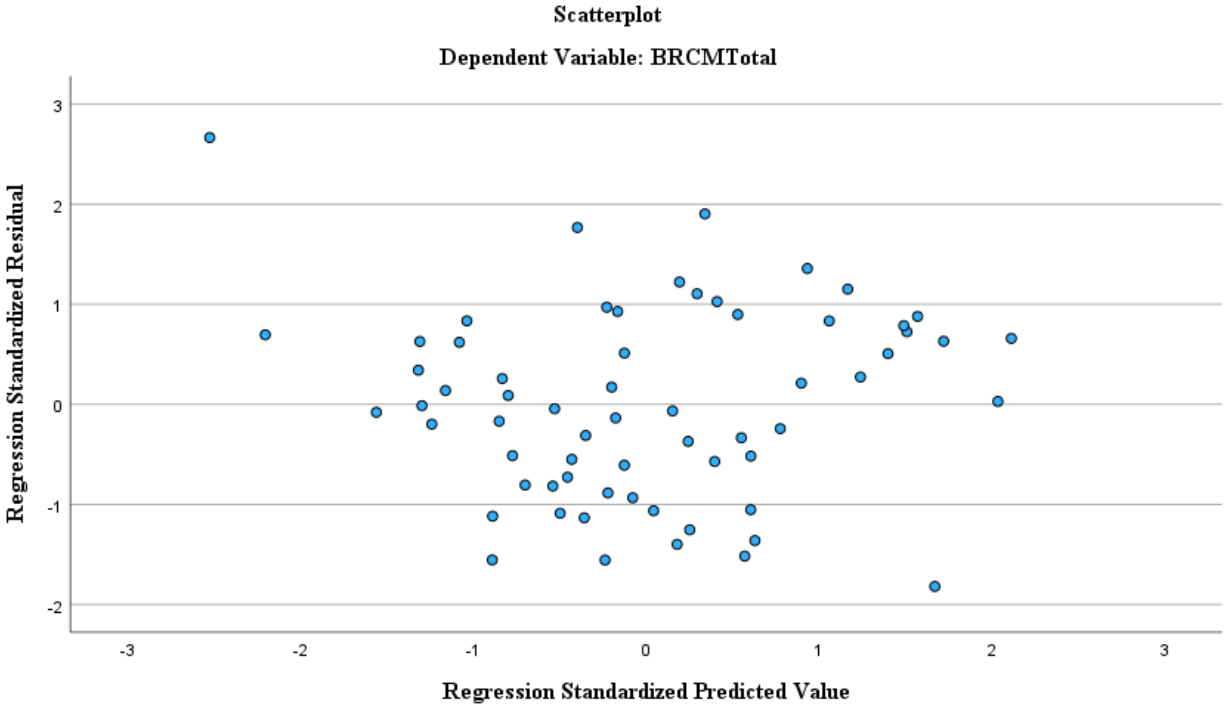
Table I.4

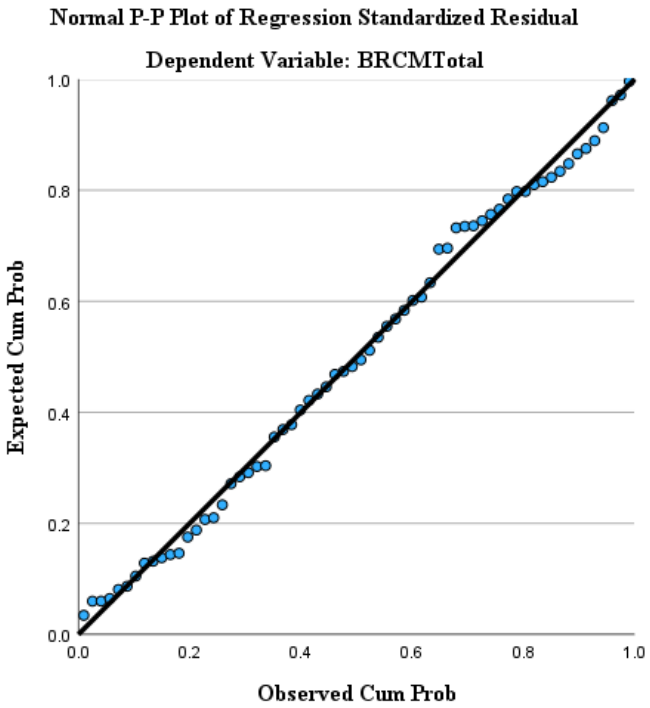
Collinearity Statistics for the Multiple Regression Analysis

BSCQ Content Area	Tolerance	Variance Inflation Factors
Sensitivity to Social Cues	.396	2.523
Complex Language	.263	3.807
Empathy	.462	2.167
Processing Complex Information	.320	3.130
Social Interaction	.405	2.470

Figure I.1

Plots Produced During the Multiple Regression Analysis





Appendix J

Theory-Driven (Main) Research Project Approval Letter

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Mr Lawson Falshaw
Trainee Clinical Psychologist
Oxford Institute of Clinical Psychology Training and Research,
University of Oxford
Oxfordshire
OX3 7JX

Email: approvals@hra.nhs.uk
HCRW.approvals@wales.nhs.uk

28 October 2022

Dear Mr Falshaw,

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**Exploring the Role of Social Cognition in Changes in Relationship Satisfaction and Relationship Continuity After Brain Injury.**
IRAS project ID:	**308894**
REC reference:	**22/NE/0176**
Sponsor	**University of Oxford**

I am pleased to confirm that **HRA and Health and Care Research Wales (HCRW) Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

Please now work with participating NHS organisations to confirm capacity and capability, in line with the instructions provided in the "Information to support study set up" section towards the end of this letter.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) have been sent to the coordinating centre of each participating nation. The relevant national coordinating function/s will contact you as appropriate.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?
HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your non-NHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?

The standard conditions document "*After Ethical Review – guidance for sponsors and investigators*", issued with your REC favourable opinion, gives detailed guidance on reporting expectations for studies, including:

- Registration of research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics, and is updated in the light of changes in reporting expectations or procedures.

Who should I contact for further information?
Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **308894**. Please quote this on all correspondence.

Yours sincerely,
Christopher Cole
HRA Approvals Specialist
Email: approvals@hra.nhs.uk

Copy to: *University of Oxford Research Governance, Ethics and Ass*