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Changes in psychosocial functioning following traumatic brain injury : a confirmatory factor analysis of the Katz Adjustment Scale (KAS-R).

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Changes in Psychosocial Functioning Following Traumatic Brain Injury: A Confirmatory Factor Analysis of the Katz Adjustment Scale (KAS-R).

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Abstract

The measurement of psychosocial functioning following traumatic brain injury has received very little attention, despite the fact that it has important applications in a variety of clinical, medico-legal and theoretical contexts. In the absence of well validated, standardised measures of psychosocial functioning, clinicians and researchers in this field have tended to employ measures which are designed for use in non-brain injury populations. The Katz Adjustment Scale (KAS-R; Katz & Lyerly, 1963) is one measure which has been widely used in brain injury studies despite the fact that it has questionable validity when applied to brain injury populations. In an attempt to resolve this problem, Jackson, Hopewell, Glass, Warburg, Dewey & Ghadiali (1992) conducted an exploratory factor analysis of a modified version of the KAS-R using a mixed sample of individuals who had a traumatic brain injury and\or spinal cord injury. The present study is an attempt to confirm the validity of the factors obtained by Jackson et al and where necessary revise the factor structure of the modified KAS-R. The present study represents a significant advance upon the work of Jackson et al in that it employs confirmatory factor analysis techniques and is based upon a new sample consisting solely of brain injured individuals. The results of this study provide support for the validity of the main first-order factors obtained by Jackson et al., and a number of *post hoc* modifications were made which appear to represent improvements upon the Jackson et al factors in terms of their relevance to brain injury. Preliminary analyses indicate that the modified factors may discriminate between different groups of brain injured individuals. Recommendations are made re further revision and validation of the KAS-R sub-scales and the potential research applications of the scales are discussed.

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Psychosocial Functioning Following Brain Injury: Confirmatory Factor Analysis of the KAS-R.

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Introduction

Traumatic brain injury

Traumatic brain injury has been defined as "an insult to the brain caused by an external force that may produce diminished or altered states of consciousness, which results in impaired cognitive abilities or physical functioning" (National Head Injury Foundation, 1989).

It is estimated that 70 per cent of traumatic brain injuries are caused by road traffic accidents. Review studies have estimated that the incidence of traumatic brain injury in Britain and the United States is approximately 250 per 100,000 of the population (Jennett & MacMillan, 1981; Frankowski, Annegers & Whitman, 1985; cited in Rose & Johnson, 1996), with one in five of these cases falling within the moderate to severe range (Jennett & MacMillan, 1981). Males are considered to be twice or three times as likely as females to suffer a traumatic brain injury and the peak incidence is thought to fall in the 15-24 age range (Anderson & McLaurin, 1980).

Psychosocial functioning following traumatic brain injury

The direct neurobehavioural consequences of traumatic brain injury for may be both profound and wide ranging. In a recent overview of the consequences of moderate to severe brain injury, Ponsford, Sloan & Snow (1995) mention a variety of cognitive and behavioural sequalae including attentional deficits and fatigue, learning and memory problems, impaired planning and problem solving, concrete thinking, lack of initiative, cognitive inflexibility, dissociation between thought and action, communication problems, changes in affect, and lack of insight\self-awareness.

However, a number of authors (e.g. Antonak, Livneh & Antonak, 1993) have argued that the psychosocial consequences of traumatic brain injury represent the most legitimate target of study with respect to clinical outcome following brain injury, rather than discrete neurobehavioural impairments. Similarly, Dickmen & Machamer (1995) have reviewed a variety of factors that determine neuropsychological and psychosocial outcome following brain injury. They concluded that there is currently very little information available concerning the factors that influence psychosocial functioning, as compared to information available about direct neuropsychological sequalae of brain injury. There is no single accepted definition of psychosocial functioning. Psychosocial functioning may be described in directly functional terms, for example in terms of employment status, interests and leisure activities, number and type of social contacts, physical independence etc. Additionally many investigators have attempted to describe psychosocial functioning in terms of personality, emotional and behavioural characteristics such as depression, social withdrawal, sleep disturbance etc.

This call for a change in emphasis in brain injury research (Antonak et al., 1993; Dickmen et al, 1995) arises from a variety of sources. Firstly, results of studies that have addressed psychosocial functioning indicate that different levels of psychosocial functioning following brain injury cannot be accounted for by the direct neurological and neuropsychological sequalae of brain injury i.e. a description of outcome in terms of impairment is not representative of their actual level of functioning or quality of life. For example, Hinkeldey and Corrigan (1990) examined the relationship between severity of head injury and residual complaints several years post-injury. These authors found that neurobehavioural sequalae such as motor slowness, poor concentration, memory problems and attentional problems were related to severity of brain injury. However, emotional problems such as anxiety, depression, headaches and irritability were not related to severity of injury or neurobehavioural sequalae. Similarly, Dickmen, Sureyya, Machamer, Winn & Temkin (1995) found an association between head injury severity and neuropsychological status, but concluded that psychosocial outcome was mitigated or exacerbated by other unknown factors. Kaplan (1991) found that psychosocial functioning was related to quality of pre-trauma family relationships and levels of social support post-injury. Dickmen, Temkin Machamer & Holubkov (1994) report that age, education and stability of pre-injury work history were strongly related to return to work. There is a growing awareness that even mild head injuries that are accompanied by minimal cognitive impairment may lead to significant problems in psychosocial functioning. For example Parker (1995) found that factors such as pain, headaches, sleep\arousal problems influence return to work following mild head injury.

Consideration of psychosocial functioning rather than impairment allows conceptualisation of outcome as a process of adjustment rather than as a static concept, and a number of authors have proposed models of psychosocial adjustment following brain injury (Livneh & Antonak, 1990; Livneh & Antonak, 1990; Antonak & Livneh, 1991). This approach also gives rise to new avenues of research with respect to clinical interventions. Post-acute brain injury rehabilitation is aimed at achieving improvements in psychosocial functioning rather than in neuropsychological impairment. An understanding of factors that influence psychosocial functioning is therefore required for the design of effective treatment plans. Consideration of psychosocial functioning is also important in medico-legal contexts where there is a requirement to assess a persons quality of life in practical\functional terms.

Measurement of psychosocial functioning following traumatic brain injury

Measurement of psychosocial functioning following traumatic brain injury has important applications in delineating the relationships between a range of demographic and injury-related variables and their relative influences upon psychosocial adjustment (Antonak, Livneh & Antonak, 1993; Siegrist & Junge, 1990). However, the measurement of psychosocial functioning following traumatic brain injury has received relatively little attention. In a recent review of research in this area, Antonak et al. (1993) stated " The lack of a psychometrically sound multidimensional instrument to measure psychosocial adjustment among persons with traumatic brain injury continues to be a significant deficiency".

In the absence of well validated, standardised measures of psychosocial functioning in traumatic brain injury clinicians and researchers have tended to employ measures which have been standardised on non-brain injured populations. Commonly used measures include the General Health Questionnaire, the Sickness Impact Profile, and the MMPI and anxiety and depression scales. Measures such as the MMPI or General Health Questionnaire may be inherently invalid in brain injured populations. For example, items designed to measure personality functioning in MMPI may reflect objective physical and emotional and cognitive problems in a brain injured individual (Burke, Smith & Imhoff, 1989).

. There are three general approaches to assessment of psychosocial functioning in brain injury: Assessment by a clinician, self-report and relative reports. Clinician assessment has the advantage of allowing information to be collected in an objective and reliable way. However clinician assessments usually take place in formal interview setting and clinicians may tend to overestimate interpersonal\emotional and adaptive functioning. Self-report methods have been widely used to assess psychological functioning following brain injury.

There is some evidence that self-report measures may have some validity with respect to assessing the experiential aspects of brain injury. However, a number of authors have criticised the use of self report measures such as the MMPI in brain injury populations on the grounds that brain injured individuals often have impairments of judgement, reasoning and insight and may exhibit a lack of awareness or denial of their problems (Burke, Smith & Imhoff 1989; Priddy, Mattes & Lam, 1988). Self-report a may also be subject to extraneous error arising from the informants concerns about pending compensation claims (Miller, 1979); although recent research suggests that this is less of a problems than was originally thought to be the case (Bornstein, Miller & Van Schoor, 1988). Relative reports provide an important source of information because the informant will usually have spent a significant amount of time with the injured person and will have had the opportunity to observe their functioning across a range of tasks and naturalistic situations. Potential problems with relative reports include denial, subjectivity, lack of expert knowledge and concerns over compensation claims. Of course, that the subjective reports of relatives are clinically important with respect to assessment of family circumstances and intervention with families.

Another issue which arises in the measurement of psychosocial functioning concerns the measurement of current functioning versus the measurement how an individuals psychosocial functioning has changed as a result of their injury. Measurement of change in functioning is particularly important in medico-legal contexts, and is also of interest to researchers who wish to model the impact of brain injury upon psychosocial functioning in terms of a variety of other independent variables. Measurement of change in functioning requires information about the functioning of the brain injured individual prior to their injury and relative reports are likely to best source of information in this respect. Measurement of change may be particularly important in brain injury because research suggests that traumatically brain injured individuals represent selective group with respect to pre-morbid psychosocial functioning i.e. that they are more likely to have engaged in activities that pre-dispose them towards a traumatic injury. For example (Chadwick, Rutter, Groun, Shaffer & Traub, 1981; Chadwick, Rutter, Shaffer, & Shrout, 1981; Brown, Chadwick, Shaffer, & Rutter, 1981.) found that children with head-injuries tend to be males of lower socio-economic status and that parents are more likely to report behavioural difficulties prior to injury. Pre-morbid personality characteristics may also effect psychosocial adjustment independently of pre-disposition towards injury. For example Weddell Oddy & Humphreys (1980) found that pre-morbid personality (nervousness and suspiciousness) influenced return to work and leisure activities. Despite these difficulties very few studies have attempted to take account of pre-morbid functioning when investigating the influence of brain injury upon psychosocial functioning.

The Katz Adjustment Scale as a measure of psychosocial functioning in brain injury populations

The Katz Adjustment Scale-Relatives Form (KAS-R1) was originally designed by Katz & Lyerly (1963) as a measure of social and emotional functioning in community-based psychiatric patients. It consists of 127 items and is designed to be completed a relative of the patient. There is now a considerable amount of literature addressing both the psychometric properties and the clinical and research applications of this scale (Clopton & Greene, 1994). Crook, Hogarty & Ulrich (1980) examined the inter-rater reliability of the KAS-R and found that ratings by each parent were in close agreement on those items that addressed directly observable behaviours but that agreement between parents was substantially less on items that required subjective judgements. Zimmerman, Vestre & Hunter (1975; 1976) found that ratings for psychiatric patients varied according to the type of rater with families for example tending to be more sensitive to belligerence and rebellious\anti-social behaviour, whilst clinicians were more sensitive to behaviours that reflect thought disorder. Parker & Johnston (1989) examined the inter-rater reliability and the test-retest reliability of the KAS-R. Change in mean sub-scale scores indicated sensitivity to change and they concluded that inter-rater reliability was acceptable during period of stability but much less reliable during periods of instability in clinical state.

Three independent factor analyses of the KAS-R in psychiatric populations have yielded different results (Clum, 1976; Graham, Lilley, Paolino, Friedman & Konick, 1973; Katz & Lyerly, 1963). It is not known whether these different results represent differences in the three study samples or whether they reflect inherent problems in the psychometric properties of the KAS-R. The most widely used factor structure is that derived by Katz & Lyerly which consists of the following 13 factors: Belligerence, Verbal Expansiveness, Negativism, Helplessness, Suspiciousness, Anxiety, Withdrawal and Retardation, General Psychopathology, Nervousness, Confusion, Bizarreness, Hyperactivity.

The KAS-R has been widely used as a measure of psychosocial functioning in brain injury populations (Posthuma & Wild, 1980). However, in common with other measures designed and standardised non-brain injured populations there may be serious construct validity problems. In a discussion of these issues, Jackson, Hopewell, Glass, Warburg, Dewey & Ghadiali (1992) suggest that a factor structure is derived from psychiatric populations would not be expected to apply to traumatically brain injured populations and they point out that the factor structure provided by Katz & Lyerly (1963) does not appear to adequately represent the emotional and personality changes associated with traumatic brain injury. In addition, many of the 127 KAS-R items which would (on basis of clinical knowledge) be relevant to traumatic brain injury do not load significantly on any of the Katz & Lyerly factors. Finally, some of the Katz & Lyerly factors are inherently difficult to interpret within the context of models of psychosocial functioning following traumatic brain injury. For example, the Katz & Lyerly factor "Motor retardation\withdrawal" may confuse physical dysfunction with social\emotional problems in brain injured individuals (Jackson et al, 1992).

These concerns are echoed by the fact that research has so far failed to yield consistent results with respect to which of the KAS-R factors are most influenced by brain injury. Newton & Johnson (1985) found that mean scores for 11 severely head injured individuals paralleled those of the psychiatric population (norms provided by Hogarty and Katz, 1971) but that the head injured individuals were significantly more confused, less anxious, less nervous, less hyperactive and exhibited less general psychopatholgy. However they were also significantly more belligerence, negative, helpless, suspicious, withdrawn and confused than normal population. In a similar study Stambrook, Moore & Peters (1990) compared KAS-R scores provided by the spouse of 43 males with traumatic brain injury with norms for psychiatric patients and the general population. Those with severe brain injury were significantly different from the general population on all KAS-R sub-scales and there were significant differences between the severely head injured and the moderately head injured and psychiatric norms on KAS-R scales that address psychiatric symptoms. The lack of consistency across studies of this kind may reflect the different samples employed by different studies or arise from poor validity of the original KAS-R factors with brain injured individuals.

A number of authors have studied the relationship between KAS-R scores and other variables. Oddy & Humphrey (1980) investigated the relationship between KAS-R scores and a variety of other psychosocial variables for 54 severely head injured individuals at 2 years post injury. They found that KAS-R scores were related to prior family relationships. Klonoff, Costa & Snow (1986) and Klonoff, Snow & Kosta (1986) conducted a study based upon KAS-R ratings for 71 individuals who had suffered traumatic brain injury 2 - 4 years earlier. They investigated the relationship between a wide range of injury-related and post-traumatic variables and KAS-R sub-scales and found that severity of injury and degree of motor dysfunction were the most important predictors of psychosocial functioning.

Standardisation of the Katz Adjustment Scale in brain injury populations

Jackson et al have argued that that the KAS-R has a number of features which are suited to the measurement of psychosocial functioning in brain injury: 1) Many of the of the items on the KAS-R ask for ratings of observable behaviour. 2) The KAS-R is based upon relatives ratings. 3) The KAS-R includes a wide range of social, emotional, psychiatric, physical and cognitive performance measures that appear to be relevant to psychosocial functioning following traumatic brain injury. 4) The KAS-R was designed to assess behaviour in community settings. 5) The KAS-R items have proven discriminative validity within psychiatric populations. 6) Extensive comparative data is available for normal and psychiatric populations.

Jackson et al have conducted an exploratory factor analysis with the KAS-R in attempt to arrive at a factor structure that would adequately represent the psychological constructs associated with personality, emotional and behavioural changes following traumatic brain injury. The studied was based upon a mixed sample consisting of 463 individuals who had suffered traumatic head injury and\or traumatic spinal cord injury and participants were drawn from a variety of centres from within the UK and the United States. Jackson et al employed a version of the KAS-R that had been modified in order to provide a measure of the change in psychosocial functioning occurring as a result of traumatic brain injury. The modified version of the KAS-R required the informant to make two ratings on each item: A rating of the injured person as they were prior to the injury and a rating of the person as they are at the time of assessment. Jackson et al claimed that measuring change would increase the validity of the resultant factor structure by reducing any extraneous variance arising from individual differences in pre-morbid psychosocial functioning. This is perhaps supported by the fact that normative data provided by Hogarty & Katz (1971) based upon 450 adolescents and adults suggests that there are significant differences in scale ratings according to age, marital status and social class.

The exploratory factor analysis conducted by Jackson et al. yielded 30 first-order factors in three pre-selected functional domains: 1. Changes in emotional\psychosocial functioning, 2. Changes in physical\intellectual functioning, 3. Changes in psychiatric symptoms; and seven second-order factors: Social adjustment, Functional dependency, Withdrawal, Problem-focused behaviour, Reactive depression, Frustration\resistance and Asocial behaviour.

Jackson et al report that the factors obtained exhibited some overlap with those of Katz & Lyerly, but the new factors were more readily identifiable in terms of the neurobehavioural syndromes accompanying brain injury. Jackson et al also found that the first-order factors obtained from the modified KAS-R were superior to the original KAS-R factors (Katz & Lyerly, 1963) with respect to their ability to discriminate between different trauma groups (mild head-injury, spinal injury-severe head injury and severe head injury). This finding provided support for the validity of the first-order factors, although it is notable that the second-order factors were less efficient in discriminating between different groups.

In a similar study Fabiano & Goran (1992) conducted a principal components analysis of KAS-R data from a traumatic brain injury sample consisting of 88 successive admissions to a rehabilitation unit. Fabiano & Goran derived a 10-component model which were reported to be consistent with clinical syndromes accompanying traumatic brain injury. The 10 components were given the following labels: Belligerence, Apathy\amotivational syndrome, Social irresponsibility, Orientation, Anti-social behaviour, Speech\cognitive dysfunction, Bizarreness, Paranoid ideation, Verbal expansiveness and Emotional sensitivity.

Theses authors also reported that these component scales showed good internal consistency, although there was some modest correlation between scales. Fabiano & Goran claimed that the scales represent statistically discrete and conceptually logical areas of neurobehavioural functioning. Comparison of these scales with the factors obtained by Katz & Lyerly (1963) reveal some similarities, for example with respect to groupings such as Belligerence, Verbal Expansiveness, Paranoia and Orientation; but there also some completely new groupings that appear to be specifically relevant to brain injury e.g. Apathy\amotivational syndrome. To date there has been no formal validation of these component scales. However, Fabiano & Goran conducted multivariate analyses in order to examine the relationship between severity of brain injury (duration of coma) and time since injury; but there were no significant effects under any of the component scales.

In a further study (using the same sample) Goran & Fabiano (1993) have attempted to refine the scaling of the KAS-R by conducting a critical item analysis. They concluded that only 79 of the original 127 items contributed to the internal consistency of their respective components. In addition two second-order component scales were derived from the original

10 scales: Emotional sensitivity and Physical\intellectual functioning. As these authors point out, one major difficulty with these two studies is that the sample size employed is extremely small for study of this kind.

The studies conducted by Jackson et al (1992) and Goran & Fabiano (1993) and Fabiano & Goran (1993) suggest that the KAS-R may have considerable potential with respect to the objective measurement of psychosocial functioning following traumatic brain injury. However, further work is required in order to confirm the validity of these factors and refine the psychometric properties and utility of this the KAS-R as a measure of psychosocial functioning following brain injury. The present study aims to confirm the validity of the factor structure obtained by the Jackson et al by employing confirmatory factor analysis techniques.

Aims of the present study

The present study aims to confirm the reproducibility of the structure obtained by Jackson et al by employing confirmatory factor analysis techniques. The present study represents a significant advance upon that of Jackson et al because it is based upon a sample consisting solely of traumatically brain injured individuals. This section is designed to provide a very brief introduction to confirmatory factor analysis and more detailed overviews of this technique are provided by Long (1983) and Hoyle (1995).

Confirmatory factor analysis was developed for the purpose of testing models generated by exploratory factor analysis. Whereas the aim of exploratory factor analysis is to generate hypotheses concerning the structural relations between a group of observed variables, in confirmatory factor analysis the investigator sets out to falsify these hypotheses by testing them against new sample data. The process involves the following stages (Hoyle, 1995): 1) Model specification, which involves making a formal statement about the hypothesised relationship between observed variables. 2) Estimation, which involves obtaining estimates of the free parameters in the model (relationship between variables) from the observed data. 3) Evaluation of fit, which involves obtaining a statistical measure of the extent to which the hypothesised model accounts for the observed covariance matrix.

Confirmatory factor analysis has a number of advantages over exploratory techniques. For example, in confirmatory factor analysis the investigator begins with a theory driven model concerning the constructs under investigation, whilst in exploratory factor analysis theoretical interpretations are made only after the model has been obtained. Hence, in exploratory factor analysis decisions such as which items are to be included in the analysis tend to be made on arbitrary grounds and a number of assumptions are made about the model regardless of how appropriate these are from a theoretical point of view. Confirmatory factor analysis allows the imposition of substantively meaningful constraints with respect to which observed variables are effected by which factors and which items have correlated error variances etc.

Confirmatory factor analysis can be used in various ways. For example, it may be used simply to confirm or disconfirm the specific model under investigation, and if the model is not confirmed no further action is taken. More usually however, when a hypothesised model does not fit the new data set, model generation procedures are applied. This involves modifying the hypothesised model on substantive theoretical grounds and re-testing it against the same data set. In this case confirmatory factor analysis is being used in an exploratory fashion, but decisions about structural relationships between variables can be made on substantive rather than purely arbitrary grounds.

Specific research aims

1. To conduct a confirmatory factor analysis of the modified Katz Adjustment Scale-Relatives Form (modified KAS-R; Jackson et al, 1992); employing data from a new sample consisting of consecutive referrals to UK brain injury rehabilitation unit.

2. Where necessary to employ model generation procedures in order to refine the KAS-R factor structure as it applies to traumatic brain injury.

3. To conduct a preliminary investigation into the relationship between changes in psychosocial functioning (as measured by the KAS-R sub-scales) and other injury-related and psychosocial variables: In particular, the data on the following variables will be presented: Severity of brain injury, employment status, effect of injury upon employment chances and frequency of cognitive problems (concentration and language comprehension problems).

Methods

Study design

The study sample was drawn from consecutive series of referrals to a brain injury rehabilitation unit during the period January, 1991 to April, 1996. The data employed in the study was obtained from archival material consisting of the International Trauma Inventory (ITI).

The brain injury rehabilitation unit provides post-acute rehabilitation, mainly for adults who have suffered a traumatic brain injury. Interventions are based upon a transitional model of rehabilitation and provides treatment for difficulties in cognitive, behavioural and emotional functioning with the specific aim of improving clients functioning with respect to independent living, leisure activities and employment. The unit caters for approximately 30 residential and day clients at any one time and referrals are received from a variety of sources within the UK, including health and social service agencies and medico-legal agencies.

The ITI forms used in this study were originally completed as part of the rehabilitation unit's routine admission assessment procedure. A close friend or relative of the injured person would be asked to complete the ITI immediately following referral. The ITI form would either be given to the injured person's relative during an initial assessment interview or it would be sent to them through the post. All completed ITI forms are reviewed by a clinical psychologist and any obvious discrepancies in the ITI would normally be discussed with the injured person's relative during subsequent clinical interviews.

Not all brain-injured individuals referred to the rehabilitation unit would necessarily fulfil the admission requirements of the unit and a number of individuals would have been 'screened out' prior to instigation of the formal admission assessment procedure. This would apply to individuals requiring extensive medical or nursing care, people with very severe physical disabilities and people who are unable to read and write and who cannot communicate verbally.

Sample

The final study sample consists of 150 adults who had suffered a traumatic brain injury and had been referred the rehabilitation unit between January 1991 and April 1996.

The mean age of individuals in the sample (at the time of completion of the ITI) was 31.3 years; s.d. 11.0; median age 28 years; min. 16 years; max. age 69 years (N=148). The mean age at time of injury was 27.6 years, s.d. 11.8; median age at time of injury 24 years; min. 4 years; max. 66 years (N=147). The mean time since injury was 3.8 years, s.d. 3.14; median 3 years; min. < 1 year, max. 18 years (N=148).

With respect to gender, 69.0 per cent of the sample were male and 31.0 per cent were female (N=148). The relationship of the informant to the injured person was as follows: Parent 56.0 per cent, Spouse 30.4 per cent, Sibling 5.3 per cent, Friend 5.3 per cent, Other Relative 0.7 per cent, Other 1.3 per cent (N=148).

Measures

The International Trauma Investigation (ITI).

The ITI (Jackson et al., 1992) is designed to be completed by a close friend or relative of the injured person. It consists of two parts:

Questionnaire 1. The demographic questionnaire.

The demographic questionnaire is a 40-item questionnaire designed by Jackson et al (1992) for the purpose of collecting demographic, pre-morbid and injury-related information concerning the traumatically brain injured person.

Questionnaire 2. The modified Katz Social Adjustment Scale - Relatives Form (modified KAS-R).

The modified KAS-R (Jackson et al, 1992; modified from Katz & Lyerly, 1963) is a 127-item questionnaire designed to assess changes in social behaviour and emotional and personality functioning following traumatic injury. Each item is rated on a 4-point scale (1 = "almost never", 2 = "sometimes", 3 = "often" and 4 = always"). The informant is asked to rate the injured person with respect to their pre-injury functioning ("as the person was before his\her injury") and with respect to their current post-injury functioning ("as he\she is now"). The final score for each item is a difference score which is obtained by subtracting the post-injury score from the pre-injury score.

A copy of the ITI, incorporating the demographic questionnaire and modified KAS-R is provided in Appendix 1.

Procedure

The clinical records of all clients referred to the rehabilitation unit between January 1991 and April 1996 were examined in order to identify those cases where the individual concerned was at least 16 years old and had suffered a traumatic brain injury. Completed ITI forms for 159 identified individuals were extracted from the files by clerical staff at the rehabilitation unit and the client's name was removed from the ITI form and each form was given an identification number.

. The raw data from each completed ITI form was then entered into an ASCII file according to a written protocol drawn up by the investigator. During this stage, nine individuals were excluded from the study because the ITI had either been completed incorrectly or had only been partially completed.

Ethical considerations and ethical approval

The study data was obtained from archival material collected during the course of routine clinical assessments. Therefore, the study procedure did not involve any direct contact with participants and was unlikely to lead to any discomfort or risk to participants. The completed ITI forms were extracted from clients clinical files by clerical staff at the study location and all identifying information was removed from the forms. Hence, the investigator was not aware of the identity of individuals included in the study. This aspect of the procedure served to minimise any invasion of the privacy of participants.

In view of these considerations, the investigator did not attempt to obtain the consent of individuals included in the study. However, full consent and approval with respect to this study was obtained from the Clinical Director of the rehabilitation unit (on behalf of the clinical team at the unit); and from the Lancashire Clinical Psychology Training Course ethical committee.

Results

Descriptive information concerning the sample

The following descriptive statistics and analyses are presented in order to allow comparison of the present study sample with that of Jackson et al (1992).

Severity of brain injury and classification of individuals according to severity.

Severity indices

Two indices of severity of traumatic brain injury were employed in this study: 1) Duration of post-traumatic amnesia (PTA): The sample was divided into four groups with respect to duration of PTA. The percentages of individuals in each group is given in Appendix 2. 2) Duration of coma: The sample was divided into four groups with respect to coma duration. The percentages of individuals in each group is provided in Appendix 2. In each case classifications were based upon widely accepted criteria (Teasdale & Jennett, 1974; Jennett, 1976).

Correlation between coma duration and duration of PTA.

Each individual was given a rating on a four point scale (1 = "Mild", 2 = "Moderate", 3 = "Severe", 4 = "Very severe") for each of the two severity criteria. There was a significant positive correlation (Spearman 1-tailed test) between coma duration and duration of PTA (rho = 0.57; $P<0.01$; $N=124$).

Final severity grouping: Combined PTA\Coma duration.

For the purposes of subsequent analyses the was sample into two groups: "Mild\moderate" head injury and "Severe\very severe" head injury. Duration of PTA was adopted as the primary criterion for this classification, employing a cut-off point of 24 hours. In cases where data on PTA was missing individuals were assigned to a severity group according to coma duration, and in these cases a cut-off point of 6 hours coma duration was employed. Percentages of individuals falling into each severity group are provided in Table 1.

Table 1. Severity of head injury: Classification by combined PTA\coma indices.

	Severity (composite PTA\coma duration)		
	Mild\moderate	**Severe\very severe**	**Total**
Percentage of individuals in each group	22.7% (N=34)	77.2% (N=115)	100% (N=149)

Severity grouping (combined PTA\coma duration) and skull fracture.

The frequency of individuals with skull fracture in each Mild\moderate and Severe\very severe head injury groups is shown in Table 2.

Table 2. Severity grouping (combined PTA\coma duration) and skull fracture.

	Severity of head injury	
	Mild\moderate	**Severe\very severe**
	Actual and (expected) frequencies	
No skull fracture	24 (17.9)	58 (64.1)
Skull fracture	8 (14.1)	57 (50.9)

Chi-Square 6.12; DF 1; P < 0.01; N= 147

Severity grouping (combined PTA\coma duration) and short-term cognitive\physical impairment.

An additional check on the validity the combined PTA\coma severity classification was performed by cross-tabulating with the composite PTA\coma measure of head injury severity with three variables on demographic questionnaire which address physical and cognitive impairment at one month following discharge from acute services (Table 3.).

Table 3. Severity grouping (combined PTA\coma duration) and short-term cognitive\physical impairment.

		Severity of head injury	
		Mild\moderate	Severe\very severe
		Actual and (expected) frequencies	
Intellectual impairment	None\mild	14 (5.2)	9 (17.8)
	Moderate\severe	16 (24.8)	94 (85.2)
	Chi-Square 23.37; DF 1; P < 0.01; N= 133		
Memory impairment	None\mild	16 (4.9)	5 (16.1)
	Moderate\severe	18 (29.1)	106 (94.9)
	Chi-Square 38.06; DF 1; P<0.01; N=145		
Physical impairment	None\mild	10 (5.2)	13 (17.8)
	Moderate\severe	22 (26.8)	97 (92.2)
	Chi-Square 6.90; DF 1. P<0.01; N=142		

Further descriptive information

Further descriptive information with respect to this sample (marital status, abode, compensation claim status, employment status and frequency of cognitive problems) is presented in Tables 4.- 9.

Table 4. Marital status.

	Marital status			
	Married	**Single**	**Divorced**	**Total**
Percentage of individuals in each group	32.9% (N=49)	59.7% (N=89)	7.4% (N=11)	100% (N=149)

Table 5. Abode.

	Abode						
	Home with family	**Home independently**	**Hospital**	**Hostel**	**No fixed abode**	**Other**	**Total**
Percentage of individuals in each group	77.7% (N=115)	11.5% (N=17)	4.7% (N=7)	0.7% (N=1)	0.7% (N=1)	4.7% (N=7)	100% (N=148)

Table 6. Compensation claim status

	Compensation claim status			
	No compensation claim	**Compensation pending**	**Compensation received**	**Total**
Percentage of individuals in each group	21.3% (N=32)	74.7% (N=112)	4.0% (N=6)	100% (N=150)

Table 7. Employment status.

	Employment status				
	Employed full-time	Employed part-time	Self-employed	Houseworker	
Percentage of individuals in each group	12.1% (N=18)	4.0% (N=6)	2.7% (N=4)	2.7% (N=4)	
	Unemployed	Retired	School or college	Other	Total
	57.7% (N=86)	2.7% (N=4)	4.0% (N=6)	14.1% (N=21)	100% (N=149)

Table 8. Informants perception of effect of injury upon employment prospects.

	Employment prospects				
	Not effected	Career progress impeded	Unemployed but likely to return to previous employment	Had to take less demanding occupation	
Percentage of individuals in each group	4.3% (N=18)	9.4% (N=6)	2.9% (N=4)	2.9% (N=4)	
	Retired on medical grounds	Unemployed but likely to be employed in much lesser capacity	Unlikely to be employed in future	Other	Total
	9.4% (N=13)	18.1% (N=25)	42.8% (N=59)	10.1% (N=14)	100% (N=138)

Table 9. Frequency of cognitive problems.

	Frequency of cognitive problems				
	No	Rarely	Sometimes	Frequently	Total
Concentration	5.3% (N=8)	2.0% (N=3)	27.3% (N=41)	65.3% (N=98)	100% (N=150)
Language Comprehension	24.8% (N=37)	7.4% (N=11)	45.6% (N=68)	22.1% (N=33)	100% (N=149)

Confirmatory factor analysis of the exploratory factor model for the modified KAS-R.

A confirmatory factor analysis was performed in order to test the exploratory factor model obtained by Jackson et al (1992). The complete exploratory model obtained by Jackson et al. is presented in Appendix 3. All statistical analyses described in this section were performed using the Structural Equation Modelling Programme, EQS (Bentler, 1989).

Initial data handling

Difference scores. A score for the difference between pre-morbid and post-morbid psychosocial functioning was obtained by subtracting the score for how the informant perceived their relative before injury from the score of how the informant perceived their relative at the time of completing the questionnaire.

Missing values. Examination of distribution of missing values indicated that missing values appeared to be distributed randomly across cases and variables. The maximum number of missing values for a single variable was seven (less than 5 per cent of cases). All missing values were replaced with the variable mean.

Variable distribution and corrections for non-normality. Descriptive statistics for all variables were examined for any departure from normality. Seven variables were found to exhibit excessive positive skewness (skewness >2.0) and\or excessive positive kurtosis (kurtosis >7.0). Variables 14, 109 and 127 were successfully transformed using a LOG(V+4) transformation. Variables 27, 60, 124 and 126 could not be successfully transformed and were eliminated from the analysis (these variables exhibited excessive kurtosis due to a high proportion of zero scores). Descriptive statistics for these variables are provided in Appendix 4.

Items 17 and 68 do not occur in the Jackson et al. factor analysis and hence were not included in the current analysis (variable 68 exhibited excessive skewness and kurtosis and would have been eliminated from the current analysis).

Method of estimation

Maximum likelihood (ML) was employed as the method for estimating the free parameters in the model. ML is the most commonly used method of estimation in structural equation modelling. Extensive research has indicated that ML performs quite well under a range of conditions, including violation of normality assumptions (Chou & Bentler, 1995).

Criteria used to estimate model fit

1. Normed fit index (NFI; Bentler & Bonett, 1980). The NFI assesses the adequacy of the hypothesised model (in this case the exploratory factor model) by comparing it to a null model in which all observed variables are assumed to be uncorrelated. The NFI may be viewed as the proportion of total covariance among observed variables that is explained by the theoretical model, when using the null model as a baseline (Chou & Bentler, 1995). NFI values larger than 0.9 are considered to indicate an acceptable fit.

2. Chi-square goodness of fit test. The chi-square test is based upon the null hypothesis (H_0) that the theoretical factor model represents the observed covariance matrix. The alternative hypothesis (H_1) is that the observed covariance matrix is different from the theoretical model. Note that a chi-square value that is small per degree of freedom indicates that the theoretical model is a good representation of the observed covariance matrix i.e. *non-significant* chi-square values indicate a good fit.

Model specification and estimation

Initially, the complete exploratory factor model obtained by Jackson et al (consisting of 30 first-order factors and seven second-order factors) was specified. However, it was not possible to obtain a solution for this model i.e. the second-order factor model did not adequately represent the data. Further analyses were then conducted in order to allow further evaluate of the lack of fit of the exploratory factor model and hence to generate and test alternative revised models.

Firstly, each individual first-order factor was specified and estimated in turn. Acceptable solutions were obtained for the following individual first-order factors without any modification to the item content: Emotional\psychosocial Factor 5. Nervousness and Factor 6. Social withdrawal; Physical\intellectual Factor 3. Arousal disorder, Factor 4. Verbal expansiveness, and Factor 5. Motor retardation; and Psychiatric Factor 3. Bizarreness.

All three domains contained a number of first-order factors which were found to consist of too few items to be statistically disconfirmable (see Tables 11 - 13). No further attempt was made to investigate these factors.

For the remaining first-order factors, acceptable solutions were obtained only after *post hoc* modification of the item content of these factors. In some cases the initial results of an estimation for a particular factor indicated that covariance matrix was not positive definite. This problem arises from linear dependency among observed variables i.e. when certain variables are perfectly predictable from other variables. Elimination of one or more of the offending variables is required in order to obtain a solution from the estimation procedure, and has the effect of reducing redundancy among variables in the KAS-R sub-scale represented by the factor in question.

In addition, *post hoc* modifications were made where the initial solution indicated that factor in question did not adequately represent the data (NFI's of less than 0.90 and significant Chi-Square values). Decisions about modifications to the original factors were made on the following basis: 1) Initial results indicated that a particular observed variable contributed greatly to the standardised residual covariance. The residual covariance represents the degree of discrepancy between the observed correlations and the model-reproduced correlations. 2) All modifications were substantively meaningful and justifiable on theoretical grounds. Modifications involved either elimination of one or more items from the factor in question, or allowing error variances of particular items to correlate. In general a conservative approach was adopted i.e. modifications were kept to the minimum required to fit the data. As far as possible (i.e. within the constraints of statistical and substantive considerations) the fit was achieved through correlation of error variances rather than through out-right deletion of items. However, as a result of these factor-by-factor modifications, five items were eliminated totally from the KAS-R and these are listed in Appendix 5. The item content of the revised first-order factors, standardised factor loadings and pairs of items with correlated error variances are provided in Table 10. The NFI and Chi-Square values for the individual first-order factor solutions are provided in Tables 11 -13.

Finally, a single second-order factor (Factor 3. Withdrawal) was individually specified (using the revised first-order factors) and estimated. This test provided an unacceptable solution (NFI < 0.6 and a highly significant chi-square value) indicating that this single second-order factor model did not adequately represent the data. Examination of items contributing most to the residual covariance suggested correlations between observed variables from different domains (i.e. correlations between variables from different factors) and\or correlated error variances between variables from different domains. Attempts to correct these problems through further *post-hoc* modifications led to only small improvements in goodness of fit indices.

Table 10. Revised first-order factors and standardised factor loadings.

Emotional\psychosocial domain

Factor 1. Belligerence

48.	stubborn	0.81	50.	curses	0.76
44.	argues	0.75	42.	bossy	0.75
33.	temper tantrums	0.74	51.	upsets routine	0.71
28.	breaks things	0.69	45.	fights	0.68
56.	critical of others	0.65	47.	does opposite	0.63
36.	doesn't care for others	0.61	59.	lies	0.59
55.	annoyed easily	0.59	46.	not co-operative	0.51
30.	no control of emotions	0.46			

Items with correlated error variances (28, 33); (28, 45); (28, 48); (30, 33); (33, 44); (33, 55); (44, 45); (44, 46); (44, 55); (45, 46); (46, 47); (46, 51)

Factor 2. Apathy\amotivational syndrome

09.	no energy	0.82	05.	no interest	0.72
08.	just sits	0.70	07.	stops moving	0.56
74.	acts helpless	0.42	72.	needs attention	0.40

Items with correlated error variances (72, 74)

Factor 3. Social irresponsibility

73.	behaviour childish	0.68	63.	is responsible	0.64 -
66.	shows good judgement	0.64 -	36.	doesn't care for others	0.60
05.	no interest	0.56	31.	laughs at strange things	0.50
37.	thinks only of self	0.47	58.	gets along well	0.41 -
62.	is dependable	0.29 -			

Items with correlated error variances (62, 63); (62, 66); (63, 66); (36, 37)

Factor 4. Emotional sensitivity

15.	gets sad	0.77	12.	feels people don't care	0.75
11.	feelings hurt easily	0.63	30.	no control of emotions	0.62
04.	feels lonely	0.57	06.	restless	0.56
03.	cries easily	0.40	67.	stays away from people	0.42

Table 10. Revised first-order factors and standardised factor loadings (continued).

Factor 5. Nervousness

20.	gets nervous	0.88	21.	jittery	0.88
23.	gets sudden fright	0.62	22.	worries of frets	0.56
74.	acts helpless	0.55	02.	self-critical	0.26
58.	gets along well	0.26 -			

Items with correlated error variances (02, 74); (02, 22)

Factor 6. Social withdrawal

67.	stays away from people	0.78	71.	prefers to be alone	0.72
69.	shy	0.64	54.	friendly	0.52 -
70.	quiet	0.43	04.	feels lonely	0.21

Items with correlated error variances (69, 70)

Factor 7. Emotional incongruity

31.	laughs at strange things	0.71	34.	excited for no reason	0.69
13.	does same thing over	0.69	35.	happy for no reason	0.60
73.	behaviour is childish	0.60	59.	lies	0.38

Factor 8. Obstreperousness

50.	curses at people	0.79	56.	critical of others	0.70
65.	obedient	0.65 -	43.	suspicious	0.62
64.	doesn't argue back	0.34 -			

Items with correlated error variances (64, 65)

Table 10. Revised first-order factors and standardised factor loadings (continued).

Physical\intellectual domain

Factor 1. General cognitive dysfunction

105.	changes subject	0.77	104.	repeats same idea	0.75
90.	confused	0.70	91.	can't get things off mind	0.73
94.	makes no sense	0.68	92.	can't concentrate	0.63
85.	loses track of day	0.60	88.	doesn't know where is	0.56
93.	can't make decisions	0.53	86.	forgets own address	0.47
89.	remembers things	0.32 -	80.	slow to react	0.32

Items with correlated error variances (85, 88); (85, 89); (85, 86); (86, 88); (86, 89)

Factor 2. Speech dysfunction

95.	hard to understand	0.84	94.	makes no sense	0.68
98.	speaks so low	0.47	96.	speaks clearly	0.42 -
97.	refuses to speak	0.40	103.	wants to speak but can't	0.39
102.	speaks slowly	0.22			

Items with correlated error variances (94, 98); (98, 102)

Factor 3. Arousal disorder

01.	trouble sleeping	0.72	41.	headaches etc.	0.59
24.	bad dreams	0.55	10.	looks worn out	0.38
14.	passes out	0.35			

Factor 4. Verbal expansiveness

99.	speaks very loudly	0.78	100.	yells for no reason	0.74
106.	talks too much	0.72	105.	changes the subject	0.67
101.	speaks very fast	0.58			

Factor 5. Motor retardation

76.	moves about slowly	0.76	77.	moves in hurried way	0.54 -
102.	speaks slowly	0.48	78.	clumsy	0.39
84.	stays in one position	0.27			

Table 10. Revised first-order factors and standardised factor loadings (continued).

Factor 7. Abnormal movement

82.	peculiar movements	0.75	81.	peculiar position	0.68
100.	yells for no reason	0.46	91.	can't get things off mind	0.46

Psychiatric domain

Factor 1. Paranoid ideation

110.	talks about how angry	0.75	112.	afraid can't control self	0.73
113.	threatens to tell people off	0.69	108.	says people are trying to make him do things	0.62
107.	says people are talking about him	0.65	111.	talks of people he is afraid of	0.49
122.	says people after him	0.46	26.	talks about suicide	0.17

Items with correlated error variances (107, 108); (108, 111)

Factor 2. Psychotic anxiety

19.	afraid something terrible	0.84	18.	has strange fears	0.81
123.	says something terrible	0.67	111.	talks of people he is afraid of	0.57
116.	talks of strange things	0.57			
109.	talks as if committed worst sin	0.40	25.	acts as if he sees things	0.38

Items with correlated error variances (18, 123); (25, 111); (25, 116); (25, 123)

Factor 3. Bizarreness

119.	says same thing over	0.71	26.	does strange things	0.62
19.	afraid something terrible	0.58	112.	threatens to injure people	0.56
18.	has strange fears	0.54	29.	talks to self	0.52
25.	acts as if sees things	0.50			

Items with correlated error variances (18, 19); (26, 29); (25, 26)

Table 10. Revised first-order factors and standardised factor loadings (continued).

Factor 4. Psychotic depression

08.	says people are trying to make him do things	0.70	116.	talks about strange things in body	0.70
120.	complains about people	0.65			
119.	says same thing over	0.62	117.	says how bad he is	0.54

Table 11. Revised first-order factor solutions: Emotional\psychosocial domain.

	Goodness of Fit Indices			
	Bentler-Bonnett Normed Fit Index	Chi-Square	DF	*P*
Emotional\psychosocial domain				
Factor 1. Belligerence (revised)	0.919	100.18	88	> 0.05
Factor 2. Apathy\amotivational syndrome (revised)	0.981	4.94	8	> 0.05
Factor 3. Social irresponsibility (revised)	0.931	25.94	23	> 0.05
Factor 4. Emotional sensitivity (revised)	0.913	28.33	20	> 0.05
Factor 5. Nervousness	0.963	12.66	12	> 0.05
Factor 6. Social withdrawal	0.941	13.16	8	> 0.05
Factor 7. Emotional incongruity (revised)	0.935	14.97	9	> 0.05
Factor 8. Obstreperousness (revised)	0.988	2.21	4	> 0.05
Factor 9. Resentfulness	(Not disconfirmable)			
Factor 10. Openness	(Not disconfirmable)			
Factor 11. Unco-operativeness	(Not disconfirmable)			
Factor 12. Determination	(Not disconfirmable)			
Factor 13. Resistance	(Not disconfirmable)			
Factor 14. Physical independence	(Not disconfirmable)			

Table 12. Revised first-order factor solutions: Physical\intellectual domain.

	Goodness of Fit Indices			
	Bentler-Bonnett Normed Fit Index	Chi-Square	DF	*P*
Physical\intellectual domain				
Factor 1. General cognitive dysfunction (revised)	**0.902**	**63.94**	**49**	**> 0.05**
Factor 2. Speech dysfunction (revised)	**0.941**	**10.85**	**12**	**> 0.05**
Factor 3. Arousal disorder	**0.951**	**4.56**	**5**	**> 0.05**
Factor 4. Verbal expansiveness	**0.967**	**8.35**	**5**	**> 0.05**
Factor 5. Motor retardation	**0.966**	**2.58**	**5**	**> 0.05**
Factor 6. Orientation	**(Not disconfirmable)**			
Factor 7. Abnormal movement (revised)	**0.945**	**5.43**	**2**	**> 0.05**
Factor 8. Rate of speech	**(Not disconfirmable)**			
Factor 9. Motor tremor	**(Not disconfirmable)**			

Table 13. Revised first-order factor solutions: Psychiatric domain.

	Goodness of Fit Indices			
	Bentler-Bonnett Normed Fit Index	**Chi-Square**	**DF**	***P***
Psychiatric domain				
Factor 1. Paranoid ideation (revised)	**0.903**	**31.21**	**20**	**> 0.05**
Factor 2. Psychotic anxiety (revised)	**0.954**	**15.13**	**10**	**> 0.05**
Factor 3. Bizarreness	**0.972**	**8.96**	**11**	**> 0.05**
Factor 4. Psychotic depression (revised)	**0.997**	**0.52**	**5**	**> 0.05**
Factor 5. Antisocial behaviour	**(Not disconfirmable)**			
Factor 6. Suicidal inclination	**(Not disconfirmable)**			
Factor 7. Unrealistic attitude	**(Not disconfirmable)**			
Factor 8. Fear of losing control	**(Not disconfirmable)**			

Preliminary investigation of the relationship between KAS-R sub-scales and other injury-related variables.

The revised KAS-R sub-scales were employed in these analyses.

Severity of head injury

Mean KAS-R sub-scales scores for two groups: Mild\moderate and Severe\very severe head injury are provided in Table 14.

Employment status and informants perception of effect of injury upon employment status.

Mean KAS-R scores for those in full\part time employment or education are compared to scores for those who were either unemployed, retired on medical grounds or attending day services (Table 15.). Comparisons were also made with respect to relatives perception of the effect of injury upon the injured persons' future employment chances: Mean KAS-R scores for individuals whose employment chances was considered to be either unaffected or slightly impeded were compared to scores for those whose career chances were considered to have been significantly effected (Table 16.).

Cognitive problems

Comparisons were made with respect to two measures of cognitive functioning: Frequency of concentration problems and frequency of language comprehension problems. Mean KAS-R scores for individuals who were reported as experiencing these cognitive problems either not at all, rarely or sometimes were compared to scores for those who were reported as exhibiting these problems frequently (Tables 17 and 18.).

Table 14. Severity of head injury: Comparison of mean scores on KAS-R sub-scales.

	Mild\ moderate	Severe\ very severe			
	Mean (s.d.)	Mean (s.d.)	*t*	DF	*P* (2-tailed)
(Emotional\psychosocial domain)					
F1. Belligerence	13.35 (11.55)	13.24 (12.31)	0.36	139	NS
F2. Apathy\amotivational syndrome	8.06 (4.66)	8.30 (4.57)	0.27	144	NS
F3. Social irresponsibility	9.03 (6.17)	8.81 (5.71)	0.18	132	NS
F4. Emotional sensitivity	10.42 (5.58)	10.05 (5.83)	0.32	143	NS
F5. Nervousness	7.61 (5.29)	7.49 (4.80)	0.12	142	NS
F6. Social withdrawal	5.30 (4.65)	5.00 (4.88)	0.31	145	NS
F7. Emotional incongruity	4.44 (4.76)	4.39 (4.04)	0.06	145	NS
F8. Obstreperousness	2.42 (2.69)	2.96 (3.22)	0.87	141	NS
(Physical\intellectual domain)					
F1. General cognitive dysfunction	12.39 (8.83)	14.31 (7.88)	1.19	139	NS
F2. Speech dysfunction	3.73 (4.00)	4.32 (3.82)	0.76	135	NS
F3. Withdrawal	6.11 (3.45)	5.64 (2.98)	0.78	144	NS
F4. Verbal expansiveness	2.52 (3.51)	3.82 (4.23)	1.80*	62.19	NS
F5. Motor retardation	3.97 (3.68)	4.95 (3.73)	1.33	143	NS
F7. Abnormal movement	2.47 (2.39)	3.22 (2.54)	1.52	142	NS
(Psychiatric domain)					
F1. Paranoid ideation	4.21 (3.84)	4.94 (4.46)	0.82	137	NS
F2. Psychotic anxiety	4.75 (4.41)	4.66 (4.14)	0.11	134	NS
F3. Bizarreness	5.50 (5.20)	5.33 (4.51)	0.18	141	NS
F4. Psychotic depression	3.76 (3.14)	4.44 (3.81)	0.95	147	NS

* t-test based upon unequal variances

Table 15. Employment status: Comparison of mean scores on KAS-R sub-scales.

	Employed	Not employed			
	Mean (s.d.)	**Mean (s.d.)**	***t***	**DF**	***P* (2-tailed)**
(Emotional\psychosocial domain)					
F1. Belligerence	10.73 (10.55)	15.02 (12.37)	1.73	139	< 0.05
F2. Apathy\amotivational syndrome	6.81 (3.93)	8.68 (4.68)	2.04	144	< 0.05
F3. Social irresponsibility	7.34 (5.74)	9.29 (5.78)	1.61	132	NS
F4. Emotional sensitivity	7.81 (5.47)	10.92 (5.64)	2.81	143	< 0.01
F5. Nervousness	6.06 (4.38)	7.97 (4.98)	1.96	142	< 0.05
F6. Social withdrawal	4.19 (3.67)	5.43 (5.13)	1.29	145	NS
F7. Emotional incongruity	2.91 (3.73)	4.86 (4.24)	2.36	145	< 0.01
F8. Obstreperousness	2.11 (2.44)	3.08 (3.24)	1.54	141	NS
(Physical\intellectual domain)					
F1. General cognitive dysfunction	11.00 (7.48)	14.75 (8.16)	2.31	139	< 0.05
F2. Speech dysfunction	2.80 (3.35)	4.56 (3.92)	2.24	135	< 0.05
F3. Withdrawal	5.11 (3.37)	6.01 (2.99)	1.45	144	NS
F4. Verbal expansiveness	1.71 (3.35)	3.95 (4.18)	3.01*	49.37	< 0.01
F5. Motor retardation	4.11 (3.37)	4.93 (3.88)	1.07	143	NS
F7. Abnormal movement	2.10 (2.02)	3.32 (2.59)	2.79*	59.87	< 0.01
(Psychiatric domain)					
F1. Paranoid ideation	3.32 (3.21)	5.21 (4.49)	2.61*	63.53	< 0.01
F2. Psychotic anxiety	3.15 (3.73)	5.11 (4.23)	2.31	134	< 0.05
F3. Bizarreness	3.75 (4.35)	5.85 (4.64)	2.27	141	< 0.05
F4. Psychotic depression	2.69 (3.06)	4.71 (3.71)	3.17*	58.48	< 0.01

*** t-test based upon unequal variances**

Table 16. Future employment prospects: Comparison of means on KAS-R sub-scales.

	Employment not effected	Employment effected			
	Mean (s.d.)	Mean (s.d.)	*t*	DF	*P* (2-tailed)
(Emotional\psychosocial domain)					
F1. Belligerence	7.53 (9.07)	15.20 (11.78)	2.69	115	< 0.01
F2. Apathy\amotivational syndrome	4.41 (4.51)	9.11 (4.29)	4.61	119	< 0.01
F3. Social irresponsibility	4.43 (4.58)	9.99 (5.64)	4.19	107	NS
F4. Emotional sensitivity	6.09 (4.16)	10.82 (5.55)	3.84	118	< 0.01
F5. Nervousness	4.18 (3.51)	8.29 (4.85)	4.61	119	< 0.01
F6. Social withdrawal	3.74 (4.01)	5.57 (4.91)	1.66	121	NS
F7. Emotional incongruity	2.04 (3.00)	4.79 (4.16)	3.64*	43.91	< 0.01
F8. Obstreperousness	1.64 (2.04)	3.14 (3.05)	2.21	117	<0.05
(Physical\intellectual domain)					
F1. General cognitive dysfunction	7.64 (6.50)	15.31 (7.75)	4.31	115	< 0.01
F2. Speech dysfunction	1.86 (2.65)	4.48 (3.80)	3.75*	40.89	< 0.01
F3. Withdrawal	4.34 (1.86)	6.14 (3.04)	3.62*	49.55	< 0.01
F4. Verbal expansiveness	1.15 (2.23)	4.04 (4.11)	4.46*	49.49	< 0.01
F5. Motor retardation	2.18 (3.29)	5.28 (3.64)	3.66	118	< 0.01
F7. Abnormal movement	1.36 (1.43)	3.39 (2.54)	5.07*	55.56	< 0.01
(Psychiatric domain)					
F1. Paranoid ideation	2.48 (2.30)	5.21 (4.30)	4.16*	59.81	< 0.01
F2. Psychotic anxiety	2.18 (3.38)	5.15 (4.20)	4.41*	51.84	< 0.01
F3. Bizarreness	2.32 (3.68)	5.91 (4.45)	3.97	36.14	< 0.01
F4. Psychotic depression	1.70 (2.18)	4.83 (3.60)	5.42*	53.09	< 0.01

* t-test based upon unequal variances

Table 17. Concentration problems: Comparison of mean scores on KAS-R sub-scales.

	None to moderate	Frequent			
	Mean (s.d.)	Mean (s.d.)	*t*	DF	*P* (2-tailed)
(Emotional\psychosocial domain)					
F1. Belligerence	10.24 (10.77)	16.06 (12.29)	2.8	140	< 0.01
F2. Apathy\amotivational syndrome	5.80 (4.19)	9.60 (4.21)	5.22	144	< 0.01
F3. Social irresponsibility	6.24 (5.72)	10.26 (5.36)	4.04	133	< 0.01
F4. Emotional sensitivity	8.21 (5.30)	11.26 (5.73)	3.15	144	< 0.01
F5. Nervousness	5.41 (3.62)	8.69 (5.11)	4.48*	132.89	< 0.01
F6. Social withdrawal	3.90 (4.01)	5.78 (5.15)	2.27	146	< 0.05
F7. Emotional incongruity	2.79 (3.46)	5.30 (4.30)	3.62	146	< 0.01
F8. Obstreperousness	1.94 (2.55)	3.33 (3.27)	2.59	142	<0.05
(Physical\intellectual domain)					
F1. General cognitive dysfunction	10.02 (7.39)	16.10 (7.70)	4.58	140	< 0.01
F2. Speech dysfunction	2.92 (3.33)	4.89 (3.96)	2.94	136	< 0.01
F3. Withdrawal	4.67 (2.84)	6.38 (3.08)	3.31	136	< 0.01
F4. Verbal expansiveness	2.37 (3.55)	4.10 (4.28)	2.59*	119.96	< 0.05
F5. Motor retardation	3.22 (3.18)	5.62 (3.82)	3.84	144	<0.01
F7. Abnormal movement	1.92 (2.00)	3.68 (2.56)	4.47*	125.34	< 0.01
(Psychiatric domain)					
F1. Paranoid ideation	3.06 (3.05)	3.62 (4.61)	3.88*	128.15	< 0.01
F2. Psychotic anxiety	3.00 (3.03)	5.50 (4.43)	3.87*	122.94	< 0.01
F3. Bizarreness	3.38 (3.44)	6.43 (4.86)	4.36*	130.61	< 0.01
F4. Psychotic depression	2.73 (2.61)	5.08 (3.89)	4.40*	139.81	< 0.01

* t-test based upon unequal variances

Table 18. Language comprehension problems: Comparison of means on KAS-R sub-scales.

	None to moderate	Frequent			
	Mean (s.d.)	Mean (s.d.)	*t*	DF	*P* (2-tailed)
(Emotional\psychosocial domain)					
F1. Belligerence	12.43 (11.19)	20.34 (13.66)	3.24	139	< 0.01
F2. Apathy\amotivational syndrome	7.68 (4.50)	10.38 (4.26)	3.03	144	< 0.01
F3. Social irresponsibility	8.00 (5.51)	11.75 (5.79)	3.32	133	< 0.01
F4. Emotional sensitivity	9.13 (5.42)	13.69 (5.59)	4.17	143	< 0.01
F5. Nervousness	6.57 (4.30)	10.97 (5.46)	4.74	142	< 0.01
F6. Social withdrawal	4.50 (5.00)	7.28 (3.65)	2.93	145	< 0.01
F7. Emotional incongruity	3.72 (3.80)	6.88 (4.66)	3.99	145	< 0.01
F8. Obstreperousness	2.38 (2.90)	4.61 (3.30)	3.69	141	<0.01
(Physical\intellectual domain)					
F1. General cognitive dysfunction	12.32 (7.54)	19.65 (7.56)	4.78	140	< 0.01
F2. Speech dysfunction	3.47 (3.53)	6.83 (3.90)	4.51	136	< 0.01
F3. Withdrawal	5.08 (2.83)	8.09 (2.75)	5.36	144	< 0.01
F4. Verbal expansiveness	3.06 (3.85)	4.94 (4.75)	2.02*	41.4	< 0.05
F5. Motor retardation	4.49 (3.70)	5.71 (3.95)	1.6	143	NS
F7. Abnormal movement	2.64 (2.24)	4.65 (2.91)	3.57*	40.27	< 0.01
(Psychiatric domain)					
F1. Paranoid ideation	4.39 (3.83)	6.20 (5.65)	1.66*	36.64	NS
F2. Psychotic anxiety	3.90 (3.55)	7.40 (5.11)	3.52*	37.28	< 0.01
F3. Bizarreness	4.35 (3.83)	8.97 (5.47)	4.47*	40.13	< 0.01
F4. Psychotic depression	3.78 (3.37)	5.97 (4.32)	2.73*	44.2	< 0.01

* t-test based upon unequal variances

Discussion

Before discussing the results of the confirmatory factor analysis in detail it will be helpful to discuss the characteristics of the current study sample and to compare the current sample with the sample employed by Jackson et al. (1992).

Sample characteristics

The sample employed by Jackson et al consists of individuals with brain and\or spinal cord injury s drawn from a variety of centres from within the UK and United States. The psychosocial problems following spinal injury are probably not similar to the problems following brain injury. For example, Alfano, Neilson & Fink (1993) conducted a comparative study of relatives reports of individuals with brain and spinal injury and found that head injury individuals reported higher levels of depression, chronic tension, social alienation and moodiness, although there were no differences between the two groups in terms of vocational or domestic status. They also found that memory function was an important predictor of emotional and psychosocial functioning in brain injury, but that degree of physical disability was most important in the spinal injury population. These findings suggest that the Jackson et al sample may not be a homogenous group with respect to psychosocial functioning and that different theoretical models may be required to explain the pattern of psychosocial functioning in spinal and brain injury populations. In addition the Jackson et al sample may represent a different, more heterogeneous group with respect to cultural and social background, severity of injury and amount of treatment\rehabilitation received.

Jackson et al reported that of head-injured individuals without spinal injury, 40.1 per cent had a mild\moderate head injury compared to only 22.7 per cent in the current study sample. Further indications of bias towards more severe difficulties in the current study sample are provided by comparison of the two samples on other variables. Jackson et al found that severely injured individuals were more likely to be single and that 55.2 per cent of severe head injured individuals were single as compared to 59.7 per cent across the whole of the current study sample. Similarly, Jackson et al found that severe head injury individuals were more likely to be living at home with family members and that 64.3 per cent of severely injured individuals were living with their family as compared to 77.7 per cent of individuals across the whole of the current study sample.

With respect to employment Jackson et al found that 29.1 per cent of individuals with a severe head injury were employed in some capacity, this compares with 21.5 per cent across the whole of the current sample. Twenty one per cent of severe head injured individuals and 45.3 per cent of less severe group reported no change or only minimal changes in career prospects in the Jackson et al sample, compared to 16.6 per cent across the whole of the current sample.

Interpretation of results of confirmatory factor analysis of the KAS-R

The results of the current study appear to offer support for the validity of the main first order factors obtained by Jackson et al. However, before interpreting the results in more detail it is necessary to outline a number of general points concerning interpretation.

Many of the original factors required some degree of modification to their item content before acceptable solutions were obtained. The results of model modification procedures must be interpreted with caution for a number of reasons. Modifications are based upon the evaluation of solutions of rejected models and the revised models are tested by re-fitting them to the same sample data. Hence, the final revised models may be determined by chance characteristics of the sample data in question i.e. these modifications may not generalise to the population from which the sample was drawn. MacCallum, Roznowski & Necowitz (1992) found that the outcome of model modification is extremely sensitive to chance sample characteristics even with quite large sample sizes. The results of the present study suggest that the revised factors represent discrete areas of psychosocial functioning following brain injury. However, these factors cannot be considered to have been validated and generalisations to the wider population of interest must be made with care until the revised factors have been tested against a new representative sample. In the current study modifications to the original factors were kept to the minimum required to obtain an acceptable solution, and all modifications were made on both statistical and substantive theoretical grounds. Under these circumstances the investigator may be somewhat more confident about interpretations and generalisations based upon the revised models (MacCallum et al, 1992).

It is also important to note that the techniques employed here do not preclude the existence of alternative models that fit the sample data equally well (or better) than the model under investigation (MacCallum, 1995). However, the possibility of the existence of alternative models does not detract from the tentative conclusion that the factors identified in the present study represent relatively robust entities across the two samples.

The modifications undertaken in this study can be divided into two broad categories: The first category concerns modifications that appear to address difficulties in item content of the KAS-R scales and hence should result in an improvement of the psychometric properties of the scales. Some of these problems in item content have been noted by previous authors (Siegrist & Junge, 1990; Clopton & Greene, 1994). Firstly a number of items which share the same meaning as other items in the scale were deleted from scales. This resulted in a reduction in redundancy among items in the scales. In addition, a number of items were eliminated because they had correlated error variances. Items that exhibited correlated error variances tended to be items that are phrased in a positive way and request the informant to make a subjective value judgement about the injured person themselves (e.g. 'Friendly' or 'Generous') or to evaluate the injured person's behaviour (e.g. 'Happy for no reason'). It is possible that such items share a common source of error variance arising from the attitudes of the informant. These items would also be expected to contribute most to any problems with the inter-rater reliability of the scales, as indicated by studies of the original KAS-R sub-scales (Zimmerman et al. 1975 & 1976; Crook et al., 1980) and the modified KAS-R (Payne, 1993). However, not all reported problems with inter-rater reliability will be of this nature as it is quite possible that different ratings across different types of informant reflect different types of relationship with the injured person.

Jackson et al (1992) employed factor loading cut-off point of 0.3. The goodness of fit criteria employed in the current study (NFI >0.9 and non-significant chi-square) effectively involved the application of very stringent criteria and may result in the deletion of items that had low factor loadings in the original model. Under these circumstances it could be concluded that in the underlying population of traumatically brain injured people, these observed variables do not really 'belong' with the factor in question. The outcome of this type of modification is that the revised factors retain their original meaning; however they contain fewer items. The remaining items in each factor tend to load more heavily upon the factor and, on an intuitive basis, the items appear to be consistent with the construct represented by that factor. Comparison of the revised factors with the original Jackson et al factors reveals that the revised factors (containing fewer items) appear to represent an improvement with respect to the measurement psychosocial functioning following brain injury. In addition, many of the revised items grouping correspond closely to the components obtained by Fabiano & Goran (1992).

In one case, *post hoc* modifications appeared to result in a change in the substantive meaning of a factor. In the original exploratory factor model the Emotional\Psychosocial factor Apathy\amotivational syndrome consisted of items which appeared to reflect both depression and apathy\amotivation. The item content of the revised factor now appears to more closely represent the construct of apathy\amotivational syndrome as it applies to brain injury. Two considerations may help to explain the difference between this finding and that of Jackson et al (1992). Firstly, the difference may arise from difference between the samples. The construct represented by Apathy\amotivational syndrome in brain injury is considered to arise from lesions to specific regions of the brain (generally the frontal lobes) and the existence of this construct would not be predicted for a spinal injury population. Secondly, the original factor derived by Jackson et al may to some extent be an artefact of the *a priori* allocation of items to the three psychosocial domains i.e. it is possible that a number of the items in the Psychiatric domain 'belong' with items that represent measure 'Depression' in the Psychosocial\emotional domain. This proposition is supported by the fact that the original Katz & Lyerly (1963) factors contain items from each of three domains used by Jackson et al. Further informal support for the item content of the revised Apathy\amotivational factor may be derived from the fact that the new item content overlaps to a large extent with the Apathy\amotivational component obtained by Goran & Fabiano (1992).

The results of the current analyses indicate that the complete second-order factor structure obtained by Jackson et al does not fit the data in the present sample. Again it may be possible to explain this difference by reference to sample differences, however this seems unlikely given that the revisions to the first-order factor structure do not involve major changes to the substantive meaning of the majority of these factors. In fact, the solution obtained for the single second-order factor, indicates that problems may arise from the *a priori* division if items into three different domains. More specifically it appears that items from one domain may actually load on factors from another domain and that large numbers of items across different domains had correlated error variances. The technique of dividing items into sub-group on an *a priori* basis is normally adopted for statistical purposes i.e. in order to increase the subject to variable ratio in an analysis. However it is possible that the three domains constructed by Jackson et al are actually of very limited validity with respect to the processes underlying psychosocial functioning following traumatic brain injury. (On purely theoretical grounds, it seems unlikely that the behaviour of the observed variables in the Emotional\Psychosocial domain is independent of the behaviour of variables in the Psychiatric domain.) If the domains have unacceptably low validity then the second-order factors would also have limited validity, hence the failure to confirm the second-order factor structure in the present analysis.

It was not possible to confirm or revise a number of the small factors from the Jackson et al model as there were too few degrees of freedom available. This problem arises when the ratio of free parameters to items in a particular model is too high. The issue of disconfirmability is not a trivial statistical point. If a model is not disconfirmable this indicates that the hypothesised model is more complex than the observed variables themselves and under these circumstances the hypothesised model would be of little theoretical or practical interest (MacCallum, 1995). This is not to say that the items groupings themselves are of no interest. The question of whether an item is clinically useful is separate question from whether a small group of observed variables are explained by a hypothesised unobserved variable or factor. Jackson et al explicitly state that they intentionally sacrificed the principle of parsimony in favour of the extraction of factors that appear clinically meaningful. Hence, they justify retention of smaller factors such as the Psychosocial\Emotional Factor Suicidal Inclination on the ground that these represent clinically useful scales. If it is considered important to investigate the theoretical underpinnings of these small items groupings it would be possible to generate and test new models by adding new items which on theoretical grounds appear to be indicators of the factor in question.

An analogous problem arises with respect to items that were deleted from the KAS-R due to excessive non-normality or low variance. For example up to 30 per cent of respondents may report positive change on items that appear to measure suicidal inclination and responses on these individual items may be clinically very useful.

As mentioned previously, in the current analysis a conservative approach was adopted with respect to model modification procedures. Inspection of the item content and item loadings in the revised first-order factors indicate that a several factors contain a one item with an item loadings of less than 0.3. This suggests that the KAS-R could be refined further by inspection and deletion of these items from the scales in question. Similarly, although some items have been deleted in the current analysis, the KAS-R still contains a number of items which clearly require the informant to make a subjective value judgement about the injured person. It is possible that deletion of these items would result in further improvements of the psychometric properties of the scales. Of course, all *post-hoc* modifications of this kind would require validation against a new sample.

Relationship of the revised KAS-R scales and severity of brain injury, employment status and cognitive functioning.

The present study includes preliminary comparisons of mean KAS-R sub-scales scores with respect to severity of head injury, employment status, effect of injury upon employment chances and cognitive functioning. These results must be interpreted with caution as research questions concerning the influence of independent variables upon KAS-R scores may be better addressed through the application of multi-variate statistical techniques. Additionally, examination of the values for mean and standard deviation scores for the KAS-R sub-scales indicate that these comparisons may be improved by detailed examination of outliers.

Jackson et al found that the modified KAS-R first-order factors discriminated between severe and less severe traumatic head-injury groups. In the present study employing the revised first-order factors there were no significant differences between mean KAS-R scores for the Mild\moderate and Severe\very severe head injury groups. However, comparison of mean KAS-R scores with respect to other selected variables (employment status, informants perception of effect of injury upon employment status, concentration problems and language comprehension problems) did reveal significant differences between groups on a range of KAS-R sub-scales. These latter finding tends to suggest that the KAS-R factors do have some degree of discriminative power.

There are a number of possible explanations for the difference between the severity results in the current study and findings of Jackson et al. Firstly, it is possible that the measure of traumatic brain injury employed in the current study is not a valid representation of the actual degree of brain injury (diffuseness of injury or number and location of lesions). The indices employed in the current study (PTA and Coma duration) are in line with current recommendations concerning retrospective assessment of brain injury severity (Teasdale & Jennett, 1974; Jennett, 1976; Wilson, Teasdale, Hadley, Weidmann & Lang, 1993;). In addition, descriptive statistics and analyses presented in the results section indicate that more people in severe group had suffered a skull fracture and that those with severe injuries were more likely to have moderate or severe impairment of intellectual, memory or physical functioning at one month post-injury. These results provide further support for the severity classification system employed in this study. However, despite the fact that these indices are considered to be the best retrospective measures available, research also indicates that they provide only a very broad indication of the type and extent of neurological injury (Kazmark, 1992; Wilson et al, 1993; Coppens, 1995; Haslam, Batchelor, Fearnside & Haslam, 1994).

The second explanation for the different severity findings concerns the difference between the two study samples. The present study is based upon consecutive referrals to a rehabilitation centre and contained a higher proportion of individuals with severe or very severe head injuries than the Jackson et al sample. Examination of other data such as employment status also indicates that the present sample is biased towards individuals presenting with high levels of psychosocial dysfunction. In addition it is recognised that a small percentage of individuals with mild head injuries exhibit long-term problems (Alexander, 1995; Parker, 1995). It seems possible that in the current sample of rehabilitation referrals individuals who have suffered a mild head injury will evidence significant problems of psychosocial adjustment. This issue has been noted by other authors. For example, Dickmen & Levin (1993) point out a number of methodological problems surrounding a study of mild injuries including sample selection, problems with head injury severity classification, the existence of other system injuries and the role of emotional reactions to injury and circumstances surrounding the accident. It is notable that Fabiano & Goran (1992) also failed to find any relationship between KAS-R scores and severity of injury in their rehabilitation sample. If accepted, this conclusion is potentially a quite important one for those involved in post-acute rehabilitation work. It implies that although severity of injury may be a useful predictor of outcome when individuals are drawn from a wide variety of sources, it may be less useful in a more selected sample involving individuals who are actively seeking rehabilitation. In this group most of the variance in psychosocial functioning may be accounted for by other factors such as pain, epilepsy, facial disfigurement, sensori-motor disability and emotional reaction to trauma. Indeed, the findings of the present study are consistent with the findings of a number of other studies (Parker, 1995; van Zomeren & van den Burg, 1985; Hinkeldey & Corrigan, 1990;). Further multi-variate analyses are required to investigate the relationship between psychosocial functioning, as measured by the revised KAS-R factors, and other injury related and post-injury variables such as severity of injury, time since injury, age at time of injury, sensori-motor impairment, pain and epilepsy.

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Appendix 2. Descriptive information on duration of PTA and coma.

Table 1. Severity of head injury: Classification by duration of post-traumatic amnesia.

	Severity (duration of post-traumatic amnesia)				
	Less than 1 hour (Mild)	1 - 24 hours (Moderate)	24 hours and 3 weeks (Severe)	More than 3 weeks (Very severe)	Total
Percentage of individuals in each group	13.6% (N=18)	2.3% (N=3)	25.8% (N=34)	58.3% (N=77)	100% (N=132)

Table 2. Classification of individuals by duration of coma.

	Severity (duration of coma)				
	Less than 15 minutes (Mild)	15 minutes - 5 hours (Moderate)	6 hours - 48 hours (Severe)	More than 48 hours (Very severe)	Total
Percentage of individuals in each group	24.5% (N=34)	7.9% (N=11)	5.8% (N=8)	61.9% (N=86)	100% (N=139)

Appendix 4. Descriptive statistics for variables eliminated due to non-normality.

Item		Mean	Standard deviation	Skewness	Kurtosis
27	attempts suicide	0.144	0.433	2.662	7.733
60	in trouble with law	0	0.591	0.582	12.326
124	believes in strange things	0.232	0.682	1.279	7.639
126	talks about strange sexual ideas	0.121	0.585	1.144	12.506

Appendix 5. Items deleted from the KAS-R questionnaire as a result of *post-hoc* modifications to first-order factors.

32	has mood changes without any reason.
39	generous.
40	thinks people are talking about him\her.
57	pleasant.
125	talks about suicide.