Cuadernos de Neuropsicología / Panamerican Journal of Neuropsychology
2020, Vol. 14 Nº 3 40- 51
ISSN: 0718-4123
DOI: 10.7714/CNPS/14.3.204

SELF-AWARENESS FOLLOWING ACQUIRED BRAIN INJURY IS LINKED WITH DEPRESSION AND EXECUTIVE FUNCTION

La autoconsciencia seguida de lesión cerebral adquirida y su relación con la depresión y la función ejecutiva

A autoconsciência após dano cerebral e sua conexão com a depressão e função executiva

RECIBIDO: 25 abril 2020 ***ACEPTADO: 05 octubre 2020***

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Keywords: Acquired Brain Injury, Awareness, Depression, Executive Function, Post-Acute, Psychotherapy.

Palabras Clave: lesión cerebral adquirida; consciencia; depresión; función executiva; post-acuda; psicoterapia.

Palavras-chave: lesão cerebral adquirida; consciência; depressão; função executiva; pós-aguda; psicoterapia.

A B S T R A C T

The current study aimed to examine the potential relationship between self-awareness, executive function and depression in post-acute acquired brain injury. 25 participants prospectively recruited from a community brain injury rehabilitation service completed the Awareness Questionnaire (AQ), the Hospital Anxiety and Depression Scale (HADS), the Trail Making Task (TMT) and the Wisconsin Card Sorting Test (WCST). Each participant's treating clinician also completed the Awareness Questionnaire (clinician form) for comparison. Hierarchical multiple regression revealed that depression (HADS) and set shifting (TMT) were significant predictors of level of self-awareness (AQ) following acquired brain injury. Contrary to previous research, the Wisconsin Card Sorting Test was not predictive of self-awareness. Consistent with previous research, reduced self-awareness appears to be protective against symptoms of depression even after the acute stages of recovery. Clinical implications include the importance of monitoring levels of self-awareness even in post-acute ABI, including neuropsychological and psychological factors that might be contributing to and maintaining varying levels of self-awareness.

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ISSN: 0718-4123
DOI: 10.7714/CNPS/14.3.204

R E S U M E N

El presente estudio buscó analizar la relación potencial entre la autoconsciencia, la función ejecutiva y la depresión con lesión cerebral adquirida en la fase post-aguda. Los 25 participantes reclutados prospectivamente desde un servicio comunitario de rehabilitación cerebral completaron el o Awareness Questionnaire (AQ), a Hospital Anxiety and Depression Scale (HADS), el Trail Masking Test (TMT) y el Wisconsin Card Sorting Test (WCST). El clínico de cada participante también respondió el Awareness Questionnaire para comparación. Las múltiples regresiones jerárquicas han revelado que la depresión (HADS) y la transformación de la configuración (TMT) fueron los predictores significativos de un nivel de autoconsciencia (AQ) seguido de la lesión cerebral adquirida. A lo contrario de las investigaciones anteriores, él no fue predictivo de autoconsciencia. Consistente con las investigaciones anteriores, la autoconsciencia reducida parece ser una protección en contra de los síntomas de la depresión mismo después de atingir niveles agudos de recuperación. Las implicaciones clínicas incluyen la importancia del monitoreo de los niveles de autoconciencia, mismo en la lesión cerebral adquirida post-aguda, incluyendo los factores neuropsicológicos y psicológicos que pueden contribuir y mantener la variación de los niveles de autoconciencia.

R E S U M O

O presente estudo buscou examinar a relação potencial entre a autoconsciência, função executiva e a depressão com a lesão cerebral adquirida na fase pós-aguda. Os 25 participantes recrutados prospectivamente de um serviço comunitário de reabilitação cerebral completaram o Awareness Questionnaire (AQ), a Escala Hospitalar de Ansiedade e Depressão (HADS), o Teste de Trilhas (TMT) e o Teste Wisconsin de Classificação de Cartas (WCST). O clínico de cada participante também respondeu o Awareness Questionnaire para comparação. As múltiplas regressões hierárquicas revelaram que a depressão (HADS) e a mudança de configuração (TMT) foram preditores significantes de um nível de autoconsciência (AQ) seguido da lesão cerebral adquirida. Ao contrário das pesquisas anteriores, o Teste Wisconsin de Classificação de Cartas não foi preditivo de autoconsciência. Consistente com as pesquisas anteriores, a autoconsciência reduzida parece ser uma proteção contra os sintomas de depressão mesmo após atingir níveis agudos de recuperação. As implicações clínicas incluem a importância do monitoramento dos níveis de autoconsciência, mesmo na lesão cerebral adquirida pós-aguda, incluindo os fatores neuropsicológicos e psicológicos que podem contribuir e manter a variação dos níveis de autoconsciência.

Introduction

Acquired brain injury (ABI) is an umbrella term that refers to an injury to the brain at any age following birth, but excludes neurodegenerative disorders such as the dementias and multiple sclerosis. It includes conditions such as traumatic brain injury, cerebral vascular accidents, and brain infections, among others. Most types of ABI typically results in cognitive impairment, loss of physical function, and personality or behavioural change. However, ABI often also has a potent effect on patients' affective world, with depression and anxiety common consequences. Furthermore, ABI can also alter a person's *awareness*, or phenomenological experience and understanding of their injury. Self-awareness in this context refers to the ability of an individual with an ABI to recognise difficulties acquired as a result of the injury (Crosson et al., 1989). Deficits in self-awareness (or "insight") are common following ABI (Schacter, 1990; Sherer, Hart & Nick, 2003) and reportedly cause the most impact on quality of life as reported by caregivers (Ergh, Rapport, Coleman & Hanks, 2002).

Deficits in self-awareness are important to identify as they can seriously hamper rehabilitation efforts, including working psychotherapeutically with patients. Without adequate awareness of deficits following ABI, patients will not be motivated to engage in rehabilitation and to learn techniques to compensate for such deficits (Allen & Ruff, 1990; Askenasy & Rahmani, 1987; Prigantio, 1988; Groswasser, Mendelson, Stem, Schechter & Najenson, 1977; Najenson et al., 1975; Schachter, Gilsky & McGlynn, 1990). Researchers have found that patients with ABI and reduced self-awareness will consistently demonstrate greater impairment in self-awareness for cognitive and behavioural difficulties as opposed to their physical difficulties (Hendryx, 1989; Prigantio, Altman & O'Brien, 1990).

Psychological therapy does not directly address physical difficulties. Rather, it targets persons' behaviour, thoughts and emotional experience to effect change, or psychological adjustment, including sometimes also to their physical impairment. At present there is not a biological or physical "cure" for the vast majority of difficulties, physical or psychological, resulting from ABI. Perhaps then unsurprisingly psychotherapeutic work with patients who have suffered ABI, has over the past few

ISSN: 0718-4123
DOI: 10.7714/CNPS/14.3.204

decades increasingly been recognised as an important component of some mainstream neuro-rehabilitation models (E.g. Block & West; Coetzer, 2007 & 2007; Hofer et al, 2016; Klonoff 2010, Laaksonen & Ranta, 2013; Prigatano 1999; Smits et al 2016). While approaches such as cognitive behaviour therapy have been used in the brain injury rehabilitation context, neuropsychoanalytic approaches to therapy (E.g. Coetzer et al, 2018; Kaplan-Solms & Solms, 2002; Turnbull & Solms, 2003) have also been applied with success.

One of the key components of neuropsychoanalytic work in a brain injury rehabilitation context concerns patients' self-awareness, and its association with emotional experience. However, at present there is a limited understanding of the association between self-awareness, cognition and emotional adjustment after ABI. Earlier work of Turnbull and colleagues found that patients were more inclined to experience feelings which relate to topics other than their impairments and its associated everyday disability (Turnbull, Jones & Reed-Screen, 2002). On the other hand, Ownsworth (2005) posited that denial of deficits might actually be protective after brain injury, but if it continued denial might have an adverse effect on emotional adjustment. Coetzer (2004) suggested that understanding the chronic nature of patients' deficits after brain injury and how self-awareness (or denial) relates to a process of experiencing grief, may be a central component of long-term psychotherapeutic work to facilitate emotional adjustment.

Some of the chronic difficulties resulting from brain injury, and patients' associated experience of loss and grief, may be related to post-injury changes in identity and personality (Carroll & Coetzer, 2011; Persinger, 1993). Tadir and Stern (1985) suggested that a process of mourning occurs in some patients who have suffered a brain injury. More recently Salas and Coetzer (2015) have argued that following brain injury, some patients' poor awareness might possibly be associated with a mourning process, impeded by deficits in executive function, namely, concreteness. Accordingly, Coetzer et al (2018) posited that working psychotherapeutically with grief and loss after brain injury constitutes one of five components of delivering psychoanalytically informed therapy to this clinical population. Clearly problems of self-awareness as well as denial, are likely to be implicated in many patients' emotional adjustment and vulnerability to depression after brain injury.

Self-awareness and depression

Psychologically based theories of self-awareness suggest that reduced self-awareness following ABI is influenced by pre-morbid personality and is the result of a 'psychological defence mechanism' (Gainotti, 1993; Prigatano, 1996; Weinstein & Kahn, 1955) which acts as a protective barrier against depression. Research has demonstrated a negative relationship between self-awareness and depression (Malec, Machulda & Moessner, 1997; Wallace & Bogner, 2000) whereby people with reduced self-awareness are more protected from depression compared to those who have intact awareness of their difficulties. Malec, Testa, Rush, Brown & Moessner (2007) examined the relationship between depression following ABI, self-awareness and demographic data. They found a strong association between self-awareness and depression whereby those participants with impaired self-awareness reported less depressive symptoms. Malec et al. (2007) interpreted this association as reduced self-awareness providing a barrier to depression, which would be consistent with psychologically based theories of self-awareness (Gainotti, 1993; Prigatano, 1996; Weinstein & Kahn, 1955). One major limitation of the above study is that the self-awareness measure was developed post-hoc from self reported measures of impairment; therefore repetition with standardized measures such as the Awareness Questionnaire (Sherer, Bergloff, Boake, High & Levin, 1998) would be beneficial.

In the social psychology literature, it has been suggested that reduced levels of self-awareness can in fact be related to increased levels of depression, contrary to the research described above. According to theories of self-efficacy (Bandura, 1977; Gage, & Polatajko, 1994) reduced self-awareness can result in outcomes or failures that were unexpected and can lead to feelings of insecurity for the individual. This environmental feedback has been linked to confusion, loss of control and depression which ultimately results in decreased self-efficacy (see Toglia & Kirk, 2000). From a clinical perspective, it is not uncommon for patients to report that "something is not quite right, but I don't know what" after repeated failures at for example, making friends, and then with this emerging awareness of their problems to become depressed. To some extent it appears that in these patients cognitive factors may underpin some of the early evolution of their increased awareness after ABI.

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DOI: 10.7714/CNPS/14.3.204

Self-awareness and executive function

Which cognitive factors are implicated in self-awareness? 'General disorder theories' suggest that deficits in executive function lead to reduced self-awareness (Mesulam, 1985; Shallice & Burgess, 1991; Stuss, 1991). Executive function is an umbrella term used to describe the plethora of complex higher order cognitive abilities that allow humans to *"formulate goals; to initiate behaviours; to anticipate the consequences of action; to plan and organise behaviour according to spatial, temporal, topical or logical sequences; and to monitor and adapt behaviour to fit a particular task or context"* (Cicerone et al., 2000; p1605). Impairments in executive function following ABI are common. Ponsford and colleagues (2014) reported in their longitudinal study that 45% of their participants (n=41) experienced some difficulties with executive function 10 years post ABI.

A number of studies have investigated the relationship between various measures of executive function and self-awareness, but findings appear to be inconclusive. Some studies have found significant associations between measures indicating impaired self-awareness and elements of the Wisconsin Card Sorting Test (specifically number of categories completed and number of perseverative responses), indicating that decreased ability to inhibit a response and poor flexibility may play a part in decreased self-awareness (Bivona et al., 2008; Noe et al., 2005). Other studies failed to find any significant correlations between reduced self-awareness and measures of executive function (Bach & David, 2006; O'Keefe Dockree, Moloney, Carton & Robertson, 2007). It is possible that the inconsistencies in these studies could be explained by differences in methodological rigour and in the tools used to measure self-awareness and executive function. Additionally, the studies do not account for depression; therefore at present it is difficult to draw any firm conclusions. The aim of the current study was to address some of the issues mentioned above by investigating whether there was a link between measures of self-awareness (with good reliability) and elements of executive function, and what role depression plays in the relationship.

Method

Participants

The group of participants consisted of 25 prospectively recruited patients with an ABI. Participants were aged between 25 and 69 and no participants dropped out of the study. The nature of ABI ranged from traumatic brain injury (TBI; classified as moderate to severe), cerebral vascular accident (CVA), encephalitis and tumour, with the time since injury ranging from 14 months to 43 years. All participants were receiving ongoing care from a community brain injury rehabilitation service commissioned by the National Health Service in the United Kingdom. Participants were referred to the service by health professionals for a range of physical, emotional or cognitive difficulties as a result of their ABI. Further demographic information is included in Table 1.

Table 1

Participant demographic data

Note. TBI = Traumatic Brain Injury, CVA = Cerebral Vascular Accident, M = Mean, SD = Standard Deviation.

	Entire sample (n=25)	TBI (n=18)	CVA (n=5)	Other (n=2, encephalitis and tumour)
Age M (SD)	49.8 (11.41)	48.67 (11.95)	55.2 (9.90)	46.5 (10.60)
Sex (Male : Female)	21:4	15:3	5:0	1:1
Time (months) since injury M (SD)	106.1 (116.30)	116.22 (134.39)	72.8 (48.50)	98.5 (30.40)
Education (years) M (SD)	13.2 (2.10)	12.94 (1.59)	13.2 (3.30)	16 (0)
Employment status (employed : unemployed)	6:19	5:13	0:5	1:1

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ABI was confirmed either by clinical imaging (e.g. Magnetic Resonance Imaging or Computerised Tomography), other clinical markers of severity such as period of loss of consciousness and post-traumatic amnesia, or confirmation from the consultant neurologist as a routine process to determine appropriateness for the community brain injury rehabilitation service. Further information regarding the nature and lesion site of the ABI were collected with consent from each participant by the principal author via retrospective examination of medical notes. Exclusion criteria were utilized to control for confounding variables. Participants were excluded from the study if they sustained an ABI less than 12 months previous to the study, had any current substance misuse difficulties, any co-morbid neurodegenerative disease, or a previous diagnosis of an intellectual disability.

Measures

Demographic data

The principal author collected demographic information from each participant, including: age, sex, work status, highest achieved education level, time since injury and nature and site of injury.

Measures of awareness

Self-awareness was measured using the Awareness Questionnaire (AQ; Sherer, Bergloff, Boake, High & Levin, 1998) which consists of three forms; patient, significant other and clinician. The questionnaires are designed to assess the amount of insight or self-awareness the patient has about their functioning following ABI. The patient form and significant other form consists of 17 items while the clinician form consists of 18. The extra item allows the clinician to directly rate their own perception of the patient's self-awareness. Each item on the forms addresses the patients' current abilities as compared to their abilities pre-injury. Scores range from 17 to 85, the discrepancy between the clinician and patient rating is calculated, and a discrepancy >20 represents clinical levels of impaired self-awareness (Evans, Sherer, Nick, Nakase-Richardson & Yablon, 2005). The discrepancy scores range from -68 to 68 where negative scores represent an over-estimation of difficulties (Cicerone, 1991; Prigatano & Altman, 1990). Internal consistency for the scale is Cronbach's α of .88 for patient and significant other versions (Sherer et al., 1998). In a more recent study, Cronbach's α values of .84 (patient), .91 (clinician) and .89 (significant other) were found across the entire scale (Carroll & Coetzer, 2011). The current study will utilise the patient and clinician forms due to predicted difficulty in obtaining significant other ratings.

Measures of executive function

The Wisconsin Card Sorting Test was used (WCST; Heaton et al., 1993) to measure various aspects of executive function including perseveration and flexibility. This task can be administered via a computerized version or by hand, the current study used the manual version. The participant is required to match cards (128) to their target cards (four) according to rules (colour, shape or number) which are unknown to the participant. Participants are to work it out via feedback from the examiner (or computer) of 'correct' or 'incorrect'. The rules change throughout the test and the participant is required to independently shift to the new rule. The WCST is used widely to measure executive function and has been used in a number of populations (Romine & Reynolds, 2005). Generalizability coefficients are reported for the nine sub-scores within the WCST and range from 0.39 to 0.72 (mean = 0.57; Heaton et al., 1993). Generalizability coefficients of 0.60 and above are deemed to show very good reliability (Cicchetti & Sparrow, 1981; Mitchell, 1979). Due to the limited sample size, it was decided to concentrate on the number of categories completed (WCST categories) and perseverative errors (WCST perseverative errors) as a measure of flexibility and inhibition in line with previous research (Bivona et al., 2008; Noe et al., 2005).

The Trail Making Task (TMT; Reitan, 1958) was selected, as a more traditional and widely used test of set shifting. In part A, participants connect 25 numerical targets as quickly as possible. Targets are numbered from one to 25 and they are connected sequentially. In part B, participants are required to connect targets switching between numbers and letters, sequentially, e.g. 1-a, 2-b, 3-c etc. The time taken to complete each task is recorded and the difference between time taken to complete TMT A and B will be calculated. The TMT has been shown to have good reliability for part A (r = 0.75), part B (r = 0.85) and the difference between part A and B (r = 0.74; Giovagnoli et al., 1996). The current study will use the difference between TMT A&B as it has been shown to minimize the visuo-perceptual and working memory demands, resulting in a more specific measure of set shifting (Sanchez-Cubillo et al., 2009).

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DOI: 10.7714/CNPS/14.3.204

Measures of psychological affect

The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) was used as a measure of psychological affect. The HADS is a self-report questionnaire that consists of 14 items giving separate subscale measures of anxiety and depression, where higher sores represent higher levels of anxiety and depression. Subscale scores of 0 – 7 are considered to be in the 'normal range', 8 – 10 'borderline range', and 11-21 are considered to be in the 'abnormal' or 'clinical' range. The HADS is deemed to have sound psychometric properties with a Cronbach's α from 0.68 to 0.93 (mean α=0.83) for the anxiety subscale and 0.67 to 0.90 (mean α=0.82) for the depression subscale (Bjelland, Dahl, Haug & Neckelmann, 2002). It has also be shown to be a reliable measure to be used with ABI populations as it has an emphasis on behavioural and affective symptoms and the exclusion of items pertaining to physical symptoms (Whelan-Goodinson, Ponsford & Schonberger, 2009).

Procedure

Full ethical approval was granted by the National Health Service Research Ethics Committee (NHS REC) and the School of Psychology at Bangor University, UK. Following approval, participants were approached in the first instance by their treating clinician at the brain injury rehabilitation service to register interest in the study, and gain verbal consent for the principal author to contact them via telephone at a later date. The principal author made contact with each potential participant to answer questions and to arrange a convenient time for testing if they wished to participate. Testing was completed in an NHS clinic room local to the participant or in their own home at their convenience or preference. Fully informed verbal and written consent was gained from each participant who agreed to take part. Testing was completed in a quiet environment free from distractions and took around one hour on average. All participants were fully debriefed following assessment and given the option of receiving their individual results at a later date.

Statistical Analysis

The statistical software package IBM SPSS version 24 (IBM Corp, 2016) was used to complete all statistical analyses. In the first instance independent sample *t*-tests were run to see if there were any significant differences in measures of self-awareness between the TBI and CVA participants. If no significant differences were found then it would be appropriate to run the analysis on the entire sample. It was not deemed appropriate to run the *t*-test for the 'other' category as only two participants fell into this category. A hierarchical multiple regression was run to understand the individual contributions of the independent variables to the explanation of variance within the AQ. Due to the exploratory nature of the present study and the inconclusive findings from previous research, it is not possible to compare the current findings with an existing model. To ensure a thorough analysis of the current data, the regression model will be run with the AQ discrepancy as the dependent variable and demographics (age and education) at the first step, as these are fundamental qualities of each participant. Due to the order of variables entered into regression models having an effect on the significance levels, it is prudent to compare the regression models with each combination of variables to ensure results are consistent. The proceeding regression analyses were run for the remaining variables in each possible order of entry (six ways) with the WCST measures consistently grouped together. The best fitting regression model was the model in which each variable continued to improve the fit, yet remained parsimonious.

Results

There was no significant difference between TBI and CVA participants on the dependent variable ($t_{(21)}$ = .078, p = .233), therefore the participants were pooled into one sample.

The discrepancy analysis between the AQ patient and clinician rating indicated that no participants fell in the clinically significant range for impaired self-awareness (Evans et al. 2005). However, nine participants scored between 10 and 20 points higher than the clinician rating, indicating scores approaching the clinical level. Descriptive statistics also indicated a range of awareness levels in the sample. 11 participants had a negative score for AQ discrepancy indicating that they had a potentially over inflated estimation of their difficulties. Mean score for Depression (HADS) fell within the 'borderline' range with 10 participants meeting the clinical range for depression. Descriptive statistics for measures are outlined in Table 2.

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DOI: 10.7714/CNPS/14.3.204

Table 2.

Descriptive statistics of neuropsychological measures

N=25	Minimum	Maximum	Mean	Standard Deviation
AQ Patient Form	21	53	34.12	8.51
AQ Clinician Form	27	46	34.84	4.47
AQ Discrepancy	-14	17	-.72	9.19
HADS Depression	3	17	8.96	4.07
TMT B-A	15	252	64.4	55.28
WCST Categories	0	6	5.08	1.77
WCST Perseverative Errors	4	68	16.4	14.61

Note. AQ = Awareness Questionnaire, HADS = Hospital Anxiety and Depression Scale, WCST = Wisconsin Card Sorting Test, TMT = Trail Making Task.

The hierarchical multiple regression was run with eight combinations of variables in total as described above. Regardless of the order of the variables entered into the regression analysis, TMT discrepancy was consistently shown to contribute a statistically significant proportion of the variance in the dependant variable (p = .014 to .039). HADS depression was also shown to consistently contribute to the model regardless of the order of variables entered into the analysis (p = .001 to .015). WCST scores (categories and perseverative errors) were consistently found not to be significant predictors of the dependant variable, regardless of the order in which they were entered into the regression model (p = .250 to .962). The amount of variance accounted for by the regression models ranged from 17.0% (model one) to 61.9% (model 4; see Table 3).

Table 3.

Each regression model with corresponding R^2 value

Note. HADS = Hospital Anxiety and Depression Scale, TMT = Trail Making Task, WCST = Wisconsin Card Sorting Test. ** = the best fitting regression model.

Model	R^2
1. Demographics	.170
2. Demographics + Depression	.479
3. Demographics + Depression + WCST scores	.454
4. Demographics + Depression + TMT Discrepancy	.619**
5. Demographics + WCST scores	.237
6. Demographics + WCST scores + TMT Discrepancy	.403
7. Demographics + TMT Discrepancy	.325
8. Demographics + Depression + TMT Discrepancy + WCST scores	.616

According to analysis of F change values (F^2), the best fitting model was Model 4 (see Table 3). Demographics were entered into step one of the analysis which accounted for 17% of the explained variance in the dependant variable (AQ discrepancy), but was not found to be a significant contributor to the variance ($F^2_{(2,\ 22)}$ = 2.247, p = .129). The introduction of HADS depression at step two was found to increase the variance of the model to 47.9%, and explained a significant amount of the variance over and above demographic information alone ($F^2_{(1,21)}$ = 12.495, p = .002). Finally, the introduction of the TMT discrepancy at step three was again found to significantly increase the variance of the regression model to 61.9% and explained a significantly higher proportion of the variance over and above steps one and two ($F^2_{(1,20)}$ = 7.314, p = .014).

Further examination of the variables in the best fitting regression model (model 4) confirmed that depression ($t_{(24)}$ = -3.924, p = .001) and TMT discrepancy ($t_{(24)}$ = -2.704, p = .014) were significant predictors of AQ discrepancy over and above the other variables' contribution to the model. Where higher levels of depression were associated with increased self-awareness and more difficulty set shifting on the TMT was associated with reduced levels of self-awareness. Education was also found to be a significant predictor in the final model ($t_{(24)}$ = 2.987, p = .007) with increased years of education being associated with reduced levels of self-awareness (see Table 4).

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DOI: 10.7714/CNPS/14.3.204

Table 4.

Coefficients of best fitting multiple regression model

	B	Std. Error	β	t	Sig.
Constant	-13.382	9.708	-	-1.378	.183
Age	-.091	.115	-.113	-.792	.437
Education	1.845	.618	.415	2.987	.007*
HADS Depression	-1.256	.320	-.556	-3.924	.001*
TMT Discrepancy	.063	.023	.376	2.704	.014*

Note. HADS = Hospital Anxiety and Depression Scale, TMT = Trail Making Task. * = significant at the .05 level.

Discussion

Consistent with previous research (Malec et al., 2007; Wallace & Bogner, 2000), the current study found that awareness was negatively associated with self-reported levels of depression. Contrary to previous research (Bivona etal., 2008; Noe et al., 2005) the current study failed to find any significant relationships between the WCST and levels of self-awareness, but this was consistent with some previous research (Bach and David, 2006; O'Keefe et al., 2007). Interestingly, the current study also found that set shifting, as measured using the TMT was a significant predictor of self-awareness. The multiple regression model confirmed that depression and the TMT discrepancy were contributing independently to the explained variance in the AQ discrepancy score.

The current study provides partial support for general disorder theories of self-awareness, which suggest that disruption to higher order executive cognitive skills lead to deficits in self-awareness. (Mesulam, 1985; Shallice & Burgess, 1991; Stuss, 1991). However, the theory does not specify which specific elements of executive function may explain deficits in self-awareness. There is some empirical support for general disorder theories finding associations between measures of executive function and measures of self-awareness (Allen & Ruff, 1990; Bivona et al., 2008; Malec, Machulda & Moessner, 1997; Noe et al., 2005; Ownsworth, McFarland & Young, 2000; Starkstein et al., 1993; Trudel, Tryon & Purdum, 1998). The studies use various measures of executive function and self-awareness, so it is impossible to draw any firm conclusions from these findings.

Our study focused on measures of flexibility, inhibition and set shifting. Interestingly the only significant predictor of self-awareness was set shifting, which suggests in this sample that a specific element of executive function is related to self-awareness, as opposed to the inclusive general disorder theories. It is plausible that if someone struggles to re-direct their attention (set shifting) then it would be more difficult to shift towards external stimuli informing the person of acquired difficulties. This is a potentially very interesting finding in light of Turnbull and colleagues' (2002) results, which suggested that patients found it easier to direct their attention to feelings *other* than those related to their own disability. Furthermore, Rowlands, Coetzer and Turnbull (2019) in their recent work focussing on emotion regulation strategies found that persons with ABI took longer and generated fewer reappraisals than healthy controls. The results also indicated that working memory was the only cognitive factor predictive of the number of reappraisals (Rowlands et al 2019). However, as regards the findings from the current study, it could also be argued that the WCST is a test of set-shifting, and recent research has cast some doubt upon the TMT as a measure of frontal executive function (see Chan et al., 2015).

In line with previous research, the current study demonstrated an association between reduced self-awareness and lower levels of reported depression (Fleming, Strong & Roderick, 1998; Malec et al., 2007; Wallace & Bogner, 2000). Psychologically based theories of self-awareness propose that because awareness is qualitatively different between each person, impaired self-awareness can be attributed to a combination of pre-morbid personality, coping style and post-injury personality (Giacino & Cicerone, 1998; Ownsworth et al., 2000). It should be acknowledged that both impairment of self-awareness and depression can serve as impediments to engagement with rehabilitation. Some patients experience a sense of loss of their sense of who they were prior to a brain injury (Nochi, 1998). Neuropsychoanalytically informed therapy approaches do have a focus on personhood, including pre-morbid personality and how ABI interacts with this, including that some patients experience a process of mourning in response to their altered identity and personality. Lewis and Rosenberg (1990) reported that changes in personality post-injury was a common theme encountered during psychoanalytic therapy with neurological patients. Potentially the significant finding of years of education found in this study could then also contribute to understanding some of these pre-morbid factors that are thought to influence self-awareness, and in some

ISSN: 0718-4123
DOI: 10.7714/CNPS/14.3.204

cases patients sense of loss of 'who they were' before the injury. These theories however fail to consider the influence of neuropsychological factors in explaining different levels of self-awareness.

To some extent the results from the current research would be more in line with integrated theories of self-awareness, which recognise that there are numerous ways in which each person with a brain injury adapts and represents themselves (Ownsworth et al., 2000). The presentation of a person with reduced self-awareness varies enormously so it is possible that a number of factors contribute to the development and maintenance of impaired self-awareness. This has important implications for psychotherapeutic practice, especially in approaches such as neuropsychoanalysis, which takes a longer-term perspective on therapeutic interventions. Allen & Ruff (1990) proposed that there are three distinct levels of processing that allow humans to have accurate self-awareness. The first level requires the individual to attend to information about the self which would naturally be vulnerable to neuropsychological deficits. The second level requires the individual to 'appraise' the information about the self and compare it to pre-morbid functioning. The final level involves the willingness of the individual to disclose such information to another person, which has direct implications for psychotherapeutic work. The authors propose that the final two levels are vulnerable to both psychological and neuropsychological factors. The ability to self-monitor will naturally be affected if an individual struggles to set shift (Borkowski, 1996; Hacker, 1998; Schneider, 1998). With support, individuals may be able to identify difficulties, but potentially, will not be able to shift to new strategies or adjust their performance accordingly (Toglia & Kirk, 2000), which may have important implications for psychotherapy, and selecting strategies to facilitate patients' long-term emotional adjustment to post-injury changes.

Limitations

The present study was subject to some limitations. Firstly, it should be noted that with a small sample size (n=25), the researchers were limited as to the number of variables which could reliably be entered into the regression model, due to the risk of 'over-fitting' the model. Smaller sample sizes are also subject to inflated type II errors where only the largest associations between variables are detected. Continuing to collect data would allow the researchers to make more reliable predictions regarding the relationships described above. The participants included in the sample also had mixed aetiologies which could be argued as reducing external validity due to heterogeneity. The cross-sectional nature of the study also means that it is impossible to make any assumptions regarding changes in self-awareness and the relationship with depression and executive function over time, or any causative relationships. More tightly controlled longitudinal studies with larger sample sizes would allow further insight into these relationships.

A standard procedure of using the AQ to determine self-awareness was used in this study, where the discrepancy between clinician and patient is used. A control measure (for example relative rating) to make sure the differences obtained were not a normal difference between the two raters was not employed due to the anticipated difficulty in obtaining a relative rating. Nevertheless, internal consistency on the AQ between patient, clinician and significant other is high (Carroll & Coetzer, 2011). The current study consisted of a "real world" clinical sample representative of individuals presenting for rehabilitation at community brain injury rehabilitation services.

Conclusion

In conclusion, the results from this investigation raise important considerations for clinical practice, and in particular psychotherapeutic work. Firstly, levels of self-awareness are still variable in the post-acute (>1 year) stages of ABI and thus it is important to continue to monitor awareness in community settings, as well as inpatient settings due to the negative impact on rehabilitation. Often short-term therapy approaches such as cognitive behaviour therapy may not always sufficiently take this into consideration. Problems of self-awareness in this clinical population require a longer term therapeutic approach, inherent to neuropsychoanalytic work. Also, 44% of the sample (n=11) reported an overestimation of their difficulties, hence it is vital to gain a comprehensive understanding of the *qualitative* nature of patients' perceptions of their difficulties following ABI. Secondly, it is likely that both higher order neuropsychological and psychological factors contribute to the development and maintenance of impaired self-awareness. As discussed above, it is possible that the ability to set shift is fundamental to accurate self-monitoring, and subsequently self-awareness. The ability to set shift may also be important for psychotherapeutic strategies to help patients with emotion regulation problems secondary to brain injury. TMT is a classic test of set shifting and is quick and easy to administer, making it a useful tool to monitor set shifting performance over time. It is important for clinicians to monitor patients' functioning in the above areas to further

ISSN: 0718-4123
DOI: 10.7714/CNPS/14.3.204

understand how people perceive changes in function following ABI in a person-centred manner as part of the rehabilitation process.

Acknowledgements (including funding and conflict of interest)

This research paper was financially supported by the North Wales Clinical Psychology Programme and was submitted in partial fulfillment of the requirements for a Doctorate Degree in Clinical Psychology. Neither author has any personal or financial relationships with other people or organizations that could influence the outcome of the work.

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