Author: C. Skilbeck, K. Holm, M. Slatyer, M. Thomas and T. Bell

Title: The Factor Structure of the Hospital Anxiety and Depression Scale (HADS) in a Traumatic Brain Injury (TBI) Population

Journal: Brain Impairment **ISSN**: 0269-9052 1362-301X

Year: 2011

Volume: 12

Issue: 1

Pages: 22-32

Abstract: Primary Objectives: To examine the HADS structure in TBI, using Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), and investigate the effects of TBI severity, Gender, and Age on factor scores. Methods and Procedures: HADS data from 186 TBI patients in a population study in Tasmania were subjected to EFA. HADS data from a second sample of 185 TBI participants in the same study underwent CFA. One-month follow-up data were used, allowing inclusion of severe TBI patients whilst still being early post-injury. Factor loadings were used to investigate the effects of demographic and clinical variables at two weeks post-injury. Results: Whilst EFA suggested 2- factor (anxiety, depression) and 3-factor (anxiety, psychomotor, depression) structures provided adequate descriptions, CFA strongly supported the 3-factor model. Using this model, significant effects of TBI severity were noted on Psychomotor and Depression scores at two weeks post-injury. Males reported significantly fewer symptoms on all three factors, as did younger participants. Conclusions: CFA indicates that a 3-factor model provides the best fit for HADS data in TBI. One factor, Psychomotor, has been relatively neglected in the literature, and the current findings suggest its assessment and rehabilitation should receive more attention.
DOI: http://dx.doi.org/10.1375/brim.12.1.22

URL: http://researchoutput.csu.edu.au/R/-?func=dbin-jump-full&object_id=29820&local_base=GEN01-CSU01

Author Address: mathomas@csu.edu.au

CRO Number: 29820

The Factor Structure of the
Hospital Anxiety and Depression Scale (HADS)
in a Traumatic Brain Injury (TBI) population.

Clive Skilbeck[1], Kieran Holm[1], Mark Slatyer[2], Matthew Thomas[3],
& Tony Bell[2]

1. School of Psychology, University of Tasmania, Australia

2. School of Medicine, Royal Hobart Hospital, Tasmania, Australia

*3. School of Social Science and Liberal Studies,
Charles Sturt University, NSW, Australia*

Corresponding author: Associate Professor Clive Skilbeck
University of Tasmania
Sandy Bay Campus, HOBART 7001
(03-6226-7459; clive.skilbeck@utas.edu.au)

Keywords: HADS, Mood, TBI, Factor Analysis, Age, Gender

The Factor Structure of the Hospital Anxiety and Depression Scale (HADS) in a Traumatic Brain Injury (TBI) population.

Abstract

Primary Objectives: To examine the HADS structure in TBI, using Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), and investigate the effects of TBI severity, Gender, and Age on factor scores.

Methods and Procedures: HADS data from 186 TBI patients in a population study in Tasmania were subjected to EFA. HADS data from a second sample of 185 TBI participants in the same study underwent CFA. One-month follow-up data were used, allowing inclusion of severe TBI patients whilst still being early post-injury. Factor loadings were used to investigate the effects of demographic and clinical variables at two weeks post-injury.

Results: Whilst EFA suggested 2- factor (anxiety, depression) and 3-factor (anxiety, psychomotor, depression) structures provided adequate descriptions, CFA strongly supported the 3-factor model. Using this model, significant effects of TBI severity were noted on Psychomotor and Depression scores at two weeks post-injury. Males reported significantly fewer symptoms on all three factors, as did younger participants.

Conclusions: CFA indicates that a 3-factor model provides the best fit for HADS data in TBI. One factor, Psychomotor, has been relatively neglected in the literature, and the current findings suggest its assessment and rehabilitation should receive more attention.

Introduction

Traumatic Brain Injury (TBI) and Mood

A number of studies have found that TBI patients experience changes in mood after their injury, and it is generally accepted that depression and anxiety frequently occur post-TBI (Deb, Lyons, & Koutzoukis, 1998; Deb, Lyons, Koutzoukis, Ali, & McCarthy, 1999). These mood problems can persist long-term and are often more disabling than the physical problems associated with the injury (Bernstein, 1999). Mood problems can provide major barriers to rehabilitation for TBI patients, negatively affecting their life satisfaction (Rapoport, McCullagh, Streiner, & Feinstein, 2003). TBI patients with depression can experience symptoms such as a decrease in activity levels and poor psychosocial functioning (Rapoport et al., 2003). Those suffering anxiety may feel anxious in social situations, worry excessively, experience free-floating anxiety, and avoid activities, events and situations associated with their head injury (Moore, Terryberry-Spohr & Hope, 2006). Therefore, it is important to identify mood changes post-injury so that appropriate psychological interventions can be provided (Roy, Thornhill, & Teasdale, 2002).

Mood Post-TBI: Demographic and Clinical Variables

In their meta-analysis study examining gender differences in TBI patients Farace & Alves (2000) found that women generally displayed poorer outcomes than men on a range of variables**.** In addition, there is specific research suggesting that women experience more symptoms of anxiety and depression following TBI (Hibbard, Uysal, Kepler, Bogdany & Silver, 1998; Sliwinski, Gordon & Bogdany, 1998; Glenn, Pirozzi, Goldstein, Burke, & Jacob, 2001).

Although TBI outcome research has focused primarily on younger adults, there is a growing recognition that older patients also need rehabilitation (Rapoport & Feinstein, 2001), with studies indicating that major depression is a common complication in older adults (Rapoport, 2003; Glenn et al., 2001). Research has also shown that older patients take longer to recover from TBI, and show more neuropsychological impairments and psychosocial limitations, compared with younger patients (Johnstone, Childers, & Hoerner, 1998; Rothweiler, Temkin, & Dikmen, 1998).

Mild TBI patients have been found to suffer significant emotional problems post-injury (e.g., Ruff, 2005), although studies suggest that individuals with more severe TBI tend to experience greater emotional problems (McCleary, Satz, Forney, Light, Zaucha, Asarnow, & Namerow, 1998; Fann, Burington, Leonetti, Jaffe, Katon, & Thompson, 2004). This may be a direct result of the more traumatic nature to the brain and/or psychological adjustment to the greater physical and cognitive deficits these patients experience.

The Hospital Anxiety and Depression Scale (HADS)

The HADS is a 14-item questionnaire, which usually takes 2 - 5 minutes to complete (Snaith, 2003). The patient responds to each item using a four-point (range 0 - 3) Likert scale (Desmond & MacLachlan, 2005), according to how they have been feeling over the preceding week (Zigmond & Snaith, 1983). The HADS consists of 7-item anxiety and depression subscales, each with a score range of 0–21. These scores are categorised as 0–7 = normal, 8–10 = mild, 11–14 = moderate, 15–21 = severe symptoms (Snaith & Zigmond, 1994).

The HADS has been extensively used in clinical practice to assess levels of anxiety and depression in patients as a concomitant of physical illness (eg, Martin, Lewin, Thompson, 2003). As indicated above, mood disturbances are frequent sequelae of TBI, and the HADS has been used with this patient group to identify, and determine the severity of their mood problems (e.g., Hawley, 2003). A patient's responses on the HADS can be an extremely useful indicator of their psychosocial rehabilitation needs, and Whelan-Goodinson, Ponsford & Schonberger (2008) found the HADS to be a reliable measure of emotional distress in patients sustaining moderate/severe TBI.

The HADS was devised to measure the two dimensions of anxiety and depression (Marinus, Leentjens, Visser, Stigglebout, & van Hilten, 2002); Martin, 2005), with findings from a number of studies supporting this view (eg, Bjelland, Dahl, Haug, & Neckelmann, 2002). A comprehensive review by Bjelland et al. (2002) found the HADS to be a reliable and valid measure of two independent dimensions of anxiety and depression in a range of populations, arguing the instrument could be used clinically with confidence. However, many of the studies obtaining a 2-factor structure for the HADS (eg, Marinus et al., 2002), have been criticised due to their reliance on Exploratory Factor Analysis (EFA), which does not provide the strong tests of 'goodness-of-fit' offered by Confirmatory Factor Analysis (CFA).

Recent studies have found support for a 3-factor structure for the HADS. A 3-factor model implies the HADS may be sensitive to somatic aspects of physical illness and injury, and is not just a measure of mood (Martin, 2005; Desmond & MacLachlan, 2005). Using an exploratory Principal Components Analysis, Dawkins, Cloherty, Gracey, & Evans (2006) examined the factor structure of the HADS in a sample of patients with acquired brain injury, most of whom had sustained a TBI. They obtained a 3-factor solution. Martin (2005) suggested a ‘tripartite’ model for anxiety and depression, consisting of the factors, anhedonic depression, negative affectivity and autonomic arousal as providing the best fit for the HADS in a range of clinical populations. These include clinically depressed patients (Friedman, Samuelian, Lancrenon, Even, & Chiarelli, 2001) and patients with coronary heart disease (Martin et al., 2003). Other three-factor models have been found to represent the HADS structure well, each including a factor representing physiological symptoms relating to psychomotor changes. In these solutions, HADS anxiety subscale items tend to ‘split’ between anxiety and psychomotor factors (Barth & Martin, 2005; Martin & Thompson, 2000). Extensive research has investigated the structure of the instrument in different clinical groups. However, no published study has addressed the factor structure of the HADS using only TBI patients, and there is a need for such research.

The Current Study

The present study aimed to investigate the underlying factor structure of the HADS in TBI patients, employing both EFA and CFA methods to provide a definitive factor solution for this questionnaire instrument in the TBI population. The study also undertook a preliminary examination of the relationships between the factors identified and age, gender, and TBI severity as measured by duration of post-traumatic amnesia (PTA).

It was hypothesised that:

1. The HADS would best be described by a 3-factor structure (given recent findings in other clinical populations, using CFA).

2. HADS factor scores would be sensitive to severity of TBI, so that longer PTA would be associated with greater symptomatology.
3. Female TBI patients would score higher on the HADS factors than male TBI patients at assessment two-weeks after head injury.
4. Older TBI patients would score higher on the HADS factors than younger TBI patients at assessment two-weeks after head injury.

Method

Participants

The Neuro Trauma Register (NTR) is conducting an adult population-based TBI research project funded by the Motor Accidents Insurance Board (MAIB) of Tasmania. The project began recruiting participants in December 2003 in Southern Tasmania. All adult TBI patients (>=16 years) presenting to the Emergency Department of the Royal Hobart Hospital, whether admitted or not, were invited to participate in the research. The sample consisted of 371 participants, identified from the NTR database. Table 1 displays medians, means and standard deviations for the demographic and PTA variables. It shows that the sample was typical of the population of head injury in age, severity (80% being classified as mild from their PTA), and gender (64% male). Median estimated premorbid IQ (100) and years of education (10) were representative of the general population.

TABLE 1 ABOUT HERE

Approval for the research was obtained from the Tasmanian Human Research Ethics Committee (H7116)

Materials

The HADS (Zigmond & Snaith, 1983).

Westmead Post-Traumatic Amnesia Scale (Marosszeky et al., 1997).

NART, to estimate premorbid IQ (Nelson, 1982)

NTR Interview Schedule to provide demographic and relevant history data

Procedure

Potential participants were approached as soon as possible after their attendance at the Emergency Department, and invited to join the study. Informed consent was obtained from those able to provide it at that time. For those patients admitted in coma initial consent was obtained from next of kin; these participants were then approached to provide informed consent as soon as they had regained consciousness and their period of PTA had ended (assessed using the Westmead PTA Scale; Marosszeky, Ryan, Shores, Batchelor, & Marosszeky, 1997). For those participants not admitted to hospital, PTA duration was obtained via subjective estimation. The HADS was administered to participants as part of a battery of neuropsychological and medical tests which were used at initial follow-up (median = 7 days post-trauma), and then at 1-, 3-, 6-, 12-. 24-, and 36-months after injury. The data used for the current factor analyses were gathered at the one-month follow-up; using this dataset allowed the inclusion of severe TBI patients (with up to four weeks PTA), whilst still being relatively early post-TBI. Factor scores were then used to investigate the effects of demographic and clinical variables at a very early point post- (two-week follow-up) to detect any immediate mood problems.

Data analysis

Exploratory (EFA) and confirmatory (CFA) factor analyses were performed on the 14 HADS items at the follow-up conducted at one month post-TBI (Mean = 31 days). The one-month assessment was chosen for analysis as it was well attended and provided a representative sample of TBI patients in terms of injury severity. The sample of 371 participants was split into two sub-samples of 186 for EFA and 185 for CFA, based on the median study number. The EFA employed Principal Axis Factoring with Varimax rotation, using the individual HADS item scores (Tabachnick & Fidell, 2001). The initial criterion used to identify factors was an Eigenvalue of >= 1, supported by a scree plot. The EFA method was chosen to maximise orthogonal variance from the data set for each succeeding factor, and Varimax rotation was selected to simplify the interpretation of factors and to offer the most appropriate approach for use in subsequent group analyses (Tabachnick & Fidell, 2001). Items were deemed to load onto a factor if they provided a factor loading of > .40. CFA was performed on the HADS second sub-sample data, and the two-factor and three-factor models identified in the EFA were tested using Analysis of Moment Structures (AMOS) version 6, applied to their factor loadings.

Raw factor scores were examined in relation to Age, Sex and PTA, using ANOVAs and t-tests.

Results

Descriptive statistics were typical of a TBI population, including 30 years as the median age of the sample, with 64% being male (Khan, Baguley, & Cameron, 2003; Hillier, Hiller, & Metzer, 1997). Also, 80% of participants experienced a mild PTA, consistent with previous TBI epidemiology studies (Tate, McDonald, & Lulham, 1998).

Exploratory Factor Analysis (EFA)

A 2-factor model was extracted on the basis of Eigenvalue >= 1.00 (Tabachnick & Fidell, 2001), which accounted for 51.42% of the total variance (table 2). The first factor was 'Depression' consisting of the seven HADS depression subscale items and four items from the HADS anxiety subscale. The second factor was 'Anxiety' containing five items from the HADS anxiety subscale. The items 'I feel tense or wound up' and 'Worrying thoughts go through my mind' loaded onto both factors.
A 3-factor model was also examined, although the Eigenvalue of the third extracted factor was marginally below criterion (0.96), to determine whether the addition of a third factor would provide a better description of the data. The Varimax rotated 3-factor model accounted for 55.44% of the total variance (Table 2).

TABLE 2 ABOUT HERE

The first factor was labelled 'Anxiety', consisting of five HADS anxiety items (table 3). The second factor of the three-factor EFA solution was labelled 'Psychomotor', as the majority of the items (four of the seven) relate to symptoms reflecting psychomotor disturbance: 'I feel tense or wound up' (agitation), 'I feel as if I am slowed down' (retardation), ‘I can sit at ease and feel relaxed’ (agitation), and ‘I feel restless as if i have to be on the move’ (agitation). However, the depression subscale item, ‘I feel cheerful’ also loaded on this factor. The third factor identified was ‘Depression’ with loadings from five HADS depression subscale items. The items ‘I feel tense or wound up’, ‘I can laugh and see the funny side of things’ and ‘I feel as if I am slowed down,’ loaded onto two factors.

Both the 2- and 3-factor models provided an adequate fit for the data, with most HADS items loading onto only one factor in both models.

TABLE 3 ABOUT HERE

Confirmatory Factor Analysis (CFA)

Maximum likelihood estimation was employed to estimate all models (Tabachnick & Fidell, 2001). The hypothesised 2-factor model was tested and some support for it was noted (table 4). However, the hypothesised 3-factor model received strong support, and the Goodness-of-Fit indices clearly confirmed the 3-factor model as providing a better fit for the data (table 4). Figure 1 shows the final 3-factor model, including standardized regression coefficients.

TABLE 4 ABOUT HERE

Figure 1 ABOUT HERE

Analyses of Factor Scores with Other Variables at 2-week Follow-up

Based on their CFA loadings, factor scores were calculated for the 195 patients who attended for follow-up assessment between 10 and 18 days after their head injury. These factor scores were then used in analyses to investigate the effects of TBI severity (PTA), Gender, and Age upon mood. Mean factor scores for these variables are provided in table 5, along with 'normative' reference scores from a UK sample (Dunbar, Ford, Hunt, and Der,2000).

TBI Severity

An ANOVA was conducted to examine the effects of TBI severity, using the three levels of PTA: very mild (PTA$<=$ 1 hour), mild (PTA$>$I hour – 1 day), and moderate/severe (PTA$>$1 day), with the factor scores as dependent variables. The results for 'Anxiety' were non-significant, $F(2,193)=1.389$, though they showed significant effects of severity with respect to the 'Depression factor, $F=(2,193)=3.536$; $p<.05$, and 'Psychomotor' factor, $F(2,193)==4.335$; $p<.05$. Tukey HSD post-hoc analyses (Tabachnick & Fidell, 2001) were used to compare the severity levels. These indicated no significant differences between the very mild and mild groups on either Depression or Psychomotor factors, although compared with the very mild group the moderate/severe group reported higher Depression symptom scores ($p<.040$) and higher Psychomotor ($p<.030$) scores. Similarly, compared with the mild group, the moderate/severe group the reported significantly greater Depression ($p<.042$) and Psychomotor ($p<.015$) symptomatology.

TABLE 5 ABOUT HERE

Gender

Independent Groups t-test analysis indicated that males (n=119) reported significantly lower levels of symptomatology for the Anxiety factor, $t(193)=3.826$, $p<.001$, than females (n=76) at the two-week assessment. Similarly, males reported significantly fewer Depression symptoms, $t(193)=3.573$, $p<.001$, and Psychomotor symptoms, $t(193)=2.951$, $p<.01$.

Age

The ANOVA carried out at two weeks post-trauma involving Age included four levels: aged 16-26 years, 26-40 years, 41-60 years, 61-87 years. Significant results were noted in relation to all three factors – Anxiety, $F(3,192)=9.769$, $p<.001$, Depression, $F(3,192)=9.037$, $p<.001$, and Psychomotor, $F(3,192)=8.584$; $p<.001$. Tukey HSD post-hoc analyses (Tabachnick & Fidell, 2001) were used to examine differences between individual age groups. There were no significant differences between the 16-26 years and 26-40 years groups, or between the 41-60 years and 61-87 years groups, for any of the three factors at two weeks post-injury. However, the 16-26 years group indicated significantly fewer problems on all three factors than both the 41-60 years (Anxiety, $p<.012$; Depression, $p<.003$; Psychomotor, $p<.004$), years and 61-87 years (Anxiety, $p<.000$; Depression, $p<.000$; Psychomotor, $p<.000$) groups The 26-40 years group also reported significantly less symptomatology on all three factors compared with the 61-87 years group (Anxiety, p<.008; Depression, p<.037; Psychomotor, p<.008), but the only 26-40 years versus 41-60 years comparison which reached statistical significance was observed in relation to the Psychomotor factor (p<.039), with the older group reporting greater symptomatology.

Discussion

Our four hypotheses related to factor structure, and to the effects of TBI severity, gender, and age, upon the factors identified.

Factor Analyses

Our first hypothesis was that a 3-factor solution would best fit the data. EFA solutions noted were consistent with findings in the field, in that both 2- and 3-factor solutions could be supported. Although intended as a scale to measure anxiety and depression, a HADS 3-factor EFA model made psychological sense, with nearly all items individually loading onto only one of the factors, corresponding to anxiety, depression, or psychomotor symptoms. In line with our hypothesis, a 3-factor structure was strongly supported by the CFA results, as it offered a very good fit and a better model than the 2-factor model as judged from the 'Goodness-of-Fit' indices (Table 3). In the CFA, each HADS item loaded onto only one factor. Additionally, the Depression factor offered more psychological clarity in the 3-factor model compared to the two-factor model, as it loadings were all from HADS depression items rather than including HADS anxiety items. The 3 -factor model accounted for 55% of the total variance, similar to that noted in previous research using coronary heart disease patients (Barth & Martin, 2005).

Moving from a 2-factor to a 3-factor model kept the same 'Anxiety'-loading items (with almost identical loadings). The anxiety scale item 'I feel tense or wound up', which also loaded on the 'Depression' factor in the 2-factor model moved its second loading to the 'Psychomotor' factor with the introduction of this third factor (table 2). Most 'Depression' factor items from the 2-factor solution which were essentially "mood" in character ("I still enjoy the things I used to enjoy", "I can laugh and see the funny side of things", "I have lost interest in my appearance", "I look forward with enjoyment to things") continued to load significantly on 'Depression' in the 3-factor solution. These items were consistent with the items loading onto the 'anhedonic depression' factor noted in Desmond and MacLachlan's (2005) study.

In our study some "motor" items ("I can sit at ease and feel relaxed", "I feel restless...") transferred from 'Depression' to the 'Psychomotor 'factor in the 3-factor model. An apparently odd finding was the shift of "I can enjoy a good book or TV programme" from 'Depression' in the 2-factor model to 'Psychomotor' in the 3-factor model, though respondents may have been indicating that they were restless and unable to sit still long enough to be able to enjoy those activities (Lemke, Puhl, Koethe & Winkler, 1999). Such an interpretation is consistent with the findings from a study of patients with malignant melanoma, in which the "I can enjoy a good book or TV programme" item loaded onto a 'Restlessness' factor (Brandner, Bolund, Siqurdardotti, Sjoden, & Sullivan, 1992). Brandner et al.'s 'Restlessness' factor shares four HADS items with our CFA 'Psychomotor' factor, the exception being our finding that 'I feel as if I'm slowed down' also loads on that factor; psychomotor symptoms can reflect both excessive motor activity and motor retardation. The finding that 'I feel cheerful' also loads on the 'Psychomotor' factor, which does not sit comfortably with its label, although it is not uncommon for factor analysis models to include factors with occasional unusual item loadings (Barth & Martin, 2005). With their 'Psychomotor Agitation' factor, the latter authors identified three items common to the CFA findings of the current study ('I feel tense....;, I can sit at ease...', and 'I feel restless...'). A key difference between the present study and those by Brandner et al. (1992) and by Barth and Martin (2005) is the identification of a factor which reflects psychomotor generally (i.e., aspects of both excessive and slowed/retarded motor behaviour. This difference in finding between earlier studies and the current investigation may be due in part to differences in the clinical populations under study. Research into the assessment of post-TBI patients has long advocated the inclusion of psychomotor and motor functioning (e.g., Ruff, Levin and Marshall, 1986), and studies on these abilities after TBI continue (e.g., Heitger, Jones, Dalrymple-Alford, Frampton, Ardagh and Anderson, 2006).

Similarly, in our study "I feel as if I am slowed down", and 'I feel tense or wound up' loaded onto two factors, which has been observed previously (Rodgers, Martin, Morse, Kendall and Verrill, 2005; Martin & Newell, 2004). These findings make psychological sense, as tension and feeling 'wound up' can indicate both anxiety and psychomotor agitation, and 'slowness' can be a feature of both depression and psychomotor retardation (Sadock & Sadock, 2003; Sobin & Sackeim, 1997).

WhileTBI patients have been noted to experience psychomotor symptoms post-injury, there are few scales that have been designed specifically to assess them (Lemke et al., 1999). The findings of the current study suggest further attention should be given to the identification and treatment of psychomotor symptoms post-TBI. Investigating the psychomotor factor of the HADS in more detail is clearly warranted, and may lead to an improved understanding of TBI patients' difficulties post-injury.

In summary, our results support the increasing body of recent research, in a range of clinical groups, which has found a 3-factor model offers the best fit for the HADS (Martin, 2005). For example, in an investigation using coronary heart disease patients, Barth and Martin (2005) identified a three-factor model, including one labelled 'psychomotor agitation whichconsisted of three items noted to load on the 'Psychomotor' factor in the current study. As with our study, recent research has found 2-factor models providing an adequate fit through EFA, with 3-factor models offering a superior fit using CFA. This can be attributed to EFA not being a model evaluation technique, and the obtained factors being based on cut-off points such as Eigenvalue and scree plots (Martin & Newell, 2004).

Factor Relationships with Demographic and Clinical Variables

The HADS factors identified in the 3-factor model were examined in terms of their relationships with a number of variables, using a sample of 195 participants who attended the Neurotrauma Register for follow-up approximately two weeks post-TBI. It was hypothesised that more severe head injuries would be reflected in greater psychological disturbance as manifested by scores on the three factors. This hypothesis was only partly supported, in that patients with longer PTAs showed significantly more Psychomotor and Depression difficulties, but only non-significant greater Anxiety symptomatology (Table 5). It might be argued that two weeks post-injury is too close to the time of injury for patients with more severe TBIs to fully appreciate their position (and, therefore, to show greater symptom awareness), whereas the more 'behavioural' psychomotor symptoms are obvious to patients. However, this reasoning would not account for the significant finding in relation to Depression, and the associations between HADS factor scores and TBI severity will be investigated in more detail in a future paper, using a number of time point post-injury,.

Our hypotheses relating to gender and to age were supported: females reported significantly greater symptomatology on all three factors, consistent with the existing literature. The literature also suggests that older TBI patients are more vulnerable to depression (e.g., Glen et al., 2001). Our findings not only reinforce this finding but also point to significantly greater anxiety and psychomotor symptoms in those patients over 40 years of age. Acknowledging gender- and age-related psychological differences post-TBI has implications for service organisation and provision.

Compared with the available normative (UK) data, in our sample males and those in the 16-40 years age range showed lower Anxiety factor scores (table 4). High anxiety scores were noted in our moderate/severe PTA group, in females, and in those over 60 years of age. All groups in our study showed mean factor scores above those derived by Dunbar et al., (2000) for Depression. With respect to the Psychomotor factor, scores similar to the Dunbar reference value were observed in milder TBIs, for males, and for those up to 40 years of age. As with Anxiety, high Psychomotor scores were noted in the moderate/severe group, in those over 60 years of age, and in females. Comparisons with the normative data provided by Dunbar and his colleagues reinforce the importance of our findings in relation to TBI severity, gender, and age.

In summary, using both EFA and CFA approaches and a large sample of patients, our study points to a 3-factor model (Anxiety, Depression, Psychomotor) as being most appropriate for the HADS when used with TBI patients. Within our sample, being female or being over 40 years of age are both significantly associated with poorer mood and psychomotor functioning at the two-week follow-up. Moderate/severe TBI patients report greater Depression and Psychomotor difficulties. Compared with the (very limited) available normative information, our data obtained soon after injury reflect elevated Depression scores for all TBI severity groups (moderate/severe reporting most symptomatology), for both males and females, and for all age groups. Whilst males and younger participants (16-40 years) show factor scores similar to the normative data with respect to Anxiety and Psychomotor factors, females and those aged more than 40 years report higher symptomatology. Those sustaining a moderate/severe TBI show elevated Psychomotor scores.

While these results suggest the HADS may best be used as a 3-factor instrument with TBI patients, when interpreting results from the psychomotor factor it is important to be aware that the relationship between a small number of the items on this factor and the psychomotor domain remains to be fully investigated. However, this factor is still valuable as a ‘flag’ for psychomotor problems after TBI.In a future paper we will examine the effects of TBI severity, gender, and age at a number of outcome points post- injury.

References

Barth, J., & Martin, C.R. (2005). Factor structure of the Hospital Anxiety and Depression Scale (HADS) in German coronary heart disease patients. *Health and Quality of Life Outcomes, 3*, 1-12.

Bernstein, D.M. (1999). Recovery from mild head injury. *Brain Injury, 13*, 151-172.

Bjelland, I., Dahl, A.A., Haug, T.T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale: An updated literature review. *Journal of Psychosomatic Research, 52*, 69-77.

Brandner, Y., Bolund, C., Siqurdardotti, V, Sjoden, P-O, & Sullivan, M. (1992). Anxiety and depressive symptoms at different stages of malignant melanoma. *Psycho-oncology, 1,* 71-78.

Dawkins, N., Cloherty, M., Gracey, F. and Evans, J.J. (2006) An evaluation of the validity of the HADS for use in acquired brain injury. *Brain Injury, 20 (12),* 1235-1239.

Deb, S., Lyons, I., & Koutzoukis, C. (1998). Neuropsychiatric sequelae one year after a minor head injury. *Journal of Neurology, Neurosurgery & Psychiatry, 65*, 899-902.

Deb, S., Lyons, I., Koutzoukis, C., Ali, I., & McCarthy, G. (1999). Rate of psychiatric illness 1 year after traumatic brain injury. *American Journal of Psychiatry, 156*, 374-378.

Desmond, D.M. & MacLachlan, M. (2005). The factor structure of the Hospital Anxiety and Depression Scale in older adults with acquired amputations: a comparison of four models using confirmatory factor analysis. *International Journal of Geriatric Psychiatry, 20,* 344-349.

Dunbar, M., Ford, G., Hunt, K. and Der, G. (2000). A confirmatory factor analysis of the Hospital Anxiety and Depression Scale: comparing empirically and theoretically derived structures. *British Journal of Clinical Psychology, 39,* 79-94.

Fann, J.R., Burington, B., Leonetti, A., Jaffe, K., Katon, W.J. & Thompson, R.S. (2004). Psychiatric illness following traumatic brain injury in an adult health maintenance organization population. *Archives of General Psychiatry, 61*, 53-61.

Farace, E., & Alves, W.M. (2000). Do Women Fare Worse? A metaanalysis of gender differences in outcome after traumatic brain injury. *Neurosurgical Focus, 8*, 1-7.

Friedman, S., Samuelian, J.C., Lancrenon, S., Even, C., Chiarelli, P. (2001). Three-dimensional structur of the Hospital Anxiety and Depression Scale in a large French primary care population suffering from major depression. *Psychiatry Research, 104*, 247-257.

Glenn, M.B., Pirozzi, T., Goldstein, R., Burke, D., & Jacob, L. (2001). Depression amongst outpatients with traumatic brain injury. *Brain injury, 9*, 811-818.

Hawley, C.A. (2003). Reported problems and their resolution following mild, moderate and severe traumatic brain injury amongst children and adolescents in the UK. *Brain injury, 2*, 105-29.

Heitger, M.H., Jones, R.D., Dalrymple-Alford, J.C., Frampton, C.M., Ardagh. M.W. & Anderson, T.J. (2006). Motor deficits and recovery during the first year following mild closed head injury. *Brain Injury, 20,* 807-824.

Hibbard, M.R., Uysal, S., Kepler, K., Bogdany, J., & Silver, J. (1998). Axis I psychopathology in individuals with traumatic brain injury. *The Journal of Head Trauma Rehabilitation, 13*, 24-40.

Hillier, S.L., Hiller, J.E., & Metzer, J. (1997). Epidemiology of traumatic brain injury in South Australia. *Brain Injury, 11*, 649-659.

Johnstone, B., Childers, M.K., & Hoerner, J. (1998). The effects of normal ageing on neuropsychological functioning following traumatic brain injury. *Brain Injury, 12*, 569-576.

Khan, F., Baguley, I.J., & Cameron, I.D. (2003). Rehabilitation after traumatic brain injury. *The Medical Journal of Australia, 6*, 290-295.

Lemke, M.R., Puhl, P., Koethe, N., & Winkler, T. (1999). Psychomotor retardation and anhedonia in depression. *Acta Psychiatrica Scandinavica, 99*, 252-256.

McCleary, C., Satz, P., Forney, D., Light, R., Zaucha, K., Asarnow, R., & Namerow, N., (1998). Depression after traumatic brain injury as a function of glasgow outcome score, *Journal of Clinical and Experimental Neuropsychology, 20*, 270-279.

Marosszeky, N.E.V, Ryan, L., Shores, E.A., Batchelor, J. & Marosszeky, J.E, . (1997). *The PTA Protocol: Guidelines for using the Westmead Post-Traumatic Amnesia (PTA) Scale.* Sydney: Wild & Wooley.Martin, C.R. (2005). What does the Hospital Anxiety and Depression Scale (HADS) really measure in liaison psychiatry settings? *Current Psychiatry Reviews, 1*, 69-73.

Martin, C.R., & Newell, R.J. (2004). Factor structure of the Hospital Anxiety and Depression Scale in individuals with facial disfigurement. *Psychology, Health & Medicine, 9,* 327-336.

Martin, C.R., Lewin, R.J.P., Thompson, D.R. (2003). A confirmatory factor analysis of the Hospital Anxiety and Depression Scale in coronary care patients following acute myocardial infarction. *Psychiatry Research, 120*, 85-94.

Martin, C.R., & Thompson, D.R. (2000). A psychometric evaluation of the Hospital Anxiety and Depression Scale in coronary care patients following acute myocardial infarction. *Psychology, Health & Medicine, 5,* 193-201.

Marinus, J., Leentjens, A.F.G., Visser, M., Stigglebout, A.M., & van Hilten, J. (2002). Evaluation of the Hospital Anxiety and Depression Scale in patients with Parkinson's disease. *Clinical Neuropharmacology, 25(6),* 318-324.

Moore, E.I., Terryberry-Spohr, L. & Hope, D.A. (2006). Mild traumatic brain injury and anxiety sequelae: a review of the literature. *Brain Injury, 20,* 117-132.

Nelson, HE (1982). *The National Adult Reading Test (NART): test manual*. NFER-Nelson:UK

Rapoport, M. (2003). Traumatic brain injury in older adults: Relevance to Psychiatrists. *CPA Bulletin, 1*, 22-27.

Rapoport, M. & Feinstein, A. (2001). Age and functioning after mild traumatic brain injury : the acute picture. *Brain Injury, 15,* 857-864.

Rapoport, M., McCullagh, S., Streiner, D., & Feinstein, A. (2003). The clinical significance of major depression following mild traumatic brain injury. *Psychosomatics, 44*, 31-37.

Reber, A.S., Reber, E. (2001). The penguin dictionary of psychology (3rd ed.). Penguin: England.

Rodgers, J., Martin, C.R., Morse, R.C., Kendall, K., & Verrill, M. (2005). An investigation into the psychometric properties of the Hospital Anxiety and Depression Scale in patients with breast cancer. *Health and Quality of Life Outcomes, 3,* 1-12.

Rothweiler, B., Temkin, N.R., & Dikmen, S.S. (1998). Aging effect on psychosocial outcome in traumatic brain injury. *Archives of Physical Medicine and Rehabilitation, 79*, 881-887.

Roy, C.W., Thornhill, S., & Teasdale, G.M. (2002). Identification of rehabilitation problems after head injury. *Brain Injury, 16*, 1057-1063.

Ruff,R.M., Levin, H.S. & Marshall, L.F. (1986). Neurobehavioural methods of assessment and the study of outcome in minor head injury. *Journal of Head Trauma Rehabilitation, 1,* 43-52.

Sadock, B.J. & Sadock, V.A. (2003). *Kaplan & Sadock's Synopsis of Psychiatry.*Lippincott Williams & Wilkins: Philadelphia, USA.

Sliwinski, M., Gordon, W.A., & Bogdany, J. (1998). The Beck Depression Inventory: Is it a suitable measure of depression for individuals with traumatic brain injury? *The Journal of Head Trauma Rehabilitation, 13*, 40-47.

Snaith, R.P. (2003). The Hospital Anxiety and Depression Scale. *Health and Quality of Life Outcomes, 1*, 1-29.

Snaith, R.P., & Zigmond, A.S. (1994). *The Hospital Anxiety and Depression Scale Manual*. UK: NFER-Nelson.

Sobin, C. & Sackeim, H.A. (1997). Psychomotor symptoms of depression. *American Journal of Psychiatry, 154,* 4-17.

Tabachnick, B.G., & Fidell, L.S. (2001). *Using Multivariate Statistics (5th ed.).* Boston: Pearson Education.

Tate, R.L., McDonald, S., & Lulham, J.W. (1998). Incidence of hospital-treated traumatic brain injury in an Australian community. *Australian and NewZealand Journal of Public Health, 22*, 419-423.

Whelan-Goodinson, R., ponsford, J., & Schonberger, M. (2008). Validity of the Hospital Anxiety & Depression Scale to assess depression & anxiety following traumatic brain injury as compared with the Structured Clinical Interview for DSM-IV. *Journal of Affective Disorders, 114,* 94-102.

Zigmond, A.S., & Snaith, R.P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatric Scandinavia, 67*, 361-370.

Table 1: Demographic and Clinical Variables

	Median	Mean	Standard Deviation
Age (years)	29.95	35.34	17.83
NART FSIQ	100	98.68	10.96
Education (years)	10	10.93	2.17
PTA (days)	.04	2.10	11.57

Table 2: Eigenvalues and Percentage of Variance for Three-Factor Model

	Initial Eigenvalues			Rotated Sums of Squared Loadings: 2-Factor			Rotated Sums of Squared Loadings: 3-Factor		
Factor	Tot	% Var.	Cum. %	Tot	% Var.	Cum. %	Tot	% Var.	Cum. %
1	6.68	47.69	47.69	4.01	28.65	28.65	2.96	21.11	21.11
2	1.40	9.99	57.68	3.19	22.78	51.42	2.50	17.88	38.99
3	.96	6.87	64.55				2.30	16.45	55.44

Table 3: EFA Two- and Three-Factor Models (Principal Axis Factoring)

	TWO-	FACTOR	THREE-	FACTOR	SOLUTION
	Anxiety 22.78%	Depression 28.65%	Anxiety 21.12%	Psycho-motor 17.88%	Depression 16.45%
HADS Item					
Anxiety Subscale					
• I feel tense or wound up	***.46***	***.58***	***.45***	***.54***	.29
• I get a sort of frightened feeling as if something awful is about to happen	***.71***	.29	***.70***	.21	.25
• Worrying thoughts go through my mind	**.65**	***.41***	***.63***	.35	.27
• I can sit at ease and feel relaxed	.29	***.72***	.27	***.69***	.33
• I get a sort of frightened feeling like 'butterflies' in the stomach	***.80***	.18	***.79***	.12	.19
• I feel restless as if I have to be on the move	.23	***.47***	.29	***.47***	.20
• I get sudden feelings of panic	***.83***	.29	***.81***	.25	.21
Depression Subscale					
• I still enjoy the things I used to enjoy	.19	***.65***	.14	.32	***.66***
• I can laugh and see the funny side of things	.33	***.68***	.30	***.45***	***.53***
• I feel cheerful	.33	***.60***	.30	***.48***	.37
• I feel as if I am slowed down	.20	***.60***	.17	***.41***	***.44***
• I have lost interest in my appearance	.36	***.42***	.34	.16	***.48***
• I look forward with enjoyment to things	.34	***.64***	.29	.25	***.74***
• I can enjoy a good book or TV programme	.12	***.61***	.09	***.69***	.19

Table 4: Goodness of Fit for Two and Three Factor Models

MODEL	INDEX x^2	p	x^2/df	RMSEA	CFI	AIC*	CN
2-factor	103.59 (70)	.006	1.48	.05	.97	201.59*	161
3-factor	67.06 (65)	.406	1.03	.01	1.00	147.06*	233
Good Fit=		*$p > .01$*	*< 2*	*< .06*	*< .90*	*	*>200*

Note. RMSEA = Root Mean Squared Error of Approximation,

CFI = Comparative Fit Index,

AIC* = Akaike Information Criterion – smaller value indicates better fit

CN = Hoelter's Critical N.

Table 5: Factor Scores for TBI Severity, Gender, & Age at 2-week Follow-up (n=195), & 'Norms'*

		FACTOR				
Variable (n)	**Anxiety Mean**	**(SEM)**	**Depression Mean**	**(SEM)**	**Psychomotor Mean**	**(SEM)**
PTA:						
Very Mild (59)	3.15	(0.38)	1.63	(0.27)	2.96	(0.29)
Mild (102)	3.23	(0.28)	1.72	(0.19)	2.95	(0.23)
Mod./Severe (34)	4.12	(0.58)	2.71	(0.41)	4.27	(0.46)
Gender:						
Female (76)	4.53	(0.34)	2.55	(0.24)	3.85	(0.23)
Male (119)	2.92	(0.24)	1.51	(0.17)	2.90	(0.22)
Age:						
<26 (71)	2.47	(0.28)	1.14	(0.18)	2.48	(0.23)
26-40 (18)	2.47	(0.65)	1.34	(0.34)	2.18	(0.42)
41-60 (56)	3.97	(0.37)	2.38	(0.29)	3.83	(0.32)
60+ (50)	4.99	(0.44)	2.80	(0.29)	4.20	(0.17)
'Norms'* (2547)	**2.82**		**0.81**		**2.94**	

** Normative data calculated from Dunbar *et al.,* (2000)

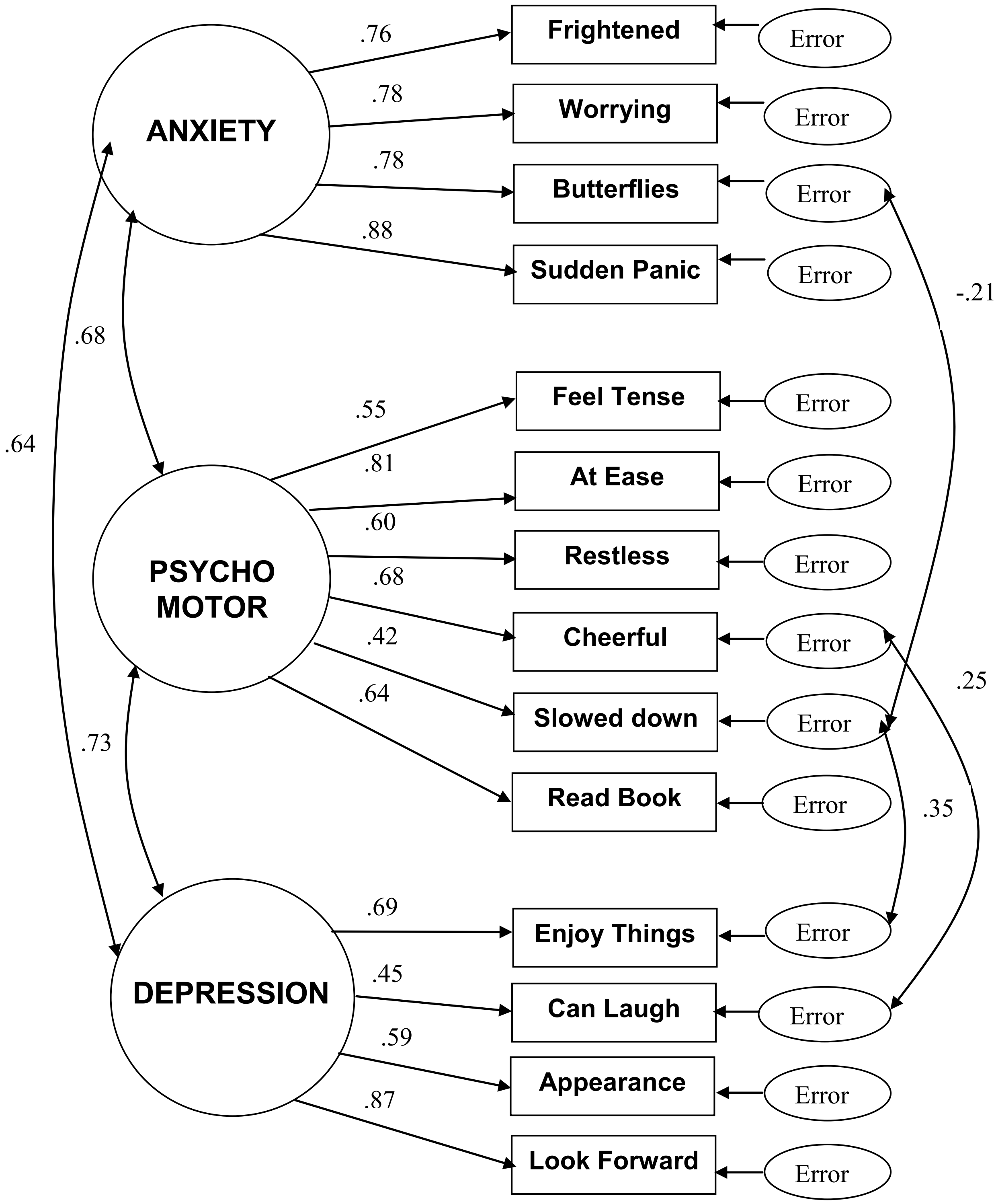

Figure 1. Three factor model identified by CFA.