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The Behavioural Assessment of Self-Structuring (BASS): A Factor Analysis in a Post-Acute Brain Injury Rehabilitation Programme

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Abstract

Research has indicated structure and a client's ability to self-structure is integral to post-acute brain injury rehabilitation. Self-structuring has previously been theorised to include components referred to as Anchors, Scaffolding, and Strategies. A reliable and validated measure of self-structuring – The Behavioural Assessment of Self-Structuring (BASS) – was used in the current study aimed to identify possible sub-groups of the scale and further explore construct validity. 197 consecutive admissions to the Transitional Rehabilitation Units (TRU) were assessed using the BASS and the results were subjected to a varimax rotation factor analysis. Four factors were revealed, all of which could be related to the theoretical model of self-structuring including Systems (Scaffolding), Routines (Anchors), Awareness and Self-Regulation (both emerging as two sub-divisions of Strategies). Despite orthogonality, all four factors were highly correlated. Only age at brain injury and cause of brain injury showed a significant relationship with Awareness (Strategies), Routines (Anchors), and Systems (Scaffolding). No significant relationship was found for gender, age at admission or length of admission. In conclusion, the findings are consistent with previous research and confirm theoretical models of self-structuring. Further insight has been gained into the complexities of self-structuring as the results propose compelling evidence that the 26-items of the BASS can now be sub-divided into four distinct sub-categories: Awareness, Systems, Routines, and Self-Regulation. Sub-categories can now be utilised to identify individual strengths and areas of weakness within self-structuring. This can inform the adaptation of neurorehabilitation programmes or approaches dependent on client need, and change in scores could be evaluated over time.

Keywords: Acquired brain injury • Self-Structuring • Neurorehabilitation • Systems • Routines • Awareness • Self-Regulation • Anchors • Scaffolding • Strategies • BASS

Introduction

Structure has been identified as an important component in reducing the difficulties experienced by cognitive impairments subsequent to an acquired brain injury. It is suggested that post-acute neurorehabilitation should endeavour to provide structure and also aim to develop self-structuring skills within its rehabilitation approach [1]. It has been proposed that self-structuring involves three key elements – 'Anchors', 'Scaffolding', and 'Strategies' [2]. Anchors are defined as the routines and rituals that are typically bound by times and environmental cues (e.g. morning routines). Scaffolding refers to the systems and aids used to plan, maintain, and re-assert structure (e.g. organisational and memory aids, making plans). Finally, Strategies are described as the independent thinking skills such as help seeking and problem solving that equip the client to maintain effective or re-adjust ineffective coping anchors and scaffolding when environments involve novelty or change.

The Behavioural Assessment of Self-Structuring (BASS) is a 26-item measure of self-structuring abilities developed by clinicians at a neurorehabilitation unit in the North West of England (Transitional Rehabilitation Unit, TRU) for staff to assess and monitor progress of clients within a residential brain injury rehabilitation setting. The BASS was developed from a theoretical over-arching model of post-acute brain injury rehabilitation that suggests structure, and more importantly the brain injury client's self-structuring, underpins important brain injury rehabilitation approaches. Not only do the items on the BASS highlight important aspects of this process, it is suggested that they also aid in focusing rehabilitation planning on developing self-structuring.

A series of empirical studies investigating the psychometric properties of the BASS were previously conducted suggesting that it is a reliable, valid and clinically sensitive device that offers a unique approach to assessing coping strategies after brain injury that involves helping the individual self-structure [3]. Specifically results indicated that the BASS had reasonably good reliability, good construct validity (via principle component analysis), good discriminant validity, and good concurrent validity, correlating well with several other outcome measures. Finally, the BASS was shown to demonstrate sensitivity to change and response through TRU's rehabilitation pathway.

It has previously been suggested that the scale could be developed by a reduction in items, however it is difficult to ignore the face validity of the diversity of BASS items ranging from complex strategy items such as "seeking help appropriately" and more basic anchor items such as "completed a morning routine". Nevertheless, findings have indicated the possible sub-grouping of self-structuring abilities requiring further confirmatory analysis before any further conclusions could be made [3]. The previous factor analysis involved a varimax rotation in order to examine orthogonal factors and identified two factors the first relating to aspects of scaffolding and strategies in self-structuring (e.g. making plans, using cognitive aids, etc.) and the second relating to anchors (e.g. kept to a morning routine, kept living areas organised and tidy). However, it was noted that in a varimax rotation several items loaded on both factors. Given that there is likely to be some overlaps between the three levels of self-structuring, Anchors, Scaffolding and Strategies [2], it was hypothesized that further factor analysis with a larger sample would permit the emergence of factors theoretically aligned with the BASS structure.

The current study used a varimax factor analysis with the aim of assessing whether any of the 26 items of the BASS form sub-groups/broader domains of self-structuring in brain injury clients.

Methods

Participants

A cross-sectional sample of both male and female clients with a moderate to severe brain injury (N = 197) was collated. All clients resided, or had been residents in recent past, within a residential neurorehabilitation service (TRU). Ethical consideration and approval was sought internally within the TRU research committee.

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Measure

Behavioural Assessment of Self-Structuring

The Behavioural Assessment of Self Structuring (BASS) is a 26-item psychometrically valid measure of self-structuring abilities used to rate a client's ability to self-structure. Items are rated on a 5-point Likert Scale relating to how much 'support' the brain injury client needed on each of the items ranging from "hardly ever did or always required very high levels of support" (1) to "did most of the time without support" (5). Support refers to any form of intervention required by others to ensure the client was successful on that item (e.g. physical help to complete the task, verbal prompts, gestures, distraction from impulsive behaviours, compensatory aids, etc.). Higher scores represent greater ability for the client to self-structure.

Procedure

The BASS is completed during routine neurorehabilitation reviews. Time frame of reviews vary dependent on the client's rehabilitation programme, but these would typically be every 6 to 12 weeks. The BASS is completed by the multi-disciplinary team and is based on the client's performance at that point in time and within the previous four-week period. In order for clients' data to be included in this study, clients had to be residing in service for at least four weeks and with at least one BASS data set.

Analysis

A reliability analysis was used to determine whether factors of the BASS correlated. The 26 items of the BASS were subsequently subjected to a principle component analysis utilising a varimax rotation. Further analysis was conducted using a Kruskal- Wallis test to assess the mean difference on demographic values for each of the BASS components.

Results

A total of 197 data sets were included in the analysis, and this is considered to be a positive data set and appropriate for this study [4]. The results are divided into several subsections which are descriptive statistics, reliability analysis, factor analysis and non-parametric technique on several demographic characteristics using the Kruskal-Wallis test.

Descriptive Statistics

The sample consisted of 197 individuals, with 76% of the sample having a diagnosis of traumatic brain injury (N=150). Age on admission ranged from 16 to 68 years (M = 32.1, SD = 11.8) and their age at brain injury ranged between 0 and 67 years (M = 24.8, SD = 13.4). Length of admission to service, for which the individual resided within the rehabilitation setting ranged from 1 month to 308 months (M = 51.4, SD = 63.1). Table 1 contains more demographic details of the sample.

Reliability Analysis

The main focus of this study was to look at factors that comprise the BASS scale. The reliability analysis result showed that the Cronbach Alpha for the entire BASS was .972 for 26 items, thus suggesting an excellent internal consistency. A Cronbach Alpha above .90 may suggest potential replication between items [5], and the extra items may render the tool inefficient [6]. Face validity of the tool is also worth considering and whilst some items may appear similar these are not replicating each other, e.g. "making daily plans", "making weekly or longer term plans". Research has found that tools composed of discrete scales can also achieve high value of alpha (above .90) and still not be unidimensional [7]. As previously indicated, "a scale may be composed of several clusters of items each measuring a distinct factor; as long as every item correlates well with some other items, the scale will demonstrate internal consistency" [8].

Factor Analysis

The 26 items of the BASS were subjected to principal components analysis using IBM SPSS version 27. Prior to performing the principal component analysis, the suitability of the data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Oklin value was .96, exceeding the recommended value of .6 [9,10] and Bartlett's Test of Sphericity [11] reached statistical significance ($p<.001$), supporting the factorability of the correlation matrix. Due to the correlation of the factors, a varimax rotation was conducted on the data.

Table 1: Demographic profile of clients including gender, age on admission, cause of brain injury, age at time of brain injury, and length of admission to service.

Demographic Factor		Frequency	Percentage
Gender	Male	156	79.2
	Female	41	20.8
Age on admission	Under 18 years old	5	2.5
	18 to 25 years old	70	35.4
	26 to 35 years old	57	28.9
	36 to 45 years old	33	16.8
	46 to 55 years old	24	12.2
	Over 56 years old	8	4.1
Cause of primary brain injury	RTA	109	55.3
	Fall	21	10.7
	Assault	20	10.2
	Cardiovascular	18	9.1
	Infection/disease	9	4.6
	Anoxia	8	4.1
	Surgery	8	4.1
	Missing data	4	2.0
Age at time of brain injury	Prior to 16 years	43	21.8
	16 to 25 years	75	38.1
	26 to 35 years	38	19.3
	Over 36 years	39	19.8
	Missing data	2	1.0
Length of admission to service	Less than 24 months	90	45.7
	25 to 72 months	61	31.0
	Over 73 months	42	21.3
	Missing data	4	2.0

Principal components analysis revealed the presence of four components. Table 2 displays the total variance for each of the components. This was further supported by the results of Parallel Analysis, showing only four components with eigenvalues exceeding the corresponding criterion values for randomly generated data matrix of the same size (26 variables x 197 responses).

It is suggested that each variable would need to load at least .45 on any particular factor to be considered strong on that factor [12]. The rotation revealed a number of strong loadings of variables on each of the four components; however some items do show a complex relationship between different factors. Table 3 shows the rotated component matrix for the BASS questionnaire.

After performing a Varimax rotation with Kaiser Normalisation, the loading on the factors provide an insight that the BASS is a tool that primarily assesses people's ability to self-structure at a functional and practical level, and with a certain focus on cognitive abilities. Table 4 demonstrates the suggested names for each factor and the correlation between each factor, thus proposing that these would be the subscales for the BASS questionnaire.

* Correlation is significant at the .001 level (2-tailed)

Kruskal-Wallis Test

The non-parametric test using Kruskal-Wallis was performed to test the mean difference on demographic values for each of the BASS components, in particular, if gender, age on admission, cause of brain injury, age at the time of injury, and length of admission to service were a contributing variable for a client's level of support on self-structure in regard to all four factors. Results suggested that there is no statistically significant difference in the levels of support that people with a brain injury may require across the four BASS factors in regards to "gender", "age of admission", and "length of admission". However, when considering "age at the time of brain injury", and "cause of brain injury" results were significant. Table 5 describes the statistical results from the analysis.

*Statistically significant p<.05

"Age at the time of brain injury" showed statistical significance in Factor 1 "Awareness", Factor 2 "Systems" and Factor 3 "Routines". A mean rank analysis (Table 6) suggested that people who were 35 years or under at the time of their brain injury seem to have greater ability to show increased awareness, use systems and follow routines during their period of rehabilitation when compared to people age 36 years or over.

Table 2: Principle Component Analysis Revealing the Presence of Four Components with Eigenvalues > 1, Explaining 73.4% of the Total Variance.

	Extraction Sums of Squared Loading		
Factor	**Total Eigenvalue**	**Percentage of Variance**	**Cumulative Percentage**
1	15.557	59.8	59.8
2	1.400	5.39	65.2
3	1.116	4.29	69.5
4	1.013	3.90	73.4

Table 3: Factor Loadings Revealed for all 26-items of the BASS.

	Factor			
Item	**1**	**2**	**3**	**4**
14. Aware of potential problems	**.810**			
24. Recognised personal limitations	**.788**			
18. Aware of risk to self and others	**.759**		.355	
23. Made reasonable self-evaluations	**.738**			
8. Checked and spotted mistakes	**.661**		.314	
7. Discussed problems or difficulties appropriately	**.649**			.433
9. Reasonable adjustments to plans where necessary	**.574**		.306	
1. Sought help appropriately	**.555**	.329		
2. Avoided confabulation or themes	**.553**			
15. Set and kept to budget	**.539**			
11. Attended and engaged with work timetables		**.762**		.370
4. Made plans for the day		**.728**	.330	
10. Made social/leisure arrangements	.357	**.694**		
5. Made weekly or longer term plans		**.685**	.318	
6. Kept to plans		**.657**		
25. Used spare time well		**.638**		.342
19. Used organisation and memory aids		**.628**		
22. Followed longer plans/tasks through to completion		**.584**		.322
21. Kept living area organised and tidy			**.758**	
3. Completed a morning routine			**.756**	.328
13. Set and kept to personal hygiene goals/routines	.324		**.725**	
12. Organised and managed a good diet			**.509**	
16. Moods were appropriate				**.683**
17. Ensured a regular sleep/wake cycle				**.657**
20. Took appropriate amounts of rest through the day			.305	**.599**
26. Did only one thing at a time			.355	**.518**

Table 4: Proposed Theme for Each Factor and Respective Correlations.

Factor	1	2	3	4
1. Awareness (Strategies)	1	.84*	.74*	.74*
2. Systems (Scaffolding)		1	.76*	.74*
3. Routines (Anchors)			1	.71*
4. Self-Regulation (Strategies)				1

Table 5: Kruskal-Wallis Test Results of Demographic Variables on Each Factor.

Variable	Statistics	Factor 1	Factor 2	Factor 3	Factor 4
		Awareness	Systems	Routines	Self Regulation
Gender	Kruskal-Wallis H	.224	.116	.189	.300
	Asymp. Sig.	.636	.733	.663	.584
Age of admission	Kruskal-Wallis H	6.00	7.65	12.1	4.90
	Asymp. Sig.	.307	.176	.074	.428
Cause of brain injury	Kruskal-Wallis H	8.23	10.76	20.19	2.86
	Asymp. Sig.	.004*	.001*	.000*	.091
Age at the time of brain injury	Kruskal-Wallis H	16.94	12.28	12.38	7.56
	Asymp. Sig.	.001*	.006*	.006*	.056
Length of admission	Kruskal-Wallis H	4.66	3.03	3.46	4.51
	Asymp. Sig.	.097	.220	.177	.105

Table 6: Mean Rank Results for Age at the Time of Brain Injury on Significant Factors (Awareness, Systems, Routines).

Factor	Age at the time of brain injury	N	Mean Rank
Factor 1 Awareness	prior to 16	43	102.53
	16 to 25	75	112.62
	26 – 35	38	95.47
	36 and over	39	67.35
	Total	195	
Factor 2 Systems	prior to 16	43	103.38
	16 to 25	75	109.98
	26 – 35	38	95.08
	36 and over	39	71.87
	Total	195	
Factor 3 Routines	prior to 16	43	108.35
	16 to 25	75	108.02
	26 – 35	38	93.09
	36 and over	39	72.10
	Total	195	

Table 7: Mean Rank Results for Cause of Brain Injury on Significant Factors (Awareness, Systems, Routines).

Factor	Cause of brain injury	N	Mean Rank
Factor 1 Awareness	Traumatic	150	103.17
	Non-traumatic	43	75.49
	Total	193	
Factor 2 Systems	Traumatic	150	104.05
	Non-traumatic	43	72.42
	Total	193	
Factor 3 Routines	Traumatic	150	106.65
	Non-traumatic	43	63.35
	Total	193	

Furthermore, "cause of brain injury" was significant across factors 1 to 3. Analysis of the mean rank data (Table 7) suggested that people who have experienced a traumatic brain injury have the highest mean rank scores on the BASS for factors 1 to 3, thus suggesting greater ability to show increased awareness, use systems and follow routines during their period of rehabilitation.

Conclusion

The main aim of the current study was to use a principal component factor analysis to identify whether the 26 items of the BASS correlate to form sub-groups/broader domains of functioning in brain injury clients. The analysis identified the presence of four highly correlated factors: Awareness, Systems, Routines and Self-Regulation. The primary findings also indicated that the BASS is a valid measure of the clients' ability to self-structure and has good internal consistency.

This factor analysis lends support to the theoretical model [1] identifying inter-related aspects of self-structuring – Anchors, Scaffolding and Strategies. Consistencies were clearly demonstrated with the identification of the two factors 'Routines' (Anchors) and 'Systems' (Scaffolding). However, the additional factors – 'Awareness' and 'Self-Regulation' – both appeared to relate to the application of 'Strategies' further dividing this concept into two distinct aspects within this area of self-structuring. This therefore suggests that there are more complex, higher-level thinking 'Strategies' which appear to be underpinned by 'Awareness', compared to more basic, practical 'Strategies' that relate to 'Self-Regulation'.

The current analyses notably identified the importance of 'Awareness' to self-structuring and applying 'Strategies', with this factor accounting for a large proportion of the variance and demonstrating a high correlation with the other three factors. Awareness is clearly a complex factor and limitations are noted with regard to the operational definition of awareness with different methods of assessment being used across studies including self-report questionnaires, variance between patient's and other's ratings and behavioural observations. A hierarchical model was proposed involving 'Intellectual Awareness' (knowing there is a problem); 'Emergent Awareness' (recognising a problem is happening); and 'Anticipatory Awareness' (preparing in anticipation of a problem) [13]. Whilst there is some debate about the hierarchical structure of 'Awareness' – with some suggesting less hierarchical and more of a interactional model [14] most research findings testify to the negative effect that impaired awareness has on outcome and response to rehabilitation [15, 16]. In the current study, items loading on factor 1 reflect intellectual awareness (made reasonable self-evaluations, discussed problems or difficulties appropriately), emergent awareness (checked and spotted mistakes, made reasonable adjustment to plans where necessary) and anticipatory awareness (was aware of potential problems, recognised personal limitations).

There have been only limited attempts to research interventions for improving self-awareness after acquired brain injury and simple information to enhance 'Intellectual Awareness' may not be adequate since 'Intellectual Awareness' has been shown to correlate poorly with 'Emergent Awareness' and 'Anticipatory Awareness' [17]. More recent research evaluated a group format programme to improve self-awareness in a residential setting [18]. Aspects of psycho-education were included and work sessions on the patients' own clinical tests' data and their sessions based on verbal feedback as a therapeutic tool were incorporated, both provided by the therapist and a peer group. Compared to a control group, the treatment group demonstrated improved self-awareness across eight group sessions and also corresponding improvements in functional outcome. Interestingly, further research found that executive functioning (inhibition, cognitive flexibility, and particularly verbal fluency) as well as episodic memory, appeared as significant predictors of post-rehabilitation self-awareness [19].

The nature of the rehabilitation programmes at TRU are primarily to provide a pathway between structure and self-structuring and a gradual and contingent pathway towards less support and greater independence. Fundamental to this process is rehabilitation aimed at developing anchors (routines), scaffolding (systems) and strategies (awareness and self-regulation) as a foundation for addressing executive impairments, episodic memory and emotional and social adjustment. Regular and contingently decreasing orientations and reviews with direct coaching support in which plans are made, possible problems are discussed, back-up support is planned and available, and support at the point of need is either planned or available. This process inevitably taps into the client's awareness at all levels. Firstly, it provides for an intellectual understanding of the client's problems be they cognitive, behavioural, or emotional. Secondly, it provides support for emergent awareness at the point of need with trained brain injury coaches in attendance; providing antecedent cues, and anticipatory awareness through developing plans, and providing feedback at reviews.

Further findings from the current study indicated that "age at the time of brain injury" was significant in its effect. Most significantly, those who were under the age of 25 years at the time of their brain injury seemed to have greater ability to show increased awareness (applying strategies), use systems (scaffolding) and follow routines (anchors) during their period of rehabilitation. Additionally, those between the ages 26-35 years scored higher compared to people aged over 36 years. It has been proposed that the developing brain has a repertoire of neuroplasticity responses that are not seen in the more mature adult brain [20]. Critical and sensitive periods of brain development provide "windows of opportunity" that may augment plasticity responses and improve clinical outcomes in children.

This study indicated that "cause of brain injury" predicted higher scores on the BASS with regards to areas of 'Awareness' (Strategies), 'Systems' (Scaffolding), and 'Routines' (Anchors) for individuals who had a traumatic brain injury as opposed to non-traumatic. It has previously been established that severity of brain injury impacts on an individuals' self-awareness, especially when there is blunt trauma to certain areas of the brain particularly those involved with executive functioning [21,22]. However, recent research [23] found no relationship between awareness at four years post-injury and severity of the initial trauma, sociodemographic data, the severity of impairments, limitations of activity and participation, or the patient's quality of life. It is hypothesised that individuals in the current study who had sustained more diffuse brain injuries (such as, anoxia, haemorrhages, infections, and disease) may present with limited plasticity to benefit from the full extent of their rehabilitation.

In summary, the current study indicates four highly correlated factors underpinning the BASS that are clearly related to self-structuring relevant to a client's rehabilitation journey following a brain injury. This now enables the BASS to be reported upon in terms of overall self-structuring ability in addition to performance on the inter-related domains 'Awareness', 'Systems', 'Routines', and 'Self-Regulation'. Subsequently, both individual strengths and areas of weakness can be identified across the domains and inform the adaptation of neurorehabilitation programmes or approaches dependent on client need.

Declaration of Interest

We declare that none of the authors have any conflict of interest in the publication of this manuscript.

Ethical Declaration

Ethical consideration and approval was sought and granted internally within the TRU research committee.

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