THE BEHAVIOUR OF CHILDREN ONE YEAR AFTER A HEAD INJURY

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Fibres as delicate as those of which the organ of the mind is composed are certainly liable to break as a result of violence to the head.

Gama, 1835

Traté des plaies de tête et de l'encéphale pus crochu.

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ABSTRACT

This study examines the behavioural sequelae in 116 subjects aged between 5 and 14 years 1 year after a head injury. Subjects were selected from consecutive admissions to trauma units on the basis of neurological criteria. Severity of injury was graded according to duration of post-traumatic amnesia (PTA). There were 53 children in the Moderate group with PTA less than 24 hours; 37 children in the Severe group with PTA between 1 and 7 days and 26 children in the Very Severe group with PTA over 7 days. The head-injured subjects were matched for age, sex, ethnic group and socio-economic background with 37 Controls who had trauma not involving the head.

Objectives: There are two main objectives to this thesis. The first is to establish which of the behaviours present in the head-injured children at one year follow-up could be attributed to their head injury. This was achieved in two ways: By separating behaviours which presented for the first time in the post-traumatic period from those with a pre-traumatic origin and through the identification of other factors such as pre-morbid behaviour patterns and persistent psychosocial adversity which may have contributed to post-head injury behaviour patterns. The above two steps made it possible to determine the existence of a defined post-traumatic syndrome. The second main objective was simply to establish whether there was a dose-response relationship between the severity of the head injury and behavioural sequelae.

Method: The areas examined included physical complaints, developmental problems, activity levels, social problems, disturbances of mood and control, neurotic behaviour and mental symptoms. Behaviour was rated: (a) prospectively by means of Graham and Rutters' Parental Questionnaire (1968) which was completed both at intake and follow-up, and (b) retrospectively by means of parental interview at one year follow-up. Questions from (a) were scored in terms of the applicability of the problem, i.e. whether it applied at all, applied somewhat, or applied strongly. Questions from (b) were scored for both prevalence and incidence. Prevalence was determined by an absent/present rating at one year follow-up. Incidence referred to the rating of behaviour on the basis of post-traumatic origin or exacerbation. Results were analysed using χ^2 tests and each

head-injured group was compared to the control group. Data from the Graham and Rutter Questionnaire was grouped into scales, together with information obtained on ten factors of psychosocial disadvantage. The behaviour and disadvantage scales were used for the formation of log-linear models.

Results: The findings indicated that the moderately, severely and very severely head-injured children all developed behavioural and physical problems in the post-traumatic period. There was evidence of symptoms comprising a post-traumatic syndrome in each of the head-injured groups and the proportion of children affected tended to increase linearly with severity of injury. Behavioural problems involving emotional control were strongly related to severity of injury. Loglinear analysis revealed that severity of injury was influential in the development of problems relating to oppositional and disinhibited behaviours whereas psychosocial adversity and pre-morbid disturbance were related to the production of developmental, activity and peer-related problems.

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CHAPTER 1
LITERATURE REVIEW

1.1 Introduction

In a retrospective investigation into the causes of non-natural deaths occurring between 1966 and 1981 in the Cape Peninsula, Knobel, de Villiers, Parry and Botha (1984) found that of 3248 medicolegal autopsies carried out on children aged under 15 years, a quarter of the children (819), had died from a head injury. A parallel study of the patterns of accident conditions (de Villiers, Jacobs, Parry & Botha, 1984), led to the development of a prospective multi-disciplinary study of head injury in children in the Department of Neurosurgery at the University of Cape Town. As part of the Head Injuries Research Project, Theron (1987) investigated factors of psychosocial adversity surrounding paediatric head injury and Hemp (1989) studied the neuropsychological outcome of a subgroup of this sample. The present study examines the behavioural outcome in a subgroup of the children studied by Theron (1987) and Hemp (1989).

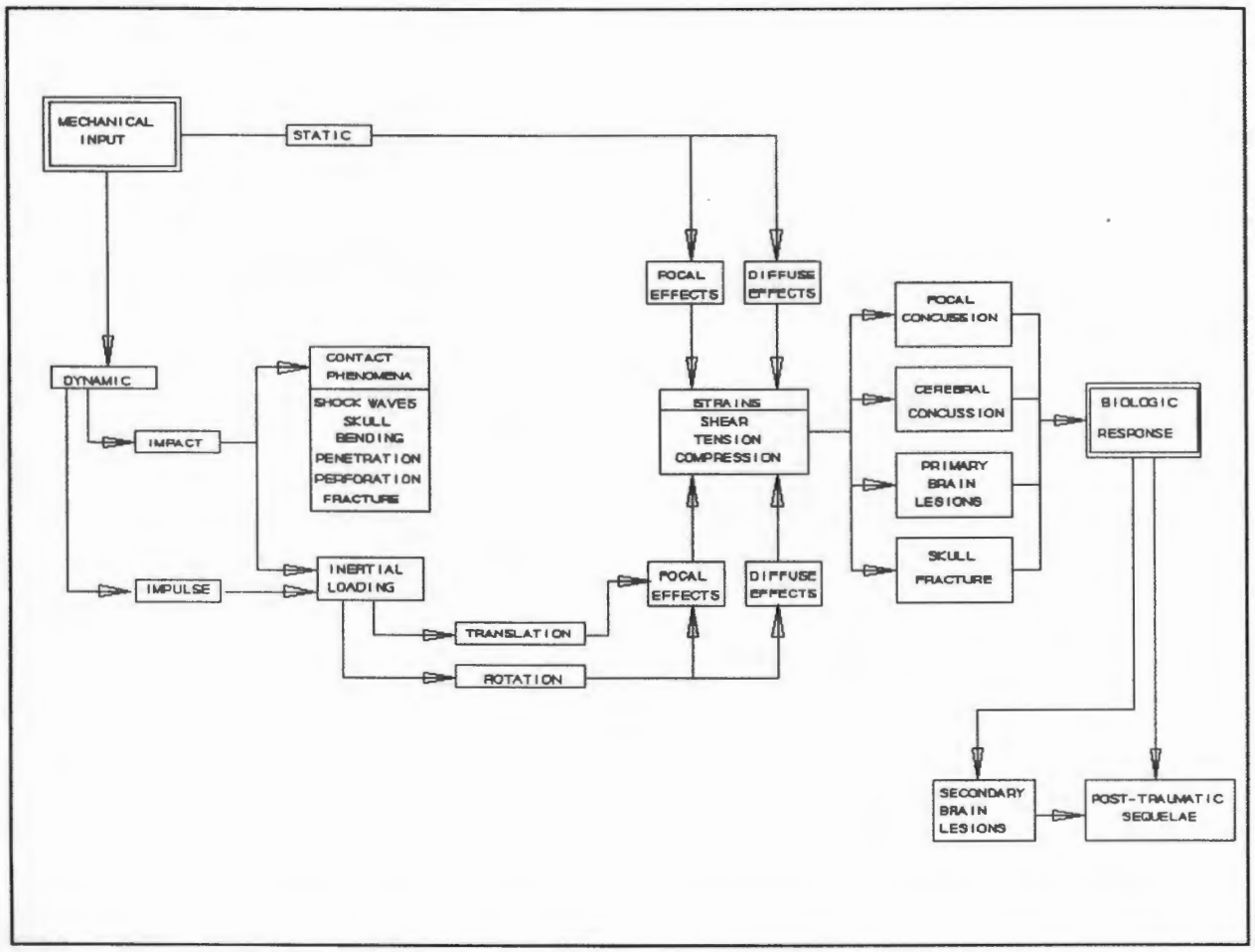
1.2 Brain injury

Figure 1 illustrates the mechanics of head injury. Brain injury may be focal and/or diffuse. Focal effects are associated with static impact (such as crushing injuries), with dynamic impact (such as falls from heights) and with the translational (linear) component of impulse injury. Diffuse injury results most commonly from the rotational component of acceleration- deceleration injury and is frequently associated with motor vehicle collisions.

2.1 Type of damage

Apart from the damage caused by the primary injury, secondary damage may result from the brain's response to oedema and/or cerebral swelling, intracerebral haemorrhage and hypoxia . All of the above may lead to an increase in intracranial pressure. Raised intracranial pressure has the effect of compromising cerebral

Figure 1
A flow chart for critical factors in the mechanics of head injury*



* Taken from Ommaya (1982), In J. R. Youmans (Ed.), p, 1880

perfusion which may in turn lead to infarction or tissue death as a result of regional blood deprivation and herniation or structural displacement of brain tissue. That disturbances of cerebral perfusion or of systemic blood supply play such a central role in the development of brain damage may be understood in the light of the fact that the brain is totally dependent on blood for provision of oxygen (Jennett, 1976; Pang, 1985). Thus the brain is affected quickly and critically by changes in oxygen supply. Complete anoxia leads to loss of consciousness within seconds, and death within 5-10 minutes (Adams & Victor, 1981).

1.3 Grading of injury

Consciousness is the state of awareness in the organism which is characterised by

maximum capacity to utilise its sensory input and motor output potential in order to achieve accurate storage and retrieval of events related to contemporary time and place, (Ommaya, 1963).

The studies cited below have categorised the severity of head injury according to the level of conscious or the length of post-traumatic amnesia (PTA), or both.

1.3.1 Level of Consciousness

The Glasgow Coma Scale (GCS) devised by Teasdale and Jennett (1974) permits determination of impairment of consciousness by rating eye opening (E), motor (M) and verbal (V) responses without reference to site of dysfunction. The responses to testing are scored giving a total derived from E + M + V with a range of 3 to 15. Coma is defined as: not opening the eyes; not obeying commands and not uttering comprehensible words. Patients in coma score 8 or less and are referred to as "severely" injured. A score of 9 to 11 indicates a "moderate" injury. Conscious patients score the highest and a score of more than 12 indicating some impairment of consciousness, is termed a "minor" injury (Bond, 1983). The GCS is tabled in Appendix A.

1.3.2 Duration of PTA

A traumatic insult to the memory mechanisms can occur with complete sparing of the neural basis of alertness. In moderate to severe concussion, although both systems are usually affected together, they are not equally vulnerable. Alertness is restored first while impaired memory almost always lasts longer. It might be expected therefore that amnesia would occur in the presence of retained alertness, (Fisher, 1966).

The time between injury and recovery of continuous memory is the period of post-traumatic amnesia (Russell, 1932). In his original paper, Russell related the length of PTA to the severity of injury in the following way :

PTA less than 1 hour = Mild injury
PTA 1-24 hours = Moderate injury
PTA 1-7 days = Severe injury
PTA > 7 days = Very Severe injury

It should be noted that in some of the literature (e.g. Brown et al., 1982), the term "Mild" is used in a less literal sense than was intended by Russell. In these cases "Mild" does not necessarily denote PTA less than one hour but refers to damage which is less than "Severe". Moreover, it is common practice to refer to all injury with PTA more than one day as "Severe".

1.4 Scope of the problem

The main problem in understanding the behavioural outcome of head injury seems to be to *evaluate the strength of aetiologically diverse factors as they relate to the type of outcome.*

The nature or type of sequelae may be broadly divided into those problems associated with milder forms of head injury and which constitute a post-traumatic syndrome (PTS) and residua which are associated with more severe brain damage (Jennett, 1972). The features of the post-traumatic syndrome are set out below and severe damage is dealt with in section 1.7.4.1).

1.4.1 Post-traumatic syndrome

McLaurin and Titchener (1982, p 2175) have stated that : "A syndrome includes a set of symptoms or signs that lead to a specific disease diagnosis, the elements of which can be attributed to certain patho-physiological mechanisms. By definition the post-traumatic syndrome should include all the consequences of head injury." This is in theory. In practice, the PTS is usually associated with milder forms of head injury such as transient stunning or concussive blows.

In less recent literature, the post-traumatic syndrome is also referred to as the post-

concussional syndrome. As such, it denoted an essentially reversible syndrome without detectable pathology. This implies a difference in meaning between head injury and brain injury: Concussion indicated the loss of consciousness and associated traumatic amnesia which occurs as the consequence of head trauma in the absence of physical damage to the brain. It suggested a clinical syndrome involving immediate and transient impairment of neural function such as alteration of consciousness, disturbance of vision and equilibrium. It was therefore thought to be characterised by the striking reversibility of the traumatic loss of consciousness.

Important studies by Ommaya and Gennarelli (1974) inter alia, have shown that structural damage does accompany transient stunning (see 1.7.4.2 below).

These results led to preferential acceptance of the term "post-traumatic" over post-concussive since post-concussive connotes non-structural brain damage. On the other hand, it does seem that in some circles, the use of "post-traumatic" rather than "post-concussive" might reflect some scepticism still that such injuries are a serious or respectable area of inquiry (Alves & Jane, 1985; Adams & Putnam, 1991).

Symptoms may of course be prevalent in severely injured patients as well, but they assume a lesser significance in comparison to the striking visibility and profound disability of deficits following more severe injuries (Alves & Jane, 1985 p 265). The usual components of the PTS are : Headache, fatigue, sensitivity to noise, irritability and a decrease in concentration (Jennett, 1972; Binder, 1986; Lishman, 1988) and are overwhelmingly of a subjective nature (more symptom-like than sign-like) (Lishman, 1988). It is this complex interplay between the objective and subjective that makes post-traumatic symptoms so hard to unscramble in aetiological terms.

1.5 Key issues

It is submitted that the key issues in evaluating the behavioural sequelae of head injuries in children are whether:

(1) A control group is used to identify post-traumatic symptoms;

(2) Pre-injury behaviour is taken into account;

(3) The direct influence of organic factors on behaviour are considered;

(4) Possible psychosocial third variables are considered;

(5) Factors of secondary psychological gain are accounted for.

1.6 Scope of the review

For the present study, an initial list of studies covering 1980 - 1989 was generated by means of the MRC's Medlars II. The search was based on the following key phrases: "head injury"; "mild and severe head injury"; "prospective study"; "behavioural response to trauma"; "brain-behaviour" and "psychological sequelae to head injury".

Of the 85 papers produced, only one study (Brown, Chadwick, Shaffer, Rutter & Traub, 1981) was closest to the present study in terms of the key issues as well as inclusion of a 1 year follow-up assessment. In fact, the present study was largely based on the methodology and findings of the Brown et al., (1981) study but with one notable modification, namely the composition of comparison and "control" groups. (see section 1.7.1.1 below).

The remainder of the papers were made up of the following:
Three studies dealt with behavioural outcome in children, and although they do not address all the issues, they are nevertheless referred to below (Casey, Ludwig & McCormick, 1986, 1987; Farmer, Singer, Mellits & Charney, 1987); 9 studies dealt with behavioural sequelae to traumatic head injury in adults; 5 with behavioural response to traumatic burns in children; 6 examined perinatal head injuries; in 9 studies the subjects were toddlers or infants; 15 investigated performance on psychological tests; 5 dealt with functional lateralisation; 11 were based on neurological syndromes in terms of medical and surgical variables; there were 4 case studies and 9 review articles; 8 papers were not available in English.

Together with references cited in some of the more comprehensive review articles from the Medlars search, namely (Black, Blumer, Wellner, Shepard & Walker, 1981; Rutter 1981, 1982; Szatmari, 1981; McKinlay & Brooks, 1984; Binder, 1986; Filley, Cranberg, Alexander & Hart, 1987; Lishman, 1988; McClelland, 1988), a manual

search of Index Medicus and Psychological Abstracts located a few relevant original papers spanning the early 1960's to 1980. Keeping in mind the central issues, there are a total of 6 core studies dealing specifically with behavioural sequels in children, that can meaningfully be related to the present study,. (Hjern & Nylander 1964; Black, Jeffries, Blumer, Wellner and Walker, 1969; Klonoff, 1971; Klonoff & Paris, 1974; Shaffer, Chadwick & Rutter, 1975; Brown et al., 1981). In addition to these 6, various other pertinent cognitive and psychosocial studies are examined below.

1.7 Evaluation of the principal studies in terms of the key issues

1.7.1 Is identification of post-traumatic symptoms based on the use of a control group?

A non-head-injured control group needs to be used in order to separate the effects of trauma from the effects of the head injury itself (Rutter 1980; 1981).

Black et al., (1969) state that whereas head-injured adults have physical complaints, this is not the case in children, in whom the tendency is towards behavioural change. For example apathy, irritability, problems with anger control and poor frustration tolerance are common. They studied 115 head-injured children of *mixed severity* aged under 14 years, with or without coma, who presented with neurological dysfunction and signs suggesting involvement of the cranial or motor nerves. Siblings acted as controls. Dominant problems were headaches, difficulty with anger control, hyperactivity and impaired attention. Discipline problems, hypokinesis, eating and sleep disturbances were less frequently reported.

In general, these results were confirmed by the other child studies. However they did not reveal a complete absence of physical symptoms but this might be due to the inclusion of infants and very young children in the study concerned.

Hjern and Nylander (1964) researched 162 *mildly* head-injured children, aged between 0 to 14 years-old one month after injury, reassessed 155 five months later and compared them to an age-matched control group of 163 non-head injured children

receiving surgical care. Motor symptoms, restlessness, difficulties with concentration, enuresis and stammering were the dominant problems and were up to four times more common in the head-injured.

In Canada, Klonoff (1971) studied 384 *mildly* head-injured and 204 non-head-injured Controls aged between 2 months and 16 years. The head-injured and their controls were matched for age, school grade and race. In the children with disturbance at 1 year follow-up, the most common problems were : headaches followed by impaired memory and concentration; learning difficulties and lastly, dizzy spells.

In 1974, Klonoff and Paris conducted a rigorous follow-up study with 231 predominantly *mildly* injured subjects- 60% of the children had had loss of consciousness but the duration in most cases was under 1 hour. Head-injured children with ages ranging from 2.7 to 15.8 years were divided into one group of under 9 year-olds and another of over 9-year olds. Although a control group was used, behaviour rates for Controls were not stated. They noted that the rank order of the most frequent complaints elicited 1 year after trauma was: headaches, personality changes, dizziness, learning difficulties, irritability, fatigue and visual or auditory defects. The same problems were still in evidence at 2 year follow-up. In older children there was a decrease in headaches from 36% to 23% between the first and second year. Most symptoms showed a similar decrease in incidence with the exception of poor memory/concentration which increased from 10% to 14% in older children.

Shaffer, Chadwick & Rutter (1975) studied 98 head-injured children of *all severity gradings* with a compound depressed fracture and associated dural tear. All the children had had their injury at least two years prior to the inquiry. These children were matched for age, between 5 and 15 years, with 98 Controls who had no injury whatsoever. Post-traumatic problems were more frequent and severe in the head-injured than in Controls.

Brown et al., (1981) based a comprehensive study on 29 *Milds* and 31 *Severes* and matched both groups on age, sex and social class with an orthopaedically injured

control group of 28 children. New psychiatric disorders, i.e arising post-traumatically, were 2-3 times as frequent in the severe group as in either Controls or Milds. They found that tantrums, hyperactivity and disobedience occurred less commonly as new post-traumatic problems. Apart from disinhibition (see section 1.7.4.1.1) only overeating, slowness and distractibility occurred more frequently in the Severe sample.

The Brown et al. (1981) study deviated from the conventional categorisation of severity laid down by Russell (see p 4 above). The following should be noted for purposes of comparison with the present study. The term "Severe" injury which refers to PTA > 7 days in the Brown study corresponds to "Very Severe" injury in the present study. The term "Mild" injury which spans PTA ranging from more than 1 hour to less than 7 days (Rutter et al., 1980; Brown et al., 1984) is divided in this study into Moderate cases with PTA of between 1 and 24 hours and into Severe cases with PTA of more than 7 days.

1.7.1.1 Objections to a methodological strategy employed by Brown et al. (1981)

Although the above-mentioned study did have a control group comprised of non-head-injured children, certain analyses involved the formation of another comparison group. In an attempt to identify new problems at follow-up, children who had been in PTA for at least a week and who had not experienced any pre-morbid problems were compared to a combined group of (a) Severes who had pre-injury problems and, (b) Controls and Milds with either pre- or post-accident dysfunction. Several objections may be made to this strategy of obscuring the boundaries of the control group. In the first place, it fails to examine the possibility that Milds with pre-injury problems have the potential to develop problems or experience an exacerbation of existing problems, in the post-traumatic period. This is important because a worsening of certain problems might be more distressing than mild problems presenting for the first time.

Secondly, not attempting to differentiate between various kinds of pre-morbid behaviour in the 3 groups in (a) and (b), makes it impossible to answer the following

question : " Are the behavioural factors that place children at risk for incurring a head injury, also risk factors for problems after the injury?" One must concede that this strategy for dividing groups was based on severity of injury, rather than on a more vague description of abnormality. However it does seem that there was not enough critical evaluation of the type of pre-morbid dysfunction, especially when one considers the importance of hyperactive, neurotic and oppositional disorders in childhood psychopathology. Many other studies are also guilty of this imprecision and the most common description of pre-injury behaviour seems to be "acting out".

Thirdly, the fact that the head-injured were matched with Controls on demographic variables means that any further systematic matching, or overmatching, in this case on the presence of pre-morbid problems, could lead to the ironic effect of systematically unmatching subjects on other variables of interest, (Meehl, 1970). It seems that pre-morbid behaviours should be regarded as dependent rather than as classificatory variables.

1.7.1.2 Overall rates of disturbance at follow-up

In spite of the rigorous nature of the key studies, there was an overall low rate of positive findings - particularly with lesser degrees of severity. For example, in the three investigations dealing with mild injury, behaviour disturbance was found in only 10% of the children at follow-up. However, judging from mixed severity studies, the rates did seem to increase somewhat. In the Black et al., (1969) study, 80% of the children were behaviourally unchanged at one year follow-up and in the Shaffer et al., (1976) study 38% of the head-injured as compared to 18% of the control group subjects were affected. It is not possible to extrapolate corresponding rates from the data presented in the Brown et al. (1981) study.

1.7.1.3 Some negative results

Post-traumatic symptoms appeared to be absent in two recent studies of minor head-injury. However the follow-up period in both studies was too short to investigate the development of subjective symptomatology.

Casey, Ludwig and McCormick (1986) conducted a prospective study of 321 children, 6 months to 14 years of age, who had sustained a minor head injury. One month after injury, physical complaints were rare, and headache, the most frequent PTS complaint, occurred in only 7% of the children. There were significantly more behavioural problems than reported for the standard normal population.

Farmer, Singer, Mellits and Charney (1987) investigated children younger than 13 years with minor head trauma by means of parental telephone interview. At two months post-injury headaches arose post-traumatically in only two percent of all children (n = 212) and in none of the Controls (n = 249) who had suffered trauma to other regions of the body.

1.7.2 Is pre-traumatic behaviour taken into account?

Because PTS symptoms are subjective and not directly accessible to observers, minor head injury generates the greatest controversy regarding psychological and organic factors in their causation. When the sole objective evidence (Lishman, 1988) of sequelae is to be found in social behaviour, it becomes important to consider sequelae in the light of pre- traumatic state, since a head injury may be incorrectly blamed for what may be a longstanding behavioural problem (Jennett, 1972). Underlying this thinking is the central hypothesis, namely: If certain types of pre-morbid behaviour act as risk factors for or somehow cause a head injury, and if a head injury leads to further behavioural problems, then pre-accident dysfunctional behaviour is an indirect cause of post-traumatic problems. Schematically,

$$a \rightarrow b \rightarrow c$$

If a causes b and b causes c, then a causes c (indirectly); where, a = pre-morbid behaviour, b = head injury and c = post-traumatic symptoms.

1.7.2.1 Rates of pre-morbid disturbance

The study by Black et al., (1969) revealed comparable rates in pre-accident disturbance in the head-injured and their controls. New PTS symptoms presented in 22% of children without pre-morbid problems and in 18% of those with earlier disturbance. Furthermore, a third of the children with follow- up problems (6.6%) had experienced at least one of the problems pre-traumatically. Thus, both pre-traumatically normal and abnormal children shared a potential for the development of symptoms (Black et al, 1971; 1981).

In the Brown et al., (1981) study, data on pre-morbid behaviour was collected at hospital intake and data on follow-up behaviour was collected at 4 months, 1 and 2 years follow-up Problems arising post-traumatically were 2-3 times as frequent in the severe group as in either Controls or Milds. The pre- morbid history of Severes revealed that 14 were without prior behavioural abnormality and of these, only 4 had definite problems at 1 year follow-up. Of 11 who had experienced slight problems previously, half developed new problems. More interesting was the finding that overall, 11% of Controls, 14% of Severes and 31% of Milds were disturbed before their injury.

Shaffer et al. (1974) ascertained that 14 of the Severes in their study were without prior behavioural abnormality and of these, only 4 had definite problems at 1 year follow-up. Of 11 who had experienced slight problems previously, half developed new problems. All of the remaining six Severes who had definite pre-injury problems acquired new post-injury disturbances.

The most common problems after head injury in the Hjern and Nylander (1964) study had a pre-traumatic origin in nearly all cases.

Thus, the demonstration by longitudinal method that head- injured children had pre-morbid behavioural disturbance was provided by most studies.

1.7.2.2 Non-randomness hypothesis

1.7.2.2.1 Accident-proneness

Since Freud's formulation of the notion of accident-proneness (cited in Frankl, 1963), researchers have identified psychological features typical of accident repeaters. For example, Manheimer and Mellinger (1967), identified 684 four to eighteen year-olds as belonging to low-, intermediate- and high- liability groups according to rates of accident repetition. Boys exceeded girls by ratio of 2:1 in all groups. They found that accident liability was enhanced by behaviours that were presumed to increase exposure to hazards. Common behaviours were high activity level, extraversion and rough-housing for both sexes and better than average athletic ability and daring behaviour in the case of boys. Attention was also given to psychological states that might influence a child's response to hazards. It was found that, particularly with boys and to a lesser degree with girls, oppositional behaviour which centred around the child's relations with authority figures played a role. Attention-seeking behaviour was indicated to play an important role in increasing accident liabilty in girls. Peer relations were marked by aggressiveness and the need to show off. Lack of self control as evidenced by poor tenacity, low frustration tolerance, impulsivity as well as mood variability all related to increased liability. It was hypothesised that the combination of the above characteristics acted in such a way as to compete with whatever desire children might have had to avoid dangerous situations and reduced their ability to cope with exposure to the danger. Thus, the probability of sustaining accidents was increased by the acting out of certain risk-enhancing behaviour patterns.

1.7.2.2.2 Accident-proneness and head-injured children

Partington (1960) refuted the role of accident proneness in the aetiology of paediatric head injuries. In a test series of 1180 moderately head-injured children studied, less than two per cent had suffered previous injuries. The only increase in liability was associated with gender and boys were found to outnumber girls at a rate of 2:1. In a second series, 30 Moderates were matched with 30 non-head-injured, hospitalised controls on age and social class. There were significantly more siblings

and relatives living with the families of the head injury group. No significant differences were found in the incidence of past injuries. The author concluded that the tendency to repeat accidents definitely did not play a role in the aetiology of head injuries. Comparing head injured to Controls, there were hardly any differences in the rates of previous accidents. Generalisations regarding accident-proneness in head-injured are found to be unwarranted in the present review.

However the key studies have shown that gender was repeatedly related to vulnerability; boys have been shown to be more predisposed to head injuries than girls.

1.7.2.2.3 Pre-morbid behaviour and accident type

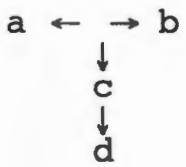
It is interesting that in the Brown et al. (1981) study, 41% of the Milds were likely to have been engaged in some dangerous or forbidden activity at the time of their accident as opposed to 18% of Severes. There was consequently a wider variety of accident type in the case of Milds: whereas 82% of Severes were pedestrian accidents, only a third of Milds were pedestrians and a third of the injuries were caused by falls with the remainder due to other causes.

Klonoff (1971) also noted that whereas falls were the most common type of accident (up to 75%) followed by vehicular accidents in the head-injured, this order was reversed in Controls. This distribution of accident type in mildly head- injured subjects was confirmed by Hjern and Nylander (1964). These differences in accident type seem to embody the pre-injury behavioural differences found with different severity gradings. For example children play a more active role in falls than they do as passengers in motor vehicle accidents. Considering that the less severely injured are more behaviourally disturbed prior to their head injury, it becomes possible to hypothesise that there are covert links between pre-traumatic behaviour patterns and the outcome of head injury which are mediated by accident variables.

1.7.3 Are possible psychosocial third variables taken into account?

The notion of accident-proneness has fallen into disrepute due to its connotation with a policy of "blaming the victim" (Rivara, 1982) and inability to account for social influences in the aetiology of disordered behaviour. Nonetheless, the interest aroused by the knowledge that children express mental conflict in bodily terms, focussed new attention on the quality of behaviour patterns that precede an injury and led to the hypothesis that when childrens' behavioural repertoire includes risk-promoting activities, this is not independent of, but related to and modified by external, situational factors. While accident proneness may not play a central role in the chain of events leading to a head injury, the studies cited below show that low SES, associated social problems as well as the presence of pre-morbid problems are over-represented in samples of head-injured persons.

A confounding variable is an extraneous variable that is both associated, in a non-causal sense, with the neurological risk factor and is also a risk factor for the behavioural outcome, (Schesselman, 1982). Psychosocial adversity cannot itself cause brain injury but increases the chances of risk-promoting behaviours and continues to exert a negative influence after the injury (Szatmari, 1985). Schematically,



Where a = psychosocial adversity, b = pre-morbid disturbance, c = the head injury and d = post-traumatic problems.

1.7.3.1 Factors acting on the child

Dershewitz (1977) has stated that the majority of accidents do not occur to the accident repeater and supports this by referring to the finding, that of 6270 children admitted to hospital for injuries, 29% reported one accident in the previous year and

only 12% had had three or more accidents. He stated that in cases where accident repetition was prevalent, living conditions, supervision of the child, one-parent familes and maternal illness needed to be investigated. Recent support for defining the concept of accident susceptibility to include environmental conditions leading up to and surrounding the injury was provided by Husband and Hinton, (1972); Jones (1980); Wadsworth, Burnell, Taylor and Butler (1987). Husband and Hinton (1972) studied 24 children whose ages ranged from 3 to 14 years, who were admitted to hospital for accident treatment and who had incurred at least two accidents during the past 12 months. Although they found no difference between the average number of accidents for males and females, the presence of overt psychiatric or serious organic illness in other members of the family occurred in over half of cases. Wadsworth et al, (1987) conducted a study based on the health and social information obtained at birth of 17588 children and followed-up 80% of the original sample 5 years later. They found that two or more accidents was related to sex (a boy to girl ratio of nearly 2:1), frequent household moves and the child's behaviour.

In a review article, Jones (1980) cited numerous studies which indicated that features such as aggression, rebelliousness, impulsivity and increased motor activity were common in accident repeaters. This list correlated positively with family backgrounds characterised by broken homes; unsatisfactory housing ; anxious nonassertive parents and limited closeness in the family. Thus it appears that accident susceptibility is not a random phenomenon.

1.7.3.2 Psychosocial adversity and head-injured children

The Klonoff studies, (1971; 1974) do not contribute very much to our understanding of how adversity affects dysfunctional behaviour.

Klonoff (1971) reported that the head-injured were more often found living in congested areas, poorer income housing and to have come from families with marital instability and low occupational status. Ten per cent of the head-injured had psychological problems at follow-up. These children were not differentiable from the remainder in terms of background characteristics. It was not stated what the rate of

disorder was in Controls.

In the Klonoff and Paris (1974) study, details of antecedent factors were collected at 1 year. Post-hoc comparison between disturbed and normal subjects in terms of antecedent conditions yielded no significant findings.

By contrast Hjern and Nylander found an almost complete overlap between adversity and pre-injury dysfunction in the head-injured. This work strongly suggests that adversity is, as hypothesised, a third variable that underlies both pre-traumatic high risk actions aand post-traumatic sequels. They reported that a higher frequency of head-injured (26%) than Controls (10%) had mothers who were "mentally insufficient", i.e with psychiatric disturbance. The head-injured came from home environments characterised by psychic tension and anxiety. Motor symptoms, restlessness, difficulties with concentration, enuresis and stammering were the dominant pre-injury problems and were up to four times more common in the head-injured. Not a single patient who came from a normal home environment and who had been free from symptoms previously, exhibited problems after sustaining the head injury. All the children who had post-injury problems (10% of the head-injured and less than 1% of Controls) came from insecure home environments and all, with the exception of one child, had pre-injury problems.

It can be surmised that adverse conditions in the home constitute a risk for incurring an injury: when parents are preoccupied with problems, this leads to diminished parental supervision and attention to the needs of children (Jones, 1980; Theron, 1987). The same factors presumably continue to exert some influence on the behaviour of children post-traumatically.

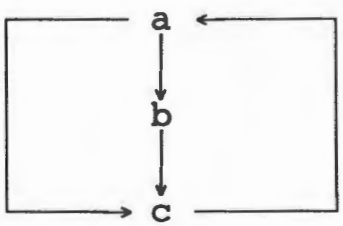
It is also intuitively clear that in cases where stress is prevalent in the community, this would have an unsettling effect on families. A finding which is pertinent to the present study is that after the Sharpeville unrest, there was a marked increase in accidents, fires and non-natural deaths, (Shaw & Sichel, 1961).

As mentioned above, in the Shaffer et al. (1974) study, pre-morbid problems seemed

to compound with severity, (see 7.2.1). It was also noted that of the disturbed children with a head injury, over 40% came from unhappy homes, in 44% of cases the mother had psychiatric problems and 33% came from families containing four or more children. Other variables related to disturbance were: broken home, unhappy marriage and contact with two or more social agencies. Psychiatric problems in the head-injured were unrelated to age, locus of injury and duration of coma. The authors concluded that problems were due to both family stresses and brain damage.

Unfortunately, Black et al. (1969) did not investigate psychosocial adversity.

However the Brown et al. (1981) study revealed an interesting contrast to the Shaffer (1975) investigation. The association between psychosocial adversity and pre-injury disturbance was comparable between Severes and Controls but follow-up disturbance was raised in those Severes who also had a background of adversity. Conversely, in the mild group, psychological problems at follow-up did not relate to adversity and pre-morbid problems were more influential irrespective of the presence of disadvantage. Although adversity does not underlie pre-morbid problems, its effects somehow become compounded with severity of injury. And yet in Milds, pre-morbid behaviour is more influential on its own than when combined with adversity. The reason for this is not clear. Perhaps Milds are more resilient in the face of adversity than are Severes. Rutter (1977) has suggested that parents tend to focus negatively on children with temperamental difficulties. This represents a *transactional* effect in which the presence of a problem (head injury) increased the frequency or amount of psychosocial adversity (parental scapegoating). Schematically,



Where a = psychosocial adversity, b = the head injury and c = post-traumatic problems.

In a study of 157 children with cerebral palsy, myelodysplasia or multiple handicaps compared with 339 Controls, Breslau (1990) found no support hypothesis that brain dysfunction renders children vulnerable to environmental stress. However the study is not directly comparable to head injury which involves acquired rather than congenital brain damage.

The transactional link may be contrasted with a situation in which increased susceptibility (high risk behaviour) *interacts* with psychosocial adversity (lack of parental attention). Furthermore the disinhibited behaviour of some head-injured children might provoke parental resentment. Either way, it certainly seems possible that the more severely injured are especially vulnerable to disadvantage.

1.7.4 What evidence is there of direct organic influence on behaviour?

However, the presence of premorbid problems and psychosocial adversity in the background of patients with PTS symptoms is not proof that PTS symptoms are of a psychogenic rather than a physiogenic origin. Studies have reflected an awareness of the danger of dichotomising complaints as either organic or psychological. Symonds (1942, cited in Cartlidge & Shaw, 1981 p, 147) remarked : " As to the distinction between physiogenic and psychogenic factors in a given case, they appear in most cases so closely intertwined that to separate them is unnatural. That a man with a hurt brain should have a disturbed mind is to be expected." There is also recognition that some symptoms may arise in response to organic damage but persist due to the development of a neurosis (Cartlige & Shaw, 1981; McLaurin & Titchener, 1982; Lishman, 1988).

It is now time to step aside from the details of potential risk factors for post-traumatic problems to consider the evidence of organic factors on behaviour.

1.7.4.1 Severe damage

Whether diffuse or localised, damage predominantly to the cerebral hemispheres, brain stem, cranial nerves, cerebellum and motor nerves gives rise to physical symptoms such as dysphysia, hemianopia, motor and perceptual disorders (Jennett, 1972). Apart from the above, generalised brain damage leads to marked personality changes such as apathy, lability and a lack of social restraint as well as intellectual deficits and memory impairment. Localised trauma within the frontal lobe areas leads to disinhibition see section 7.4.1.1 below). Focal damage to the right hemisphere produces visuo-spatial disturbances whereas damage to the left hemisphere results in verbal deficits (Jennett, 1972; Lishman, 1978).

1.7.4.1.1 Behaviour change

There is evidence that in childhood, active disturbance of brain function has a greater effect than loss of function and children may be better off with only one hemisphere than with two, if one is producing active electrical disturbance, (Rutter, 1977). The question surrounding the role played by epilepsy for the production of dysfunctional behaviour is therefore important.

Rutter, Graham and Yule (1970) executed an epidemiological study examining the psychiatric status of all children living on the Isle of Wight known to have either epilepsy or brain damage or both. Because these children had indisputable neurological conditions, it was possible to compare them in terms of psychiatric disorder with the general population. It appeared that epilepsy does not unconditionally affect behaviour. Psychiatric problems were commoner in children with low I.Q and in cases of psycho-motor epilepsy. Behavioural reports revealed that the rate of psychiatric disorder was double in the brain damaged group and was even more frequent in brain damaged children with epilepsy. Apart from this investigation, very few studies and none of the key studies reviewed here, explicitly mention epilepsy.

Brown et al. (1981) wanted to establish whether symptoms in Severes were caused by severity of brain damage. The Severes were divided into those with PTA of 22 days and those with PTA of 7-21 days. The only post-traumatic symptom increasing with PTA was distractibility.

Apart from the above, the only other statistically significant pattern of behaviour found in the Rutter-Brown study was one of disinhibition, a pattern of behaviour characterised by social insensitivity, overtalkativeness, impulsivity and a tendency to make make embarressing remarks . Disinhibition was found to distinquish the Severes from both Moderates and Controls ($p=0.037$). Although site of lesion was not stated, this cluster of behaviours is reminiscent of the frontal lobe syndrome found in adults. The effect on personality of bifrontal lesions was demonstrated by the celebrated case of Phineas Gage who in 1848 had a crowbar driven through the front of his skull. He was described as "fitful, irreverent, indulging at times in the greatest profanity, maintaining but little deference for his fellows, impatient of restraint, at times obstinate, yet capricious and vacillatory" (cited in Walton, 1989). Thus, a "frontal lobe syndrome" has come to be recognised.

It was discussed earlier that the study appears to suggest that very few problems arose in response to severity of brain injury since organic factors played a role only in the case of Severes whereas pre-traumatic psychological problems were more influential in the case of Milds. It seems that the most meaningful data in this study would be those in which symptoms are absent in the comparison group.

As children become more cognitively advanced they acquire more social knowledge and are able to form more complex and organised ideas about people (Shantz, 1983). This type of social cognition involves judgement and the ability to regulate behaviour within a social framework. Thus, although disinhibition is reflective of a lack of affective control, it is equally a deficit of higher cognitive control.

1.7.4.1.2 Cognitive deficits

Whereas the type of cognitive deficit depends largely on the site of brain damage and the extent to which damage is isolated, the persistence of sequelae depend on the severity of damage (Jennett, 1972; Newcombe, 1981). Chadwick, Rutter, Brown, Shaffer & Traub (1981) have stated that the presence of a recovery pattern provides a strong indication that the initial cognitive deficit was a consequence of acute damage whereas the absence of a pattern reflects either extremely severe damage or the influence of prior intellectual limitation. Localised damage produced by skull penetration resolves more quickly i.e reaches a peak and therafter levels off sooner than is the case with diffuse damage caused by closed head injuries (Alexander, 1982).

Overall cognitive impairment has been found to be long-lasting with severe injuries. For example, Richardson (1963) noted a loss in IQ of 10 to 30 points from pre-injury to one year follow-up in children who were in PTA longer than 7 days. Heiskanen and Kaste (1974) predicted that more than 50% of children with a coma lasting more than two weeks would not regain their previous standard of cognitive functioning. Stover and Zeiger (1976) have stated that a coma lasting more than a week makes return to pre-injury status highly unlikely.

With regard to specific deficits, comparisons of neuropsychological profiles have shown that the pattern of deficit after severe injury is more distinctive than are those after mild and moderate injury on measures of performance IQ, motor speed, fine-motor coordination, tactual-visual functions and verbal fluency (Winogron, Knights and Bawden, 1984). In general, visual/ perceptual and visuo-motor deficits are more resistant to recovery than are verbal abilities (Chadwick et al., 1981).

1.7.4.2 Mild and minor damage

As Adams and Putnam (1991) have put it:" ... those relying on a postconcussion syndrome should not ask others to accept on faith that symptoms are due to a change in the biological substrate."

The structural and physiological dysfunction associated with mild injury is dealt with by Pang (1985). In his discussion of "minor concussive trauma", Pang has suggested that the persistence of problems in the mildly head-injured is due to the fact that the pathology involved is incompatible with recovery. He has drawn attention to experimental findings which show that even transient loss of consciousness results in structural damage to certain brain stem nuclei. It has also been demonstrated that non-brain stem damage is more diffuse than once supposed, and may affect higher cortical functions. Centripetal forces cause greater damage in the temporal lobes and limbic system (dealing inter alia, with emotional association and memory) than in the mesencephalon (including the cerebellum and pons and mediating among other functions, fine motor movements).

Strich (1969; 1970) and Pilz (1983) have ascribed microscopic structural changes, as evidenced by diffuse axonal injury in the absence of gross brain lesions, to non-impact angular acceleration of the head. Such damage takes the form of "retraction balls" (RB) or "trackless lesions" which are produced at the ends of a severed axon. Pilz (1983) noted from histological evidence of head injury cases involving unconsciousness of only a short time that there was a high incidence of mild axonal injury i.e where there were a few RB's which were not numerous or widespread.

Structural changes have been produced experimentally in subhuman primates using non-impact controlled acceleration of the head (Ommaya & Gennarelli 1974). It was postulated that patients with mild head injury experience similar diffuse axonal injury. The animal experiments produced profound behavioural deficit. However damage was sustained through non-impact acceleration and it can be surmised that the damage would be less severe in real life with humans since an impact would absorb a certain amount of energy transmitted.

In humans, diffuse axonal injury (DAI) occurs at the time of head injury. It is not due to complicating factors such as hypoxia, brain swelling or intracranial pressure, (Gennarelli, 1982).

The amount of DAI is directly proportional to the severity of injury (duration of coma

and quality of outcome) and is an important cause of prolonged coma, in very severe injuries, (Gennarelli, et al., 1982).

Evidence of physiological disturbance provided by Smith, Ducker and Kempe (1969) indicated that mean cerebral circulation time was on average, 15% slower in PTS patients than in control subjects who had a head injury but who were without PTS symptoms. In addition, abnormalities in electroencephalographic recordings of positional nystagmus i.e involuntary, rapid eye movements (Cartlidge and Shaw, 1981) as well as in brain-stem auditory evoked potentials (Rowe and Carlson, 1980) have been noted PTS patients. The time taken for improvement or resolution has not been documented.

1.7.4.2.1 Behaviour change

Klonoff (1971) found that in the 28 children with disturbance at 1 year follow-up, the most common problems were : headaches followed by impaired memory/concentration; learning difficulties and dizzy spells. These problems appeared to be unrelated to factors such as age, sex, intelligence, predisposing factors, PTA (which is not surprising since the sample was mildly injured) and quality of relationships. Only one variable, neurological signs at time of injury, discriminated between the sequelae and non-sequelae groups. In the Klonoff and Paris study, most symptoms showed a similar decrease in incidence with the notable exception of poor memory/concentration which increased from 10% to 14% in older children. Since sequelae were related to duration of unconsciousness, were unrelated to psychosocial history and showed some decrease over time, organic factors clearly played a decisive role.

The problems themselves are similar to those found by Hjern & Nylander (1964) although the origin of symptoms are different.

1.7.4.2.2 Cognitive deficit

Although it has not been possible for researchers to determine cognitive functioning prior to injury with the same precision allowed by neuropsychological testing after injury, some studies have attempted to control for pre-morbid problems by matching the head-injured with Controls in terms of school achievement (Klonoff, Low and Clark, 1977; Levin and Eisenberg, 1979; Rutter et al., 1980). Chadwick et al., (1981) observed minimal impairment in verbal IQ and slight deficits in performance IQ and concluded that persistent cognitive impairment in the case of minor injury is unlikely. Klonoff and Paris (1974) noted a slight reduction in overall intellectual problems between one and two years follow-up. Boll (1983) has also reported that while I.Q changes after mild head injury remit quickly, language, memory and attentional problems may be more persistent.

Klonoff, Low and Clark (1977) reported that over a fifth of children either failed or were placed in a special class for the first time after injury. Levin and Eisenberg (1979) found impairment on tests of visuospatial, somatosensory and language functioning were related to length of unconsciousness even within a mildly head-injury sample of children aged 6-12 years.

Organic factors are also influential when it comes to memory problems (Newcombe, 1981). They have been noted as distinct from other types of cognitive deficit in so far as they can coexist with an overall return to normal intellectual functioning (Newcombe, 1981) and are unrelated to either education or age (Levin, Eisenberg, Wigg and Kobayashi, 1982).

1.7.5 Are factors of secondary gain considered?

1.7.5.1 Insurance claims

Prior to the proof of structural and functional damage in milder injuries, one line of reasoning (Miller, 1961) argued for the development of neurotic or secondary gain in patients presenting with PTS symptoms. Furthermore, development of post-concussional symptomatology in adults has been related to the question of pending litigation and unsettled insurance claims and it has been suggested that symptoms are resistant to treatment and persist until compensation occurs. Miller (1961) stated that "accident neurosis" or "compensationitis" is notably more common in mild than in severe injuries.

Kelly (1975) investigated these assumptions and found that over two-thirds of head-injured adults of all severity gradings (n=106), developed a PTS. He noted that 76% of individuals, returned to work before settlment. Post-traumatic symptoms were indeed more common in milder (88%) than in more severe (46%) injuries. McKinlay, Brooks and Bond, (1983) also found that patients pursuing compensation claims had higher rates of subjective complaints than patients not involved in litigation.

It has not been documented how parental desire for compensation may affect symptoms in the child but some studies do suggest that not only the attitude of authorities but also the beliefs of family members may influence the production of symptoms. In the Hjern and Nylander (1964) study, over one-third of the patients' families believed that head injury was a serious condition which gives rise to lifelong mental effects. Furthermore, 17% of children whose parents who did not receive reassurance through counselling after the injury, developed behavioural problems whereas only 6% of children whose parents who were given psychological counselling displayed symptoms. Parental anxiety and over-reaction has also been found to be positively related to the development of behavioural problems in mildly injured children (Casey, Ludwig and McCormick 1987).

1.7.5.2 A iatrogenic effect

Kelly (1975) identified one group of patients (n=76) for whom no attempt at treatment for post-traumatic symptoms had been carried out. Of these, only 14% returned to work free of symptoms before settlement of a pending insurance claim. Identification of a second group (n=30) comprised of patients who had received treatment for their symptoms revealed that 83% had recovered and returned to work before settlement. Finally, none of a group of five patients who were discharged from hospital while still amnesic had recovered and returned to work. He concluded that persistent disability due to a PTS were not motivated by a desire for damages but were instead, a function of the attitude of health care professionals.

Apart from the negative effects of witholding treatment examined in the study by Kelly, another study has emphasised that outcome may be influenced by bias on the clinicians part towards outcome. Hart and Faust (1988) demonstrated that of 120 clinicians, who had received identical case hisories except for the age of the patient, 116 made predictions concerning the outcome of paediatric head injury solely on the basis of the patient's age. Adolescent cases were judged much more likely to have serious impairment than child cases.

1.8 Conclusion

Table 1 summarises the main findings for the key studies.

Table 1
Summary of significant findings of the principal studies

Study	Pre-morbid	Psychosocial	Organic	Secondary Variables	Best known finding
Hjern and Nylander (1964)	X	X		X	PTS symptoms appear to have pre-traumatic origin, associated with adversity.
Klonoff (1971)			X		Organic factors underlie disturbance in Milds.
Klonoff and Paris (1974)	X				Most PTS problems are still present at 1-2 year follow-up.
Black et al. (1969)	X				Physical problems are uncommon in children. Both pre-traumatically normal and abnormal children share potential for post-traumatic disturbance.
Shaffer et al. (1975)	X	X	X		All Severes, with pre-injury problems, acquired new problems post-traumatically. Problems were related to family stresses and brain damage.
Brown et al (1981)	X	X	X		The mildly injured are behaviourally more disturbed pre-traumatically than Severes. The effects of psychosocial adversity become compounded with the organic effects of brain damage. Disinhibition is common when PTA is more than 7 days.

The main findings are the following:

1 When the significance of symptoms is based on comparison with a control group, they do not reflect reaction to the trauma itself.

2 Premorbid problems are influential and increase the likelihood of new problems arising post-traumatically.

3 The mildly injured are generally more disturbed prior to their injury than children with more severe damage.

4 Pre-injury disturbance tends to overlap with psychosocial adversity in the mildly injured.

5 Psychosocial adversity increases the potential for post-traumatic disturbance in the severely injured.

6 Organic factors are influential in both Milds and Severes. In Severes organic damage is reflected by physical impediment and social disinhibition and often overshadows more subtle behaviour problems.

7 Although it is not known how childrens' roles are acted out in relation to their injury, there is evidence that parental expectations are influential.

CHAPTER 2

METHODOLOGY

2.1 Introduction

In general descriptive terms, the relationship between behaviour patterns, both post-traumatic and antecedent, and head injury, may be conceptualised as:

(a) The total spectrum of behaviour present in head-injured subjects at follow-up minus their pre-injury behaviour, equals behaviour arising after head injury.

(b) The effects of traumatic injury rather than of head injury can be schematised as: The range of post-injury behaviour in a non head-injured control group present at follow-up less their pre-morbid symptoms.

(c) Behaviour arising post-traumatically in the head-injured sample less post-injury behaviour in the control sample equals behaviour which may result from head-injury. (Brown et al., 1981).

2.2 Aims

There were two major research objectives to this thesis. One was to identify which of the behaviour patterns manifested by head-injured children and adolescents could be attributed to the head injury, the other to establish whether there was a dose-response relationship between the severity of head injury and behavioural sequelae.

Within the context of the first objective, (i.e. to identify behaviour patterns in the head-injured) there were three lines of enquiry: (1) To separate behaviours which presented for the first time after head-injury from those which were also in evidence pre-morbidly; (2) To determine the existence of a defined post-traumatic syndrome (PTS) following head injury; (3) To report the differential influence of pre-morbid

behavioural patterns, persistent psychosocial adversity and severity of head injury on the type of post-head injury behavioural pattern. The second objective may be seen as looking for a means to discriminate between degrees of severity of head injury on the basis of the strength of behavioural outcome.

2.3 Selection

During the period 15 June 1983 to 15 June 1985, children under 14 years with head injuries of sufficient severity to meet the clinical inclusion criteria (see 3.1) were drawn from a series of 388 consecutive trauma unit admissions to Groote Schuur and Red Cross Childrens' War Memorial hospitals. Of the 388 children of all ages, 349 survived and of these, 116 met with the non-clinical inclusion criteria, that is, the additional age and language criteria for this specific study (see section 3.2). Control group subjects, with trauma or undergoing orthopaedic operations, were selected from children admitted to Conradie, Groote Schuur, Red Cross Childrens' War Memorial, and Victoria hospitals as well as other institutions in the Cape Peninsula. The non-clinical inclusion criteria yielded 37 children in the control group. Children retained in the present analysis were those whose parent or guardian was interviewed at both intake and one year follow-up.

2.3.1 Clinical inclusion criteria

The criteria were designed specifically with the aim of including any subject who had a significant disturbance of consciousness, neurological involvement or a severe blow to the head.

This meant that children were included in the follow-up study if they met one, or more, of the following neurological criteria :

1. Post-traumatic amnesia (PTA) of more than one hour
2. Level of consciousness scored on the Glasgow Coma Scale (GCS) as 12/15 or less on admission
3. Unconsciousness lasting more than five minutes

4. Focal neurological signs
5. Presence of any seizure activity
6. Compound depressed fracture
7. Any evidence of intracranial haemorrhage
8. Clinical evidence of base of skull fracture

Subjects who were not out PTA by 6 months were excluded from the study.

2.3.1.1 Allocation of subjects to severity groups

In this study, as in other studies aimed at assessing outcome of a broad spectrum of injuries (Shaffer et al., 1975; Klonoff, and Paris, 1974; Rutter et al., 1980), subjects were assigned to categories of severity of injury on the dimension of PTA duration. In general keeping with the classification set out originally by Russell (1932), PTA length relates to severity of injury in the following way:

1 -24 hrs = Moderate injury;
1 - 7 days = Severe injury;
PTA > 7 days = Very Severe injury.

Application of the above categorisation to this study produced: Moderates (n = 53); Severes (n = 37); Very Severes (n = 26). Of the 53 Moderates, there were 4 with PTA under an hour and 12 without any PTA. They were admitted on the basis of meeting clinical criteria 4-8 (see 2.3.1 above). Please refer to p 52 for a more complete commentary on the Moderate group.

According to Morris and Fletcher (1988), the most practical null hypothesis in research where classification plays a central role is that there are no useful subgroupings within the subject population undergoing classification. Not all subjects manifested any one of the neurological inclusion criteria, including loss of consciousness, whereas PTA represented a single property by which all subjects differed. PTA duration has also been noted to be a better predictor of cognitive outcome than either coma length or initial GCS scores (Bond, 1986; Hemp, 1989).

Furthermore, because PTA involves memory mechanisms, it reflects functional disruption irrespective of whether structural damage is located cerebrally or not (Gennarelli, 1982) and in this way simplifies the heterogenous effects of a wide variety of injuries (i.e injuries which do not result in homogenous damage to the brain). Therefore, subjects within the parameters of a particular category of PTA were more similar to one another, with respect to being functionally disordered, than they were to subjects in any other category of post-traumatic amnesia.

2.3.1.2 Assessment of PTA

It must be noted that the end of PTA is marked by the return of full memory for day-to-day events on a continuous basis (Russell, 1932; Jennett & Teasdale, 1981; Bond,1983). Some studies measuring PTA duration (Artiola et al., 1980 ; Levin, O'Donnell & Grossman, 1979, cited in Ewing-Cobbs, Fletcher & Levin, 1985) include daily monitoring of correct orientation for time, place and person. However, even normal children may be expected to experience some degree of disorientation and confusion in an unfamiliar environment. Thus, objective determination of the end of PTA in children depends on the uniform assessment of when continuous memory returns rather than on the vagaries of how the patient relates to his or her environment.

Rating of PTA was carried out by the head injury team's senior nursing sisters who planted tokens such as sweets and crayons with the child so that memory of these events could be judged on subsequent visits.

2.3.2 Non-clinical inclusion criteria

These criteria applied equally to head-injured and control group subjects :

1. Age not younger than 5 years or older than 14 years
2. English or Afrikaans-speaking family
3. No history of mental retardation
4. No previous serious head injury or cerebral disease of significance
5. Admission to one of the hospitals where arrangements had been made for the

research team to carry out procedures.

6. Willingness on the part of subjects to participate in psychological testing.

Burn victims were excluded from the control subjects because they are known to present unique psychological reactions to their injury (Sawyer, Minde & Zuker, 1982).

Only three children with Mild head injuries failed to keep initial appointments. Attrition from intake to 1 year follow-up was less than 5% for the head-injured.

2.3.2.1 Rationale for the control group

As mentioned in chapter 1, a control group allows separation of the effects of head injury from the psychological effects which are common to other forms of traumatic injury (Klonoff & Paris, 1977; Rutter et al.,1980; McKinlay & Brooks, 1984). Thus, the kind of control group chosen should be one which is similar to the head-injured groups in certain respects, yet has no brain injury. If a moderately head-injured group, as opposed to a non head-injured group, had been used as the controls for more severe injuries, it would not have been possible to say with any certainty whether the sequelae were specific to head injury or if they included psychological reactions associated with the event of trauma. There was an added need, in the present study, where one of the goals was to identify the presence of a distinctive post-traumatic syndrome, to make comparisons with non head-injured controls before conclusions could be drawn about the relationship between severity of injury and defined syndromic sequelae. The control group included subjects who were psychologically normal before their injury as well as those who were behaviourally disturbed. However, once it was known which behaviours in the control group presented for the first time post-traumatically, it was possible to relate these to those behaviours which arose after head-injury.

2.4 Matching

The question concerning the type of pre-morbid behaviour was important. As discussed in the previous chapter, the literature indicates that children who have

accidents resulting in injury to the head or elsewhere are not random samples of the population. Amongst the head-injured, boys, the socially disadvantaged and children with psychological disturbances are over-represented (Klonoff & Low, 1974; Rutter et al., 1980; Shaffer et al., 1975). Matching of controls to head-injured subjects was therefore desirable firstly because it was known that the above variables could mask the relationship between trauma and behavioural outcome and secondly, to ensure that both groups were drawn from a similarly "at risk" population (Szatmari, 1985).

In this study, which was not a case-control study because there was not a control subject for each head-injured child, (Schesselman, 1982), head-injured and control groups were matched proportionately for age, sex, ethnic group and social class.

2.5 Behavioural assessment

Broadly, the behavioural assessments for the present study may be divided into a prospective and a retrospective part.

The prospective part was carried out at intake as well as at follow-up whereas the retrospective part only applied to the follow-up assessment. Together with questions concerning demographic variables, clinical aspects of the injury, conditions surrounding the injury, past illnesses and previous accidents, the intake assessment focussed on administration of the Rutter Parent Questionnaire (Graham & Rutter, 1968).

The retrospective part consisted of an open interview in addition to administration of the Rutter Questionnaire. This interview section must be regarded as retrospective since it involved asking the parents, one year after the injury, to report on when and how, specific behavioural problems presented for the first time, i.e either before or after the injury.

Thus, in one section of the follow-up interview the emphasis was on the presence of symptoms (Rutter Parent Questionnaire) and in a second section (open interview) the focus was on when the symptom first manifested, it's duration, and whether it was

showing signs of improvement or deterioration (see Appendices B and C).

2.5.1 Rationales for the prospective format

2.5.1.1 Rationale 1

To identify, by means of the Rutter Parent Questionnaire, the presence of problems at intake and follow-up.

2.5.1.1.1 Rutter Parent Questionnaire

Completion of the questionnaire by the interviewer on the basis of information given by the child's parent or guardian was carried out at intake, at three months, six months and one year follow-up. This study focussed only on information obtained at intake and at one year follow-up.

A proforma of this questionnaire which comprises 33 questions is tabled in Appendix B. The 33 questions have been divided into scales based on a taxonomy for childhood psychiatric diagnosis (Rutter, 1965; Graham & Rutter, 1968) which subdivides disorders into being predominantly antisocial, neurotic or hyperactive. In order to consider other conditions such as developmental disorders and social difficulties, questions in these areas were grouped together to form additional scales. On the strength of findings by Brown et al. (1981), four additional questions aimed at establishing the presence of disinhibition were asked. Accordingly, a further scale, namely one of disinhibited behaviour was formed.

2.5.1.1.2 Behaviour scales based on Rutter questions

The six scales were each composed of between three and five individual items:-

(1) <u>Hyperactive behaviour:</u>
Restless
Squirmy or fidgety
Cannot settle

(2) Neurotic behaviour:

Worries

Specific fears

Miserable

Fussy

Tearful

(3) Antisocial behaviour:

Truants

Destructive

Disobedient

Steals

(4) Developmental disorders:

Wets or soils

Eats too much or too little

Sleeping problem

Sucks thumb or bites nails

(5) Social problems:

Not much liked

Solitary

Bullies children

(6) Disinhibition:

Overtalkative to strangers

Makes personal remarks or asks embarrassing questions

Careless in dress or hygiene

Impulsive

2.5.1.2 Rationale 2

To establish the differential influence of severity, pre-morbid problems and psychosocial adversity on post-traumatic behaviour.

2.5.1.2.1 Psychosocial adversity

The presence of psychosocial adversity was rated according to the following ten factors : Family size; overcrowding; parental unemployment; maternal educational level of Std 6 or less ; presence or history of maternal psychiatric disorder; presence or history of paternal psychiatric disorder; single parenthood; dysharmony in the family; familial illhealth and poor nutrition. Most of the terms are self-explanatory but one or two may require clarification. The descriptions are from Theron (1987):

Large family size - referred to a family of four or more children.
Overcrowding - included the number of inhabitants and referred to a person to room ratio greater than 3:1.
Parental illhealth - referred to instances of chronic physical problems such as asthma, heart disease and diabetes.
Poor nutrition - referred to too little food.

2.5.1.3 Scoring of prospectively assessed variables

2.5.1.3.1 Rutter Parent Questionnaire

The 33 behaviours or symptoms comprising the Rutter Parent Questionnaire were scored according to the format set out by Rutter et al., (1980) with a score 0 indicating absence of the symptom; a score of 1 in cases when the symptom applied somewhat and a score of 2 when it applied strongly. The scoring of scales is dealt within the relevant results sections.

2.5.1.3.2 Psychosocial adversity

The ten factors of psychosocial adversity were rated as 0 when absent and as 1 when present. Responses to questions dealing with medical background were recorded as 0 for no, 1 for yes and 2 for unknown.

2.5.1.3.3 Log-linear analysis

The second rationale concerns the differential influence of premorbid disordered behaviour, psychosocial adversity and severity of injury on the prevalence of disordered post-traumatic behaviour. Together with severity of head injury the patterns which emerged were analysed using loglinear models, (see section 2.9.3 below).

The statistical fitting of a log-linear model to the data was based on scores obtained on each of the scales in order to describe the relationship between severity of head injury, pre-morbid behaviour patterns, post-traumatic behaviour patterns and psychosocial adversity, in the head-injured group. Data on each of the intake and follow-up Rutter or other scales was dichotomised as either high, i.e above the median, or low i.e below the median. The psychosocial adversity total was similarly dichotomised, providing a measure of high or low adversity at intake. The dependent variable in all cases was high scoring on the follow-up scale.

2.5.2 Rationale for the retrospective format

2.5.2.1 Rationale 1

To identify by means of interview which of the problems present at one year follow-up had arisen post-traumatically.

2.5.2.1.1 Interview

The interview was structured but open-ended. A directed approach was useful because it allowed interviewers to formulate questions in such a way that comparable information could be obtained across individuals and specific areas of behaviour change hypothesised to relate to head injury could be covered. The open-ended nature was indispensible for obtaining a wealth of behavioural descriptions and countering the response bias which often accompanies a more closed format. The schedule was based on the description given by Brown et al., (1981); please see

Appendix B. All the variables were taken from one or more of the six core studies discussed in chapter one.

Wherever possible, the interviewer framed questions within a specific context, for example, at school, in the home, in dealing with peers. A single behaviour or symptom was dealt with at a time. It often happened that elaboration of one question led to recall in another area. Rutter et al., (1980) and Brown et al.,(1981) have stressed that the order in which questions are presented should be interchangeable and influenced by the direction taken by the informant. The former authors pointed out that it was not the respondant's answer to a particular question that was being rated but the presence or absence of a symptom which the question was designed to elicit. This may be illustrated by an example from the present study. If the parent was asked whether the child was "apathetic" and responded that he or she was "withdrawn or played alone a lot" this would be considered when social activities were rated, but "apathetic" would be positively scored only if the description included listless, uninterested behaviours.

Recognition of a certain problem was asked for before recollection of actual examples of the behaviour. In most instances the same interviewer saw the same case from intake throughout follow-up. Interviews lasted approximately one hour and were conducted informally in wards rather than in offices., As Theron (1987) has observed, this may well have been less threatening and inhibiting to some parents than a more formalised enquiry.

2.5.2.2 Scoring of retrospectively assessed variables

Behaviours were scored as 0 if the behaviour was absent at the time the interview was conducted, irrespective of whether it had been in evidence at a time preceding the injury; as 1 if it either presented for the first time or worsened in some way in the period following the injury ; as 2 if the behaviour was said to have been present both before the injury and at the time of interview.

Each behavioural variable rated for duration was dichotomised as absent versus present and as old versus new.

2.5.2.2.1 Absent versus present

To determine the prevalence of a behaviour regardless of whether or it originated pre- or post-morbidly:

The percentage of behaviour absent (scored as 0) was analysed *versus* the percentage of behaviour present, that is, the combined scores of behaviour arising post-traumatically (scored as 1) and behaviour originating before the injury (scored as 2).

2.5.2.2.2 Old versus new

To determine the incidence of a new problem after head injury:

The percentage of behaviour reported as arising post-traumatically (1), was analysed *versus* the percentage of behaviour absent (0) and behaviour arising pre-morbidly (2), combined.

The main features regarding measurement are summarised in Table 2.

Table 2

Summary of assessment features

Prospective	Retrospective
Assessment	
Intake and follow-up	Follow-up only
Instrument	
Rutter Parent Questionnaire	Open interview
Aims	
First, to establish the presence of problems at intake and follow-up. Then, to establish the role of severity,pre-morbid problems and psychosocial adversity on post-traumatic problems	To establish the incidence of post-traumatically arising problems

2.6 Reliability and validity

2.6.1 Reliability

Using the information given by the parents of psychiatrically disturbed children, Graham and Rutter (1968) examined the scoring of individual items comprising scales with the aim of determining inter-rater reliability. They found agreement on the prevalence of symptoms to be above 60% for 26 questions.

Brown et al., (1981) tested the inter-rater reliabilty in the case of head injured subjects. Raters were either psychiatrists who were familiar with the cases or interviewers who were "blind" to the severity of the head injury. Scoring was based on information given by the mother. Behaviours were rated as either absent, or present (whether slightly or definitely). At intake, complete agreement on rating was reached in 85% of cases and agreement for whether a symptom was present or absent in 93% of cases (n = 88). At one year follow-up, concurrence was obtained in 79% of cases whilst agreement for absence or presence was reached in 92% (n = 87) of cases. The present study did not investigate inter-rater reliability specifically, but most interviews were undertaken by the same social worker (H. Theron), with psychologists completing data in a minority of cases.

Graham and Rutter (1968) have ascribed the inconsistency of ratings based on parental information as being due to the fact that certain areas of a child's behaviour are more accessible and better known to the parent than are other aspects. In general,the mother has better knowledge of those behaviours which are visible and occur in the home. However by one year follow-up, having been interviewed at least at intake if not also at 3 and 6 months, informants could be expected to have been sensitised to a wider range of their children's behaviour.

2.6.2 Validity

Rutter (1965) has stated that the aim of this type of research is to classify disorders not children. Apart from referring to the finding that a reliable and valid distinction

between neurotic disorders and antisocial disorders has appeared in many factor analytic studies, no mention has been made of the actual reliabilities and validities of the various questions. In this study, criterion-related validity may be understood solely in terms of severity of head injury and comparisons were for the most part made between a severity grouping and a control group. Where comparisons were made within the head-injured groups, the aim was to establish the divergence between factors which were hypothesised to be unrelated (Szatmari,1985). For example high scores on the disinhibition scale when it was associated with very severe injury, would not have been expected to accompany a high degree of pre-morbid disinhibition. The issues raised in connection with the reliability of questions have bearing on construct, or more accurately, face validity and in this regard Rutter (1965) has indicated that scales were derived on the basis of the hypothesised construct face validity and the reliability of individual questions.

2.7 Hypotheses

The questions being investigated in this study may be stated as :

(1) Whether the prevalence of post-traumatic behaviours observed in the head-injured differs from that of controls.

(2) Whether there is a dose-response relationship between severity of head injury and behavioural sequelae.

(3) Whether the frequency and combination of certain post-traumatic behavioural variables indicates the presence of a defined post-traumatic syndrome.

(4) Whether behaviours which arise post-traumatically in the head-injured group are associated with the presence of either the same behaviours at intake or with a high degree of psychosocial adversity.

2.8 A word on data presentation

In the results sections data are not presented according aetiological factors. For example, it is probably true that the majority of problems in the more severely injured are due to a reduction in inhibitory control. But without first establishing the role of pre-morbid disturbance and factors of psychosocial disadvantage, it would be presumptuous to group behaviours from the outset. The reader should also bear in mind that the present study deals with groups and not with individual subjects and that the primary goal is comparison between the head injured groups and the control group rather than validation by correlation of problems within the head-injured groups. Rutter (1982) reminds us that preconceived ideas about how behaviours should cluster are dangerous in the field of head injuries. A case in point is the development of the notion of the neuromythological "minimally brain dysfunctional" child.

2.9 Statistical analysis

2.9.1 Descriptive statistics

At the descriptive level, data is presented as percentages; central tendency is indicated by the Median rather than by the Mean since distributions are skewed in many cases; the range of scores falling in the interquartile range is indicated by the 25th and 75th percentiles.

2.9.2 Comparisons

Comparisons between each of the head-injured groups and the control group were made using a chi-squared test (Siegel, 1956). Fisher's exact two-tailed probability test (F/E) was used when the frequency of a cell was five or less. Data was dichotomised as either present versus absent or as arising pre- versus post-traumatically. The significance level was adjusted to 0.02 (McGuigan, 1983) whenever comparisons were made between the three head-injured groups and the control group. The reason for doing so was that the probability of finding differences attributable to chance rather

than real differences increases with the number of comparisons performed. Head-injured groups were not compared with each other. The Median test was used for comparisons at either intake or follow-up on the behavioural scales.

2.9.3 Loglinear analysis

Loglinear analysis involves the selection of a model which best describes the distribution of observed scores and discriminates between all levels of all variables (Fienberg, 1981; Kennedy, 1983). It becomes possible to generate expected scores based on the parameters of data imposed by the model. In this study 24 levels or cell probabilities were derived in the following way - stars substitute actual scores; 0 indicates a low score and 1 indicates a high score.

Follow-up score	Intake score	Adversity	Group		
			1	2	3
0	0	0	*	*	*
		1	*	*	*
	1	0	*	*	*
		1	*	*	*
1	0	0	*	*	*
		1	*	*	*
	1	0	*	*	*
		1	*	*	*

The likelihood chi-squared test statistic is interpreted against a probability level of 0.05. The probability value associated with the model itself progresses to 1.000 as a reflection of the extent to which the model accounts for the data. Degrees of freedom are calculated as the difference between the number of cells and the number of parameters fitted. It should be noted that log-linear analysis is based on cut-off scores whereas the other statistical methods used in the study are based on percentages.

In the analyses presented, letters denote variables: G = groups, i.e. Moderate, Severe and Very Severe; P = psychosocial adversity at intake ; I = intake scores ; F =

follow-up scores. The important interactions are those which indicate effects on follow-up scores, i.e. GF; PF; IF; GIF and GPF.

2.9.3.1 Odds ratios

Following the loglinear analysis (and 95% confidence intervals) odds ratios were calculated to estimate the strength of association between factors. The odds ratios are tabled in Appendix D.

CHAPTER 3

SAMPLE DESCRIPTION

3.1 Demographic variables

Head-injured subjects were matched with controls on age, sex, socio-economic standard and ethnic group. Table 3 summarises the demographic background of all subjects.

Table 3

Matched and other demographic variables

Variable		Controls (n=37)		Moderates (n=53)		Severes (n=37)		Very Severes (n=26)	
Sex									
Boys	% (n)	67.6	(25)	69.8	(37)	64.9	(24)	57.7	(15)
Girls	% (n)	32.4	(12)	30.2	(16)	35.1	(13)	42.3	(11)
Ethnic group									
Coloured	% (n)	97.3	(36)	88.7	(47)	89.2	(33)	100.0	(26)
White	% (n)	2.7	(1)	11.3	(6)	10.8	(4)	0.0	(0)
Age									
Median (yrs,mnths)		9.4		11.0		8.1		7.10	
25th ; 75th		(7.10;11.8)		(7.6;11.9)		(6.11;11)		(6.7;11.10)	
SES									
Median *		3		4		4		4	
Professional	% (n)	5.4	(2)	5.7	(3)	2.7	(1)	0.0	(0)
Clerical	% (n)	16.2	(6)	7.6	(4)	16.2	(6)	3.9	(1)
Skilled	% (n)	46.0	(17)	35.9	(19)	32.4	(12)	30.8	(8)
Unskilled	% (n)	32.4	(12)	50.9	(27)	48.7	(18)	65.4	(17)
Language									
English	% (n)	37.8	(14)	22.6	(12)	24.3	(9)	0.0	(0)
Afrikaans	% (n)	62.2	(23)	77.4	(41)	75.7	(28)	100.0	(26)
Religion									
None	% (n)	0.0	(0)	1.9	(1)	2.7	(1)	0.0	(0)
Christian	% (n)	62.2	(23)	58.5	(31)	77.8	(28)	69.2	(18)
Moslem	% (n)	37.8	(14)	34.0	(18)	16.7	(6)	30.8	(8)
Other	% (n)	0.0	(0)	5.7	(3)	2.7	(1)	0.0	(0)

* Grading of SES : 1=professional; 2=clerical; 3=skilled; 4=unskilled; 5=pensioner; 6=unemployed.

3.1.1 Age

The median age of the head-injured sample (8 years and 7 months as calculated from the data in Table 3) and that of the control group (9 years and 4 months) was not found to be significantly different:- The Kruskal- Wallace test had a p value of 0.061 at the 5% significance level. The distribution of age was found to vary with severity group and the more severe injuries were associated with younger age (see Table 4). However, Wilcoxon pairwise comparisons revealed that none of the three head-injured groups differed significantly from the control group. The probability level of 0.05 was adjusted to 0.02 to accommodate three pairwise comparisons. The p values were : 0.042; 0.076 and 0.130 for Moderates, Severes and Very Severes respectively.

3.1.2 Sex

The boy:girl ratio of 2:1 is similar to that of most other studies including that of Shaffer et al., (1975) and Rutter et al., (1980) but was higher than the ratio of 8:5 cited by Klonoff and Paris (1974) in their study of predominantly Mild injuries. The overall χ^2 statistic indicated that the head-injured group was not significantly different from the control group (p = 0.752).

Table 4

Distribution of age at intake

Age group	Controls (n=37)	Moderates (n=53)	Severes (n=37)	Very Severes (n=26)
% < 9 years	37.8	34.0	62.2	53.8
% 9 - 12 years	62.2	52.8	29.7	46.2
% 13 years +	0.0	13.2	8.1	0.0

3.1.3 Socio-economic standard

Median one-way chi-squared analysis showed no overall statistically significant difference between the head-injured versus control subjects on SES, (p= 0.076). It is noteworthy that over 80% of the head-injured children came from families with low SES. However, multiple pairwise comparisons revealed a significant difference between Controls and Very Severes (p = 0.010).

3.1.4 Ethnic group

The children in this study were selected from a larger group of head-injured children aged under 14 years. In this larger group, 75% (n=238) were from the so-called "coloured group", 9% (n=28) were white and 16% (n=52) were black (Theron, 1987). According to the Cape population census of 1980, 64% of children aged under 14 are coloured, 25% are white and 11% are black. Although census data concerning blacks is probably unreliable due to the unstable housing conditions of this sector, it does seem that the more advantaged white group was underrepresented in the head-injured sample. In the present study, blacks were excluded on language criteria and the total percentage of whites was low (16%). There was no statistically significant difference between the head-injured and controls groups in terms of percentage white versus coloured subjects.

3.1.5 Language and religion

It is striking that Afrikaans was the home language for all of the Very Severes and that only two children came from homes in which there was no religious affiliation. Language and religion were not used as matching criteria.

3.2 Accident type

The high rate of falls shown (see Table 5 on the following page) in the Controls and Moderates corresponds with the trend in the study by Rutter et al., (1980) as does the preponderance of pedestrian accidents in Severes and Very Severes. Overall, the

more severe head injuries tended to be traffic-related. There was one case in which the child's head injury was caused by parental abuse/assault. There was no indication that any of the children were victims of chronic abuse/assault. The term "other" refers to injuries sustained during play and sporting activities.

3.3 Accident history

Table 6 shows the percentages of children who had sustained a previous accident not involving the head and/or a prior mild head-injury (a severe injury was grounds for exclusion). Data was missing in the case of one Control group subject and one moderately head-injured child. The higher rates of previous accidents and injuries in the head-injured has been interpreted as being an indication of the non-randomness of children who sustain head injuries (Brown et al., 1981; Rutter et al., 1980; and Theron, 1987).

Table 5

Type of accident

Accident	Controls		Moderates		Severes		Very Severes	
	%	(n)	%	(n)	%	(n)	%	(n)
Pedestrian	18.9	(7)	28.3	(15)	54.1	(20)	76.9	(20)
Other MVA	10.8	(4)	17.0	(9)	32.4	(12)	15.4	(4)
Fall	43.2	(16)	26.4	(14)	2.7	(1)	0.0	(0)
Abuse/assault	0.0	(0)	22.6	(12)	8.1	(3)	3.9	(1)
Other	27.0	(10)	5.7	(3)	2.7	(1)	3.9	(1)

Table 6

Previous accidents and head injuries

	Controls		Moderates		Severes		Very Severes	
	%	(n)	%	(n)	%	(n)	%	(n)
Previous accidents	5.6	(2)	25.0	(13)	24.3	(9)	15.4	(4)
Previous mild head injury	13.5	(5)	23.1	(12)	13.5	(5)	15.4	(4)

3.4 Clinical variables

3.4.1 Post-traumatic amnesia

Table 7 shows the duration of PTA for all the head-injured.

Table 7

Duration of PTA

Duration	N
None	12
Mild injury < 1 hr	4
Moderate injury 1-24 hrs	37
Severe injury 1-7 days	37
Very Severe injury > 7 days	26

3.4.2 Duration of unconsciousness

Table 8 shows the duration of unconsciousness. In the case of Moderates and Severes, this was loss of consciousness as described by witnesses and was usually brief. With unconsciousness lasting more than an hour, rating was more likely to have been based on the GCS, where a score of 8 and under was taken as indicating coma (Jennett & Teasdale, 1981).

Median duration of unconsciousness was as follows: Moderates (n=53, 0 hr); Severes (n=37, 1 hr); Very Severes (n=26, 4 days).

The proportion of subjects with loss of consciousness under an hour (29%) is comparable to the rate of 24% in the Black et al., (1969) study and not very different from the rates in other studies. In the Shaffer et al., (1975) study a total of 48% of subjects had no loss of consciousness. Klonoff and Paris (1974) stated that this applied in 40% of their subjects and that unconsciousness was either momentary or not proven in 16% of cases.

Table 8

Duration of unconsciousness

Duration	Moderates		Severes		Very Severs	
Nil	79.2	(42)	40.5	(15)		
< 1 hour	20.8	(11)	40.5	(15)		
1 - 5 hours			16.2	(6)	3.8	(1)
6 - 24 hours			2.7	(1)	42.3	(11)
1 - 7 days					34.6	(9)
7 days +					19.2	(5)

3.4.3 Comment on the moderate group

If the eligibility of the 12 children without PTA and unconsciousness (see Tables 7 & 8) to participate in a study of head injury seems questionable, it should be kept in mind that the clinical inclusion criteria aimed at capturing data concerning children who had had neurological involvement or a severe blow to the head and not only those who had a significant disturbance of consciousness.

Since all the subjects all meet with one or more of the remaining criteria (see Table 7), they must be considered as head-injured.

As to the question of whether they can confidently be included with the Moderates, the following is relevant:

The formation of a separate "Mild" group would have repurcussions for the entire study. Since there would be 4 pairwise comparisons, the probability level would have

to be adjusted to 0.01. Raising the *p* level would conceal significant comparisons at 0.02 which is where the *p* level is set at present for 3 pairwise comparisons, (McGuigan, 1983). In addition, one of the aims of this study is to relate sequelae to a continuum of severity. The creation of an additional group would jeopardize results at the upper end of the continuum. If the focus of this study was on aetiology, favouring the lower end would be justified. As it is, both ends of the severity spectrum are crucial to the present study.

The more prudent choice seems to be violation of internal homogeneity in one group over a premeditated bias in four groups.

Table 9

Distribution of Milds and subjects without PTA on clinical inclusion criteria

Clinical criterion	N of subgroup
Seizure activity	5
Compound depressed fracture (open)	5
Compound depressed fracture (closed)	1
Intracranial haemorrhage	3
Clinical evidence of basal skull fracture	2

A broad range of focal neurological signs such as disturbances of gait, impairment of speech and vision, cranial nerve signs, unequal power, tone and movement were observed.

3.5 Other clinical variables

The prevalence of clinical impairment is indicated by Table 10. Hemiparesis, or motor weakness to one side of the body as noted at initial psychological assessment and confirmed either by neurological observation at intake or at six months was present in 6 of the Very Severes and in only one of the Severes. One of the Very Severes had a spastic quadriparesis. Overt tremors were present in two Very Severes.

Table 10

Other clinical variables

Variable	Moderates (n=53)	Severes (n=37)	Very Severes (n=26)
Number x-rayed (skull)	52	36	24
Of these number with fractures	16	22	11
Number CT scanned	12	12	20
Of these number with abnormal CTs	9	8	17

3.6 Psychosocial adversity

Table 11

Family income and dependents

	Controls %	Moderates %	Severes %	Very Severes %
Nett monthly income (Rand)	(n=34)	(n=53)	(n=36)	(n=23)
0 - 380	50	59	39	70
400 - 650	12	27	50	26
700 - 900	15	3	3	0
1000 - 2000	23	11	8	4
Number of dependents	(n=36)	(n=52)	(n=36)	(n=24)
2 - 4	30	34	28	21
5 - 8	64	56	69	75
9 - 11	6	10	3	4

From the information in Tables 11 and 12, it appears that there was a higher rate of psychosocial disadvantage associated with the very severely head-injured children. The figures representing income in Table 11 were approximate and income could vary from month to month within a family. The distribution of pre-morbid psychosocial adversity in the head-injured versus the controls was the subject of another study

Table 12

Presence of psychosocial adversity

Variable	Controls		Moderates		Severes		Very Severes	
	%	n	%	n	%	n	%	n
Unskilled or Unemployment	35.1	(13)	37.7	(20)	51.4	(19)	65.4	(17)
Family size	48.7	(18)	45.3	(24)	46.0	(17)	50.0	(13)
Overcrowding	35.1	(13)	54.7	(29)	48.7	(18)	61.5	(16)
Mat. ed Std 6	56.8	(21)	75.5	(40)	70.3	(26)	92.3	(24)
Mat. psychiatric	5.4	(2)	32.1	(17)	51.4	(19)	23.1	(6)
Pat. psychiatric	18.9	(7)	28.3	(15)	27.0	(10)	46.2	(12)
Single parent	21.6	(8)	30.2	(16)	27.0	(10)	30.8	(8)
Dysharmony	19.4	(7)	49.1	(26)	59.5	(22)	46.2	(12)
Illhealth	13.5	(5)	20.8	(11)	13.5	(5)	30.8	(8)
Poor nutrition	2.7	(1)	20.8	(11)	18.9	(7)	34.6	(9)

(Theron, 1987) in which the head-injured were found to differ significantly from Controls on the level of maternal education, parental psychiatric status, dysharmony in the home and poor nutrition. The relationship between disadvantage, disordered behaviour and severity of head injury is dealt with by means of loglinear analysis in the results sections.

CHAPTER 4

RESULTS AND DISCUSSION: SENSORY-MOTOR, PHYSICAL AND DEVELOPMENTAL PROBLEMS. OVERALL PSYCHOLOGICAL DISTURBANCE AND PSYCHOSOCIAL ADVERSITY

4.1 Sensory-motor problems

Table 13 summarises the percentage of children with sensory-motor symptoms at 1 year, while Table 14 shows the percentage of children in whom the symptoms were said to be new i.e arising after trauma. Statistical comparisons between each of the head-injured groups and the control group were based on the percentage developing new symptoms.

4.2 Motor weakness and incoordination

Table 13 shows that motor weakness, which included weakness attributable to broken limbs, as well as weakness of neurological origin was the dominant sensory-motor problem in all groups. Slightly over two-thirds of Very Severes were impaired whereas approximately a fifth of Controls, Moderates and Severes were affected. The data (Tables 13 and 14) indicate that, with the exception of one Control subject and two Moderates, motor weakness was rated as a new problem throughout the groups. As a consequence of the relatively high incidence in Controls (16.2%), χ^2 comparisons revealed a statistically significant difference in only the case of Very Severes (61.5%; p=0.001). The prevalence of motor weakness in the Very Severes far

Table 13
Presence of sensory-motor symptoms at follow-up

Symptom	Controls		Moderates		Severes		Very Severes	
	%	(n)	%	(n)	%	(n)	%	(n)
Visual	13.5	(5)	18.9	(10)	2.7	(1)	15.4	(4)
Auditory	5.4	(2)	15.1	(8)	10.8	(4)	11.5	(3)
Sensory	2.7	(1)	1.9	(1)	2.7	(1)	11.5	(3)
Motor weakness	18.9	(7)	18.9	(10)	18.9	(7)	61.5	(16)
Incoordination	8.1	(3)	7.5	(4)	18.9	(7)	57.7	(15)

exceeded the rates reported in other follow-up studies dealing with injury of comparable severity: 30% (Heiskanen & Kaste, 1974); 9% (Klonoff & Paris, 1974); 9% (Mahoney et al., 1983). It should be noted however, that in these studies figures were based on neurological observation whereas the present study relied on parental reports.

Hemiparesis was noted in 7 children by 6 month follow-up. By 1 year, observable limb weakness which was of a mild nature was present in only 2 children and of these, one had a spastic quadriparesis.

Parental reports of motor weakness indicated that there was limitation of movement of the arms, legs and face and changes in gait. The most common complaint was of falling easily and showing difficulty with running. Descriptions included the following: "Sy linker been word swak... dit gee in." "Hy loop styf met sy regter been." A moderately injured boy was described by his mother in the following way: "As sy kop so erg pyn is hy soos iemand wat lam word." One of the Severes was said to be "Shaky on his legs... he gets very tired and has collapsed on the soccer field." The rate of incoordination (see Table 13) was low in Controls and

Moderates, somewhat raised in Severes and 3 times higher in Very Severes than in any of the other groups. Nearly all instances of incoordination were reported to have originated post-traumatically (see Table 14). The children whose problems of motor weakness and incoordination did not arise after injury were generally described as clumsy or awkward and as having been poor at games involving hand to eye

Table 14

New sensory-motor symptoms:
Significance of differences between the control group and head-injured groups at follow-up

Symptom	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D	A vs D		
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Visual problems	2.7	(1)	13.2	(7)	F/E	0.134	2.7	(1)	F/E	1.000	15.4	(4)	F/E	0.150
Auditory problems	2.7	(1)	15.1	(8)	F/E	0.076	5.4	(2)	F/E	1.000	7.7	(2)	F/E	0.564
Sensory problems	2.7	(1)	1.9	(1)	F/E	1.000	2.7	(1)	F/E	1.000	11.5	(3)	F/E	0.297
Motor weakness	16.2	(6)	15.1	(8)	0.02	0.885	18.9	(7)	0.09	0.760	61.5	(16)	13.80	0.001
Incoordination	5.4	(2)	3.8	(2)	F/E	1.000	18.9	(7)	F/E	0.152	57.7	(15)	21.19	0.001

coordination. Jaffe, Mastrilli, Molitor and Valko (1985) have stated that although motor deficits plateau soon after brain injury, the residua are related to impairment of visuo-spatial or perceptual functioning since these make it difficult for children to regain spatial orientation of body position and coordination of movement.

Both motor weakness and incoordination contributed to the inability of many children to play sport after injury. There was a change in extra-mural activities in 10.8% of Controls and in 23.5%, 10.8% and 26.9% of Moderates, Severes and Very Severes respectively.

Visual and auditory problems

The next most common problem in Controls and Moderates was a difficulty with vision (see Table 13). The ratio for visual problems was 2:1 between Moderates and Controls and 4:1 for auditory problems. Differences between the head-injured and Controls were non-significant. Many of the cases with visual problems were said to have experienced a worsening of poor eyesight since the injury. Although some field deficit is not uncommon after even mild injury (Jennett, 1972), in the present study, most reports referred to blurred vision.

The reporting of auditory problems was objective in the sense that the difficulty had usually been confirmed by a physician, but there was some suggestion that mothers related difficulty with hearing to disobedience: "Ek moet baie praat voordat hy luister." Although this type of description was not recorded as an auditory problem, it is possible that these problems were slightly over-reported in cases where the child was characteristically disobedient or unresponsive. The rates with which both visual and auditory problems presented was comparable to the overall 12% cited by Klonoff and Paris (1974) for all severity groups. Sensory problems were negligible in all groups.

4.3 Physical symptoms

Headache

Headache was the most common somatic symptom (see Table 15) which corresponds

to findings by Hjern and Nylander, 1964; Black et al., 1969; Klonoff and Paris, 1974 and Levin et al., 1987). The incidence of post-traumatic headaches (see Table 16) in each of the head-injured groups was much higher than the 27% reported by Black et al., (1969) and the 29% reported by Klonoff and Paris (1974). Furthermore, the rate for Controls was relatively low and the contrast with high rates in the head-injured which were extremely significant statistically suggest a specific effect of head injury.

Table 15

Presence of physical symptoms at follow-up

Variable	Controls %	(n)	Moderates %	(n)	Severes %	(n)	Very Severes %	(n)
Headaches	24.3	(9)	52.8	(28)	56.8	(21)	65.4	(17)
Nausea	5.4	(2)	28.3	(15)	18.9	(7)	15.4	(4)
Dizzy	8.1	(3)	28.3	(15)	18.9	(7)	46.1	(12)
Fatigues easily	18.9	(7)	39.6	(21)	40.5	(15)	57.7	(15)
Blackouts	0.0	(0)	5.7	(3)	2.7	(1)	11.5	(3)
Fits	0.0	(0)	3.8	(2)	5.4	(2)	15.4	(4)
Sensit. to noise	16.2	(6)	24.5	(13)	27.0	(10)	42.3	(11)

As in adulthood, headache in childhood is common. Epidemiological findings by Silanpaa (1983) indicated that over one third of 7-year-old and over two-thirds of14-year-old non-injured children had suffered from at some stage or other. In this study, most of the headaches were said to arise post-traumatically and those which antedated the injury were described as significantly worse after injury. Migraneous headaches, i.e. those preceded by a blind spot and accompanied by vomiting and nausea occurred in only a few isolated cases. Many of the Moderates were said to complain of headaches only after playing in the sun or playing "wildly". In the more severely injured, they tended to be accompanied by fatigue, loss of appetite and physical activity such as running. A few children from each of the groups described their headaches as painful "kopsteke", which referred to severe twinges of pain where the scalp had been bruised or cut at injury. Rowbotham (1954) has stated that while such pain is characteristic of the acute stages following a head injury, longlasting

post-traumatic headache may be due to the continued presence of this discomfort. Causes of headache in the post-traumatic period include the following : (1) vascular sensitivity i.e the distension of vessels previously sensitised by trauma (Haas, Pineda and Lourie, 1975); (2) excessive muscle contraction in the neck and scalp (McLaurin and Titchener, 1982); (3) involvement of sensory nerves in local injury to the scalp leading to neuralgic-type headaches which are particularly sensitive to pressure and exposure to heat and cold (Denny-Brown, 1942; Cartlidge and Shaw, 1981).

Nausea

Nausea was commonly reported as a new symptom. The data on nausea as a post-traumatic symptom (Table 16) indicates that only the Moderates were statistically different from Controls. The absence of significant rates in the more severely injured as well the fact that an extremely low proportion of Controls (5%) were affected highlights the point made by Alves and Jane (1985) that the problems observed in the mildly injured are often different to and more subtle than those presenting in the more severely injured.

Sensitivity to noise

The frequency with which the head-injured subjects were sensitive to noise (25% to 40%) was higher than that found in Controls (16%) (see Table 15). The high rate of sensitivity found in the Very Severes (42%) suggests that sensitivity to noise was a fairly specific disturbance in response to head injury. Hypersensitivity to noise has been reported as being typical of diffuse, severe head injury in children (Jaffe, et al., 1985). However, Waddell and Gronwall (1984) tested a group of very mildly injured subjects who had had transient loss of consciousess or PTA of less than 1 hour and found that this group had lower tolerance for sound than their matched controls.

Fatigue

Fatigue was the next most frequent post-traumatic physical complaint and has been reported as a common effect of both moderate (Boll, 1983) and severe (Richardson, 1963) head injury. When compared to Controls, the incidence of new fatiguability was marked in Severes (p=0.009) and Very Severes (p=0.001) while Moderates were very close to statistical significance (p=0.029). Levin et al., (1987) examined the factor

Table 16

New physical symptoms : Significance of differences between the control group and head-injured groups at follow-up

Symptom	Controls A		Moderates B			A vs B	Severes C			A vs C	Very Severes D			A vs D
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Headache	16.2	(6)	49.1	(26)	10.26	0.001	56.8	(21)	13.12	0.001	61.5	(16)	13.80	0.001
Nausea	5.4	(2)	26.4	(14)	6.58	0.010	18.9	(7)	F/E	0.152	15.4	(4)	F/E	0.220
Dizzy	8.1	(3)	28.3	(15)	5.55	0.018	18.9	(7)	1.85	0.174	46.2	(12)	12.18	0.001
Fatigue	13.5	(5)	34.0	(18)	4.79	0.029	40.5	(15)	6.85	0.009	53.9	(14)	11.79	0.001
Blackout	0.0	(0)	5.7	(3)	F/E	0.266	2.7	(1)	F/E	1.000	11.5	(3)	F/E	0.065
Fits	0.0	(0)	3.8	(2)	F/E	0.510	2.7	(1)	F/E	1.000	15.4	(4)	F/E	0.025
Sensit. to noise	8.1	(3)	18.9	(10)	2.04	0.153	24.3	(9)	3.58	0.058	42.3	(11)	10.33	0.001

loadings of post-concussional variables divided into five clusters. They found that fatigue correlated poorly with other physical symptoms but was strongly and positively associated with both cognitive-depression and sensory-sleep clusters. In the Brown et al., (1981) study fatiguability and sleep disturbances were absent in the comparison group but presented as new problems in five percent of Severes.

Dizziness

Dizziness, or the subjective experience of disequilibrium (Lishman, 1968) was generally reported to have coincided with sudden movements of the head. The incidence of dizziness arising post-traumatically was statistically different from Controls (8%) in the case of Moderates (28%) and Very Severes (46%). Adult studies have revealed high rates of dizziness in cases of otological dysfunction and injuries resulting in longer periods of unconsciousness (Jacobsen, 1963 ; Lidvall, Linderoth and Norlin, 1974). Current evidence indicates that post-traumatic dizziness is caused by a disturbance of the vestibular apparatus in the internal ear (labyrinth). Such damage occurs to both the severely and the mildly injured (Cartlidge and Shaw, 1981).

Fits and blackouts

Tables 16 and 17 show that, taken as a group, relatively few head-injured children were epileptic at follow-up. However, that 15% of the Very Severes had fits post-injury must be considered as high in light of the finding by Jennett (1972) that 5% of all closed head injury victims could be expected to develop epilepsy within

four years of the injury. There is no known behavioural pattern associated specifically with epilepsy. However, findings from an epidemiological study conducted by Rutter et al. (1970) indicated that the rate of psychological problems in children with epilepsy was four times that found in the general poulation. They also noted that when epilepsy co-occured with a brain lesion (cerebral palsy rather than a head injury was the criterion in their study), this further enhanced the risk for psychological disturbance. Because the rates of disturbance were higher than those found in children with other chronic physical disorders, the authors concluded that behaviour disturbance in epileptics is to a great extent an effect of brain dysfunction.

Rutter (1977) has made the point that active electrical disturbance of brain function has a greater effect than actual loss of function. Also, since epilepsy does reflect an alteration in electrical activity, anti-convulsant medication has the same effect. Consequently, side effects to medication ranging from drowsiness, inattention and lack of concentration, to disorientaion, irritability and incoordination have been reported (Vallarta, Bell and Reichert, 1974). However, epileptic children may develop psychological problems in response to the attitudes of parents and teachers, particularly as a result of lowered expectations and lack of understanding shown by peers (Stores, 1978).

It should be noted that in the present study, the type of epilepsy was not always known by parents. There is evidence that some generalised seizures are precipitated by mood changes such as excitability and irritability which terminate with seizure onset (Stores, 1985). Attacks of this nature are generally the result of damage to the temporal lobes and limbic areas.

"Blackouts" were noted where the descripion was not clearly that of a fit . Instances referred to faints or inadequately described fits. Neither fits nor blackouts were reported in the case of Controls and blackouts occurred seldom in the head-injured. When they did occur they were associated with other physical complaints and fits. One moderately injured boy was described as: " Hy kla nog altyd van 'n dronk kop. Toe hy hierheen moes kom, het hy snaaks aan die muur vasgehou - agteroor getrek."

4.3.1 The post-traumatic syndrome

The post-traumatic development and persistence of headaches, dizziness and fatigue in both moderately and more severely injured subjects indicate the presence of a classic post-traumatic syndrome as it presents in adults. Although the relationships between individual symptoms and other major problems are not known, it should be noted that the incidence of these symptoms as new problems when compared to Controls was usually extremely, rather than moderately, significant. It is of interest that approximately 13.5% of Controls; 13.5%, 54.0% and 72.0% of Moderates, Severes and Very Severes, respectively, were involved in litigation. However, apart from evidence that PTS symptoms follow even the mildest injury, it should be remembered that no attempt was made in this study to identify possible instances of malingering. Thus, the attribution of symptoms to any "functional overlay" is unwarranted. It is often said that litigation tends to maintain the patient's or family's focus on symptomatology but it can just as validly be argued that symptoms tend to maintain focus on litigation (Binder, 1986).

4.4 Developmental problems

Eating problems

Some difficulty with eating was the predominant developmental problem in all the children (see Table 17). The incidence of post-traumatic eating problems was statistically different from Controls only in the case of Severes and Very Severes (see Table 18). Very Severes were on the whole described as overeating . One child was said to overeat until 11 pm at night ; others were reported to be constantly asking for food : " As hy klaar is, wil hy weer eet," or as eating excessively : " Hy eet nou gevaarlik baie". It is worth noting that inadequate nutrition was in present in 35% of the Very Severes (see Table 12). One parent described the situation in this way " As ek werk, kry ons die einde van die maand geld. Tussen- in is ons honger." Instances of both under- and overeating were reported in the case of Moderates and Severes. There was a greater tendency to faddishness reported in Moderates and Controls. Post-traumatic undereating was found to be more common (22%) than overeating (17%) in the Brown et al., (1981) study although overeating was one of

four behaviours more frequent in the group of disorders that the authors attributed to brain damage. As already mentioned, the composition of the comparison grooup in this study necessitates some caution in interpreting results. Interestingly the rate of 17% found in Moderates (Table 17) is identical to the figure cited by Black et al., (1969) for children with eating problems at 1 year follow-up.

Bladder problems

Table 18 reveals that in Very Severes, the incidence of enuresis as a new problem was double that found in either Moderates or Severes. The incidence was negligible in Controls. According to the DSM III-R, diurnal enuresis is more usually associated with emotional disturbance. In this study, the majority of cases were nocturnal and precipitated by tiredness. There were no cases of nocturnal epilepsy producing the enuresis. Brown et al., (1981) found that 28% of children who also had some psychological disturbance became enuretic but this was not found to be statistically significant. Bedwetting was another problem which was regularly associated with those psychological disorders attributable to head injury.

Table 17

Presence of developmental symptoms at follow-up

Symptom	Controls		Moderates		Severes		Very Severes	
	%	(n)	%	(n)	%	(n)	%	(n)
Speech disturb.	2.7	(1)	7.6	(4)	10.8	(4)	19.2	(5)
Eating problems	8.1	(3)	17.0	(9)	29.7	(11)	46.2	(12)
Sleeping problems	2.7	(1)	13.2	(7)	5.4	(2)	15.4	(4)
Bladder problems	10.8	(4)	18.9	(10)	18.9	(7)	23.1	(6)

Sleeping problems

A comparison between Tables 17 and 18 shows that problems relating to sleep were slightly more frequent in the head-injured than Controls but occurred as new post-traumatic problems in only a small percentage of children. The Very Severes were described as having increasing difficulty with getting up in the morning rather than as having any disturbance of sleep. Some of the head-injured were said to be sleeping more since their injury and instances of insomnia were also reported. One

Moderate had regular nocturnal fits while another was described as: "Sy het altyd in haar slaap gepraat. Sy praat nou meer." The Control subject suffered from insomnia occasionally and had bad nightmares. Therefore, it does not appear that there was any pattern of disturbed sleep associated with head injury. In the Brown study, problems were attributed to injury in only 6% of cases.

Table 18

New developmental problems:
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A %	(n)	Moderates B %	(n)	χ2	A vs B p	Severes C %	(n)	χ2	A vs C p	Very Severes D %	(n)	χ2	A vs D p
Speech disturb.	0.0	(0)	1.9	(1)	F/E	1.000	0.0	(0)	-	-	15.4	(4)	F/E	0.025
Eating problems	2.7	(1)	13.2	(7)	F/E	0.134	24.3	(9)	7.40	0.007	38.5	(10)	F/E	0.001
Sleeping problems	2.7	(1)	9.4	(5)	F/E	0.394	5.4	(2)	F/E	1.000	15.4	(4)	F/E	0.150
Bladder problems	2.7	(1)	9.4	(5)	F/E	0.394	8.3	(3)	F/E	0.615	19.2	(5)	F/E	0.073

Speech problems

Tables 17 and 18 show that post-traumatically arising speech problems were statistically significant only in the case of Very Severes of whom about 15% were affected. Hemp (1989) found that the psychologists rated about 5% of all the groups in the UCT study as having immature articulation, but that, with the exception of a few Severes in the early stages, impaired speech, i.e slow or indistinct speech, was rated chiefly in the case of Very Severes. The fact that 15% of the Very Severes were rated by psychologists as having deficits at one year follow-up, suggests that the parental reports were accurate. In the Moderates and in two Severes stuttering was the problem reported by parents and had been present pre-morbidly. The following were examples of descriptions given by parents: " Hy bry verskriklik as hy praat." "..moet eers diep asemhaal voor hy praat." "Ek verstaan nie altyd wat hy sê nie." Slow, indistinct speech is a very common sequel to head injury as is hypernasality and an unvarying voice pitch (Jaffe et al., 1985).

4.1 Scale of developmental disturbances

The scale summarised in Table 19 was comprised of the following questions takenfrom the Rutter Parent Scale: *wets or soils; eats too much or too little; sleeping problems; bites nails or sucks thumb.* The maximum score was 10. The results show

that all the head-injured groups had developmental problems as defined by the scale at intake as well as at follow-up. From the results presented in the foregoing section, it appeared that bladder and sleeping problems would have made the made the major contribution. Very few children had a problem with nailbiting/thumb sucking although it was negligibly more common in the Very Severes at intake and follow-up. This was probably due to the fact that they were, on average, slightly younger (see Table 20 and section 4.4.1.1 below). According to the DSM III-R these behaviours may be suggestive of a neurosis and regression in older children but are of no major significance when they occur as they did in the study i.e. sporadically rather than chronically and when they do not form part of a stereotypic, repetitive pattern. At follow-up, the Severes (p=0.021) and the Very Severes (p=0.019) were statistically different from Controls.

Table 19

Scale of developmental disturbances :
Comparisons between the control group and each head-injured group:
Median, 25th and 75th percentiles and significance of differences at intake (t1) and at follow-up (t2) using the Median test

Statistic		Controls	Moderates	Severes	Very Severes
t1	Median	0	1	1	1
	25th ; 75th	0 ; 1	0 ; 2	0 ; 2	0 ; 2
	χ^2	-	6.43	6.47	6.57
	p	-	0.011	0.011	0.010
t2	Median	0	1	2	2
	25th ; 75th	0 ; 1	0 ; 2	0 ; 2	0 ; 3
	χ^2	-	3.32	5.34	5.51
	p	-	0.069	0.021	0.019

4.4.1.1 Age and developmental variables

In order to examine whether there were differences between the head-injured and Controls on the above described scale, on the basis of age, children were divided into three age groups : under 9, between 9 and 12 and over 13. Table 20 shows only one

Table 20
Age and developmental variables :
Comparisons between the control group and each head-injured group: Median, 25th and 75th percentiles and significance of differences at intake (t1) and at follow-up (t2) using the Median test

Statistic		Controls	Moderates	Severes	Very Severes
Age <9					
t1	Median	0	0	0	0
	25th ; 75th	0 ; 1.3	0 ; 1.3	1 ; 2	0 ; 1.3
	χ^2	-	F/E	F/E	F/E
	p	-	0.712	0.045	1.000
t2	Median	0.5	0	1	0
	25th ; 75th	0 ; 1.3	0 ; 1	0 ; 2	0 ; 2
	χ^2	-	F/E	F/E	F/E
	p	-	0.397	0.698	0.685
Age 9-12					
t1	Median	0	0	0	0
	25th ; 75th	0 ; 0	0 ; 2	0 ; 2	0 ; 2
	χ^2	-	F/E	F/E	F/E
	p	-	0.071	0.111	0.220
t2	Median	0	0	0	2
	25th ; 75th	0 ; 0	0 ; 2	0 ; 2	0.3 ; 3.5
	χ^2	-	F/E	F/E	F/E
	p	-	0.054	0.238	0.006
Age 13+					
t1	Median	-	0	0	-
	25th ; 75th	-	0 ; 2	0 ; 0	-
	χ^2	-	-	-	-
	p	-	-	-	-
t2	Median	0	0	0	1
	25th ; 75th	0 ; 0	0 ; 1	0 ; 0	0 ; 2
	χ^2	-	F/E	F/E	F/E
	p	-	0.603	1.000	0.217

instance where age was seen to be a factor. At 1 year follow-up, only the Very Severes aged between 9 and 12 years were different from Controls (p=0.006). The difference is attributable to the higher rate of speech disturbance and nail-biting found in this group. Overall, age was not found to be of importance in separating the head-injured from Controls.

4.5 Overall psychological disturbance and adversity

Before examining the association between developmental problems and psychosocial adversity, it is helpful to know the frequency of overall psychological disturbance in the four groups and how it relates to psychosocial adversity. A cut-off score of 3 or more on the Rutter Parent Scale is the point at which psychological disturbance is regarded as being present (Rutter et al., 1980). Table 21 summarises the percentage of children from each group who had a total score of $\leq$13 or >13 on the Rutter Parent Scale at 1 year follow-up. The data indicate that very few Controls were affected whereas the rate of disturbance increased linearly with severity of head injury. Approximately a third of the Moderates, half the Severes and over two-thirds of the Very Severes were disturbed. Table 22 on the following page shows that four factors of psychosocial adversity, unemployment, maternal psychiatric disturbance, familial dysharmony and maternal education equal to or less than Std 6, differentiated between Controls with and without disturbance. Table 22 on the following page reveals that three factors, namely, poor nutrition, large family size and low maternal education separated normal from disturbed head-injured subjects. Unemployment was the most significant factor in the case of Controls and poor nutrition was the most distinguishing factor for the head-injured. Poor maternal education was a common significant factor in both Controls and the head-injured. Although far more head-injured than control group subjects were disturbed, fewer factors of psychosocial adversity were statistically significant indicators of disturbance in the head-injured than in the Controls.

Table 21

Percentage overall disturbed (total Rutter score of >13) and non-disturbed (total Rutter score of ≤13) behaviour in Controls and the head-injured groups at 1 year follow-up.

Rutter score	Controls		Moderates		Severes		Very Severes	
	%	(n)	%	(n)	%	(n)	%	(n)
>13	13.5	(5)	37.7	(20)	46.0	(17)	69.2	(18)
≤13	86.5	(32)	62.3	(33)	54.0	(20)	30.8	(8)

Table 22

Psychosocial adversity and overall behaviour disturbance in Controls: Comparison between disturbed (total Rutter score of >13) and non-disturbed (total Rutter score of ≤13) subjects at 1 year follow-up.

Adversity factor	Disturbed (n = 5) Presence of adv. factor				Non-Disturbed (n = 32) Presence of adv. factor				
	Yes		No		Yes		No		
	%	(n)	%	(n)	%	(n)	%	(n)	
Family size	20	(1)	80	(4)	44	(14)	56	(18)	0.18
Overcrowding	60	(3)	40	(2)	31	(10)	69	(22)	0.32
Unemployed	100	(5)	0	(0)	25	(8)	75	(24)	0.003
Mat.ed ≤Std 6	100	(5)	0	(0)	50	(16)	50	(16)	0.0
Mat. psych	40	(2)	60	(3)	0	(0)	100	(32)	0.02
Pat. psych	20	(1)	80	(4)	19	(6)	81	(26)	1.00
Single parent	40	(2)	60	(3)	19	(6)	81	(26)	0.29
Dysharmony	60	(3)	40	(2)	13	(4)	87	(28)	0.04
Illhealth	20	(1)	80	(4)	13	(4)	87	(28)	0.54
Poor nutrition	0	(0)	100	(5)	3	(1)	97	(31)	1.00

Table 23

Psychosocial adversity and overall behaviour disturbance in the head-injured: Comparison between disturbed (total Rutter score of >13) and non-disturbed (total Rutter score of ≤13) subjects at 1 year follow-up.

Adversity factor	Disturbed (n = 55) Presence of adv. factor Yes		No		Non-Disturbed (n = 61) Presence of adv. factor Yes		No		
	%	(n)	%	(n)	%	(n)	%	(n)	
Family size	56	(31)	44	(24)	38	(23)	62	(38)	0.04
Overcrowding	58	(32)	42	(23)	51	(31)	49	(30)	0.43
Unemployed	56	(31)	44	(24)	41	(25)	59	(36)	0.09
Mat.ed ≤Std 6	85	(47)	15	(8)	70	(43)	30	(18)	0.05
Mat. psych	38	(21)	62	(34)	34	(21)	66	(40)	0.67
Pat. psych	35	(19)	65	(36)	30	(18)	70	(43)	0.56
Single parent	29	(16)	71	(39)	30	(18)	70	(43)	0.96
Dysharmony	55	(30)	45	(25)	49	(30)	51	(31)	0.56
Illhealth	24	(13)	76	(42)	18	(11)	82	(50)	0.46
Poor nutrition	35	(19)	65	(36)	13	(8)	87	(53)	0.006

4.6 Loglinear model describing developmental problems

To investigate the relationship between severity, intake scores on the developmental scale, psychosocial adversity and follow-up score on the developmental scale, a loglinear model was fitted, consisting of severity, intake (developmental scores dichotomised into ≤1 versus >1), psychosocial adversity (points dichotomised into ≤4 versus >4) and follow-up (developmental scores dichotomised into ≤1 versus >1).

The following loglinear model described the data (see Table 24): High follow-up scores depended on high intake scores as well as on psychosocial adversity, but severity of injury did not play a role. The likelihood ratio $\chi 2$ was 14.26 with df = 16 and p = 0.579. The interaction between intake and follow-up scores was highly significant (IF : p = 0.002) as was the interaction between psychosocial adversity and follow-up scores (PF : p = 0.016).

However, in spite of the individually significant associations between psychosocial adversity and pre-injury problems on post-traumatic developmental difficulties, there

was no interaction between pre-injury behaviour and psychosocial adversity as is indicated by the nonsignificant effect (PIF : $p = 0.277$). This implies that a child from a disadvantaged background is as likely to have later developmental problems as a child with early developmental problems and that a disadvantaged background and the presence of early developmental problems do not combine to enhance the probability of acquiring these problems in the head-injured sample.

These findings would seem to imply that the developmental problems arising in the Very Severes were a function of psychosocial adversity and pre-morbid developmental problems. It should be noted however, that the developmental problems are slightly different in composition (for example, nail biting, problems with bowel control) to the new developmental problems dealt with in the previous section. Furthermore, the loglinear model is based on a categorisation of behaviour (high versus low) rather than on the percentage present. Consequently, it cannot be concluded that new developmental difficulties presented in the previous section are explained by pre-morbid and adversity factors.

Table 24

Loglinear model describing the interactions between severity of injury, psychosocial adversity and developmental disturbances

Model	df	χ2	p
IF, PF, G	14	14.26	0.579
Main effects:			
G	2	9.52	0.009
P	1	2.80	0.094
I	1	8.94	0.003
F	1	4.20	0.041
Interaction effects:			
GP	2	1.98	0.371
GI	2	0.33	0.849
GF	2	1.18	0.553
PI	1	0.00	0.947
PF	1	5.84	0.016
IF	1	21.23	0.000
GPI	2	0.70	0.705
GPF	2	4.64	0.098
GIF	2	3.73	0.155
PIF	1	1.18	0.277
GPIF	2	0.80	0.670

CHAPTER 5
RESULTS AND DISCUSSION:
PROBLEMS WITH ACTIVITY, ANTISOCIAL BEHAVIOUR AND SOCIAL PROBLEMS

5.1 Activity problems

Table 25 summarises the prevalence of post-traumatic activity problems in all groups, while Table 26 summarises behaviour reported by the parents as new, i.e arising only after the head injury.

Restlessness

Together with the behavioural descriptions obtained from parental interview, comparison of the rates in Table 25 with those in Table 26 reveal that:

Of the 13 Controls who presented with restlessness at follow-up, only one was scored as new post-traumatically. Furthermore, this child was described as becoming more restless post- traumatically rather than developing restlessness for the first time since injury: "Nou is hy baie meer woelig as voor die tyd."

Table 25

Presence of activity problems :
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Restless	35.1	(13)	52.8	(28)	2.80	0.097	54.0	(20)	2.70	0.102	73.1	(19)	8.80	0.003
Hyperactive	2.7	(1)	3.8	(2)	F/E	1.000	2.7	(1)	F/E	1.000	7.7	(2)	F/E	0.564
Hypokinetic	0.0	(0)	0.0	(0)	-	-	2.7	(1)	F/E	1.000	7.7	(2)	F/E	0.166

Whereas the presence of restlessness in the Moderates was not significant given the high rate in Controls, their new post-traumatic rates significant at follow-up (p = 0.008). Behavioural descriptions indicated that the Moderates were exhibiting a more marked pattern of restlessness than before their injury. An exacerbation of pre-injury restlessness was also noted for the six of 20 Severes who presented restless behaviour at follow-up.

A different situation applied in the case of Very Severes. Not only were the majority of cases affected (73%; n = 19), most were also scored as post-traumatically new (n = 17) and the behavioural accounts suggested that the problem was not an exacerbation of previous behaviour, but generally arose for the first time after injury. There also seemed to be a qualitative difference to these reports. Restlessness in the other groups was characterised by a tendency to fidget or fiddle, to be squirmy and distractible whereas Very Severes were often said to be "wild", overly energetic and generally distracted.

In the Rutter-Brown study, restlessness was more frequent (48%) in the group of disorders not attributable to head injury than in the group of Severes without a history of disturbance (11%). It should be noted that the combination of both head-injured and control subjects with pre-traumatic disturbance in the Rutter -Brown comparison group obscured the development i.e increase or decrease with time, of overactivity.

Table 26

New activity problems :
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Restless	2.7	(1)	22.6	(12)	7.01	0.008	16.2	(6)	F/E	0.107	65.4	(17)	29.00	0.000
Hyperactive	0.0	(0)	1.9	(1)	F/E	1.000	2.7	(1)	F/E	1.000	7.7	(2)	F/E	0.166
Hypokinetic	0.0	(0)	0.0	(0)	-	-	2.7	(1)	F/E	1.000	3.9	(1)	F/E	0.413

Hyperkinesis

Diagnosed hyperactivity was negligible in all groups and most instances were new problems after the injury. The children were described as overactive to the extent that they were not able to sit still for more than a few moments and as being into everything: " Hy wil nie stilsit nie...vroetel met alles... dan dwaal hy in die ronde." "Hy is gedurig aan die gang. Dit lyk nie asof hy moeg raak nie." Brown et al., have stated that "some varieties of the hyperkinetic syndrome", presumably those accompanied by disturbances such as disinhibition and concomitant problems with affective and cognitive control, occur in response to organic damage.

Hypokinesis

Post-traumatic rates reflected a worsening of pre-injury underactivity. Very few children were affected and all were said to be generally without energy - "Sy is dikwels dooierig en sonder energie... was altyd so." Subjects who were described as listless and without energy tended to score under apathy as well. Black and co-workers noted hypokinesis in 7 (8%) of their subjects at 1 year follow-up. Although the rate is very similar to that found in Very Severes (Table 25) in the present study, the severity of head injury in underactive subjects was not indicated in the Black study.

5.1.1 Scale of hyperactive behaviour

This scale was comprised of the following questions from the Rutter Parent Scale: *restlessness; squirmy or fidgety behaviour and inability to settle.* Since there were three questions, the maximum score was 6 (see Appendix B.) The intake data revealed that both Moderates and Severes had a wider range of scores (0-4) than either Controls (0-2) or Very Severes (0-3). Table 27 reflects the higher levels of premorbid restlessness in the Moderates and Severes, although differences with the Controls reached statistical significance only for the Moderates. This gives support to the above-mentioned reports of restlessness pre-dating the injury and post-traumatic rates reflecting deterioration in these two groups. At follow-up, Controls showed a slight decrease in the upper end of the distribution of scores and only diferences with the Very Severes reached statistical significance. The Very Severes, whose level of

restlessness premorbidly was very similar to that of Controls, exhibited a significantly higher level at follow-up.

Table 27

Scale of hyperactive behaviour :
Comparisons between the control group and each head-injured group:
Median, 25th and 75th percentiles and significance of differences at intake (t1) and at follow-up (t2) using the Median test

Statistic		Controls Severes	Moderates	Severes	Very
t1	Median	0	2	2	0.5
	25th ; 75th	0 ; 2	0 ; 4	0 ; 4	0 ; 3
	χ^2	-	4.68	3.54	0.54
	p	-	0.031	0.060	0.461
t2	Median	0	2	2	4
	25th ; 75th	0 ; 2.5	0 ; 3.5	0 ; 4.5	1 ; 5
	χ^2	-	3.04	1.93	4.56
	p	-	0.081	0.165	0.033

5.1.2 Loglinear model describing hyperactivity

To examine the association between severity, intake score on the hyperactivity scale, psychosocial adversity and the follow-up score on the hyperactivity scale, a loglinear model was fitted, consisting of severity, intake (scores dichotomised into ≤ 1 versus >1), psychosocial adversity (points dichotomised into ≤ 4 versus >4) and follow-up (scores dichotomised into ≤ 1 versus >1).

The following loglinear model described the data (see Table 28): High follow-up scores depended on an interaction between severity of injury and high intake scores as well as on psychosocial adversity. The likelihood ratio χ^2 was 10.71 with $df = 11$ and $p = 0.468$. The interaction between intake scores and severity of head injury was significant (GIF : $p = 0.052$). There was also a significant 4-way interaction (GPIF : $p = 0.052$) which implies that the association between intake and follow-up depends on the group the child is in as well as the presence of psychosocial adversity.

Table 28

Loglinear model describing the interactions between severity of injury, psychosocial adversity and hyperactivity

Model	df	χ^2	p
IF, P, G	17	21.15	0.220
Main effects:			
G	2	9.53	0.009
P	1	2.80	0.094
I	1	0.14	0.710
F	1	2.80	0.094
Interaction effects:			
GP	2	1.91	0.385
GI	2	3.77	0.152
GF	2	1.99	0.370
PI	1	0.00	0.951
PF	1	0.14	0.706
IF	1	12.11	0.001
GPI	2	0.34	0.844
GPF	2	0.80	0.671
GIF	2	5.93	0.052
PIF	1	0.66	0.418
GPIF	2	5.92	0.052

5.2 Antisocial behaviour

Discipline problem

Undisciplined behaviour was the dominant conduct disturbance in all groups and the incidence increased linearly across groups (see Table 29). The rates in the head-injured were not statistically different from Controls. Table 30 shows that post-injury disobedience arose in only one Control. The qualitative details of the parental interviews revealed that about half the Moderates and Severes who were rated for new disobedience had been undisciplined prior to injury and had shown signs of worsening in the follow-up period. For the majority of Very Severes, disobedience was said to be a new problem after their injury. The reports were qualitatively similar in all groups and examples ranged from mild instances of disobedience such as laziness and sulkiness to more serious oppositional behaviour " Ek moet eers skreeu... doen net wat hy nie moet nie." In one or two cases,

behaviour was said to have improved post-traumatically and it was suggested by parents that this was due to an increase in parental attention. On the whole, reports referred to instances occurring in the home. There was a tendency on the part of mothers, particularly those of moderately and severely injured children, to qualify or justify their childrens' behaviour. Reasons included the following : "He is a bit naughty because he is light in the head; Ek dink dis van hy in sy tienerjare is; Soms is hy baie stout...maar nooit lelik nie; Soos normaal vir seuntjies." The mother of one of the Moderates initially stated: " Hy het nooit straf nodig nie... hy's 'n baie kalm kind." Yet, later in the same interview she admitted "...ja, hy vertel leuens, weier om skooltoe te gaan en hy vat nog ander mense se honde."

Stealing

Overall, the incidence of stealing was slight (Table 29) with behaviour reported as new post-traumatically in only a few cases (Table 30). Some instances took place in the home with children pocketing loose change. There were several children who came home from school with other childrens' toys, clothes and food. Most of the mothers seemed to regard these instances as deliberate theft rather than being due to carelessness or borrowing without permission. Shoplifting of food at supermarkets was reported for two Moderately injured girls; one incident occurred pre- and the other post-traumatically.

Lying

Overall, there were no statistically significant differences between the head-injured and Controls (Table 29), but there was a trend for more of the head-injured to be reported as lying only after their head injury (Table 30). A number of children supposedly lied to avoid trouble but at least one child was said to be "a big liar now". Instances of fantasy production were noted in the case of one Severe and one Very Severe. Fein (1978) has stated that children who lie are usually deprived of affection but it was not known to what extent this applied in the present study. Since the lying was of a persistent nature it is likely that instances also occurred at school.

Table 29

Presence of conduct disorder:
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Discipline problem	13.5	(5)	24.5	(13)	1.65	0.199	35.1	(13)	4.69	0.030	34.6	(9)	3.93	0.047
Steals	0.0	(0)	11.3	(6)	F/E	0.041	13.5	(5)	F/E	0.054	11.5	(3)	F/E	0.065
Lies	8.1	(3)	22.6	(12)	3.31	0.069	21.6	(8)	2.67	0.102	15.4	(4)	F/E	0.434
Truants	0.0	(0)	7.6	(4)	F/E	0.140	8.1	(3)	F/E	0.240	7.7	(2)	F/E	0.166

Table 30

New conduct disorder:
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Undisciplined	2.7	(1)	11.3	(6)	F/E	0.233	18.9	(7)	F/E	0.056	34.6	(9)	F/E	0.001
Steals	0.0	(0)	9.4	(5)	F/E	0.075	10.8	(4)	F/E	0.115	7.7	(2)	F/E	0.166
Lies	2.7	(1)	17.0	(9)	F/E	0.043	13.5	(5)	F/E	0.199	11.5	(3)	F/E	0.297
Truants	0.0	(0)	5.7	(3)	F/E	0.266	8.1	(3)	F/E	0.240	3.9	(1)	F/E	0.413

Truanting

After their injury, the majority of Controls had returned to school by 1 week; Moderates returned by 2 weeks; Severes by 1 month but the majority of Very Severes had still not returned by 6 weeks. Furthermore, there were about five Very Severes who had not yet returned to school on a regular basis by one year follow-up. Tables 29 and 30 show that none of the Controls and very few of the head-injured truanted once yhey had returned to school. The problem pre-dated the injury in all cases with the exception of one Moderate and one Very Severe. Several reports stated that children were spending their days in town or travelling on trains and buses. There were also cases where pre-morbid truanting had ceased to be a problem by one year follow-up. The conditions surrounding instances of truancy were not always made clear in the interview, which suggests that most parents were not aware of reasons for the problem.

This was not always the case - the mother of a severely injured child discovered that the girl had been lying about missed transport. After being confronted she admitted that she could no longer cope with schoolwork. Her mother saw the headmaster, there was an improvement afterwards and the truanting stopped.

5.2.1 Scale of antisocial behaviour

The scale was comprised of the following four questions from the Rutter Parent Scale: *truancy; disobedience; stealing and destructiveness.* The maximum possible score was 8. Table 31 shows that at intake both Moderates and Severes were significantly different from Controls, which was confirmed by reports of pre-injury truancy, stealing and disobedience. Destructiveness, which refers to damage to own or others' property, is the only variable which has not been dealt with thus far. Examination of responses to the Rutter questionnaire at intake and follow-up showed that pre-morbid destructiveness was more prevalent in Moderates (15%) and Severes (13%) than in either Controls (7%) or Very Severes (7%) although there was no significant difference from Controls. At follow-up, there seemed to be an association with severity of injury since both Severes (18%) and Very Severes (32%) showed an increase in prevalence whereas the rates dropped for Controls and Moderates. That only Very Severes reached statistical significance at follow-up on the anti-social scale, is then, mainly due to the post-traumatic development of destructiveness and as already mentioned, undisciplined behaviour, in this group.

Table 31

Scale of antisocial behaviour :
Comparisons between the control group and each head-injured group:
Median, 25th and 75th percentiles and significance of differences at intake (t1) and at follow-up (t2) using the Median test

Statistic		Controls	Moderates	Severes	Very Severes
t1	Median	0	0	0	0
	25th ; 75th	0 ; 0	0 ; 1	0 ; 1	0 ; 1
	χ^2	-	10.98	9.19	2.73
	p	-	0.001	0.002	0.098
t2	Median	0	0	1	1
	25th ; 75th	0 ; 1	0 ; 1.5	0 ; 2	0 ; 2
	χ^2	-	0.00	4.33	5.51
	p	-	0.945	0.037	0.019

5.2.2 Loglinear model describing antisocial behaviour

The cut-off points for the loglinear model describing antisocial behaviour were identical to the points mentioned above in connection with previous models.

This model was found to describe the data (see Table 32): High follow-up scores depended on severity of injury. The likelihood ratio χ^2 was 14.64 with $df = 16$ and $p = 0.397$. There was a significant relationship between the severity of head injury and antisocial behaviour at follow-up (GF : $p = 0.012$). No other factor was significantly associated with oppositional behaviour at follow-up. The odds ratios in Appendix D indicate that Severes are about twice more likely and Very Severes three times more likely than Moderates to be antisocial at follow-up irrespective of either pre-morbid rates or the presence of psychosocial adversity.

A positive relationship between either disobedience, stealing or truanting and severity of head injury was not supported in the Rutter-Brown study. All these behaviours occurred more commonly in the group of children whose behaviour disturbance was regarded as not attributable to brain damage.

Table 32
Loglinear model describing the interactions between severity of injury, psychosocial adversity and antisocial behaviour

Model	df	χ^2	p
GF, P, I	16	14.64	0.551
Main effects:			
G	2	9.53	0.009
P	1	2.80	0.094
I	1	2.21	0.139
F	1	0.00	1.000
Interaction effects:			
GP	2	2.23	0.327
GI	2	3.29	0.193
GF	2	8.78	0.012
PI	1	0.80	0.372
PF	1	0.53	0.465
IF	1	1.92	0.166
GPI	2	1.82	0.402
GPF	2	1.00	0.605
GIF	2	0.37	0.831
PIF	1	0.16	0.691
GPIF	2	3.47	0.177

5.3 Social problems

Overall, social problems in the head-injured need to be interpreted in light of the fact that very few Controls were affected (see Table 33) and that of those who were problematic, even fewer were rated as having their problems occur for the first time post-traumatically (see Table 34).

Impatience

Table 33 shows that impatience was prevalent in Controls, Severes and Very Severes. Statistical significance for new rates was realised in all the head-injured groups (see Table 34). It can be surmised that impatience may have occurred initially in reaction to physical or cognitive defects and disruption of routine caused by school absence. However, impatience or "cerebral irritation" has been documented as a common response brain damage (Jennett, 1972; Lishman, 1978).

Low frustration tolerance

As was the case with impatience, the follow-up rates for inability to handle frustration were statistically significant in all three head-injured groups. The data (Tables 33 and

34) indicate that the problem had preceded date of injury in both Moderates and Severes but not in Very Severes.

Table 33

Presence of social problems :
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B			A vs B	Severes C			A vs C	Very Severes D			A vs D
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Low stress tolerance	21.6	(8)	60.4	(32)	13.25	0.000	56.8	(21)	9.58	0.002	73.1	(19)	16.51	0.000
Impatience	27.0	(10)	47.2	(25)	3.72	0.054	64.9	(24)	10.67	0.001	76.9	(20)	15.24	0.000
Aggression	8.1	(3)	28.3	(15)	5.55	0.018	40.5	(15)	10.57	0.001	61.5	(16)	20.70	0.000

There were slightly more Moderates with low frustration tolerance than with impatience which suggests that some children, although not characteristically impatient, were nevertheless unable to deal with situations demanding delay of gratification and sustained effort. In general, examples of low frustration tolerance were more serious than those describing impatience and there were a number of instances of children throwing things, slamming doors and having uncontrollable outbursts. Shaffer (1985) has pointed out that while such pathological rage reactions might be common in children with temporal lobe epilepsy, it is difficult in the case of head-injured children to differentiate aggression due to brain damage from that which exists as part of a conduct disorder. His view is that there is no reason to believe that there exists any specific neurological syndrome of uncontrollable rage and poor impulse control which differs materially from aggression seen in children without brain damage. Two findings have surfaced in the present study. In the first place, poor stress tolerance can, in some instances, be seen as a separate entity from conduct disorder since post-traumatic rates were higher than either undisciplined behaviour or destructiveness in each of the head-injured groups. Secondly, isolating lowfrustration tolerance from antisocial behaviour does not undermine the part played by brain damage, considering that, in this study, antisocial behaviour was strongly related to severity of injury (see section 5.2.2 above).

Table 34

New social problems :
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Low stress tolerance	5.4	(2)	37.7	(20)	12.33	0.000	35.1	(13)	10.12	0.001	69.2	(18)	28.71	0.000
Impatient	0.0	(0)	32.1	(17)	14.63	0.000	46.0	(17)	22.07	0.000	69.2	(18)	35.86	0.000
Aggressive	2.7	(1)	18.9	(10)	F/E	0.024	21.6	(8)	F/E	0.028	61.5	(16)	26.83	0.000

Aggression

Table 33 shows a significantly higher prevalence of aggression in all the head-injured groups, and Table 34 indicates that for the head-injured groups, and particularly for the Very Severes, this aggression was new behaviour, arising after the head injury. Several instances were of a rather serious nature. For example, one child was described thus: "Hy slaan sy boetie ongelukkig." Girls were often verbally aggressive but there was an instance of a severely injured girl who threw stones at her mother. Other cases involved flaring up and hitting out at parents and other children for no reason.

5.3.1 Scale of social problems

The scale summarised in Table 35 was formed by questions from the Rutter Parent Scale dealing with the frequency with which the child was *not much liked; solitary; and bullying others.* The highest possible score was 6. There were no statistically at intake and at follow-up the only significant comparison was between Very Severes and Controls. Examination of the scores at follow-up revealed that bullying behaviour was the most prevalent problem in all groups and applied to 5% of Controls; 30% of Moderates; 21% of Severes; and 54% of Very Severes. Both Moderates and Very Severes were statistically different from Controls. Very Severes were less liked (24%) than Severes (8%), Moderates (13%) or Controls (3%). The extent to which Very Severes were solitary (46%) was also higher than the 21%, 38%, and 29% for Severes, Moderates and Controls respectively. The high rate of bullying in the

Table 35

Scale of social problems:
Comparisons between the control group and each head-injured group:
Median, 25th and 75th percentiles and significance of differences at intake (t1) and at follow-up (t2) using the Median test

Statistic		Controls	Moderates	Severes	Very Severes
t1	Median	0	1	0	0
	25th ; 75th	0 ; 1	0 ; 2	0 ; 1	0 ; 2
	χ^2	-	1.73	0.22	0.02
	p	-	0.188	0.641	0.889
t2	Median	0	1	0	2
	25th ; 75th	0 ; 1	0 ; 2	0 ; 1.5	0.8 ; 3
	χ^2	-	3.98	0.06	18.61
	p	-	0.046	0.811	0.000

head-injured is probably a manifestation of the raised levels of aggression reported in the previous section.

5.3.2 Loglinear model describing social problems.

The cut-off points for this model were the same as mentioned in previous sections. The following loglinear model described the data (see Table 36): Severity of injury was found to interact with psychosocial adversity in producing high scores at follow-up. The likelihood ratio χ^2 was 14.73 with $df = 14$ and $p = 0.397$. The interaction between severity of injury and high rates of psychosocial adversity which produced high follow-up scores was statistically significant (GPF : p=0.038). The odds ratios in Appendix B show that, regardless of severity, a child coming from conditions of high psychosocial adversity is three times more likely to develop social problems at follow-up than a child with low adversity. Whereas Severes are only slighly more at risk than Moderates, Very Severes are three times more likely than Moderates to have post-traumatic social problems.

Table 36

Loglinear model describing the interactions between severity of injury, psychosocial adversity and social problems

Model	df	χ^2	p
GF, PF, IF	14	14.73	0.397
Main effects:			
G	2	9.52	0.009
P	1	2.80	0.094
I	1	0.03	0.853
F	1	1.24	0.265
Interaction effects:			
GP	2	0.76	0.683
GI	2	2.79	0.248
GF	2	9.35	0.009
PI	1	1.73	0.189
PF	1	5.38	0.020
IF	1	6.95	0.008
GPI	2	5.26	0.072
GPF	2	6.56	0.038
GIF	2	1.37	0.504
PIF	1	0.65	0.419
GPIF	2	0.51	0.777

CHAPTER 6

RESULTS AND DISCUSSION: PROBLEMS WITH CONTROL, MENTAL SYMPTOMS, NEUROTIC BEHAVIOUR AND MOOD DISTURBANCES

6.1 Disinhibition

Impulsiveness

Table 37 shows that impulsiveness was the most common disturbance of control in the head-injured. Both Severes and Very Severes were statistically different from Controls and Moderates approached significance. A comparison with the figures for new impulsiveness (Table 38) indicates that the problem antedated the injury in more Controls, Moderates and Severes than in Very Severes. Fourteen of the 15 Very Severes who were impulsive at 1 year follow-up were new cases.

Behavioural descriptions provided some very telling examples of the type of behaviour that is likely to lead to accidents : "That's what caused his problems - he's too rough; " " As iets gevaarlik is, doen hy dit graag... dis sy gewoonte;" and "Hy's een wat sommer oor die pad hardloop;" "Hy kyk nie rond as hy loop nie ... voor rygoed in." A boy in the Very Severely injured group was described as: " Nou die ander dag was hy besig om bossies aan die brand te sit." Not only physical activities were cited as examples of impulsiveness. There were several verbal instances : " Hy dink nie voor hy praat nie;" "Somtyds kan hy baie lelik vloek... nie voorheen so nie."

In the Brown et al., (1981) study, socially inappropriate behaviour presented for the first time in 55.5% of the severely injured group. This figure corresponds to the 53.9% for new impulsiveness in Very Severes (see Table 38).

Table 37

Presence of control disorder:

Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Impulsive	10.8	(4)	28.3	(15)	4.00	0.045	35.1	(13)	6.19	0.013	57.7	(15)	15.93	0.000
Overtalkative	13.5	(5)	17.0	(9)	0.20	0.655	29.7	(11)	2.87	0.090	53.9	(14)	11.97	0.001
Personal remarks	8.1	(3)	17.0	(9)	F/E	0.346	24.3	(9)	3.58	0.058	42.3	(11)	10.33	0.001
Careless	13.5	(5)	9.4	(5)	F/E	0.735	24.3	(9)	F/E	0.728	23.1	(6)	F/E	0.530

Overtalkativeness

The prevalence of overtalkativeness was significantly different from Controls only in the group of Very Severes (Table 37). There was a trend towards significance in the Severes. As was the case with impulsiveness, the incidence of new overtalkativeness was highest in the Very Severes (Table 38) which suggests that the problem pre-dated injury in several children from the other groups. Most children were said to talk too much to anyone. There were also several references to constant talking "... praat aanhoudend."

Personal remarks

Personal remarks or embarrassing questions were most prevalent in Very Severes (Table 37). Comparison with Table 30 reveals that the problem pre-dated the injury in the Controls. By contrast, the disturbance in all the Very Severes (n=11) was rated as arising post-traumatically. The following descriptions were typical : " Vra dinge van vroue en mans - dan lag ander vir haar. Sy lag nie daaroor nie." "He's insulting... doesn't care what he tells you. " The mother of a 15 year-old boy said that her son: "Vertel seksstories wat my skaammaak."

Table 38

New disturbance of control :

Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Impulsive	5.4	(2)	18.9	(10)	F/E	0.113	24.3	(9)	5.23	0.022	53.9	(14)	18.91	0.000
Over-talkative	2.7	(1)	13.2	(7)	F/E	0.134	10.8	(4)	F/E	0.358	46.2	(12)	17.60	0.000
Personal remarks	0.0	(0)	9.4	(5)	F/E	0.075	13.5	(5)	F/E	0.054	42.3	(11)	F/E	0.000
Careless	2.7	(1)	5.7	(3)	F/E	0.641	21.6	(8)	F/E	0.028	19.2	(5)	F/E	0.073

Carelessness

The problem of carelessness which generally pertained to hygiene was not found to be significantly more prevalent in the head-injured than in Controls. The data (Tables 37 and 38) show that only one of three Control subjects developed carelessness post-traumatically as opposed to 8 of 9 Severes and all of the five Very Severes with the problem at follow-up. These examples were representative :" He doesn't like to bath or dress himself." " He will go without a bath for two to three days."

6.1.1 Scale of disinhibited behaviour

This scale was comprised of the following four questions which were scored according to the format used in the Rutter Parental Questionnaire: *impulsiveness; overtalkativeness; embarrassing remarks and carelessness.* There were four questions and the maximum possible score was 8. Table 38 reveals that Moderates had a wider range of scores (0-3) than either Controls and Very Severes (0-1) or Severes (0-2) at intake. The higher median score in this group was highly significant (p = 0.001). It has been stated above, that problems with control were new difficulties particularly for the Very Severes whereas for the less severely injured, many of the behaviours were in evidence premorbidly. The intake data on Moderates confirmed this for all variables dealing with disinhibition. For example, 8% of Controls were impulsive; 5% were overtalkative; 11% made personal remarks and 11% were careless prior to their injury. The corresponding values for Moderates were as follows : impulsiveness 26%; overtalkative 28%; personal remarks 27% and carelessness 27%. This corresponds with the overall view expressed by Rutter that children who sustain milder injuries are behaviourally different from controls before they sustain their head injury. At follow-up, the fact that Very Severes reached significance (p=0.02) in relation to Controls while Severes approximated significance (p=0.037) confirms what was shown in Tables 37 and 38.

6.1.2 Loglinear model describing disinhibition

To investigate the association between severity, intake score on the disinhibition scale, psychosocial adversity and the follow-up score on the disinhibition scale, a loglinear model was fitted, consisting of severity, intake (dichotomised into ≤1 versus >1), psychosocial adversity (dichotomised into ≤4 versus >4) and follow-up (dichotomised into ≤1 versus >1). The following loglinear model described the data: High follow-up scores depended on severity of injury. The likelihood ratio χ^2 was 9.44 with $df = 14$ and $p = 0.802$, (see Table 40). The association between severity of head injury on follow-up scores was significant (GF : p=0.043). In Appendix D the odds ratio shows that a child with a very severe head injury is nearly three times more likely to be disinhibited after injury than a moderately injured child and a severely injured child is about twice as likely as a the Moderate to have problems with control. This corresponds with the Rutter-Brown findings that disinhibition and socially inappropriate behaviour characterised those children with severe brain damage.

GI ($p = 0.43$) seems to suggest that disinhibited behaviour relates to severity of injury - a fact which, once again, lends support to the idea of head injured children as predisposed to sustaining the injury.

Table 39

Scale of disinhibited behaviour :
Comparisons between the control group and each head-injured group:
Median, 25th and 75th percentiles and significance of differences at intake (t1) and at follow-up (t2) using the Median test

Statistic		Controls	Moderates	Severes	Very Severes
t1	Median	0	1	1	0
	25th ; 75th	0 ; 1	0 ; 3	0 ; 2	0 ; 1
	χ^2	-	5.49	2.64	0.00
	p	-	0.019	0.104	0.966
t2	Median	0	0	1	2
	25th ; 75th	0 ; 1	0 ; 2	0 ; 3	0 ; 6
	χ^2	-	1.48	3.48	8.16
	p	-	0.223	0.062	0.004

Table 40

Loglinear model describing the interactions between severity of injury, psychosocial adversity and disinhibition

Model	df	χ^2	p
GF, GI, P	14	9.44	0.802
Main effects:			
G	2	9.53	0.009
P	1	2.80	0.094
I	1	0.31	0.577
F*	1	0.55	0.457
Interaction effects:			
GP	2	1.84	0.398
GI	2	6.27	0.043
GF	2	5.07	0.079
PI	1	0.14	0.707
PF	1	0.93	0.336
IF	1	2.88	0.090
GPI	2	0.73	0.695
GPF	2	0.36	0.836
GIF	2	1.07	0.587
PIF	1	0.15	0.703
GPIF	2	0.53	0.769

6.2 Mental symptoms

Forgetfulness

Forgetfulness was the most common mental symptom in all groups (see Table 32) and was reported by parents as new behaviour in a significantly greater proportion of head-injured than of Control subjects (Table 33). Examples cited in the interviews referred to absent-minded, scatterbrained and generally aimless behaviour. Children needed constant reminding of routine activities such as taking books to school, remembering to buy or fetch things and keeping times and appointments. Most cases were said to present for the first time since injury.

At neuropsychological testing, Hemp (1989) found that 10% of Controls; 20% of the Moderates; 30% of Severes and 60% of Very Severes were persistently impaired on at least one of the following three memory measures: recall, long term storage and consistent retrieval of a shopping list. This would suggest that parental reports of forgetfulness, at least in Very Severes was accurate. Jansen (1989) found persistent

impairment of verbal memory tasks following mild and moderate traumatic brain injury.

Attention and learning problems

Table 41 indicates that an attentional deficit was more common in the head injured (from 27% to 52%) than in Controls (15%). However, there was a significant difference in only the Very Severes. Table 42 shows that when it comes to deficits reported as new post-traumatically, both Moderates and Very Severes are significant with Severes approximating significance.

Similarly, whereas only Very Severes reached statistical significance on the presence of learning problems at follow-up (Table 41). Moderates were also highly significant when rated for incidence, (Table 42).

Difficulty with attending is important in childhood disorders because of the relation to hyperactivity and conduct disorder. Attention deficits are often secondary to over-and hyperactivity (DSM III, 1987). Apart from its association with other

Table 41

Presence of mental symptoms:
Significance of differences between the control group and head-injured groups at follow-up

Symptom	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Forgetful	21.6	(8)	41.5	(22)	3.88	0.049	54.1	(20)	8.27	0.004	64.0	(16)	11.29	0.001
Attention problems	13.5	(5)	26.9	(14)	2.32	0.128	27.0	(10)	2.09	0.148	52.0	(13)	10.73	0.001
Learning problems	18.9	(7)	30.8	(16)	1.58	0.208	29.7	(11)	1.18	0.278	62.5	(15)	11.99	0.001

Note: n = 52 for Moderates on attention and learning problems;
n = 25 for Very Severes on attention and forgetful;
n = 24 for Very Severes on learning problems.

behaviours, an inability to attend is suggestive of inflexible thought processes and may present as an inability to shift mental sets. Perseverative or stimulus-bound behaviour can impede academic and social progress. Distractability and difficulty with concentration are common post-injury problems and known to become significantly worse after head injury in case where these were pre-injury complaints (Lezak, 1983). However with head-injured children, that which appears to be attentional or related to learning may in fact be reflective of an underlying visuospatial, perceptual or constructional deficit (Szekeres et al., 1985).

6.3 Neurotic behaviour

Attention-seeking behaviour

Table 43 shows that although the frequency with which attention-seeking was present at follow-up was high in all the groups, only the proportion of Moderates (59%) approached statistical significance (p = 0.029) when compared with the rate in Controls (35%). The incidence of new attention-seeking (Table 44) were significant in the case of Moderates (28% ; p = 0.002) and Very Severes (58% ; p = 0.000). However, the behavioural descriptions revealed that there were hardly any cases in which demands for attention presented as an entirely new post-injury problem. Instead, behaviours were cited as worsening in quality after injury. Therefore, comparison between Tables 43 and 44 indicates that nearly all the Very Severes (15 of 16) became more attention-seeking after their head injury. By contrast, this was the case in about half the Moderates and Severes. This suggests that, in the other half of Moderates and Severes, the problem was present prior to head injury. It is instructive that Manheimer and Mellinger (1967) noted a strong

Table 42

New mental symptoms:
Significance of differences between the control group and head-injured groups at follow-up

Symptom	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Forgetful	5.4	(2)	37.7	(20)	12.33	0.000	43.2	(16)	14.39	0.000	64.0	(16)	24.86	0.000
Attention problems	2.7	(1)	21.2	(11)	F/E	0.012	21.6	(8)	F/E	0.028	52.0	(13)	20.74	0.000
Learning problems	5.4	(2)	26.9	(14)	6.79	0.009	16.2	(6)	F/E	0.261	62.5	(15)	23.61	0.000

Table 43

Presence of neurotic behaviour :
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Attention Seeking	35.1	(13)	58.5	(31)	4.76	0.029	43.2	(16)	0.51	0.475	61.5	(16)	4.29	0.038
Fussy	35.1	(13)	39.6	(21)	0.19	0.666	43.2	(16)	0.51	0.475	34.6	(9)	0.00	0.966
Fears	13.5	(5)	20.8	(11)	0.78	0.377	16.2	(6)	0.11	0.744	42.3	(11)	6.68	0.010
Worried	16.2	(6)	20.8	(11)	0.29	0.588	18.9	(7)	0.09	0.760	23.1	(6)	F/E	0.530

connection between rates of attention-seeking behaviour (up to 39% of boys and 36% of girls) and accident liability. Arguably, all troublesome behaviours, including those which can be described as fitting some other defined pattern such as hyperactivity and disinhibition can be ascribed to a motive of attention-seeking (Shaffer, 1985). In the study, mothers were vague about specific acts of, and situations surrounding attention-seeking. They emphasised that the demands were for more parental time, availability and responsiveness. It is interesting that the presence of attention-seeking was most significant in Moderates since there were also high rates of large family size (45%) and single parenthood (30%) in this group (see Table 12).

Fussiness

Fussiness was prevalent in all the groups (see Table 43) and none of the head-injured were statistically different from Controls in whom the rate was high (35%). Reports of faddishness centred on food and clothing and there was no qualitative or descriptive difference between groups. None of the descriptions suggested an obsessive quality to the fussiness.

Table 44

New neurotic behaviour :
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B			A vs B	Severes C			A vs C	Very Severes D			A vs D
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Attention seeking	2.7	(1)	28.3	(15)	9.77	0.002	21.6	(8)	F/E	0.028	57.7	(15)	24.37	0.000
Fussy	2.7	(1)	13.2	(7)	F/E	0.134	16.2	(6)	F/E	0.107	11.5	(3)	F/E	0.297
Fears	5.4	(2)	15.1	(8)	F/E	0.188	10.8	(4)	F/E	0.674	38.5	(10)	F/E	0.002
Worries	8.1	(3)	13.2	(7)	F/E	0.516	13.5	(5)	F/E	0.711	23.1	(6)	F/E	0.144

Specific fears and general worry

The number of Very Severes (n = 11) versus Controls (n = 5) with specific fears post injury was significant (p = 0.010; see Table 43). Table 44 shows that 10 of the 11 developed fears in the follow-up period. In the case of Controls, the content of fears was mainly restricted to objects such as dogs, the dark, mice, cats, worms, plastic snakes and spiders. Fears in the head-injured were less concrete and included ghosts, new situations, an imaginary man at the window and violence. At least one child from each of the groups was said to be afraid of the fighting and shouting exhibited by his or her father or stepfather. Several children expressed a fear of accidents or injury. General worry was not a problem of statistical significance in the head-injured at follow-up (Table 43). However, Table 44 indicates that in the Very Severe group, all 6 children with general worry at follow-up developed this post-traumatically.

6.4 Mood disturbances

Tearfulness

With the exception of tearfulness, mood disturbances were not common in the Controls (see Table 45). Tearfulness was also the problem occurring most often in Moderates and Severes but it was not statistically significant given the frequency in Controls (16%). It appeared from the parental interview, that children in the control group cried in response to "teasing" ; "when I shout at her" ; "when the teacher

shouts". The head-injured were reported to cry often "trane loop maklik" and without any apparent cause. The mother of a moderately injured boy said that since the accident, her son had become "depressed" every two to four weeks at which time he would cry for no reason. Another mother stated that : "Hy huil oor alles. Ek mag hom niks sê nie." A severely injured girl was described as: "Sy huil oor die gerinste ding - nes 'n baba. Sy was nie altyd so nie." Thus, although none of the head-injured were statistically different from Controls with respect to the overall incidence of post-traumatic tearfulness, it does seem that there was a clinical difference in the quality and frequency of their crying after the head injury.

Table 45

Presence of mood disturbances :
Significance of differences between the control group and head-injured groups at follow-up

Problem	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Tearful	16.2	(6)	22.6	(12)	0.56	0.453	32.4	(12)	2.64	0.104	38.5	(10)	3.99	0.046
Apathetic	5.4	(2)	20.8	(11)	4.15	0.042	27.0	(10)	6.37	0.012	42.3	(11)	12.70	0.000
Withdrawn	8.1	(3)	20.8	(11)	2.65	0.103	8.1	(3)	F/E	1.000	30.8	(8)	F/E	0.040
Too cheerful	0.0	(0)	17.0	(9)	F/E	0.009	10.8	(4)	F/E	0.115	50.0	(13)	23.31	0.000
Changeable	10.8	(4)	15.1	(8)	F/E	0.755	16.2	(6)	0.46	0.496	50.0	(13)	11.90	0.001

Apathy

Table 45 shows that apathy was common in the head-injured and that in spite of the fact that the incidence in Moderates was four times (20%) that found in Controls (5%), Moderates were the only group not found to be statistically different from Controls. Apathy arising post-traumatically (see Table 46) was highly significant in Very Severes (p=0.000) and somewhat significant in Severes (p = 0.028). The mother of the child in the Control group who was described as developing apathy after trauma, stated that : "He stays tired now." In the Moderates, apathy was defined as : " Hy is baie dooierig...slaperig", "... word baie gou moeg", "... wil altyd net sit." There seemed to be an association between apathy and headaches in the Moderates which was not noted in any of the other groups: " Hy raak dooierig as hy die kop kry." " As hy uit die skool kom, sê hy sy kop is seer - hy gaan nou slaap." There was an overlap between apathetic mood and social withdrawal in some of the Severes :

Table 46

New mood disturbances:
Significance of differences between the control group and head-injured groups at follow-up

Variable	Controls A		Moderates B		A vs B		Severes C		A vs C		Very Severes D		A vs D	
	%	(n)	%	(n)	χ^2	p	%	(n)	χ^2	p	%	(n)	χ^2	p
Tearful	8.1	(3)	20.8	(11)	2.65	0.103	27.0	(10)	4.57	0.032	30.8	(8)	F/E	0.040
Apathetic	2.7	(1)	15.1	(8)	F/E	0.076	21.6	(8)	F/E	0.028	38.5	(10)	F/E	0.000
Withdrawn	0.0	(0)	13.2	(7)	F/E	0.039	8.1	(3)	F/E	0.240	23.1	(6)	F/E	0.003
Too cheerful	0.0	(0)	17.0	(9)	F/E	0.009	10.8	(4)	F/E	0.115	50.0	(13)	23.31	0.000
Changeable	5.4	(2)	11.3	(6)	F/E	0.463	16.2	(6)	F/E	0.261	46.2	(12)	14.67	0.000

"Ek soek in die kamer, dan sien ek hy lê onder die bed." "Sy sit net in die kamer... praat nie." Severes were often described as "too quiet" and as showing lack of interest in activities. Instances of apathy in the Very Severes were similar to those found in the other groups in so far as most children were described as generally listless and quiet. There were however, Very Severes in whom the apathy was more marked : "Hy sit net doodstil", "... Hy sit net so", "... asof sy in 'n trance is."

Pang (1985) has explained apathy, or the general loss of affective responses, as resulting from diffuse brain damage which involves the limbic and reticular activating systems. Such damage causes a change in the level of affect. He cited pathologic studies which have revealed that apathy is associated with lesions in widely separated areas of the brain.

Social withdrawal

Although the presence of withdrawal (see Table 45) in the head-injured was not statistically different from Controls, the post-traumatic incidence was notable (p=0.003) in the case of Very Severes (see Table 46). Withdrawal is common in very severely head-injured subjects (Jennett, 1972). There was no difference between groups in reports by the parents. One severely injured boy was described as " He never goes out now... he was always on his bike... we never saw him." Considering that children in early adolescence become increasingly aware of their own and others' psychological processes, are as a result more introspective and self-consciousness (Fein, 1978), some degree of social withdrawal may be regarded as an age appropriate

(Fein, 1978), some degree of social withdrawal may be regarded as an age appropriate behaviour.

Too cheerful effect

Table 45 shows that 17% of Moderates (p = 0.009) and 50% of Very Severes (p = 0.000) appeared to be too cheerful and Table 37 shows that, without exception, the problem developed post-traumatically. Too cheerful affect in the Moderates was characterised by euphoria and excessive laughter and was sometimes accompanied by aggression : "Hy slaan ander kinders, dan lag hy hard". Excessive or inappropriate laughter was the predominant feature in Very Severes and these children were said to burst out laughing for no reason. It was clear from the descriptions that too cheerful affect and pathological laughter were related to disinhibition in the Very Severes. For example, the following descriptions were typical : " The neighbours complain of his laughing... sometimes he laughs so much that he lies on the floor with his legs kicking." " Sy perform verskriklik - niemand lag nie, maar sy lag vir goed wat nie eers snaaks is nie." "Die kinders sê sy is mal... lag sy hard dan pyn haar kop." "Hy lag op snaakse tye. Jy weet nie waarvoor nie."

Pang (1985) has stated that although pathological laughter presents as an affective disorder, it is more accurately a disorder of the motor concomitants of affective expression. It occurs when higher limbic emotions (such as pleasure) are uncoupled from the effector that mediates the motor components of emotion (laughter and the facial expression of smiling). Thus, this type of laughter is considered pathological because it is unprovoked and occurs without an appropriate underlying mood.

6.4.1 Scale of neurotic behaviour and mood disturbances

This scale was comprised of the following from the Rutter Parent Scale: *worries; miserable; fearful; fussy and tearful.*

Table 47

Scale of neurotic behaviour and mood disturbances : Comparisons between the control group and each head-injured group: Median, 25th and 75th percentiles and significance of differences at intake (t1) and at follow-up (t2) using the Median test

Statistic		Controls	Moderates	Severes	Very Severes
t1	Median	1	2	1	1
	25th ; 75th	0 ; 1.5	0 ; 3	0 ; 2	0.8 ; 2
	χ^2	-	9.14	2.92	3.22
	p	-	0.003	0.088	0.073
t2	Median	1	2	1	2
	25th ; 75th	0 ; 2	0 ; 3	0 ; 2.5	0 ; 3
	χ^2	-	3.04	0.49	3.38
	p	-	0.081	0.483	0.066

The highest possible score was 10. Table 47 reveals that only the Moderates were disturbed at intake. Examination of the individual Rutter items showed a statistically significant difference from Controls on the question of tearfulness ($p = 0.04$). The rate was 0% for Controls and 13% for the Moderates. There were obvious clinical differences between Moderates and Controls. On variables of worry, miserable, fearful and fussy, 26%, 13%, 2% and 41%, respectively, of Controls were affected. The proportion was considerably higher for Moderates in whom the values were: 40% (worry), 31% (miserable), 14% (fearful) and 53% (fussy). There were no significant differences at follow-up. No loglinear model was found to adequately describe the data from this scale. Severity, intake scores as well as psychosocial adversity simultaneously produced high scores at follow-up.

CHAPTER 7
CONCLUSION

In conclusion I would like to return to the hypotheses stated in chapter 2 and relate them to the main findings of the study.

7.1 Findings in terms of the hypotheses

(1) *The prevalence of post-traumatic behaviours observed in the head-injured differed from that of Controls.*

Overall, the head-injured were more disturbed than Controls at 1 year follow-up, and in general, most of the disturbances also developed post-traumatically. There were however exceptions. The finding that Moderates and Severes were more often disturbed pre-traumatically, when compared to Controls, than was the case with either Severes or Very Severes, when compared to Controls, confirms the results of other investigations (Hjern & Nylander, 1964; Brown et al., 1981). In terms of the six scales employed in the study, Moderates were found to have had earlier problems with activity, emotional control and antisocial behaviour.

(2) *There was a dose response relationship between severity of injury and behavioural sequelae.*

A linear increase across groups in the proportion of head-injured children with problems was most notable for impatience, forgetfulness and headaches and low stress tolerance (Figure 2, Appendix E). A severity effect was noticeable for eating problems, impulsiveness and fatiguability where rates were significant for both the Severes and Very Severes (Figure 4). Furthermore, problems relating to disturbances of mood and control as well as certain physical symptoms were characteristic of children with very severe damage (Figure 5).

(3) *A post-traumatic syndrome of behavioural complaints was observed in all the head injured groups.*

Our expectations of PTS symptoms are directed by two features, namely that: (1) problems tend to be associated with mild damage and, (2) in adults, complaints tend to be more physical than behavioural whereas the opposite is usually true of children.

Thus an interesting observation was made in connection with post-traumatic symptomatology in that the classic features of the PTS (Figure 2) which usually accompany milder cases of head injury were also common in the more severe cases.

That remaining post-traumatic syndrome symptoms such as fatigue and sensitivity to noise were associated with very severe injury is particularly unexpected since these are commonly obscured by the more obvious problems of physical impairment and behavioural change such as disinhibition (Jennett, 1972; Alves & Jane, 1985). It could be concluded that these complaints were of a serious nature and well-defined in the minds of parents.

Problems that arose secondarily to such lack of control were associated specifically with more severe cases and could not be considered as part of a PTS since they represented a severity-specific effect.

(4) *Certain behaviours which arose post-traumatically were associated with the presence of the same behaviours at intake or with a high degree of psychosocial adversity.*

Whereas certain behaviours were associated with severity of injury, other behaviours were connected to pre-traumatic disturbances and psychosocial adversity. Severity of injury played a role in follow-up problems with activity, oppositional behaviour, social or peer-related problems and disinhibition. The only area in which severity was not found to play a role was in the case of

developmental problems. Psychosocial adversity was an additional factor for social problems whereas both adversity and intake behaviour was important for problems with activity.

7.2 Summary of the main findings

The major findings of this study were the following:

* The pre-traumatic presence of risk-promoting behaviours in Controls and Moderates suggests that both groups were at risk for incurring an accident.
* Moderates were far more often disturbed pre-traumatically than any other group. They were oppositional - destructive and undisciplined and also tended to be more miserable. At follow-up even though oppostional behaviour was strongly related to severity of injury in the study. However in the Moderates, it appears that they were of more diverse aetiological origin in the Moderates and thus not only due to brain damage.
* The presence of psychosocial adversity seemed to increase with severity of injury and overall the Very Severes were by far the most disadvantaged. Fewer factors were found to differentiate between disturbed and non-disturbed in the head-injured than in the Controls. Familial dysharmony and psychiatric disturbance in the mother were related to disturbance in the Controls but not in the head-injured. Factors more directly related to economic deprivation, such as overcrowding and poor nutrition were influential as markers of disturbance in the head-injured.
* The Very Severes had more problems than either Moderates or Severes. Apart from physical impairment, their difficulties were overwhelmingly expressed in their social interactions.

7.3 Limitations of the design and qualifications of the conclusions

The study did have limitations which although not invalidating the findings necessitate some caution in their interpretation. Ideally, checks should have been made on whether symptoms which were described as being new were in fact scored as absent at intake. This was not done because questions asked at intake were not always identical to those asked at follow-up. So although the head injuries project was

planned as a prospective investigation, the present study relied on both prospective and retrospective methods.

The main criterial requirement of the control group was that it be comprised of subjects with trauma not involving the head: comparisons with such a group would isolate behaviours in the head injury groups that were not due to the experience of trauma *per se*. The above assumption would be justified if the control group consisted only of children who were, in addition, normal before their injury. The question arises as to what the implications of a history of behaviour problems in the control group are for statistical comparisons with the head-injured. As it turned out, there was, in the present study, some clinical indication of pre-traumatic disturbance in the Controls. The main problems were restlessness; impatience and attention-seeking behaviour. It is rather interesting that in the Moderates, there was a worsening post-traumatically of precisely these behaviours, namely, restlessness; impatience/impulsiveness and attention-seeking behaviour. As mentioned in the literature review these problems are regularly associated with accident-proneness. Clearly the Controls and Moderates were similar to the extent that they were behaviourally at risk for sustaining an accident. But unfortunately it is not known to me which behaviours are conducive to psychological resilience in response to an accident and conversely which would lead to even greater problems. It would be simplistic to infer psychological responses by only referring to behaviour descriptions and not relying on personality, cognitive and other assessments. Therefore, I cannot be certain that all the problems present in the Controls at follow-up are solely representative of reaction to the trauma experience. However, since the pre-traumatic difficulties seemed to be confined to the three mentioned above, I would be inclined to favour the notion that problems in the Controls are mainly due to the accident incident.

The preponderance of pre-morbid disturbance in the Moderates is interpreted only in terms of "accident susceptibility". This criticism is related to the foregoing. It might have been beneficial to determine the childrens' development within a psychodynamic or psychosocial framework. This would go a long way towards identifying which personality features place a child at risk not only for an accident, but also for the

development of psychopathology in general.

The dominance of psychosocial adversity which was found particularly in the Very Severes, suggests the possibility of a transactional effect at work. It would have been a useful adjunct to the study had changes in parental perception of what constituted major problems in the family been addressed. A serious shortcoming of the study was the lack of differentiation between acute and chronic stressors in the environment. After all, one would expect different patterns from a child who had experienced five years of disadvantage to say, ten years of exposure to the same factors.

The data on the type of disturbance associated with the upper end of the severity continuum indicates a mixture of withdrawn behaviour and disinhibtion - a combination which is of course suggestive of frontal damage. Yet there is reference in some of the literature (Lishman, 1977) to a "basal syndrome" in adults which results from lesions of the midbrain, hypothalamus and orbital frontal cortex and is marked by sluggishness and apathy. It would be instuctive to find out whether this type of damage was prevalent in children presenting with the problem.

Furthermore, another perspective suggests that many of the problems arose secondarily to a profound underlying cognitive deficit. It would have been meaningful to determine directly by questioning and observation, the extent of frustration in response to and awareness of the cognitive impairment.

Finally, no attempt was made to account for the belief and expectancy effects held by parents and others. Fortunately, in the study there was no indication of neurotic elaboration of a problem. For example none of the difficulties were the presenting complaint of school refusal. Thus, it can be said that a child study portrays a far purer picture of sequelae than is the case with adults. On the other hand, it is possible that parents would hesitate to present children in a neagative light, especially if the child is rather seriously injured.

In terms of generalisability of findings, the main advantages of this study were that a multidisciplinary approach was used and assessment was in part prospective. It was

however difficult to integrate information from multidisciplinary sources. As a consequence a descriptive analysis was employed. I found that this study reinforced my belief in the importance of methodology in determining the discourse of the enquiry. The position of the researcher also moulds the methodology and within the framework of research psychology a positivistic descriptive stance seemed natural. While this made it possible to present a broad picture of the sequelae, at the same time it prevented a more in-depth analysis.

7.4 Recommendations for future research

Focusing on the above aspects would be profitable for future studies. Specifically, it would be important to interview the child personally and to control for age and cognitive status. Some investigation into the centrality of disinhibition for the production of other problems is also desirable. This could be achieved by longitudinally studying children with and without symptoms and then correlating the results with a severity of injury index. The difficulty with this is that the study would have to be carried out on a very large scale since one would not know in advance which of the children would sustain a head injury. If I were to repeat the study, I would focus on only one severity group - preferably Milds in whom early disturbance is commoner; there would be a concerted effort to cluster these symptoms validly in terms of identifiable patterns; there would be control of age factors; and finally as already mentioned, I would endeavour to integrate behavioural findings with established cognitive findings.

In my view the counselling of these children would require determination of how the family perceives and defines the problem and how the child makes sense of his predicament.

7.5 Conclusion

The findings lead to the overall impression that both the mildly and severely head-injured may be expected to manifest both psychological and physical disturbance. Interpersonal relationships stand to suffer the most. In the mild cases, problems

seemed to be due to a worsening of earlier dysfunction and to the effect of the trauma experience itself. More severely injured children were affected by a post-traumatic lowering of inhibitory control. Psychosocial adversity was pervasive in the study and until more is known about how persistent disadvantage, particularly within a specific socio-political context, affects psychological resilience and vulnerability, there will remain doubt as to the permanence or reversibility of problems.

APPENDIX A

GLASCOW COMA SCALE

	Examiner's test	Patients response	Assigned score
Eye opening	Spontaneous	Opens eyes on own	E4
	Speech	Opens eyes when asked in a loud voice	3
	Pain	Opens eyes when pinched	2
	Pain	Does not open eyes	1
Best motor response	Commands	Follows simple commands	M6
	Pain	Pulls the examiner's hand away when pinched	5
	Pain	Pulls a part of body away when examiner pinches him	4
	Pain	Flexes body inappropriately to pain (decorticate posturing)	3
	Pain	Body becomes rigid when examiner pinches (decerebrate posturing)	2
	Pain	Has no motor response to pinch	1
Verbal response (talking)	Speech	Carries on a conversation correctly and tells examiner where he is, who he is and month and year	V5
	Speech	Seems disorientated or confused	4
	Speech	Talks so that examiner can understand but makes no sense	3
	Speech	Makes sounds that the examiner can't understand	2
	Speech	Makes no noise	1

Coma Score (E + M + V) = 3 - 15
from (Bond, 1986)

APPENDIX B

RUTTER PARENT QUESTIONNAIRE

0 = Not applicable
1 = Applies somewhat
2 = Certainly applies

1. Restless, has difficulty staying seated for long
2. Truants from school
3. Squirmy, fidgety child
4. Often destroys or damages own or others' property
5. Frequently fights or is extremely quarrelsome with other children
6. Not much liked by other children
7. Often worried, worries about many things
8. Tends to be on own - rather solitary
9. Irritable. Touchy. Is quick to "fly off the handle"
10. Often appears miserable, unhappy, tearful or depressed
11. Has twitches, mannerisms or tics of the face or body
12. Frequently sucks thumb or finger
13. Frequently bites nails or fingers
14. Tends to be absent from school for trivial reasons
15. Is often disobedient
16. Cannot settle to anything for more than a few moments
17. Tends to be fearful of new things or new situations
18. Fussy or over-particular child
19. Often tells lies
20. Has stolen things on one or more occasions
21. Unresponsive, inert or apathetic

22. Often complains of headache, stomach ache or vomiting

23. Has tears on arrival at school or refuses to go into the building

24. Has a stutter or stammer

25. Resentful or aggressive when corrected

26. Bullies other children

27. Has temper tantrums i.e. complete loss of temper with shouting, angry movements

28. Asthma or attacks of wheezing

29. Wets the bed or pants

30. Soils or loses control of bowels

31. Eats too much, not enough or faddishly

32. Difficulties with getting to sleep, waking or other

33. Has any other difficulty with speech

APPENDIX C

PARENT INTERVIEW SCHEDULE

A. IDENTIFYING DETAILS

1. FOLDER NO.
2. SURNAME
3. FIRST NAME
4. ADDRESS CHANGED 0 = NO 1 = YES
5. CONTACT NO. CHANGED 0 = NO 1 = YES
6. LITIGATION 0 = NO 1 = YES

B. PHYSICAL AND PSYCHOLOGICAL OUTCOME

0 = NO, PROBLEM IS NOT PRESENT
1 = YES, PROBLEM IS PRESENT AND AROSE POST-TRAUMATICALLY
2 = YES, PROBLEM IS PRESENT AND WAS ALSO PRESENT BEFORE INJURY

7. PHYSICAL SYMPTOMS
Headaches
Nausea
Dizziness
Sensitive to noise
Fatigues easily
Blackouts
Fits
Speech disturbances
Visual problems
Auditory problems
Sensory problems
Motor weakness
Incoordination
Eating problems
Sleeping problems
Bladder/bowel control

MEDICATION 0 = NO 1 = YES

DETAILS

8. MENTAL SYMPTOMS
Impaired attention/concentration
Memory : forgetfulness
learning difficulties

9. BEHAVIOUR

Activity	:	restless
		hyperactive
		hypokinetic
Control	:	impulsive (acts without thinking)
		talkative (too much to anybody)
		asks embarrassing questions or makes personal remarks
		careless (dress ; hygiene)

Attention-seeking
Fussy, over-particular (obsessional)
Irritable/impatient
Low tolerance for stress, frustration
Aggressive

Anxiety	:	specific fears
		worried/fearful
Moods	:	tearful/depressed
		apathetic, lacks volition
		withdrawn
		too cheerful/pathological laughs
		changes easily
Conduct disorder	:	discipline problem
		stealing
		lying
		truanting
		other

10. ADDITIONAL COMMENTS
11. CONSECUTIVE HEAD INJURIES 0 = NO 1 = YES

DETAILS

12. OTHER ACCIDENTS 0 = NO 1 = YES

DETAILS

13. SERIOUS ILLNESSES SINCE HEAD INJURY 0 = NO 1 = YES

DETAILS

14. OPERATIONS 0 = NO 1 = YES

DETAILS

C. SOCIAL CIRCUMSTANCES

15. EDUCATION - ANY CHANGE 0 = NO 1 = YES

If yes, DETAILS
School .....

Principal .....
Class teacher .....
Std. .....

16. SCHOOL ATTENDANCE
How long after injury did patient go back to school?
(state in weeks)
0 = not applicable
1 = 1 week (part of a week counted as a week)
2 = 2 weeks
3 = 3 weeks
4 = 4 weeks
5 = 5 weeks
6 = 6+ weeks

17. SCHOOL PROGRESS
0 = not applicable/unknown
1 = above average
2 = average
3 = struggling
4 = failing
5 = special class

18. BEST SUBJECT
0 = not applicable/unknown
1 = maths/science
2 = language
3 = content subject
4 = practical
5 = other (specify)

19. POOREST SUBJECT
0 = not applicable/unknown
1 = maths/science
2 = language
3 = content subject
4 = practical
5 = other (specify)
DETAILS (e.g. struggles with all subjects)

20. REMEDIAL TEACHING 0 = NO 1 = YES
DETAILS

21. CHANGE IN STUDY HABITS 0 = NO 1 = YES
DETAILS

22. CHANGE IN RELATIONSHIPS WITH TEACHERS 0 = NO 1 = YES
DETAILS

23. CHANGE IN EXTRAMURAL ACTIVITIES 0 = NO 1 = YES

DETAILS

24. CHANGE IN LEISURE ACTIVITIES 0 = NO 1 = YES
DETAILS

25. CHANGE OF FRIENDS 0 = NO 1 = YES
DETAILS

26. CHANGE IN LEFT/RIGHT DOMINATION 0 = NO 1 = YES
DETAILS

27. FAMILY COHESION
0 = no change in relationships
1 = improved relationships
2 = deteriorsted relationships
DETAILS

IF NO CHANGES IN FAMILY COMPOSITION, HOUSING OR OCCUPATION - STOP HERE

28. CHANGE IN FAMILY COMPOSITION 0 = NO 1 = YES
DETAILS

29. CHANGES IN CROWDING 0 = NO 1 = YES
DETAILS

30. CHANGES IN HOUSING 0 = NO 1 = YES
DETAILS

31. CHANGES IN CHILD CARE 0 = NO 1 = YES
DETAILS

32. SOCIAL PROBLEMS ARISING SINCE HEAD INJURY
0 = NO, PROBLEM IS NOT PRESENT
1 = YES, PROBLEM IS PRESENT AND AROSE POST-TRAUMATICALLY
2 = YES, PROBLEM IS PRESENT AND WAS ALSO PRESENT BEFORE INJURY
Alcoholism
Drug abuse
Crime
Antisocial behaviour
Child abuse/neglect
Financial problems
(costs to family because of head injury)

DETAILS

33. CHANGES IN OCCUPATION

Father
DETAILS

Mother
DETAILS

34. CHANGES IN INCOME 0 = NO 1 = YES
DETAILS

35. WELFARE ORGANISATION SINCE INVOLVED 0 = NO 1 = YES
DETAILS

36. NUTRITION
0 = Satisfactory/well balanced
1 = Fair
2 = Poor
3 = Unsatisfactory

37. THERAPY RECEIVED SINCE INJURY
0 = None
1 = Yes
2 = Has had, but discontinued
SPECIFY WHICH THERAPY

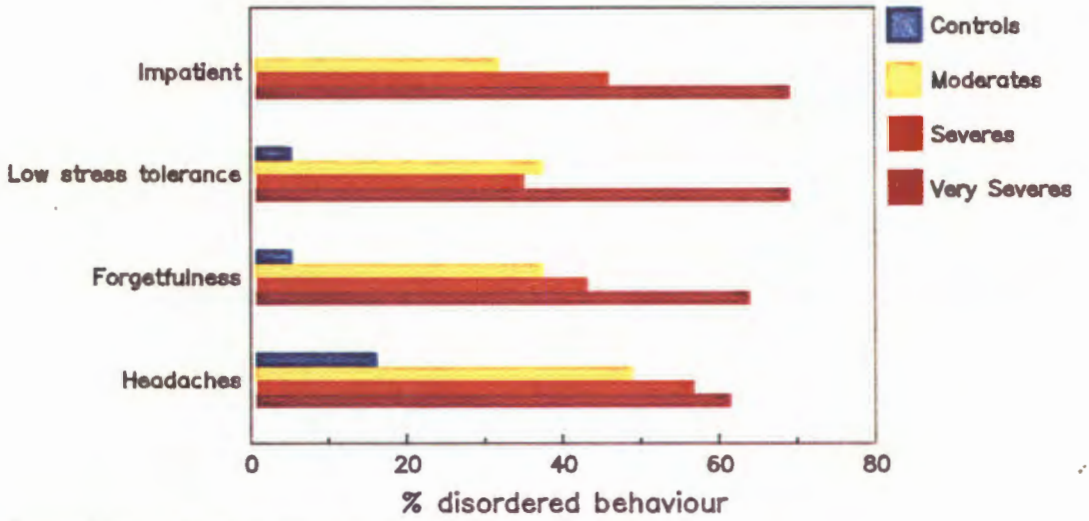
38. FOR HOW LONG DID NEUROSURGEON FOLLOW-UP?
0 = Still
1 = One further appointment
2 = No further appointment

APPENDIX D
ODDS RATIOS OF HIGH SCORES ON BEHAVIOUR SCALES

Scale	Comparison	Odds Ratio	95% confidence interval
Disinhibition			
	Severes to Moderates	1.4	0.6 ; 3,3
	Very Severes to Moderates	2.7	1.0 ; 7.3
Social Problems			
	Severes to Moderates	0.5	0.2 ; 2.1
	Very Severes to Moderates	2.8	0.9 ; 8.6
	High to low psych. adversity	3.4	1.1 ; 6.0
Antisocial			
	Severes to Moderates	2.6	1.1 ; 6.2
	Very Severes to Moderates	3.4	1.3 ; 9.0
Developmental disorders			
	High to low intake	6.9	2.9 ; 16.4
	High to low psych. adv.	2.8	1.2 ; 6.7

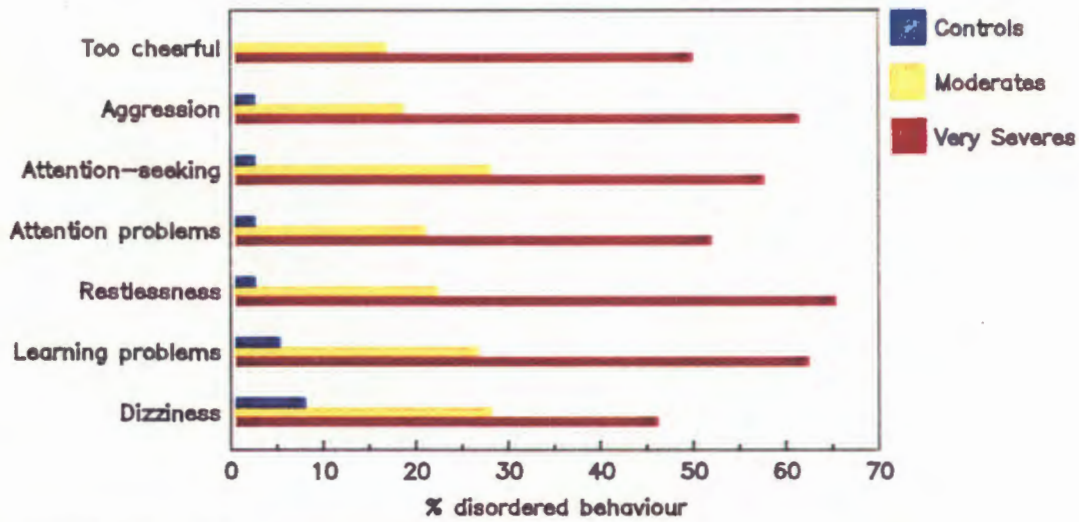
APPENDIX E

Fig 2 Statistically significant behaviours arising post-traumatically in all the head-injured groups



Comparisions with the control group.
P is equal to or less than 0.02.

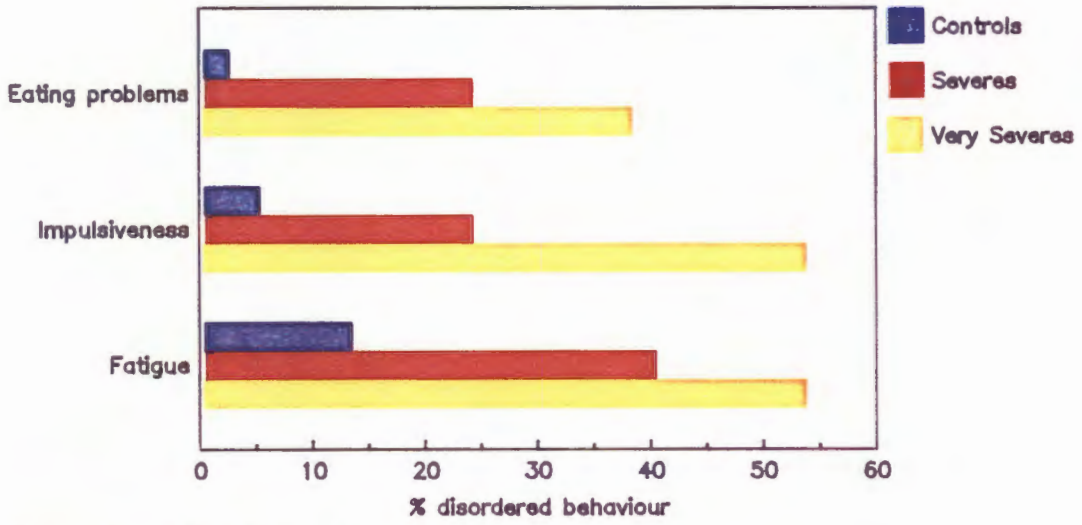
Fig 3 Statistically significant behaviours arising post-traumatically in Moderates and Very Severes



Comparisions with the control group.
P is equal to or less than 0.02.

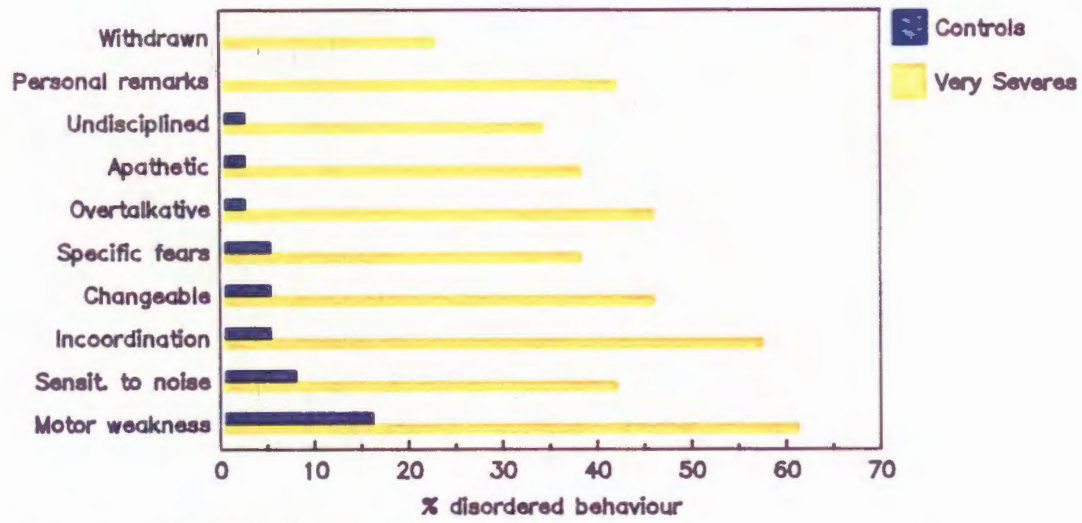
APPENDIX E

Fig 4 Statistically significant behaviours arising post-traumatically in Severes and Very Severes



Comparisions with the control group.
P is equal to or less than 0.02.

Fig 5 Statistically significant behaviours arising post-traumatically in the Very Severes



Comparisions with the control group.
P is equal to or less than 0.02.

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