[RESEARCH ARTICLE]

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Changes in cognitive functional performance and basic activities of daily living in patients with traumatic brain injury after two methods of cognitive retraining

ABSTRACT

Introduction: Evidence supports a bottom-up approach to assist in addressing functional cognitive deficits in patients with traumatic brain injury (TBI). There is however, little evidence supporting the use of online programmes for this purpose. The aim of this research was to describe the outcomes for cognitive functional performance and basic activities of daily living (bADL) or self-care functioning after cognitive retraining using an online programme versus task-oriented intervention for patients with acute mild and moderate traumatic brain injury.
Methods: A quantitative, quasi-experimental, longitudinal research design was used for determining within-group and between-groups changes for cognitive functional performance and bADL functioning in two sample groups with mild to moderate TBI. Intervention using an online programme (n=7) or task-oriented activities (n=15) was evaluated at three assessment intervals: on recruitment into the study (Assessment 1), on completion of inpatient hospital intervention (Assessment 2) and after four weeks of home programme intervention and fortnightly outpatient intervention (Assessment 3).
Results: Results for both groups showed a statistically significant change for cognitive functional performance assessed on the Bay Area Functional Performance Evaluation (BaFPE) while the task-oriented cognitive training group also achieved a statistically significant change in bADL scores during the first inpatient assessment period. Only the online programme group had statistically significant improvement during the home programme in the third assessment period.
Conclusion: Cognitive retraining using an online programme or task-oriented activities resulted in positive change in a therapist-directed inpatient programme but a structured, graded, online programme was more effective in supporting significant improvement in cognitive functional performance when used together with an outpatient home programme.

Implications for practice

- Cognitive retraining using an online programme or task orientated activities have a positive outcome for cognitive functional performance in patients with mild or moderate TBI in a therapist directed inpatient intervention.
- A task orientated approach for cognitive retraining appears to have positive effect on bADL outcomes.
- Cognitive retraining using an online programme intervention should be considered as a home programme to improve cognitive functional performance in patients with mild or moderate TBI.

INTRODUCTION AND LITERATURE REVIEW

Traumatic brain injury (TBI) is an "alteration in brain function, or other evidence of brain pathology, caused by an external force"[1:1368] Individuals with TBI are treated by the multi-disciplinary team (MDT), including occupational therapists[2], and frequently present with a combination of physical, cognitive, perceptual and emotional deficits which lead to occupational dysfunction[3]. The cognitive sequelae of TBI often affect all components of occupational performance such as work, social participation, and engagement in basic activities of daily living (bADL) including self-care functioning. Individuals may not return to their previous level of functioning which impacts the quality-of-life for TBI survivors and their caregivers[4]. Accurate assessment of cognitive functioning following TBI is critical for directing rehabilitation and evaluating treatment effectiveness[5].

A 2020 study by Nowell et al.[6] found international current practice for cognitive rehabilitation following TBI most commonly involved cognitive retraining and functional restoration or compensation. This concurs with Poulin et al.[7] who in 2021 stated that best practice in cognitive rehabilitation after acquired brain injury should be based on the evidence-based guidelines from the Canadian Stroke Best Practices Recommendations[8] and the Ontario Neurotrauma Foundation (ONF) Clinical Practice Guideline[9]. These guidelines support the occupational therapy philosophy for intervention for TBI, which include the client-centred nature of functional treatment goals, adaption to the patient's cognitive and communication profile and should, if possible, include family involvement. Focus on education and support for caregivers of patients should be a priority, as well as collaboration with mental health professionals in providing intervention for mood disturbances or other behavioural changes[7].

Both international and national best practice guidelines support cognitive retraining associated with impaired self-awareness and personalised life skills training, as well as facilitating learning and internal and external compensatory strategies for memory[8,9]. Visual perceptual deficits, apraxia, and visual neglect should be addressed using remedial-based strategies. Technology such as computers have been recommended for improving working memory and attention[8,9]. Other techniques such as mirror therapy for unilateral inattention can also be considered[7]. Intervention should occur in a structured and distraction-free environment[7]. Functional restoration or compensatory cognitive rehabilitation is also indicated in best practice guidelines to facilitate resumption of desired activities and participation in all occupations or aspects of daily life using functional activities[7].

These best practice guidelines support occupational therapy intervention in understanding the impact of functional cognition on everyday task performance for both assessment and intervention[10] since this has been shown to lower hospital readmission[10]. A number of different approaches have been suggested to address cognitive rehabilitation[11]. Alternative cognitive retraining approaches based on best practice include remediation of specific cognitive deficits directly or using tasks targeting cognitive skills that allow engagement with the environment in goal-directed ways. A top-down occupation-based approach in which performance in activities of daily living such as bADL and engagement in other meaningful occupations is prioritised[12] may also be used to compliment cognitive retraining. Studies by Giles[13] and Radomski et al.[14] support the use of cognitive retraining and occupation-based approaches which have been reported to yield improvements in cognitive functional performance in the intervention for patients with acute TBI.

There is also evidence that cognitive retraining supports the ability to accomplish daily life functional activities that rely on cognitive abilities or functional cognition[5,15]. However, the effect of cognitive retraining on functional performance is not clear. Radomski et al.[14] attributed this lack of clarity to the fact that occupational performance in research studies, if assessed, is not considered a primary outcome to be measured. They recommend that future research reports on both daily life occupational performance and bADL outcomes. They also reported very little published evidence for the use of computer or phone-based online programme for cognitive retraining[14]. The use of online programmes to assist in compensating for cognitive deficits such as memory and attention[16] has limited evidence and this has not been extended to occupation-based outcomes and information processing[6]. Questions remain around the dosage, content and duration this intervention for improving cognitive performance[16].

In their systematic review of computer-based cognitive interventions in TBI in 2020, Lopéz and Antoli[17] reported only on the improvement in visual and verbal working memory. This type of intervention did not support any change in attention, processing speed, executive functions and memory. They also supported the importance of using daily living assessments since it is unknown what effect intervention using cognitive online programmes have on these outcomes in patients with acute TBI. It has been recommended that research–practice studies should be used to investigate cognitive interventions in relation to clinically feasible functional performance outcomes[14] which include activities that allow engagement with the environment in goal-directed ways. Reliable, valid performance-based functional outcome measures related to cognition such as the Bay Area Functional Performance Evaluation (BaFPE)[18], the Cognitive Performance Test (CPT)[19]. and the Executive Function Performance Test (EFPT)[20] should be used. Since cognitive function after TBI has been associated with the awareness of and ability to complete bADLs[21], occupational performance in this regard should be considered as part of the functional outcomes after TBI. Standardised assessments such as the Modified Barthel Index (MBI)[22] allow for objective evaluation of this outcome.

This study investigated interventions that are in keeping with evidence-based practice to support treatment modalities used in the cognitive rehabilitation of individuals with mild to moderate TBI in the South African public health care service. The purpose of the study was to compare outcomes for cognitive functional performance and bADL using two methods of cognitive retraining intervention.

METHODOLOGY

Research Design

A quantitative quasi-experimental longitudinal research design was used in order to compare cognitive functional performance and bADL outcomes in patients with mild and moderate acute TBI. Intervention for cognitive retraining included either an online programme or a task orientated approach in conjunction within a routine occupational therapy intervention programme[23].

Research setting

The study took place at tertiary hospital in South Africa. The occupational therapy department at the research site serves patients with a variety of neurological deficits, including patients with TBI. The TBI survivors are referred by the multidisciplinary team or by routine screening of the neurosurgical wards. Patients include those who survived traumatic external insults to the brain such as assaults, falling from heights and motor or pedestrian vehicle accidents as well as those with internal brain insults due to tumours.

The patients are hospitalised for periods varying from five days to over a month depending on the extent of physical injury or the need for surgery. A multidisciplinary team, consisting of doctors,

nurses, occupational therapists, physiotherapists, speech therapists and dieticians, provides comprehensive intervention. Occupational therapy intervention occurred either in the ward or in the occupational therapy department. Therapists were using an eclectic approach which addresses cognitive and physical deficits as well as independence in activities of daily living. On discharge, TBI patients were booked for follow up appointments with the multi-disciplinary team. The waiting time for an outpatient post-discharge appointment was approximately two weeks.

Research population and sample

The population for this study consisted of potential participants that were referred to occupational therapy with mild or moderate TBI who met the inclusion criteria during the 10-month research period.

Inclusion criteria included males and female patients aged between 18 and 60 years, with mild or moderate TBI based on the Glascow Coma Scale (GCS) ≥ 12 on admission to hospital. Participants needed to be medically stable and required adequate motor skills of the non-affected hand to perform tasks successfully[24]. The treating occupational therapists, all licenced to administer the Saint Louis Mini Mental Status Examination (SLUMS), used the patient's score to determine their eligibility for the study. If the patients had a score of ≤ 24 on SLUMS and now had a GCS =15, they were deemed to need rehabilitation for cognition and were invited to participate in the study. Those with receptive aphasia, as confirmed by a speech therapist, and those who were unable to speak were excluded from the study since the assessment tools required patients to give verbal responses. Patients with a history of mental illness were also excluded from the study.

The sample size for this study was based on an 18 points difference with an SD of 15, between Assessment 1 when recruited into the study to Assessment 2 on completion of inpatient treatment[22] on the Modified Barthel Index (MBI), set at a significance of 0.10 and a power of 80%. A sample of 11 participants per group were required for the study[25]. While 50 participants were recruited and consented to participate only 22 returned for their follow-up appointment, post discharge.

Measuring instruments

Demographic Questionnaire

A demographic questionnaire was specifically designed for this study. With participants' permission the family was contacted for collateral information if the participant could not give sufficient information.

Saint Louis Mini Mental Status Examination (SLUMS)

The SLUMS[26] was used at Assessment 1 to determine the patient's eligibility for the study and was repeated at Assessment 2 and 3 to confirm the continuing need for intervention. The SLUMS measures cognitive dysfunction and need for intervention. This screening assessment has 11 items and is more sensitive to mild cognitive deficits than the Mini-Mental State Examination (MMSE)[27]. The test takes seven minutes to administer and assesses orientation, attention, memory and executive function[28]. There is limited evidence for the reliability and validity of the SLUMS but the test has a one-factor structure with few floor or ceiling effects, and the internal consistency is adequate (0.78)[29]. Zhang et al.[30] report SLUMS is suitable for the evaluation of cognition in patients with TBI but places the cutoff for normal function at 22.5 and compared with the MMSE, the evaluation of verbal fluency, abstract thinking and executive function is superior[31].

Bay Area Functional Performance Evaluation (BaFPE)

The BaFPE[32] consists of a task-oriented assessment (TOA) which evaluates components of functioning that are needed for daily living as well as a Social Interaction Scale (SIS) that was not used in the current research study.

The BaFPE TOA is consistent with a functional perspective and evaluates functional parameters reflected by productive and active use of skills for successful interaction with the environment[32]. This scale has five tasks:- sorting shells, money and marketing, home drawing, block design and kinetic person drawing[18]. A combined score for each task provides a parameter total for the TOA. Each task is also assessed on 12 functional parameters which are grouped into three areas: cognitive, performance and affective parameters[32]. Low scores indicate areas of difficulty.

The validity of the BaFPE has been reported from different research findings. Kaufman[33] reported concurrent validity with the Kohlman Evaluation of Living Skills (KELS) at r =0.8433 and with the Comprehensive Evaluation of Basic Living Skills at r=0.63. This suggests that BaFPE is a good predictor of functional performance[34]. The construct validity was determined by significant correlations between the internal parameters[34,35].

Modified Barthel Index (MBI)

The Modified Barthel Index[22] (MBI) is a self-report or direct observation assessment with a five-point scoring system for self-care or bADL such as feeding, bathing, grooming, toileting as well as bowel and bladder control, transfers, walking, and climbing stairs. The MBI is more sensitive to small improvements in functional independence than the original Barthel Index[36]. Items are scored from 0-15, 0-10 and 0-5, with a score of 99 indicating slight dependence, a score below 90 indicating moderate dependence, a score below 60 indicating severe dependence and a score below 20 indicating total dependence. The MBI can be completed as a 20-60 minutes direct observation tool[36]. Validity and reliability of MBI includes inter and intra-rater reliability of 0.99 and strong criterion related validity when compared with original Barthel Index[37] and the instrument has been validated for the South African context[38].

The components of the SLUMS used to assess cognition, the BaFPE for functional performance and the MBI for self-care are represented in Figure 1, (below).

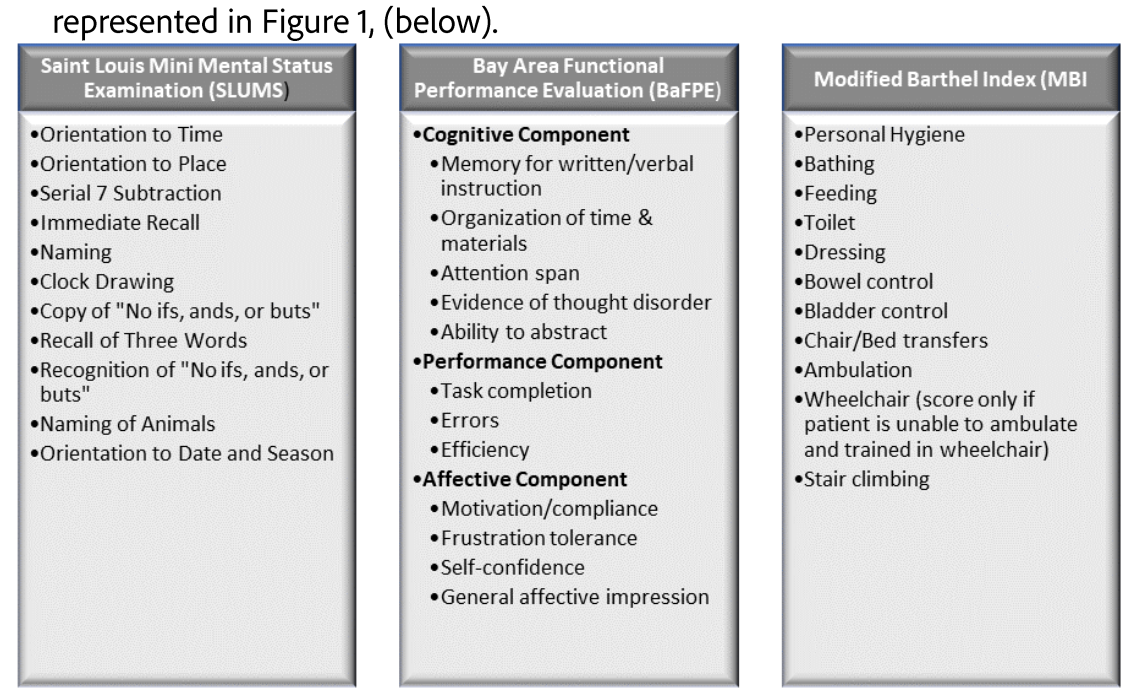

Figure 1. Components of the three research instruments used to assess cognition, functional performance and basic activities of daily living.

Data collection

Treating occupational therapists identified patients who met in the inclusion criteria and recruited patients into the study. Signed informed consent for participation in study and permission to access to medical records was obtained from either the patients or their family members if the patient was functioning at a level of self-presentation or below according to the Vona du Toit Model of Creative Ability (VdTMoCA)[39] which has similar descriptors to Rancho Los Amigos Level VII[40].

The first author who was the primary researcher collected the demographic information from the participants, or their relatives and the medical history was obtained from the patients' medical

record. She also administrated and scored the BaFPE and MBI to establish baseline cognitive functional performance skills and bADL function within 24 hours after referral to the study (Assessment 1). Participants were allocated to either the online programme group if they indicated that they had access to a smart phone or the task orientated group if they did not. All participants formed part of the second author's patient load to ensure consistent routine therapy for each group. The routine occupation-based intervention focussing on assisting them in reducing or compensating for motor fallout for hemiplegia present in all participants, as well as achieving emotional and behavioural goals. Participants received treatment a minimum of four times per week for 45 minutes as inpatients.

After discharge from the hospital, participants followed a daily home programme using the online programme or task-oriented home programmes for a minimum of four weeks with an out-patient appointment every two weeks. The second author reassessed their cognition using the SLUMs to confirm continuing impairment and need for intervention. Cognitive functional performance skills and bADL functions were reassessed using the BaFPE and MBI on the completion of inpatient treatment (Assessment 2) and at four weeks post discharge. (Assessment 3).

Intervention

Online programme group

The online programme intervention group used Luminosity[41] - a free online programme available for a computer or cell phone - while in hospital and at home in addition to their routine out-patient occupational therapy programme. The programme is graded from a low to higher level of cognitive functioning. It identifies the level at which the participant is functioning on their first attempt and allows 30 minutes of training a day. Lumosity presents problems on the participants' current level and contains the most important aspects of cognition: speed, memory, attention, flexibility, and problem solving. This programme was chosen even though evidence for generalisation across tasks in everyday life in healthy subjects is limited[41]. Studies on elderly people with mild cognitive impairment did find improvement in cognitive skills such as visual attention after using Lumosity with significant correlations to executive function skills on the CANTAB assesssment[42].

Task-oriented activities group

The task-oriented activities intervention which was completed by participants as in-patients and as a home programme, aimed to improve learning, memory, awareness, problem solving and attention as well as addressing any identified visual perceptual problems, using purposeful tasks and recreation activities to maintain patient motivation[43]. The activities required cognitive performance skills and the participants practiced whole tasks with the aim of restoring cognition and function. Feedback was focused on the critical features of the task as well as on specific cognitive impairments[44].

Home programme

All participants were provided with a home programme on discharge. The online programme group continued with the Luminosity programme once a day while the task-oriented activities group were provided with a schedule for 30-minute task orientated activities to complete each day. All participants were asked to keep a diary of their compliance to both home programmes. They received daily messages on their phones reminding them to complete the programme via WhatsApp or SMS and the log for completion of Luminosity tasks was checked on participants phones during their outpatient visits.

Ethical Considerations

The research protocol was approved by the Medical Advisory Committee at the Chris Hani Baragwanath Hospital and the head of the occupational therapy department at the research site. Ethical clearance was gained from University of the Witwatersrand, Human Research Ethics Committee (M200883). Patients with TBIs were identified by treating occupational therapists who provided the approved information sheets to all the participants or a family member. The research was verbally explained in three languages (English, isiZulu and Sesotho) as they applied to the participants or their family. All participants or family members gave signed informed consent for participation in the study and review of the patients' medical records. Participation was voluntary and participants or their family had the right to withdraw from the study at any time without consequence. Autonomy was ensured by respecting the decisions of the participants or their family about participating in and continued participation in the study beyond discharge from the hospital. Within this research study there was an exchange of information between the researcher and participants keeping the participants (and the family with the participants' permission) fully informed throughout the study period.

Data Analysis

Descriptive statistics were used for the demographic data, SLUMS, BaFPE and MBI for this study. The outcomes of online programme and the task-orientated group were compared using statistics that suited the small sample size and ordinal data[45]. Medians and interquartile ranges (IQRs) were calculated for observations made. The Mann-Whitney U test compared the changes in the outcome measures of online programme and task-orientated groups using means and SD[46]. A relationship between the change in the MBI scores at discharge and after the home programme and the SLUMS and BaFPE scores was calculated using Spearman's rank order correlation[47].

RESULTS

The analysis of the data was completed on 22 participants who all scored in the moderate range for cognitive function on the SLUMS on referral to occupational therapy. Five participants had smart phones and made up the online programme group while 17 were in the task-orientated group.

Table I Demographic and medical characteristics

		Total Group (n=22)	Online programme group (n=5)	Task-orientated group (n=17)
		Mean (SD)		
Age - years		32.45 (9.89)	38.8 (12.31)	30.58 (8.62)
Years of education		10.04 (1.83)	9.20 (1.48)	10.29 (1.89)
		n%		
Gender	Male	20(91%)	3 (60%)	17 (100%)
	Female	2 (8%)	2 (40%)	0
Cause of TBI	Trauma	17(77%)	3 (60%)	14 (82%)
	Internal insult	5 (23%)	2 (40%)	3 (18%)

Most participants were male (91%), and the mean age of participants was 32.45 years. On average participants had nine years of education and trauma (77%) was the most frequent cause of the TBI (Table I. above).

Within-Group Results

The online programme group presented with lower SLUMS scores on Assessment 1 indicated participants presented with severe cognitive deficits even though they had a GCS indicating mild to moderate TBI when recruited into the study. At Assessment 2 on discharge than the task-orientated group had further improvement but both groups had mild impairment with median scores of 20 and 22 respectively at Assessment 3 after four weeks home programme (Table II, below):

Table II. The Saint Louis University Mental Status (SLUMS)

		Online programme group		Task-orientated group	
		Median (IQR)	Interpretation	Median (IQR)	Interpretation
Saint Louis University Mental Status	SLUMS Assessment 1	10 (10-10)	Severe impairment	15 (9-16)	Moderate impairment
	SLUMS Assessment 2	11 (10-12)	Moderate impairment	19 (12-22)	Moderate impairment
	SLUMS Assessment 3	20 (19-21)	Mild impairment	22 (17-24)	Mild impairment

The BaFPE total TOA scores improved for both groups during therapist guided intervention in-hospital programme between Assessment 1 and Assessment 2 and greater improvement was seen in the online programme group during the home programme between Assessment 2 and Assessment 3. Both groups scored standard z scores of -2.0 on Assessment 1 when recruited into the study indicating moderate dysfunction. The total change within both groups was statistically significant and both groups had standard scores close to 0 at Assessment 3 (Table III, below):

Table III. The Bay Area Functional Performance Evaluation (BaFPE) and Modified Barthel index (MBI) scores

		Online programme group		Task-orientated group	
		Median (IQR)	Standard score	Median (IQR)	Standard score
Bay Area Functional Performance Evaluation	BaFPE TOA Assessment 1	142 (141-158)	-2.00	146 (121-167)	-2.00
	BaFPE TOA Assessment 2	188 (179-193)	0	172 (149-195)	-0.5
	BaFPE TOA Assessment 3	212 (210-218)	0.50	190 (161-206)	0
	p value: Total within group change	0.002**		0.016*	
	BaFPE Cognitive Assessment 1	64 (60-65)	>-2.00	62 (50-71)	>-2.00
	BaFPE Cognitive Assessment 2	75 (72-82)	-1.50	73 (64-81)	-1.50
	BaFPE Cognitive Assessment 3	91 (90-93)	0	80 (67-86)	-1.25
	p value: Total within group change	0.030*		0.130	
	BaFPE Performance Assessment 1	30 (29-32)	>-2.00	28 (22-35)	>-2.00
	BaFPE Performance Assessment 2	38 (34-39)	-1.5	35 (26-43)	-1.5
	BaFPE Performance Assessment 3	48 (44-49)	0	39 (30-47)	-1.25
	p value: Total within group change	0.041*		0.179	
	BaFPE Affective Assessment 1	55 (45-65)	>-2.00	53 (48-63)	>-2.00
	BaFPE Affective Assessment 2	73 (73-74)	1.25	62 (57-72)	-0.55
	BaFPE Affective Assessment 3	75 (75-75)	1.45	69 (61-74)	0.55
	p value: Total within group change	0.073		0.147	
		Median (IQR)	**Interpretation**	**Median (IQR)**	**Interpretation**
Modified Barthel index	MBI Assessment 1	77 (58-88)	Moderate dependence	59 (19-100)	Severe dependence
	MBI Assessment 2	87 (79-95)	Moderate dependence	93 (81-105)	Mild dependence
	MBI Assessment 3	103 (101-105)	Independent	105 (103-105)	Independent
	p value: Total within group change	0.052		0.003**	
Significance p≤ 0.05*, 0.01**					

Results for BaFPE cognitive, and performance parameters found that scores for the two groups were similar for the Assessment 1 when recruited into the study and Assessment 2, but the online programme groups had higher scores at Assessment 3 after a four-week home programme. with a statistically significant change for both parameters. The total change for the affective component was not statistically significant for either group.

The MBI scores were lower for task-orientation group on Assessment 1 when recruited into the study but were nearly equal for both groups at Assessment 2 with scores the online programme group still having moderate dependence at this stage. All participants were independent at Assessment 3 with the total change for the task orientation group being statistically significant (Table III. adjacent).

Between-Group Results

Change in functional performance scores.

Bay Area Functional Performance Evaluation (BaFPE)

Functional performance in the total TOA indicated greater change in the online programme group during in-hospital-based programme from Assessment 1 when recruited into the study compared to Assessment 2, but this did not differ significantly from the task orientated group (Table IV, below). However, the change when completing the home programme from Assessment 2 to Assessment 3 and the total change from Assessment 1 when recruited into the study to Assessment 3 was statistically significant between the two groups with the online programme group having a greater change. The results for changes in cognitive scores and performance scores were similar. Affective functional performance did not differ significantly between the two groups.

Table IV Between-group comparison of change for the Bay Area Functional Performance Evaluation (BaFPE)

		Online programme group (n=5)		Task-orientated group (n=17)		Change between groups
		Mean	SD	Mean	SD	p value
TOA	Change from Assessment 1 to Assessment 2	35.00	15.01	20.76	16.65	0.099
	Change from Assessment 2 to Assessment 3	30.00	14.88	7.17	37.08	0.041*
	Total change	65.00	22.43	27.94	44.23	0.037*
Cognitive	Change from Assessment 1 to Assessment 2	13.60	6.77	9.18	6.21	0.158
	Change from Assessment 2 to Assessment 3	15.20	6.30	4.82	3.92	0.005**
	Total Change	28.80	1.64	14.00	6.16	0.001**
Performance	Change from Assessment 1 to Assessment 2	7.60	5.18	9.18	6.21	0.480
	Change from Assessment 2 to Assessment 3	9.60	4.51	4.82	3.92	0.020*
	Total Change	17.20	5.16	9.65	6.17	0.031*
Affective	Change from Assessment 1 to Assessment 2	16.00	11.73	7.94	8.18	0.136
	Change from Assessment 2 to Assessment 3	3.20	3.96	4.23	4.04	0.666
	Total Change	19.20	13.31	12.17	9.09	0.272
Significance p≤ 0.05*, 0.01**						

Change in Basic Activities of Daily Living scores

The change between Assessment 1 when recruited into the study to Assessment 2 (discharge) was greater for the task-orientated group who had lower MBI scores indicating severe dependence on Assessment 1 when recruited into the study. The online programme group showed less improvement while in hospital and greater improvement at home when completing the home programme on Assessment 3 with no significant difference found between the groups at any assessment period (Table V, page 6).

Table V Between group comparison of change for the Modified Barthel index (MBI)

	Online programme group (n=5)		Task-orientated group (n=17)		Change between groups
	Mean	SD	Mean	SD	p value
Change from Assessment 1 to Assessment 2	15.40	7.89	23.88	24.91	0.468
Change from Assessment 2 to Assessment 3	15.20	12.70	11.00	14.68	0.570
Total change	30.60	19.14	34.88	32.54	0.784
Significance p≤ 0.05*, 0.01**					

Correlations between basic activities of daily living and cognitive/functional performance scores

All low and moderate non-significant corrections indicated 16%-20% of variation in bADL assessed with the MBI can be accounted for by variation in functional performance assessed by the BaFPE and cognition assessed by the SLUMS for the Assessment 1 when recruited into the study scores and for overall change (Table VI, below).

Table VI Change in Modified Barthel index (MBI) correlated to change in Bay Area Functional Performance Evaluation (BaFPE) and The Saint Louis University Mental Status (SLUMS)

	MBI Change from Assessment 1 to Reassessment1	MBI Change from Assessment 2 to Assessment 3	MBI Total Change
	Rho		
BaFPE Functional parameters Change from Assessment 1 to Assessment 2	0.29		
Task Oriented Assessment (TOA) Change from Assessment 1 to Assessment 2	0.37		
SLUMS Change from Assessment 1 to Assessment 2	0.40		
BaFPE Functional parameters Change from Assessment 2 to Assessment 3		0.01	
Task Oriented Assessment (TOA) Change from Assessment 2 to Assessment 3		0.10	
SLUMS MBI Change from Assessment 2 to Assessment 3		0.05	
BaFPE Functional parameters Total Change			0.31
Task Oriented Assessment (TOA)Total Change			0.38
SLUMS Total Change			0.35

DISCUSSION

The aim of the research was to describe the outcomes of cognitive retraining using an online programme or task orientated interventions on daily living cognitive functional performance and bADL functioning, in patients with mild or moderate TBIs.

The demographics of the patients did differ in the two groups for gender with both females in the online programme group. The sample did however reflect the profile for patients with mild and moderate TBI reported for South Africa by Malale et al[48] in that the majority were young males and the cause of injury was assault due to interpersonal violence, alcohol and other substance abuse or motor vehicle accidents.

All participants were identified with cognitive impairment based on a SLUMS score below 24 set as a cutoff for TBI patients. The SLUMS examination has been found to be more accurate than other cognitive screening tools for identifying cognitive impairment in TBI patients with less than 12 years formal education[26] and was therefore an appropriate tool for screening in this study even if the cutoff score of 22.5 suggested by Zhang et al.[30] was considered. The ease of use and time needed for administration of the SLUMS in the initial screening to recruit participants was a consideration for the current study[29], and discrimination issues with this assessment[49] were not apparent when used with these TBI patients. Even though minimally clinically important differences (MCID) are not available for the SLUMS, improvement was found on the progression from severe/moderate cognitive impairment on Assessment 1 when recruited into the study to mild cognitive impairment at Assessment 3 after a four-week home programme.

The within-group results for all the scores on the BaFPE indicated a significant improvement overall for the online programme group while only the TOA and the MBI indicated a significant improvement overall within the task orientation group. This result appears to indicate that both interventions were effective in addressing task based functional performance over the in-patient study period. Only the online programme group had significant improvement for the cognitive and performance parameters on the BaFPE, indicating improvement in memory for instructions, organisation, ability to abstract, task completion and efficiency as well as reduction in errors during task completion. The improvement in these skills were supported by Finn et al.[42] using the Luminosity programme, where they found significant correlations between improved reasoning and processing speed indicating the importance of a structured approach in retraining of specific cognitive deficits to reduce cognitive and functional disability[6] for persons with TBI in the post-acute period as part of a comprehensive occupational therapy intervention[50]. The moderate correlations found in this study for the change in scores may affirm the conjecture by Douglas et al.[51] that the BaFPE contains elements such as the block design task which are not transferable to everyday living but that support the direct retraining of cognitive deficits.

It appears that when using the online programme which targeted specific cognitive components there was carry-over particularly in the cognitive and performance parameters assessed by the BaFPE. The BaFPE cognitive parameters included memory for instructions, organisation of time and materials, attention span, thought progression and ability to abstract. These findings are supported by Dams-O'Connor and Gordon[52] who reported that the restoration of basic cognitive functions using training and repetition allows the processing of more complex input. This result was supported by evidence of the increase in accuracy and speed for participants using the online programme for cognitive retraining[52].

The between group change in scores from Assessment 1 to Assessment 2 did not differ between the two groups when they completed the intervention while in hospital. In the second assessment period while using the home programme, a significant change was found for all scores on the BaFPE, when the online programme group was compared to the task-orientated group, with a highly significant total change between the groups over the study period. The results of this study support the use of the online programme for effective intervention within a home programme. The app provides a structured graded programme which patients can easily follow.

The task orientated intervention was effective when it was therapist-directed in hospital but as a home programme, the support required to facilitate performance and application of cognitive skills in everyday activities may have been lacking. Thus, the implementation of this type of home programme was less effective. The standard z scores of the task-orientated group indicated participants were still at risk for dysfunction in both cognitive and performance parameters on the BaFPE after completing their home programme for four weeks post discharge.

The affective parameter which assesses motivation, compliance, frustration tolerance, self-confidence as well as general affective and behavioural impression[32] did not indicate any significant changes

for the participants with moderate to mild TBI. Both groups showed improvement from a standard z score of -2.00 to 0 or normal during their in-hospital intervention period from Assessment 1 when recruited into the study to Assessment 2 as this aspect was addressed during therapy for both groups.

A highly significant within-group change on the MBI was found for the task-orientated group while in hospital on Assessment 2. This change was greater than that reported by Shah et al.[22] for patients with TBI receiving post-acute rehabilitation and was supported by limited literature which indicates evidence for intervention addressing a task-oriented approach translating into improvement in bADL functioning tasks[50].

The online programme group achieved similar change to the task-orientated group for bADL functioning during the home programme to Assessment 3. This may have occurred since there was no control over what activities participants engaged in once they were discharged and the online programme group may well have been involved in similar activities to those suggested for the task-orientated group in this time. The final MBI scores indicate that participants in this sample were independent in bADL functioning despite their residual motor deficits. However, based on the BaFPE cognitive and performance parameter scores, the participants in the task-orientated group still required reminders to complete activities. Although the MBI is identified as suited to assessment of bADL it does need to be administered as an observed assessment for TBI patients when cognition affects bADL. It is possible that other assessments which consider habits and routines and evaluate a broader aspect of functional cognition considering tasks in bADL functioning and instrumental activities of daily living (iADLs) should be considered[38].

Limitations of the study

The second author who collected the data was not blinded to the participant groups and for logistical reasons had to complete both the assessments and the treatment for all participants. The resource constrained context from which the participants were recruited resulted in only a small number of participants with access to a smart phone or computer. This was in line with the about one third of the country's population who use smart phones[53] but should have been considered when setting the sample size.

CONCLUSION

This study considered the effectiveness of cognitive retraining interventions using an online programme as compared to a task-oriented activity approach with patients with mild or moderate TBI. The outcomes for daily life cognitive functional performance and bADL function indicated both intervention approaches were effective for an inpatient hospital programme which was therapist directed. Both the online and task orientated interventions supported the assumption that intervention for basic cognitive functions may be a prerequisite for improving higher-order cognitive skills to achieve outcomes for performance and cognition in tasks.

However, this assumption appears to be better supported by the online intervention in home programmes where engagement in therapy is patient-directed. The use of an online programme with daily reminders facilitated significant improvement in the cognitive and performance parameters required for task completion as assessed by the BaFPE. The task-oriented activities approach did not achieve similar results when only a task-based home programme was used with participants post discharge.

Author contributions

Denise Franzsen and Zukiswe Msengana conceptualised the project and Zukiswe Msengana collected the data. Denise Franzsen analysed the data. Both authors wrote and revised the article to completion and approved the final version.

Conflicts of interest

Authors have no competing interests to declare

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