COGNITIVE DEFICITS IN TRAUMATIC BRAIN INJURED ADULTS

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Register No. : 02SH0017

A Dissertation submitted in part fulfillment of
Final year M.Sc. (Speech and Hearing),
University of Mysore, Mysore

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Certificate

This is to certify that this dissertation entitled **"Cognitive Deficits in Traumatic Brain Injured Adults"** is bonafide work in part fulfillment for the degree of **Master of Science (Speech and Hearing)** of the student **(Register No. 02SH0017).**

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Certificate

This is to certify that this dissertation entitled **"Cognitive Deficits in Traumatic Brain Injured Adults"** has been prepared under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier in any other university for the award of any diploma or degree.

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DECLARATION

This is to certify that this dissertation entitled **"Cognitive Deficits in Traumatic Brain Injured Adults"** is the result of my own study under the guidance of Mr. S.P. Goswami, Lecturer in Speech Pathology, Department of Speech Pathology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier in any other university for the award of any diploma or degree.

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Mysore
April, 2004

वक्रतुंड महाकाय सूर्यकोटि समप्रभ ।
निर्विघ्नं कुरू मे देव सर्व कार्येषु सर्वदा ।।

Dedicated

to

my loving family

ACKNOWLEDGEMENT

I am thankful to **Goswami Sir,** my guide, for guiding and supporting me throughout the year. Thank you Sir, for all your help and guidance. I would like to thank the Director, **Prof. M. Jayaram** to permit me to conduct this study.

My sincere thanks towards **Dr. Girish Menon,** to help me getting my subjects.

I would also like to thank **Lancy Sir,** to help me with the statistics.

I also thank all my **subjects** for being a co-operative.

I would like to thank all the **Library Staff** for their timely help.

I also thank **Softouch** for their great work.

Dearest **Papa** and **Mummy,** you are my strength and confidence.

Dear **Didi** and **Bhaiya,** your love and support is always with me.

Dear **Sapna,** thanks a lot for all your love and support for me.

Tanu, we have enjoyed our work and we have done it.

I would like to thank all my **friends, classmates** and **juniors** for their help, love and support.

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INTRODUCTION

Cognitive abilities include attention, perceptions, memory and learning, language, and visualospatial perception. Hierarcbial organization is characteristic of cognitive processing, in that attention is necessary for memory processing and attention and memory are basic cognitive skills that support the perception and comprehension of both linguistic and nonliguistic input (Hartley, 1995).

Ellis and Christensen (as cited in Gillis, 1996), defined "Traumatic Brain Injury (TBI) as a blow to the head that results in diminished abilities subsequent to. . . . .(and) is primarily caused by motor vehicle accidents and violent crimes". TBI can either be open or closed head injury. Closed head injury (CHI) is where the trauma does not cause an opening in the skull. It is also called as acceleration - deceleration injuries and diffuse axonal injuries. Open head injury (OHI) are also called penetrating injuries, the common cause being gunshot wound or fracturing of the skull. Such injuries may produce focal lesions (Gillis, 1996).

The National Head Injury Foundation (as cited in Beukelman & Yorkston, 1991) defines head injury (i.e., TBI) as a traumatic insult to the brain capable of producing physical, intellectual, emotional, social and vocational changes. An estimated 500,000 individuals sustain TBI each year (200 per 100,000 populations). Of this number, 20,000 will die, 50,000 to 100,000 survive with significant impairment preventing independent living, and more than 20,000 suffer continuing sequel that interfere with daily living skills. Of the individuals who sustain TBI, nearly twice as many males as females are injured. The risk of TBI is higher for children 4 to 5 years of age, males 15 to 24 years of age, and the elderly (over 75 years). In the United States, trauma is the third leading cause of death among individuals under the age of 35, National Head Injury Foundation (as cited in Beukelman & Yorkston, 1991). Shapiro, (as cited in Beukelman & Yorkston, 1991) found the incidence of children sustaining TBI similar to that of adults, with a morbidity of 10 per 100,000 per year. In India, 100, 000 people die every year due to road traffic injuries.*

Causes of TBI include penetrating and non penetrating causes. Pathophysiology of TBI consists of primary mechanisms of injury where trauma directly cause damage to the brain and secondary mechanisms of injury where the pressure is exerted by something as blood clot caused by trauma.

Communication challenges following TBI are most often non-aphasic in nature that is they co-exist with intelligible speech, reasonably fluent and grammatical expressive language and comprehension adequate to support everyday interaction. Depending on the severity of injury, stage of recovery and particular focus of research, the characteristic communication profiles following TBI have been variously referred to as 'the language of confusion', 'sub clinical aphasia', 'Cognitive-language distrubances' and 'non-aphasic language disturbances' (Chapey, 2001).

*Reported by Dr. G. Gururaj (Dept. of Epidemiology, NIMHANS) in The New Indian Express Bangalore, April 7, 2004.

Several authors have documented reduced alertness levels in individuals having sustained TBI. It is reported that sustained attention decreases significantly as measured by reaction times. After TBI, the rate of making adjustments in response to automatic tasks is significantly slower. Zomeren and Colleagues (as cited in Kennedy & Deruyter, 1991) found that when a distraction was imposed during a visual reaction task, decision making time was significantly slower in TBI group than in the control group. Speed of processing, or information processing rate, has been shown to be delayed following TBI (Kennedy & Deruyter, 1991).

Visuoperceptual impairments following brain damage may be primary or secondary. Primary deficits include those, which are specific such as visual field cuts, visual neglects, agnosias, spatial or body neglects, topographic (environmental) disorientation, and inability to copy and synthesize shapes and images, and are associated with specific lesions. Secondary visuosperceptual deficits are the result of generalized cognitive disruption following TBI. A breakdown in sequencing, association or categorization indicates a disturbance in the encoding phase of memory affecting both immediate and recent recall. These internal organizational strategies are frequently impaired following TBI. A breakdown in sequencing, association or categorization indicates a disturbance in the encoding phase of memory affecting both immediate and recent recall (Kenneyd & Deruyter, 1991). These internal organizational strategies are frequently impaired following TBI and are the result of impaired attention and monitoring processes.

Amnesia studies have found the presence of both retrograde and anterograde amnesia following TBI. Although controversy exists over the nature of immediate memory (due to its dependency on attention and perceptual processes), recent memory impairment is well documented in TBI individuals. Disordered or delayed recall of recent events and facts is also well documented in the literature (Kennedy &Deruyter, 1991).

Impaired reasoning (inductive, deductive and analytic), thinking processes (divergent and convergent), insight and problem solving have been documented as occurring in TBI during all stages of cognitive recovery. Difficulties with integration and part whole relationships have been documented by several investigators. Some authors have reported organizational difficulties loading to impaired planning and execution (Kennedy & Deruyter, 1991).

Bond (as cited in Keenedy & Deruyter, 1991) suggests that cognitive intellectual deficits and emotional behavioural difficulties are both more persistent and contributory to the psychosocial disability following head injury than are physical impairments. Reports in literature indicate that cognitive and emotional difficulties can occur with relatively high frequency even when there are no documented physical or neurological difficulties. Thus, this particular study was taken up to investigate cognitive-linguistic deficits in Kannada speaking individuals with TBI.

NEED FOR THE STUDY

1. There is a dearth of studies on cognitive aspects in individuals with TBI especially in Indian scenario.
2. At time the language disorders found among those with TBI are more than simply a reflection of underlying cognitive deficits. At other times, specific language processing deficits occur in conjunction related communication disorders, so, there is a need for further investigation of cognitive deficits for effective rehabilitation planning.

AIMS OF THE STUDY

1. To investigate the cognitive linguistic deficits in individuals with TBI.
2. To compare the cognitive-linguistic performance of TBI subjects with that of normal subjects.
3. To compare the cognitive-linguistic performance across TBI subgroups of bilateral damage, left hemisphere damage and right hemisphere damage.

REVIEW OF LITERATURE

In the area of head injury, terminology has been an issue of confusion for some time. The term head injury itself is problematic in that it encompasses a range of injuries that includes simple bumps on the head, scalp lacerations, facial injuries and injuries that result in severe brain damage, Jennett (as cited in Gillis, 1996). In recent years, attempts have been made to standardize terminology to the extent possible. Traumatic Brain Injury (TBI) appears to be the preferred term, at least in rehabilitation, because it accurately reflects the structure injured and to some extent, the cause. It differentiates brain damage that occurs as a result of trauma (also commonly referred to as mechanical forces) from that which occurs secondary to cerebrovascular disease, tumors, infection, progressive neurological disease, and metabolic or neurochemical disturbances, although some have interpreted the term to include brain damage resulting from or in any traumatic event in the broadest sense (Gillis, 1996). In literature, four different labels are used apparently to refer to the same entity or population. These include traumatic closed head injury, head trauma, closed head trauma and non-focal brain damage. (Gillis, 1996).

The term acquired brain damage, or acquired brain injury, is sometimes used to refer to brain damage that did not occur prior to or during birth(Gillis,1996). The term typically includes brain damage resulting from TBI, strokes, tumors, infectious processes, metabolic disturbances, or other causes, but does not usually include alzheimer disease and other progressive neurological conditions. It is a term often used to differentiate these conditions from congenital or developmental disabilities.

Vogenthaler (as cited in Gillis, 1996) has defined head injury as "damage to living brain tissue that is caused by an external mechanical force" and he further adds that it is usually accompanied by altered consciousness.

Ellis and Christensen (as cited in Gillis, 1996), defined "Traumatic brain injury as a blow to the head that results in diminished abilities subsequent to the injury and that requires rehabilitation intervention... (and) is primarily caused by motor vehicle accidents and violent crimes". A key and clarifying point to this definition is that the injury results in diminished abilities indicative of brain damage, as distinguished from an injury to the head that may or may not result in brain damage.

Prior to mid to late eighties, closed head injury (CHI) appeared to be used most often to refer to non-penetrating injuries to the head. CHI has been used more often to refer to injuries produced by "blunt" trauma, as differentiated from "sharp" or penetrating trauma. Although, used for some time, the open / closed classification system may have developed in part from the International Classification of Disease (ICD) (as cited in Chapey, 2001), used by most medical facilities. A variety of codes (categories) are available to use in the classification of head injury, but fractures to the skull are divided into closed and open. Either classification can include other aspects of the injury, such as hematoma, cerebral laceration, contusion, or intracranial injury, if presented and detected. However, the natures of brain injury are not clearly delineated by the terms closed and open unless additional criteria are included (Gillis, 1996).

Incidence of TBI

The National Head Injury Foundation (as cited in Beukelman & Yorkston, 1991) defines head injury (i.e., TBI) as a traumatic insult to the brain capable of producing physical, intellectual, emotional, social and vocational changes. An estimated 500,000 individuals sustain TBI each year (200 per 100,000 populations). Of this number, 20,000 will die, 50,000 to 100,000 survive with significant impairment preventing independent living, and more than 20,000 suffer continuing sequel that interfere with daily living skills. Of the individuals who sustain TBI, nearly twice as many males as females are injured. The risk of TBI is higher for children 4 to 5 years of age, males 15 to 24 years of age, and the elderly (over 75 years). In the United States, trauma is the third leading cause of death among individuals under the age of 35, National Head Injury Foundation (as cited in Beukelman & Yorkston, 1991). Shapiro, (as cited in Beukelman & Yorkston, 1991) found the incidence of children sustaining TBI similar to that of adults, with a morbidity of 10 per 100,000 per year. In India, 100, 000 people die every year due to road traffic injuries.*

Causes of **TBI**

The causes can be divided into:

(a) *Penetrating causes* — in which skull is penetrated by external object as bullet or knife, high velocity weapons or projectiles. It is the result of sharp trauma.

(b) *Non-Penetrating causes* - include blows, falls, and high-speed motor vehicle accidents. These are injuries produced by blunt trauma.

*Reported by Dr. G. Gururaj (Dept. of Epidemiology, NIMHANS) in The New Indian Express Bangalore, April 7, 2004.

Motor vehicle accidents are the most common cause, with falls of various types being the second most common cause of TBI. Among school-aged students, recreational and sports injuries such as bicycling, skating, and horseback riding are common causes of TBI. Among adolescents and young adults, assaults, especially in lower socio economic groups, are common. A dramatic increase in TBI in the young adult age group also occurs as a result of motor vehicle accidents with the adolescent as driver or passenger. Alcohol or drugs are often involved (Beukelman & Yorkston, 1991).

Types of Head Injuries

Head injuries can be divided into two major types:

Closed head injury (CHI)

The term CHI refers to one of the most common types of TBI. The term implies that the trauma does not cause an opening in the skull. Injuries associated with CHI are most commonly caused when the head suffers a sudden acceleration or deceleration, such as against the dashboard of a car. Therefore, they are at times referred to as acceleration - deceleration injuries. They may also be called diffuse axonal injuries because they result in diffuse shearing of axons with their myelin sheaths in the brain. Axonal shearing is felt to be a major cause of unconsciousness in these patients. (Brooks, Umoto, Mc Clean & Fraser, 1991).

Open Head (OHI) or Penetrating Injuries

When the trauma results in penetrations as in the gunshot wound or a fracturing of the skull, injuries are referred to as open head or penetrating injuries.

Such injuries may produce focal lesions rather than the diffuse damage associated with CHI (Brooks, et al, 1991).

Due to the nature of the pathology, a number of authors have suggested that there may also be differences in the associated communication deficit between OHI vs. CHI (Murdoch, 1990).

Luria (as cited in Murdoch, 1990) reviewed 800 head injury cases and compared the speech and language deficits exhibited by CHI cases with those observed in patients with OHI. He concluded that there was no significant difference in the language abilities of each group immediately post-trauma. A better prognosis was reported for the language disorder following CHI than for the communication deficit associated with open head wounds (Murdoch, 1990). Groher (as cited in Murdoch, 1990), however, conducted a closer analysis of Luria's results and found that OHI patients exhibited language deficits for a longer period than did CHI patients. Further the re-analysis showed that, in the initial period post-trauma, the patients with CHI as a group suffered fewer communication deficits than patients with penetrating head wounds. From this re-analysis, it can be implied that CHI patients with communication deficits exhibit greater and faster improvement than those with OHI.

The immediate effects of TBI can be :

Coma

Coma is not a disease but the product of damage to or depression of the function of the Central Nervous System (CNS). In TBI, coma may be due to neuronal or axonal injury, hypoxemia, or ischemia. A fully conscious patient is awake and normally aware of both internal and external stimuli. Precise definition of coma is difficult. Typically, the depth of coma is assessed using the Glasgow coma scale. Scores can range from 3 (with the patients receiving a score of 1 on "eyes open", "best motor response," and "verbal response") to 15. When the score rises to 9 or more, the person is considered to be out of coma (Brooks et al., 1991).

Post-traumatic Amnesia (PTA)

Post-traumatic amnesia is defined as the period following injury when the patient does not have continuous memory of daily events (Brooks et al., 1991). The duration of post-traumatic amnesia is estimated by asking the patient about his or her first and subsequent memories after the injury. It has been suggested that post-traumatic amnesia is a better predictor of outcome than measures such as the duration of coma (Brooks et al., 1991).

Pathophysioilogy of TBI

Mechanism of TBI is extremely dynamic with a less predictable course. The nature of injury is diffuse and results in widespread disruption of the neuronal structures supporting cognitive and communicative functions. Injury to the brain is most often classified into primary insults (which occur immediately upon impact of the brain) and secondary results (those occurring at a later point in time, but during the critical medical recovery period). Primary injuries include contusions, lacerations, skull fractures, tissue tear hemorrhages, and diffuse axonal injury, the latter being the hallmark of TBI. The secondary insults can be numerous and are the focus of early medical intervention, which offers the most promise for improving outcome, other than preventive measures (Gillis & Pierce, 1996).

Classification of severity

Patients, who remain unresponsive for two weeks or longer frequently are described as being in a persistent vegetative state. This term was proposed initially by Jenaett and Plum (as cited in Gillis, 1996) to describe patients who develop reflexive eye opening, but have no response to commands and apparently lack all cognitive functioning. Although some authors consider the development of the persistent vegetative state to be a negative prognostic sign, other authors, Bricolo, Turazzi & Feribthi, (as cited in Gillis, 1996) claim its presence has no predictive value with regard to further improvement. Approximately 60% of patients with this diagnosis show some evidence of improvement during the first year. In the study of Bricolo et al.,(as cited in Gillis, 1996), who followed the recovery of 135 comatose patients, 52 % of patients began to follow commands in the first three months, 13 % did so between three and six months, and 1.5% only after the sixth month. Although some authors have defended the term "vegetative state" as possessing greater dignity than many other terms, the use of this term is controversial and has led to many attempts at renaming this syndrome, Plum and Posner (as cited in Gillis, 1996). Synonyms include "prolonged post-traumatic unconsciousness" and "post-comatose unawareness", Bricolo et al., (as cited in Gillis et al., 1996). Patients in a persistent vegetative state are characterized as having intact sleep-wake cycles, preservation of spontaneous eye-opening and extra ocular movements, and preservation of primitive brain stem reflexes including yawing, sucking, and chewing (Gillis, 1996).

Although many variables may be used to classify the severity of TBI, classification is primarily determined on the basis of the length and depth of coma. Glasgow coma scale is the most widely used measure to quantify coma, and therefore had formed the basis for classification. An initial Glasgow coma scale of 13 to 15 equates with a 'mild' brain injury and may or may not involve a loss of consciousness. Patients with "moderate" brain injury will have an initial Glasgow coma scale of consciousness lasting less than 24 hours. "Moderate" brain injuries are alternatively termed "moderately severe" injuries by some clinicians. Patient with "severe" injuries have an initial Glasgow coma scale score of 8 or less, and usually have a loss of consciousness for longer than 24 hours, Teasdale and Jennett (as cited in Books, et al., 1991).

Table 1: Glasgow Coma Scale

Eye opening	Best Verbal Response	Best Motor Response
4. Spontaneous	5. Oriented	6. Responds to verbal commands
3. Non specific reaction to speech	4. Confusion, disorientation	5. Localized movement to terminate painful stimulus
2. Responses to painful stimulus	3. No sustained or coherent conversation	4. Withdrawal from painful stimulus
1. No response	2. No recognizable words	3. Decorticate posture
	1. No response	2. Decerebrate posture
		1. No response

An additional factor useful in determining the severity of brain injury is the persistence of post-traumatic amnesia (PTA), which is the loss of memory for events occurring subsequent to the injury. This implies that during the period of post-traumatic amnesia, the patient is unable to retain newly acquired information. Patients with moderate degrees of injury usually have periods of post-traumatic amnesia of less than 24 hours, whereas patients with severe injuries will have post-traumatic amnesia for periods greater than 24 hours, Katz & Alexander (as cited in Pierce, 1996).

A widely used scale is the levels of cognitive function, developed at Rancho Los Amigos hospital in the 1970s, consists of eight levels of cognitive function. These levels are described briefly as follows:

Level I		no response to external stimuli
Level II	-	generalized response
Level III	-	localized but purposeful response
Level IV	-	confused and agitated
Level V	-	confused but non-agitated
Level VI	-	confused but appropriate
Level VII	-	automatic but appropriate
Level VIII	-	purposeful and appropriate

Patients typically progress from the lower levels of functioning to the higher levels as they recover from a TBI. Some patients, however, may progress rapidly and appears to skip some levels. Other patients may reach a plateau and then fail to progress until weeks or even months have passed. The utility of these levels is in providing a common vocabulary for members of the treatment team. Familiarity with these different levels of functioning may at an appropriate level for the patient's capacity to participate. However, this is relatively insensitive in detecting changes in the early stage coma recovery (Gillis, 1996).

An alternative evaluation tool, the coma / near-coma scale, Rappaport, Dougherty and Kelting (as cited in Gillis, 1996), was designed to detect early signs of improvement in severely impaired individuals, and has shown promise in predicting recovery from coma. This assessment scale places patients in one of five levels of coma, according to their response to eleven separate modes of stimulation.

Gennarelli (as cited in Gillis, 1996) describes a spectrum of concussion type syndromes, the least severe of which includes only transient visual disturbance, focal dysesthesia (painful or unusual tactile sensation), and motor dysfunction, implying a localized disruption of the cortex. He defines the most severe level of concussion as the "classic concussion", in which the individual may have a period of coma lasting up to six hours. It is useful to classify the severity of brain injuries, since the prediction of outcome is based, to a large extent, on the severity of the injury and the duration of coma and posttraumatic amnesia (Gillis, 1996).

Mild TBI may be subdivided further into different grades of mild injury, These gradations are based on the pressure of amnesia and loss of consciousness. In the mildest forms of TBI, there may be no amnesia or loss of consciousness, but merely confusion. Transient confusion, which occurs immediately following a TBI, has been termed concussion. (Gillis, 1996).

General characteristics of TBI

Communication challenges following TBI are most often non-aphasic in nature that is they co-exist with intelligible speech, reasonably fluent and grammatical expressive language and comprehension adequate to support everyday interaction. Depending on the site of the injury, stage of recovery and particular focus of research, the characteristic communication profiles following TBI have been variously referred to as "sub-clinical aphasia", "cognitive-language disturbances" and "the language of confusion" (Chapey, 2001).

The communication impairments of TBI patients can be broadly discussed under the following headings:

i) Linguistic features

ii) Extra-linguistic features

iii) Non-Linguistic features

i) Linguistic Features

Mc Kinley (as cited in Chapey, 2001) has noted that language is disturbed in 75 % or more of individuals with TBI. The nature of this language disturbance in TBI - that is whether it is aphasic, aphasics like, or non-aphasic - is not clear-cut. An examination of specific linguistic deficits following TBI that are reported in the literature indicates that anomia, (difficulty retrieving words), and impaired auditory comprehension are the most commonly observed symptoms.

Holland (as cited in Chapey, 2001) noted that there is overlap in these deficit areas between aphasic and TBI patients as well as in the associated reading and writing deficits that both groups often demonstrate. However, it is the qualitative differences in the naming errors between the two groups that may be most useful in distinguishing between aphasic and non-aphasic responses. Both aphasic and TBI individuals produce circumlocutions and various paraphasias and have reduced fluency in the generation of category-specific words; TBI individuals, however, demonstrate additional naming errors. For example, TBI individuals may also produce naming errors related to their personal situations or make errors of confabulation (bizarre responses related to the patient's disorientation), Coelho (as cited in Chapey, 2001).

Levin and colleagues (as cited in Chapey, 2001) have defined a condition called mutism, secondary to severe TBI but not attributable to cranial nerve injury, in which the patient is speechless in the presence of an ability to comprehend simple commands and to communicate non-verbally. These investigators observed the incidence of mutism in a group of 350 TBI patients to be approximately 3 %. Two types of mutism were identified (i) associated with lesions to the left basal nuclei (sub cortical structures deep within the brain) believed to have a better prognosis, and (ii) associated with severe diffuse brain injury, considered to be a permanent condition, Coelho (as cited in Chapey, 2001).

ii) Extra linguistic Features

The hallmark of TBI is the resulting cognitive disturbances that are most often present. Individuals with TBI may also demonstrate significant problems in the area of what has been termed confused language. Confused language is described as receptive/expressive language that may be phonologically, syntactically, and semantically intact, yet lacks meaning because responses are irrelevant, confabulatory, circumlocutory, or tangential in relation to a specific topic; confused language also lacks a logical sequential relationship between thoughts, Hagen (as cited in Chapey, 2001). Such language dysfunction may be mistaken for a fluent aphasia, but is more appropriately considered cognitively. Sohlberg and Mateer (as cited in Chapey, 2001) have described several areas of cognition that may be disrupted following TBI, including orientation attention memory, reasoning / problem solving, and executive function.

Pragmatics refers to a system of rules that structures the use of language in terms of situational and social context. Sohlberg and Mateer (as cited in Chapey, 2001) observed that whereas aphasic individuals may communicate better than they talk, individuals with TBI appear to talk better than they communicate. Pragmatic deficits are probably most prevalent in those patients with injuries to the frontal lobes. Although the frontal lobes are not thought to be responsible for primary cognitive functions, it appears they are involved in coordinating and actualizing many functions involved in cognitive processing, such as attention, motivation, regulation and self-monitoring, Stuss and Benson (as cited in Chapey, 2001). Individuals with prefrontal injury frequently demonstrate problems with disorganized discourse, inappropriate social interactions based, as opposed to linguistically based, Coelho (as cited in Chapey, 2001). eg. difficulty in interpreting social cues and abstract forms of language (irony or sarcasm) among other things.

iii) Non-linguistic Features

TBI may also affect motor control system. The non-linguistic-fearures present in TBI are:

Dysarthria- Rusk, Block and Lowenann (as cited in Chapey, 2001) observed dysarthria in approximately 30 % of 96 head injured patients.

Thomsen (as cited in Chapey, 2001) observed that in the group of head-injured individuals that she monitored longitudinally, those with dysarthria showed little improvement up to 15 years after onset. This was consistent with the findings of Sarno, Buoaguro, and Levita (as cited in Chapey, 2001), who noted that 34 % of the 125 TBI patients in their study demonstrated dysarthria. Although, there are no reports in the literature regarding the incidence of specific types of dysarthria following TBI, a few studies suggest a variety of characteristics that depend on nature and location, as well as the severity, of the brain injury. Ataxic dysarthria has been the predominant dysarthria reported among TBI individuals in a few studies. Flaccid dysarthria as well as mixed dysarthrias (flaccid spastic, spastic, ataxic) have also been described in TBI survivors (Chapey, 2001).

Dysphagia- Dysphagia is a condition in which the action of swallowing is difficult or painful to perform. The incidence of dysphagia following TBI has been carefully studied. Winstein (as cited in Chapey, 2001) reported an incidence of 27 % for consecutive TBI patient admissions to a rehabilitation center. Lazarus and Logemann (as cited in Chapey, 2001) reported that of a group of 53 dysphagic patients with TBI referred for video fluoroscopic evaluation, 39 % demonstrated severe dysphagia, 33 % moderate dysphagia, and 27 % mild dysphagia. The most frequently occurring dysfunctions were delayed triggering of the swallow response (81%), reduced tongue control (53%), and reduced pharyngeal transit (32%). Relatively few of these patients' demonstrated difficulties related to laryngeal function (14%) (e.g., reduced laryngeal closure, elevation or spasm). Of the 53 TBI patients studied, 20(38%) aspirated (swallowed materials entering the airway below the level of the vocal folds) during the video fluoroscopic examination, Coelho (as cited in). Cherney and Halper, (as cited in Chapey, 2001) noted a nearly identical incidence of 26% in the 189 TBI patients they studied.

Emotional disturbances- Rosenthal (as cited in Murdoch, 1990), identified the emotional and behavioral changes that would appear to have their origins in the structural damage accompanying severe CHI. For e.g., decreased drive and initiative, dull or flat affect, disinhibition and apathy are known to be related to damage of the frontal lobes. Three types of secondary behavioral disturbances including denial, depression and the emotional dependence upon others have been identified as being the result of the stress of adapting to the trauma (Murdoch, 1990).

The overlapping collections of communication deficits highlighted by several investigators have been grouped by the American Speech, Language and Hearing Association under the heading "cognitive-communicative impairment", ASHA (as cited in Chapey, 2001) and are associated with frontolimbic damage, the most common damage in CHI. These impairments are included in table 2.

Table 2: Vulnerable frontolimbic structures and frequently associated impairments

Executive system Impairment	Cognitive Communicative Impairment	Cognitive Impairment	Psychosocial/Behavioural Impairment
• Reduced awareness of personal strength and weakness. • Difficulty in setting realistic goals • Difficulty in planning and organizing behavior to achieve the goals. • Impaired ability to imitate action needed to achieve the goals. • Difficulty in inhibiting behavior incompatible with achieving the goals • Difficulty in self-monitoring & self-executing. • Difficulty in thinking & acting strategically & solving real world problems in a flexible efficient manner • General inflexibility and concreteness in thinking, talking and acting.	•Disorganized, poorly controlled discourse or paucity of discourse (spoken and written). •Inefficient comprehension of language related to increasing amounts of information to be processed (spoken or written) and to rate of speech. •Imprecise language and word retrieval problems. •Difficulty in understanding and expressing abstract and indirect language. •Difficulty in reading social cues, interpreting speaker intent and flexibility adjusting interactive styles to meet siruational demands in varied social contexts. • Awkward or inappropriate communication in stressful social context •Impaired verbal learning	• Reduced internal control over all cognitive functions (eg., attentional, perceptual, memory, organizational and reasoning process), • Impaired working memory. • Impaired declarative and explicit memory (encoding and retrieval). • Disorganized behavior related to impaired organizing schemes (managerial knowledge frames, such as scripts, themes, schemes, mental models) • Impaired reasoning • Concrete thinking • Difficulty in generalizing	• Disinhibited, socially inappropriate and possibly aggressive behavior • Impaired initiation or paucity of behavior • Inefficient learning from consequences • Perseverative behavior, rigid, inflexible behavior. • Impaired social perception and interpretation.

Though the linguistic, extralinguistic and non-linguistic deficits are seen in these patients, but the cognitive deficits are the most obvious deficits seen in the TBI patients.

Cognitive disturbances are most commonly seen as a result of TBI.

Cognition : Cognitive abilities include attention, perception memory and learning, language and visualospatial perception, cognitive processing is influenced by sub cortical - limbic inputs, especially arousal, and by the knowledge base with which it can interface. The execute control center exerts control over cognitive processing, particularly in new situations or where effort is required.- Several investigators have identified impaired cognitive processes following TBI, arousal and attention (vigilance, selective attention, and attention span), delayed and disordered information processing, thought disorganization, disorders of sequential analysis and problem solving, disorders of memory (particularly storage and retrieval of new information), impaired reasoning and integration. These consequences are viewed as an interwoven hierarchy, ranging from alertness and attention to integration. The impaired dynamic interrelationships between these processes are the underlying cause of disrupted behavior, not any one process in isolation. The exact extent and nature of the injury determines which processes are more impaired (Kennedy & Deruyter, 1991).

Cognitive deficits present in TBI are discussed under the following headings:

I. Attention processes

II. Perception

III. Memory and learning

IV. Reasoning and problem solving

V. Organization and story arrangement

I. Attention processes : Whyte and Rosenthal (as cited in Gillis, 1996) consider attention to be the selective channeling of arousal. Attention refers to a group of processes including alertness, selective attention, attention span, speed of processing, shifting attention, and sustained attention (Kennedy & Deruyter, 1991).

Varieties of attention deficits are seen in TBI, which can be classified as:

(a) Alertness and arousal

(b) Sustained attention

(c) Vigilance

(e) Focused and divided attention

(d) Selective attention

(f) Reaction time

(a) ***Alertness or arousal*** has been referred to as a state of central nervous system (CNS), which by its very nature fluctuates from low to high levels, influencing the reception of stimuli from the environment (Gillis, 1996). Several authors have documented reduced alertness levels in individuals having sustained TBI (Kennedy & Deruyter, 1991).

(b) ***Sustained attention* -** It is the ability to maintain a consistent behavioral response during continuous or repetitive activity (Gillis, 1996). Van Zomeren **and** Colleagues (as cited in Kennedy & Deruyter, 1991) found that sustained attention (ability to maintain attention to a specific activity over time) decreases significantly as measured by reaction times. Although there was a significant difference between overall performance time between the TBI group and the control group, the reaction times for the TBI group remained constant and did not became worse, as was anticipated.

Bronwer and Wolffelaar (1985) studied sustained attention and sustained effort after CHI. They investigated sustained attention in an auditory vigilance task and no evidence for any impairment was found with an interval of about three months, 8 patients, tested in the first half year after CHI, and 8 healthy control subjects were confronted twice with a low event rate vigilance task. This yielded measures of signal detection and response latency. Also, the amplitude of 0.10 Hz heart rate variability, a power spectral measure, was calculated to indicate sustained effort independent of sustained attention patients differed from controls in terms of response latencies and sensitivity of response latencies and sensitivity of discriminating small differences of loudness especially on the first occasion.

(c) *Vigilance* is the capacity to sustain a readiness to respond to a continuous and repetitive activity over a period of time (generally 30 minutes to 8 hours), (Gillis, 1996). Dencker and Lofuing (as cited in Kennedy & Deruyter, 1991) presented a paced continuous reaction task of 15 minutes duration to predominantly mildly concussed patients tested years after injury. Ewing et al., (as cited in Kennedy & Deruyter, 1991) administered a low event rate auditory vigilance task of 30 minutes duration to mildly concussed patients tested 2 years after injury of concussion, the subjects were tested under mildly hypoxic conditions. In both studies, patients made significantly more errors than a matched control group, but no effects of time-on-task were obtained. The tasks may not have been valid for testing sustained attention. In the older study time-on-task effects may have been produced the relatively short duration of the task and by the machine paced manner of presentation. It was also found to be impaired in a few studies and not in others. Impaired vigilance can be the result of poor arousal or poor control over attention (Kennedy & Deruyter, 1991).

(d) *Selectivity or selective attention* is the ability to "select one stimulus over another or to differentially manipulate levels of arousal / alertness to specific stimuli" (Gillis, 1996). After TBI, individuals demonstrate difficulty-making adjustments in response to automatic tasks. This ability to "override" the automatic response requires monitoring and selection and is considered difficult even for normal populations. After TBI, the rate at which this occurs is significantly slower (Kennedy & Deruyter, 1991).

Van Zomeren and colleagues (as cited in Kennedy & Deruyter, 1991) found that when a distraction was imposed during a visual reaction task, decision-making time was significantly slower in the TBI group than in the control group. Again, these findings point to a "slowness" in the attention mechanism rather than actual impairment of selectivity (Kennedy & Deruyter, 1991).

Stablum, Leonard, Mazzoldi, Umilta and Morsa (1994) studied attention and control deficits following CHI. This study was aimed at identifying the impaired attentional components in patients who had sustained a severe CHI several years before. A group of 14 CHI patients and a control group were tested. Experiment 1 used a dual-task paradigm. The double task-single task difference was greater for the CHI group, indicating a specific damage at a central executive stage where decisions are made and responses are coordinated. Experiment 2 used a task-shifting paradigm from one task to the other, and it was greater for CHI group, but only in the short series condition where a new task paradigm could be pre-activity.

Stablum, Mogentale and Umilta (1996) aimed to identify impaired attentional components in mild CHI patients. The CHI features taken into account were age (< 30 years vs. > 30 years), loss of consciousness (yes vs. no), and time after injury (few days vs. some months). The groups tested were composed of 26 patients and 26 controls. Experiment 1 used a dual task paradigm, which taps executive functions. The double task-single task difference was greater for the CHI group, but only for patients older than 30 years and / or with consciousness loss. Two years after injury, some of these patients were retested and the results showed that this deficit was still present. Experiment 2 studied visual selective attention and found no differences between patients and controls.

The main findings can be summarized as showing a selective vulnerability for the anterior attentional system. There is a selective vulnerability within the mild CHI population, indicating that older patients and patients that have experienced a brief episode of loss of consciousness (less than 20 minutes) are more likely to show some difficulties for executive functions.

(e) *Focused attention* is the ability to respond directly to specific visual, auditory, or tactile stimuli; however *divided attention* is the ability to simultaneously respond to multiple tasks (Gillis, 1996).

Murray (2000) studied the effects of varying attentional demands on the word retrieval skills of adults with aphasia, right hemisphere brain damage, or no brain damage. Adults with mild aphasia, right hemisphere brain damage (RDB), or no brain damage (NDB) provided one-word phrase completions under isolation, focused attention, and divided attention conditions and in response to relatively constrained or' unconstrained phrase stems. Despite comparable word retrieval accuracy among groups during the isolation condition, aphasic and RBD groups performed less accurately than the NBD group during focused and divided attention conditions. Across conditions, there were no significant differences between aphasic and RBD group. However, semantic and phonological aspects of word retrieval were influenced by increased attentional demands. These findings suggest that for adults with aphasia or RBD, there was a negative relation between attention impairments and word retrieval abilities.

(f) *Reaction time* is defined by the nature of task. Simple reaction time is assessed only when one stimulus is presented and a single response is required. Choice reaction time is measured when one must choose a response from a number of options, in the presence of more than one stimulus; the response must match a particular stimulus (Gillis, 1996). It is also known as *execution time or speed of processing*

Speed of processing, or information processing rate, has been shown to be delayed following TBI. Reaction time is influenced by two different variables in this population: the number of stimulus alternatives and the stimulus-response compatibility. For e.g., the more stimuli on which focusing is required, the more likely that, reaction time will be slower for individuals after TBI. If the response required in a given situation is new, for different from the "routine" response, processing time will be slower. The implication here is that when placed in new or unpredictable situations or required performing new tasks, the TBI individuals will experience difficulty in rate of processing. Clinical observation supports this, since responses to these situations are frequently slow and disorganized. For e.g. turn-taking rules are easily followed in structural and automatic conversations, however, if the conversation, becomes open-ended, requiring the generation of creative responses, turn - taking skills become disordered (Kennedy & Deruyter, 1991).

Tartaglione, Oneto, Manzino and Favale (1987) analyzed changes of simple visual reaction time in two groups of unilateral brain damaged patients in order to evaluate to what extent intra-hemispheric localization of lesions affects performance. Possible interactions with size were avoided by selecting a localization criterion i.e., the median section of lesion, uncorrelated with size of damage. By preliminary establishing that the distribution of lesions in their hemispheric groups did not differ, authors were enabled to confirm that intra-hemispheric localization of damage has a different bearing on performance depending on site of lesion. In the right hemisphere group slower performances were generally associated with frontal damage whereas in the left hemisphere group localization did not influence the performance. The use of independent indexes for size and locus of lesion proved the existence of an interaction between these parameters in the right hemisphere group.

Gentilini, Nichelli and Schonhuber, (as cited in Stablum et al., 1996) showed significantly longer execution times in a visual search task (matrix test) in a group of mild CHI patients, examined one month and again three months after the accident. The results showed significantly longer execution times in a visual search task (matrix test).

Another study by Shum, Mc Farland, Bain et al., (as cited in Stablum et al., 1996) examined attentional processes in terms of four processing stages: feature extraction, identification, response selection, and motor adjustment. No evidence of impairment was found after the mild CHI patients (one patient was tested about six months after injury and the remaining six were tested about one month after injury).

Some studies utilized the stroop interference task, where subjects say aloud the color in which color's names are printed. The stimuli can be "consistent", when the word and the color are the same, or "conflicting", where the word and the color are unable to ignore the words and this interferes with color naming (i.e., slower RTs in the conflicting condition). In this task, mild CHI patients, compared to controls, showed slower RTs, but the interference effect was not greater (Stablum et al., 1996). The patients were not much distracted by the irrelevant information. Bohmen, Jolles, Twijinstra et al., (as cited in Stablum et al., 1996) modified the stroop to include an additional condition, which adds a further conflict studying patients with persistent post concessional symptoms vs. those whose symptoms resolved after mild CHI, these investigators found that the symptomatic patients performed at a lower level on the modified stroop.

Unilateral brain damage produces a significant lengthening of simple reaction time (RT) involving the hand ipsilateral to the side of lesion. Some evidence suggests that such a result is related to the intra-hemispheric locus of lesion, at least in right hemisphere patients whose performance worsens significantly when the basal ganglia or the parietal lobe are involved (as cited in Tartaglione, et al, 1987).

Normal frontal lobe functioning ensures the efficient allocation of attentional resources in a goal directed fashion particularly in new or complex situations. The frontal system can actuate the lower arousal system when increased mental effort or divided attention is required. It helps maintain attention and concentration, inhibiting attention to irrelevant or redundant sensory information. It controls the focusing to irrelevant or redundant sensory information. It controls the focusing and shifting of attention. The frontal lobes influence attention through extensive bi-directional connections with the reticules activating system and the diencephalon and connections with the primary sensory areas of the brain (Hartely, 1995).

Fitts and Posner (as cited in Hartely, 1995) proposed that expecting the presentation of a stimulus would optimize the processing of the stimulus. Because alertness and arousal mechanisms are impaired in the TBI population, a breakdown in processing may then occur at the initial presentation of the stimulus as seen in inattentiveness or slow rise time.

Linguistic processing deficits (auditory and visual) are present to varying degrees as the causes vary from attention deficits to visual perceptual deficits. Auditory processing and word retrieval deficits are believed to be the most common linguistic impairments associated with the TBI population (Kennedy & Deruyter, 1991). Because of the location and incidence of damage to the frontal - temporal and associated sub cortical regions. Auditory processing deficits observed in individuals after TBI include an overall slowing of processing, inattentiveness, impaired selective listening, noise buildup phenomena, slow rise time, and intermittent auditory imperceptions. One explanation of these phenomena is that the impaired altering or directing mechanism will interfere with the initial receipt, recognition, association, and categorization of the stimulus (Kennedy & Deruyter, 1991).

Hagen (as cited in Kennedy & Deruyter, 1991) suggests that the types of responses elicited during testing will assist in identifying the point of processing breakdown. Random errors that fluctuate at the beginning of a response indicate impaired selective attention, while errors that occur toward the end of a response suggest a reduced attention span or a noise buildup phenomenon. Intermittent errors during a language activity would indicate a fading of the attention mechanism.

Reduced inhibitory control mechanisms also may result in non-parallel, temporal processing difficulty. Thus, the rate of processing cannot be controlled. As the rate increases, accuracy in processing decreases. Analysis synthesis processes can be affected by impaired attentional mechanisms, organization and integration, resulting in inaccurate conclusions and disordered part-whole analysis (Kennedy & Deruyter, 1991).

Speed of processing affects daily communication, including comprehension, verbal and gestural expression, writing, and reading and the integrative use of these processes. Following TBI, individuals may be able to grasp only parts of messages and therefore interpret and integrate information inaccurately (Kennedy & Deruyter, 1991).

The processing of feedback is frequently impaired, as demonstrated by the TBI individual's difficulty in attending to and interpreting subtle changes in facial expressions, gestures, and body language in listeners (e.g., double meanings, sarcasm, humor) (Kennedy & Deruyter, 1991).

Hence, attention is impaired to several extents as a result of TBI. Impairments are present at the level of arousal, selective attention, sustained attention, vigilance, focused attention, divided attention and in terms of slowed reaction time as seen from the review of studies mentioned above. These deficits in attention lead to several other problems in communication.

II. Perception and discrimination : is defined as knowing and comprehending the nature of the stimulus Muma, (as cited in Chapey, 2001). It involves the use of previous knowledge in order to interpret the stimuli that are registered by our senses (Matlin, 1983).

The frontal lobes influence visualospatial processing by ensuring the drive and attention needed for processing relevant features, by organizing the input, and by synthesizing the visual information and integrating it with past knowledge and with verbal input (Hartely, 1995).

Perception is highly dependent on attention processes and involves the interpretation of stimuli compared with what is already known (one's knowledge base or long-term storage). Differentiation of patterns, detail and "gestalt" occur visually and auditorially, involving both hemispheres. Information that is considered to be new (whether it actually is, is not relevant) is more difficult to perceive because there exists no representational store with which to compare it (Kennedy & Deruyter, 1991).

Visuoperceptual impairments following brain damage may be primary or secondary. Primary deficits include those, which are specific, such as visual field cuts, visual neglects, agnosias, spatial or body neglects, topographic (environmental) disorientation, and inability to copy and synthesize shapes and images, and are associated with specific lesions. Whereas, secondary visuo-perceptual deficits are the result of generalized cognitive disruption following TBI. "Perceptual inefficiency may result from general weak organizing processes, from a shallow knowledge base on from impaired executive control" (Kennedy & Deruyter, 1991).

Goldstein and Oakley (1986) investigated color versus orientation discrimination in severally brain-damaged and normal adults. Normal adults and adults with severe, diffuse brain damage were tested on a two-choice simultaneous discrimination where either the color or orientation on stripes on the stimulus cards was the relevant dimension. There was no overall impairment in discrimination learning by the brain-injured subjects. In the normal subjects, however, the discrimination was produced more readily for line orientation than for color whereas the converse was true for the brain-damaged group.

These generalized perceptual problems appear in various forms, depending on the other interfering processes. Facial recognition impairments, common in the early cognitive recovery stages, may be related to impaired visual discrimination, visual retention, or alertness and attention. Visual inattentiveness to certain quadrants, observed in the non-speaking TBI population, interferes with the use of communication boards, making positioning of the device important (Kennedy & Deruyter, 1991).

Levin (as cited in Gillis, 1996) reported research on perceptual disorders secondary to CHI. He documented selective cases of prosopognosia (impaired recognition of familiar faces), although rare. Other cases of impaired recognition for unfamiliar faces (photographs) were discussed with an incidence as high as 25 % of the subjects studied. Another study found patients with CHI to have impaired perception of facial affect. One study of auditory perception found impairment in sentence comprehension during a dichotic listening task in the presence of a unilateral temporal lobe lesion (Gillis, 1996).

Thus, perceptual impairment exists following TBI. These deficits mostly include visual and facial recognition and discrimination impairments and exist at different stages of post injury.

III. Memory and Learning : Memory can be defined as stored representation and the process of encoding, consolidation, and retrieval through which knowledge is acquired and manipulated and learning is an interaction between the world around us and the theory of world in our heads (Chapey, 2001).

Memory and learning impairments are the most common complaints made by individuals and their family members following TBI. 50% of severely injured individuals and 79% of their families mentions memory deficits; present even 7 years post injury, Oddy, Coughlan, Tyerman, and Jenkin, (as cited in Kennedy & Deruyter, 1991). The types and severity vary according to the site of injury, severity of injury, and concomitant cognitive dysfunction. (Kennedy & Deruyter, 1991).

Memory is composed of 3 parts -

- Encoding
- Storage and
- Retrieval.

Encoding of stimuli involves association with verbal and sensory representational stores. Storage, including short and long-term stores, has recently been described in functional-clinical terms, such as semantic and episode memory. Retrieval includes recall (free and cued) and recognition (Kennedy & Deruyter, 1991).

Studies have reported that damage to the frontal lobe results in memory problems (Wallesch, Kornhuber, Kunz & Brunner, 1983; Risse, Rubens & Jordan, 1984). A wide variety of reduplicate phenomenon after brain damage has been reported. Among the better known delusions in reduplication of a familiar other, duplication of one's own body, or parts thereof, reduplication of place and time (Marshell, Halligan & Wade, 1995).

The various types of memories and their disturbances are :

(a) Immediate memory

(b) Free recall

(c) Word fluency

(d) Recognition memory

(e) Visual and Verbal memory

(f) Semantic memory

(g) Episodic memory

(h) Amnesia

(i) Post traumatic amnesia

(j) Short term memory and long term memory

(k) Digit span

(1) Autobiographical memory

(a) ***Immediate memory-*** is how long an individual retains information. It is also known as recent and remote memory (Gillis, 1996). Although controversy exists over the nature of immediate memory (due to its dependency on attention and perceptual processes), recent memory impairment is well documented in TBI individuals. Although remote memory remains relatively intact compared with recent memory, the presence of remote memory loss indicates the severity of the memory impairment (Kennedy & Deruyter, 1991).

Immediate recall of information is generally intact or mildly impaired by brain injury, but recall after a delay (as short as 30 minutes) is often significantly reduced (Brooks, 1975), making learning of new information difficult. In contrast to other types of memory, procedural learning is relatively preserved after brain injury (Kennedy & Deruyter, 1991).

Confusion and disorientation are the result of a severe impairment, whereas delayed responses and vague answers demonstrate a milder recall deficit. Inability to remember events and facts was related to the lack of motivation to continue trying to remember. However, recall impairment is related to disordered organizational strategies and recognition (Kennedy & Deruyter, 1991).

Brooks (as cited in Schacter & Crovitz, 1977) examined recall of verbal and visual material at immediate and 30 minutes delay in CHI patients and controls. He found that CHI patients performed significantly worse than controls at immediate recall and further found that they retained proportionately less of what they did learn than controls at 30 minutes delay. Thus faulty retention of information that has been stored may be a problem for CHI patients.

A case study reported by Levin and Peters (as cited in Schacter & Crovitz, 1977) of a CHI patients tested one year after trauma provides evidence supporting Brooks findings. Recognition memory for nouns was tested in this patient and six controls immediately following inspection of the nouns and at 30-minute delay. In the immediate condition, the patient performed perfectly and the controls were 95% correct. At 30-minute delay, performance of the patient decline to 50% correct, whereas only a 10% decrement was observed in the control subjects.

Carlesimo, Sabbadini, Loassess and Cattagirone (1997) studied effects of retrieval conditions and semantic organization. The study was aimed at investigating long-term forgetting in chronic survivors of severe CHI. For this purpose, performance decay passing from a 30 seconds to a 60 minutes delay test in four memory procedures (free recall of unrelated stimuli, free recall of related stimuli cued recall and yes/no recognition) of 20 CHI and 20 normal controls was analyzed. Results demonstrated accelerated forgetting in CHI patients in the free recall of the related list only. This finding was particularly evident in CHI patients suffering from a focal temporal lobe lesion. These data were discussed in light of retrieval and encoding deficits characterizing memory disorders in CHI patients.

(b) *Free recall* - is a term used to refer to a test condition in which subjects or patients are not required to recall test information in the order of presentation

(Gillis, 1996). When forgetting has been explored by means of conventional memory tasks, such as free recall of word lists, short -story recall, word-pair learning, brain damaged individuals with memory disorders have most frequently displayed accelerated memory decay passing from immediate to delayed recall (cited in Carlesimo, et al., 1997).

Jetter, Poser, Freeman and Markowitsch, (1986) investigated memory functions in a group of patients with frontal lobe lesions demonstrated a normal performance decrement passing from the 15 minutes delayed to the 1-day-delayed memory test when a yes/no recognition or a semantic cued recall test was given and accelerated decay when a free recall retrieval procedure was used.

Richardson (1984) studied the effects of CHI upon intrusions and confusions in free recall. Previous research suggests that CHI impairs the use of semantic encoding in human memory, and especially the use or mental imagery. An analysis of intrusion and confusion errors in immediate free recall was carried out to provide further evidence on the effects on head injury upon different categories of encoding operation. There was no sign of any effect of CHI upon the incidence of either phonemically related or semantically related confusion, errors, nor upon the overall incidence of intrusion errors from previous lists. However, the control subjects demonstrated a strong tendency to produce intrusion errors of similar concreteness to the current list, a tendency that was totally absent in case of head-injured subjects. It is suggested that the persistent effects of CHI upon human memory may be attributable to a failure to attend to the image-evoking quality of the stimulus material.

(c) *Word Fluency* - The ability to name words or nouns beginning with a specific sound within a specified time limit. Word fluency - retrieval deficits have been identified, as a residual problem after TBI (Levin, Grossman & Kelly, 1976).

Word fluency tasks are those that require subjects to list examples of different categories, such as words that begin with's' or animals. They have been used extensively with brain damaged subjects and it has been consistently shown that brain damaged subjects do not list as many examples as do non brain damaged subjects (Grossman, 1981; Levin, Grossman, Sarwar & Meyers, 1981).

In the absence of a focal lesion, word retrieval impairment is related to other cognitive impairment, as noted by Kaye and colleagues (as cited in Kennedy & Deruyter, 1991) in the correlation of word fluency impairment with poor initiation and impaired higher cognitive processing (planning, problem solving, executing, and abstraction). This supports the clinical observation that word retrieval deficits are most common during the highly confused stages of recovery, when other cognitive processes are severely impaired (Kennedy & Deruyter, 1991).

Adamovich and Henderson (as cited in Kennedy & Deruyter, 1991) demonstrated that TBI adults used fewer strategies to generate word lists than did the left cerebrovascular accident (CVA) group and changed strategies more often than did any group (Kennedy & Deruyter, 1991).

Adhoc categories are goal directed categories that are even less well established in memory and are created to achieve novel goals. Words that begin with the letters S, T, P, C is an example of this type of category which has been the type most frequently used for assessing word fluency skills in subjects with CHI (Levin, et al., 1981). Given the nature of these categories, it is not surprising that subjects with CHI have considerable problems retrieving examples. Subjects must search through diverse aspects of their semantic lexicon to retrieve examples that meet the goals of the tasks but are otherwise unrelated. Since these categories are not inherently organized and the examples are not closely related to each other, it is necessary to develop plans and strategies for searching through the lexicon.

The fact that the frontal lobe is particularly vulnerable to damage in CHI is consistent with Adamovich and Henderson's (as cited in Lohman, Ziggas & Pierce, 1989) findings that CHI subjects used fewer strategies on word fluency tasks than did non brain damaged subjects or those with damage caused by either right or left hemisphere strokes. The demands that adhoc categories place on CHI subjects flexibility and ability to use strategies may impact negatively on their word fluency performance (as cited in Lohman, et al., 1989).

Lohman, et al., (1989) obtained word fluency performance or common categories by subjects with CHI. Previous research on word fluency performance in subjects with CHI had used adhoc categories such as listing words that begin with particular letters the nature of this category type may have contributed to the poor performance of these subjects. This study used common categories, such as fruits and furniture, which are more semantically coherent to assess word fluency performance. In addition to tallying the number of examples retrieved, the nature of the example was examined in terms of their typicality ratings. The results indicated that the subjects with CHI retrieved significantly fewer examples than did non-brain-damaged subjects. This suggests that their retrieval problems exist independent of the type of category used. Despite the difficult in retrieving sufficient number of category examples, those retrieved were similar to the examples recalled by non-brain-damaged subjects in terms of typicality ratings. This suggests that CHI subjects perceptions of what category members constitute good example is relatively intact.

(d) Recognition memory - presents some pregenerated stimulus for the person to judge whether or not it is accurate (Leahey & Harris, 1993).

Persistent impairment of recognition memory following CHI has been demonstrated by Brooks (1974) by utilizing continuous presentation of recurring and new designs. The extended delays imposed between repeated presentations of old designs presumably stressed mechanisms of storage and retrieval. Impairment of performance on the task was positively correlated with duration of post-traumatic amnesia in patients over 30 yrs old but was unrelated to the interval between injury and testing, presence of neurological signs, or dysphagia. There was no difference in the degree of impairment of recognition memory for both geometric designs and nonsense forms when dysphagic CHI patients and CHI patients without linguistic disturbance were compared. He also found that immediate recall of paragraphs and reproduction of designs was disturbed in CHI patients.

Brooks (1974) found that CHI patients achieved significantly fewer correct responses than control subjects on continuous recognition task which could be due to impaired memory function, or alternatively might result from the use of strict decision criteria by CHI subjects - that is, CHI patients might offer a response only if they are quite certain that it is correct.

(e) Visual and Verbal memory - Visual memory is the strategy that could be employed for objects or pictures in which the visual replica is reviewed in STM. Whereas, Verbal memory is one strategy employed to maintain information in STM (Gillis, 1996).

Smith (as cited in DeRenzi & Nichelli, 1975), noting the prevalence of countercoup damage in CHI, studied visual vs. verbal memory functions in patients with differing sites of impact. She found that patients with right side impact (and presumably maximal left hemisphere damage) performed more poorly than those with left side impact (and presumably maximal right hemisphere damage) on verbal memory tasks. This finding was expected given the major role of the left hemisphere in verbal processing. However, patients with right - side impact also performed more poorly than those with left, side impact on test of visual spatial memory. He was puzzled by the fact that the left impact group did not show greater visual -spatial memory impairment, given the role of the right hemisphere in mediating visual spatial processing.

Impairment of visual memory after CHI relative to normal subjects is found in the case report of Levin and Peters (as cited in DeRenzi & Nichelli, 1975). Their patient achieved a score corresponding distribution on the facial recognition task. Test of verbal memory showed a mixed pattern of result.

Brooks (as cited in DeRenzi & Nichelli, 1975) found that CHI patients performed as well as controls on verbal memory tasks. Brooks noted that this result might be due to the relatively easy visual memory task that was used in this study.

Lezak (1979) reported data on verbal memory and learning tests. Twenty four TBI males, of whom eight had sustained right sided, eight left sided, and eight bilateral or diffuse CHI, took a battery of neuropsychological tests within the first six months, the second six months, the second year and the third year post injury. Performance on WAIS digits forward and backward and Roy's auditory-verbal learning tests were classified as within or below normal range. Comparisons were made (1) between time period's tests and (2) between subgroups formed by severity, site of lesion, and age. The findings give an overall picture of wide performance variability with consistent improvement in immediate memory span and learning. Recovery varied with the specific nature of the tested function, task complexity, and severity of injury. Neither age, site of injury nor recency, were associated with improvement.

(f) *Semantic memory* - refers to the well-learned facts, word meanings, and abstract concepts that one generally thinks of as knowledge. It is decontextual, without spatial and temporal codes (Gillis, 1996).

Patterson and Hodges (as cited in Levin et al., 1976) concluded that (1) features of semantic memory implicate involvement of multiple neural networks; (2) to the extent that specific brain structures have a major role in subserving semantic memory, the anterolateral areas of the temporal neo cortex are involved with greater participation of the left side than the right.

Apart from the controversy surrounding the episodic-semantic distinction, clinical studies of head injured adults have indicated partial preservation of semantic memory despite profound memory deficit on conventional tests of recall and recognition. Findings obtained in severely injured adults document reduced accessibility of semantic knowledge and less spontaneous use of semantic information, such as super ordinate categories (e.g., animals, fruits) to guide recall of test material (Levin et al., 1976).

(g) *Episodic memory*- is contextual. Information is stored along with temporal and spatial information, that is with the time and place, or when and where aspects (Gillis, 1996).

In studies of episodic memory, the subjects are required not only to encode the intrinsic (e.g. visual, phonemic or semantic) properties of the stimulus materials, but also to encode those extrinsic properties which discriminate among successive episodes in normally contingent upon the particular the subjects will be unable to receive the appropriate information on a given trial if the encoded representations do not adequately discriminate between different lists or even between different tests.

Brooks (1975) found that head -injured subjects actually produced fewer intrusion errors from previous lists, which he interpreted to mean that CHI affected the storage of information, rather than its retrieval. However, Schacter and Crovitz (1977) objected to this interpretation and Thomson (as cited in Richardson, 1979) found that head injured patients had a greater tendency to produce intrusion errors from previous tests into their recall.

(h) Amnesia - occurs when damage to the brain erases old memories and makes it difficult or impossible to form new ones. *Anterograde amnesia (AM)* is the difficulty or inability to form new memories and *retrograde amnesia (RA)* is the loss of some memories prior to the event causing the brain damage responsible for the amnesia (Leahey, & Harris, 1993).

Russell (as cited in Schacter & Crovitz, 1977) questioned head injured patients after they had regained normal consciousness, and found a retrograde amnesia (RA) covering a few seconds in 69 patients, 1-30 minutes in 24 patients, and over 30 minutes in 3 patients. In addition, good correspondence between duration of impaired consciousness and RA length was observed, RA tends to be longer with increasing duration of PTA. He claimed that RA was of greater length when patients were questioned during the PTA period than after it, suggesting shrinkage of RA, but he does not provide data pertaining to this statement.

Eden and Turner (as cited in Schacter & Crovitz, 1977) have also provided data on the distribution of RA length as assessed after the termination of PTA in CHI patients. They found no RA in 5 patients, RA of seconds in 45 patients, of minutes in 35 patients, and of hours in 8 patients.

Russell and Nathan (1946) present data on length of permanent RA from a larger sample of CHI patients who had emerged from PTA. Nil RA was found in 133 patients, RA covering under 30 minutes in 707 patients, and RA covering under 30 minutes in 133 patients. Again, longer RA tends to be associated with longer PTA duration, but this relationship is not statistically documented.

Blomert and Sisler (as cited in Schacter & Crovitz, 1977) conducted several interviews with CHI patients within hours of trauma in order to determine RA duration. Interviews were conducted until RA had reached a stable minimum as evidenced by no change in memory from the previous interview or a RA of less than one second. Using this criterion for permanent RA, they found that 14 patients had RA of less than one second, 9 had RA of one second to one minute, and 2 had RA of over one minute. They noted that shrinkage of RA was observed in 5 patients. They also studied the relation between RA duration and length and found a statistically reliable relationship between RA length and duration of anterograde amnesia (AM), thus lending support to the non-statistical findings mentioned above.

Sisler and Pennes (as cited in Schacter & Crovitz, 1977) have provided data covering RA shrinkage, and the question of RA permanence. In this study, the RA length of 24 CHI patients was assessed in psychiatric interview at various times post-trauma (ranging from a few days to almost two years post trauma, each patient was interviewed several times). RA length was classified at each interview as being either less than a minute, less than an hour, less than a day, and so on, up to "more than year". RA length was defined as 'changed' for a given patient if at a particular interview it fell into a different category than RA length as assessed at the previous interview. They found that five patients exhibited no change in RA length over the various interviews, eight showed shrinkage of RA, five showed increases of RA, and six showed both increase and shrinkage of RA.

(i) *Post-Traumatic Amnesia (PTA)* - is the loss of memory for events occurring subsequent to the injury (Gillis, 1996). The duration of PTA has often been taken as a mark of the 'severity' of CHI and has been related to a number of indicators of recovery of function.

Symonds and Russell (as cited in Schacter & Crovitz, 1977) reported that invalidism is more problem with increasing PTA duration. Similarly, Moore and Ruesch (as cited in Schacter & Crovitz, 1977) noted that the length of "disorientation" correlates well with the severity of a variety of neurological signs.

Russell and Nathan (1946) also reported that the length of PTA is a good indication of 'recovery of efficiency' among soldiers with CHI.

Studies by Russell (as cited in Schactre & Crovitz, 1977), Russell and Nathan (1946) had shown a positive relationship between PTA duration and length of permanent RA. Also the data presented severity of memory loss following PTA termination as a function of PTA duration. This data indicates that longer PTA duration is associated with more severe memory loss.

Conkey, Ruesch and Moore (as cited in Schacter & Crovitz, 1977) studied CHI patients in the first injury. They compared the performance of CHI and control patients on a variety of memory and after cognitive tests. The first testing was given two or three weeks post-trauma, with retesting done four time at about three months intervals. They found gradual recovery of memory and cognitive functions from the first through the fourth test (which was administered 34 weeks post-trauma). No further improvement was seen on the final test, administered at 50 weeks post-injury. By the time of the fourth test, performance of the head injured group approximated that of the control group. They claimed that recovery in memory performance lagged behind recovery of other functions. However, statistical analysis is lacking in this study.

Ruesch and Moore (as cited in Schacter & Crovitz, 1977) found that performance on serial subtraction test did not significantly improve during the first four days after CHI, either with respect to the time it took to do the task, nor the number of errors made. However, both faster times and fewer errors were observed at a follow-up testing one to three months later. Interpretation of these results is complicated by the fact that it is not known whether patients were in or out of the PTA period at any of the various test times.

Recent studies have suggested that time since injury at test and age of patient may be important variables of consider when relating PTA duration to late memory impairment.

Studies reported by Brooks (1974, 1975) indicate a fairly clear-cut effect of age on the relation between PTA and subsequent memory impairment.

Brooks (as cited in Schacter & Crovitz, 1977), tested 27 patients on a variety of memory tests about 7 months after trauma. Mean age of these patients was 32. A significantly negative correlation was found between PTA duration and scores on immediate and delayed tests of logical memory, associative learning, visual reproduction, and continuous recognition task, for the patients over the age of 30 years. Only 'percent forgetting' on logical memory was significantly negatively correlated with PTA duration in the patients under age 30.

Brooks (1974) found a significantly negative correlation between PTA duration and number of correct response (minus false positives) on continuous recognition test in his older (>30 years) but not in his younger (<30 years) subjects. A significantly positive correlation between PTA duration and number of false positives was found in the older but not the younger subjects. An insignificant correlation between number of false negatives and PTA duration was observed in both age groups.

However, Brooks (1975) did not find significant differences between three PTA duration groups (7 days or less; 8-28 days, more than 28 days) on performance of a number of short-term and long-term memory tests. Although the mean age of subjects in this study is comparable to that of the subjects in his previous studies (early to mid thirties), he did not examine the relation between PTA duration and memory performance separately for the older and younger subjects, as he did in previous studies. Thus age effects may well be embedded in the Brooks (1975) data.

A number of studies suggest a strong effect of time since injury at test. Klove and Cleeland (as cited in Schacter & Crovitz, 1977) found that duration of PTA correlated significantly with an impairment index derived from various memory and cognitive test scores if testing is done within 3 months of injury, but not after. The significant correlations reported by Brooks (1972 & 1974) in older subjects were obtained with mean time since injury at test being 6.9 months in Brooks (as cite din Schacter & Crovitz, 1977) and 12 months in Brooks (1974).

Smith (as cited in Schacter & Crovitz, 1977), who tested patients 10-20 years post-trauma, found no correlation between PTA length and performance on the Weschler Memory Scale in 77 CHI subjects.

Norman and Svahn (as cited in Schacter & Crovitz, 1977) found a non significant correlation between PTA duration and performance on a picture memory task in 28 CHI patients tested 2 years and more since injury. These studies appear to suggest that a significant correlation between PTA duration and later memory function is more likely to emerge if memory testing is done fairly soon after injury. However, results from other studies considerably weaken this suggestion, Dailey (as cited in Schacter & Crovitz, 1977) was able to find significant correlations between PTA duration and memory cognitive performance in CHI patients tested 5 years after injury.

Similarly, Von Zomeren (as cited in Schacter & Crovitz, 1977) tested CHI patients several years after trauma, and found more severe 'dementia' to be associated with longer PTA, with dementia assessed though tests. Also Norman and Svahn (as cited in Schacter & Crovitz, 1977) were able to correlate PTA duration with memory and concentration ability as judged from patients, self-reports and from clinical ratings in their subjects tested 2 years after injury.

Fodor (as cited in Schacter & Crovitz, 1977) found that memory performance in patients who were tested only hours after CHI were unrelated to 'period of unconsciousness' and 'period of disorientation'. He found no improvement in the memory performance of CHI patients tested one, two, three and four days after injury. However, methodological shortcomings of this study limit the force of these findings.

(j) *Short Term Memory (STM) and Long Term Memory (LTM)* - STM refers to the temporary and limited capacity storage of information, that when processed in some effortful manner, can be learned and then retrieved at a later time, however, LTM is the permanent storage of information and has no limits in capacity (Gillis, 1996).

Brooks (1975) has provided the major quantitative investigation of LTM vs. STM in CHI patients. He tested 30 CHI patients with a mean PTA duration of 28.8 days (who were out of PTA, and compared their memory performance with that of a matched control group. He used the Glanzer and Cuniz paradigm (as cited in Brooks, 1975) in order to distinguish between LTM and STM. Recall of word lists was tested immediately after list presentation and at a 20 second delay. At immediate recall, there was a strong recency effect, which was attributed to STM. At 20-second delay, the recency effect disappeared, which was supposed to reflect the more stable LTM component. Subjects in this experiment were presented with 20 lists containing 10 words per list at both immediate and 20-second delay. Subjects were instructed to count backwards by 3's starting from a 3-digit number in the delay condition. Digit span was also assessed. He found no significant difference between CHI and control subjects on the immediate recall trials on digit span. At 20-second delay, CHI subjects were significantly worse than controls. He interpreted these findings as indicating a defect in LTM, and normal STM in CHI subjects.

Brooks (1975) also analyzed the kinds of errors made by his subjects. It has been found that errors from LTM tend to be semantic confusions and that errors from STM tend to be acoustic confusions. He found that CHI patients made significantly less semantic errors than controls and about the same amount of acoustic errors and interpreted this result as supporting the hypothesis that CHI patients are impaired in LTM relative to STM.

Third method used by Brooks (1975) to investigate LTM vs. STM in which items were classified as either LTM or STM based on the total trials between item presentation and item retrieval-has been found to be relatively sound method for assessing LTM vs. STM (as cited in Schacter & Crovitz, 1977). Using this procedure, he found that CHI patients recalled significantly less words designated as LTM than did controls, and non-significantly less words designated STM.

De Renzi and Nichelli (1975) studied verbal and non-verbal STM impairment following hemispheric damage. STM was investigated in 30 control and 125 unilaterally damaged patients with a series of tests requiring the immediate reproduction of strings of items of increasing length. On both the digits forward test and the two other verbal tests not requiring the use of speech, left brain-damaged patients were impaired in comparison to normal, while the right brain-damaged patients were not. A lesion posteriorly located in either hemisphere significantly affected spatial span. There were also two right hemisphere damaged patients who showed an extreme reduction of spatial span, which could not be accounted for by space perceptual disorders and contrasted with a normal performance.

Jetter, Poser, Freeman and Mankowitsch (1986) studied verbal LTM deficit in frontal lobe damaged patients. The retention performance for learned words was compared in two groups of cortically damaged patients, 14 patients with uni-or bilateral damage to the frontal lobes (group F), and 14 patients with post rolandic damage. The patients learned three lists of words each of which had to be reproduced after 15 min and after 1 day: one list under free recall, one under cued, recall, and one under a recognition condition. While the performance of the two groups of patients was similar under all three conditions when tested after 15 min, group F was significantly inferior in the one-day free recall retention test. Authors interpreted this deficit as related in part to the classic 'frontal' symptomatology (reduced attention and lack of initiative, device and concentration), and in part to a distinct disturbance of LTM. No or only minor differences could be established between the side of damage or between unilateral Vs. frontal damage.

(k) Digit Span - STM is most often assessed using the digit span format with either numbers, words, sentences, or paragraphs (Gillis, 1996).

McFie, Newcombe (as cited in DeRenzi & Nichelli, 1975) have reported that in adults digit span is sensitive to damage to the left side of the brain, irrespective of the locus of lesion.

Sterne, Costa (as cited in DeRenzi & Nichelli, 1975) found no significant difference was shown comparing the digits forward scores of left with those of right brain-damaged patients and of controls.

There have been descriptions of a few left-hemisphere patients showing a striking inability to immediately reproduce strings of three or even two auditorially presented items, inspite of a satisfactory recall of information from the long term storage. It is remarkable that the likely locus of lesions of these patients coincides with that proposed for conduction aphasics.

Weinberg, Diller, Gerstman and Schulman (as cited in DeRenzi & Nichelli, 1975) found that patients with left hemisphere lesions perform like poorly educated normals on both forward and backward digit repetition. In their right hemisphere lesion patients, digit span forward was superior to that of left hemisphere lesion patients, and did not differ significantly from that of normal controls. The right hemisphere lesion patients with visuospatial dysfunction (as assessed by visual confrontation task) performed significantly poorer on digit span backward with no corresponding deficit on digit span forward. This impairment was hypothesized to be due to deficits in visual scanning or to difficulties in eye movements.

Costa (as cited in DeRenzi & Nichelli, 1977) reported no significant differences between samples of patients with right and left hemisphere lesions and normals on a test of digit span forward, but did find significantly lower scores for the brain-damaged patients on digit span backward. This discrepancy in findings suggested that digit span backward is more sensitive to the cognitive dysfunction resulting from any brain lesion than is digit span forward.

Black and Strub (1978) found digit repetition performance in patients with focal brain damage. Digit span forward and backward was investigated in well-matched samples of patients with discrete quadrant brain lesions. The incidence of significantly impaired digit repetition performance and the incidence of large forward and backward digit span discrepancies were also studied.

Co-relational data of digit span performance and various intellectual, memory and constructional measures was examined. Approximately 60% of all brain-damaged patients showed an impairment of digit span forward, while only 5% showed a similar impairment on the digit span backward task. These data indicate that digit span forward is a more sensitive measure of brain dysfunction from focal brain lesions. No differences was found in the performance of patients with right or left hemisphere lesions; however, the low incidence of aphasia (8%) in this sample may account in part for the relatively adequate performance by the left hemisphere patients. Digit repetition performance does appear to be related to both general intellectual ability and to performance on the Weschler Memory scale.

(l) Autobiographical Memory- involves the study of memory for events in one's own life (Leahey, & Harris, 1993).

Stracciari, Ghidoni, Guarino, Poletti and Pazzaglia (1994) found post-traumatic RA with selective impairment of autobiographical memory. A selective, temporally limited RA, confined to autobiographical memory, was the only sequale of a 'minor' head trauma in two young men. The retrograde memory gap covered only one year of life before the trauma and persisted for several months, without any anterograde deficit or any cognitive disturbances. The unusual pattern of RA deserves close consideration and points to the dissociation of memory sub-systems and mechanisms.

To summarize, memory deficits are very common in TBI patients varying from minor memory problems to severe amnesia. The several processes of memory involved in these patients are immediate memory, free recall, word fluency, and recognition memory, visual and verbal memory, semantic memory, episodic memory, amnesia, and post traumatic amnesia, STM & LTM, digit span and autobiographical memory.

IV. Reasoning and problem solving : Reasoning is the process of evaluating information in order to reach a conclusion however, problem solving involves the evaluation of a situation (information) in order to find as answer (reach a conclusion) (Gillis, 1996).

On the other hand, thinking refers to the ideational components of mental activity, process used to imagine, appraise, evaluate, forecast, plan, create and will (Yager, Michad & Gitlin, 2000).

Problem solving and abstract thinking are functions associated with the frontal lobes. Problem solving required the ability to adequately perceive the social and physical environment, anticipate consequences of possible responses, control impulses and emotional responses for selection of the most appropriate solution, and make social inferences regarding the perspective of others. It also requires the executive skills of planning, executing monitoring and evaluating the solution that is selected (Kennedy & Deruyter, 1991).

Impaired reasoning (inductive, deductive and analytic), thinking processes (divergent and convergent), insight, and problem solving are documented as occurring in TBI during all stages of cognitive recovery. Difficulty with integration and part-whole relationships has been documented by several investigations (Kennedy & Deruyter, 1991).

The several types of reasoning and problem solving and their deficits are:

(a) Planning and execution

(b) Reasoning and problem solving

(c) Text comprehension

(d) Story arrangement

(a) ***Planning and execution*** - Planning includes abilities to conceptualize change (look ahead), be objective, conceive of alternatives and make choices, develop a plan conceptually, and sustain attention (Gillis, 1996).

Disorders of planning and execution reflect a range of deficits from basic to integrative. In the severe form, highly confused individuals demonstrate preservation (motorically and verbally) as well as the disconnection of acts or responses. Each act is separate from the previous one, so that each step in an activity may require external assistance (verbal guidance on mediation) to become connected to the next step or part in the sequence (Kennedy & Deruyter, 1991).

Prigatano & Fordyce (as cited in Kennedy & Deruyter, 1991) noted that family members complained that TBI individuals required literal and step-by-step instructions to perform activities that they previously had performed independently. Deficits in abstract reasoning were present. Several authors have reported organizational difficulties leading to impaired planning and executing (Kennedy & Deruyter, 1991).

(b) ***Reasoning and problem-solving*** behavior are increasingly recognized as a critical aspect of cognitive functioning following head injury. Deficits in the ability to organize and shift responses, to utilize feedback, and to evaluate final performance have been found across all severity levels, including patients with apparently good recoveries as measured by return to work or intact neurological indices. The executive processes are conceptualized as the overseer of lower-level functions such as memory and language, modulating the efficiency of these operations. Impairments can result from reduced motivation to apply active strategies, decrease in the productive aspects of thought, and failure to monitor one's actions or to modify behavior based on environmental feedback.

Ablation studies have emphasized the role of the frontal lobes in producing these deficits. Although the frequency of frontal lobe contusions and hematomas, after head injury is well-established. Precise neuro-anatomical, neuropsychological links are complicated by the presence of diffuse a multifocal trauma (Golding, 1991).

The Four Card Problem in which there are a large number of possibilities from which concrete instances have to be considered in relation to a test sentence. A conclusion has to be drawn in order to determine which particular instance would allow a valid inference to be made in relation to the test sentence. Numerous studies of this problem have shown a high frequency of incorrect solutions. In fact only 4 % of undergraduate subjects gain complete insight and a further 7 % gain partial insight. In addition it has been suggested that errors can occur due to a failure to consider the problem as a whole, Wason and Shapiro (as cited in Golding, 1981) or by incorrectly "matching" the masked cards to the text sentence.

Furthermore, studies of attempts to correct made by subjects have indicated that once an incorrect selection has been made it is highly resistant to correction and that the visual aspects of the task interfere with verbal reasoning. It was postulated that visual skills known to be lateralized to the right hemisphere inhibited the verbal skills of interference, thought to be lateralized to the left hemisphere, thus preventing insight into the problem (Golding, 1981).

Golding (1981) investigated the effect of unilateral brain lesion on reasoning. The results of the four-card problem and those of perceptual tests were compared in order to tease out the relevance of a "perceptual classification" deficit on reasoning. The prediction that right hemisphere brain lesions would facilitate insight into the problem was upheld. In addition all patients who had a specific perceptual classification deficit solved the problem.

Villardita (as cited in Villardita, Grioli & Quattropain, 1988) reported on semantic clustering in a sample of RHD patients investigated with respect to their immediate and delayed recall of familiar, concrete words belonging to a small number of semantic categories. He showed that a right hemisphere lesion might cause a significant deficit in semantic clustering and learning of this class of words.

(c) *Text comprehension* - is the ability to understand and interpret the written text or matter (Crystal, 1985). The available studies targeting structural processes during text comprehension have failed to yield clear support for the hypothesis that frontal lobe dysfunction might lead to an impairment of text comprehension.

Brookshire & Nicholas, (1984) used 10 short paragraphs and distinguished main ideas from details, as well as explicitly stated information from implicit, to be inferred information. Four groups of subjects read the stories and answered yes/no questions. The subjects were healthy control subjects, aphasic patients, right hemisphere patients and CHI patients. Overall performance was worse for the patients group. However, the qualitative pattern of recall was equivalent across the four subjects group. All patients answered more questions about main ideas correctly, explicit information was easier than implicit information, and there was an interaction between the two factors. The difference between the implicit and explicit information was larger for details than for main ideas.

Novoa and Ardila (1987) studied a text comprehension task and reported dramatically poor recall for story information after left prefrontal lesions. However, the method was not described in sufficient detail for a thorough evaluation of the results.

Haut, Petros, and Frank (as cited in Ferstt,Guthke & Cramon,1999) used the logical memory sub-test of the Weschler memory scale – revised to test whether CHI patients have difficulties with distinguishing main ideals from details. After rating the idea units of the two stories used in this test according to their importance for the meaning of the passage, they found that CHI patients recalled fewer content units than a student control group, and that their forgetting rate was higher. However, their sensitivity to the salience of the information was comparable across groups. Just like control subjects, CHI patients recalled main ideas better than details.

Thus, these studies failed to support the hypothesis that CHI leads to difficulties with evaluating the relative salience of information within a text.

Hough (1990) reported a detailed study investigating impairments of structure building processes after brain injury. She used short paragraphs, which had a theme sentence either at the beginning or at the end. When the theme sentence was at the beginning of the story, the subsequent information could be linked to it, facilitating comprehension of the paragraph. When the theme sentence was at the end, subjects needed to infer the topic of the paragraph during reading. Thus, in the latter case, deriving the situation model of the text was more difficult.

The results showed that subjects with lesion of the right hemisphere answered fewer questions correctly when the theme sentence was presented at the end of the story. Thus, these subjects needed the header for deriving the situational information. An additional distinction of anterior and posterior lesions showed that patients with right anterior brain damage produced embellishments and confabulations during free recall, a pattern consistent with text production difficulties after frontal lobe damage. More importantly, though there was no difference in accuracy compared to patients with right posterior lesions (cited in Ferstt, et al., 1999).

There is evidence from the aphasia literature to suggest that the utilization and formation of macrostructures in text comprehension is dependent on right hemisphere functioning. For example, left-brain-damaged (LBD) aphasics with intact right hemispheres are able to employ thematic information and formulate macrostructures in order to comprehend discourse. Right brain-damaged patients (RBDs), on the other hand, appear to be impaired in their general ability to arrive at appropriate macrostructures (as cited in Schneiderman, Murasugi & Saddy, 1992).

Hough (1990) observed that RBDs were unable to utilize the organizing principle of a macrostructure to comprehend a paragraph. Rehak and Gardner (as cited in Schneiderman et al., 1992) report that RBDs were more likely than non-brain-damaged individuals (NBDs) to judge direct conversations (i.e., those with redundant or tangential elements) as normal. They conclude that RBDs have difficulty keeping track of what is importantly leading them to ignore central themes in conversation.

Brownell, Potter, Bihrle, and Gardner (1986), reported that RBDs are unable to distinguish between in salient and trival elements in a discourse, resulting in a failure to extract its global meaning. In retelling stories, RBDs have been observed to focus on isolated events and details, missing the main point or moral (Wapner, Hamby & Gardner, 1981). They also tend to add extraneous or unnecessary comments and to justify rather than reject non-canonical elements. Because it is the macrostructure, which normally acts as a guide to what the salient and appropriate elements are in a discourse, without it there are no limits, leading to confabulation and the acceptance of non-canonical elements.

This acceptance of deviant elements is also revealed in RBD's inability to reject false statements and inferences that are not part of the preceding narrative (Brownell et al., 1986; McDonald & Wales, 1986). Without a macrostructure within which to integrate relevant information, there is presumably no rationale for recognizing statements and inferences that do not belong. The poor performance of RBDs in comprehending humour may also stem from their inability to formulate macrostructure (Wapner et al., 1981; Brownell, Michel, Powelson, & Gardner, 1983). Their tendency to choose surprising but incoherent endings for jokes suggests that they understand the superstructure or schemata of a joke, but are unable to formulate a macrostructure for the body of the joke within which to fit the appropriate punch line.

(d) Story arrangement - is used to refer to any sequence of linguistic elements in terms of their relative position, or distribution in a story (Crystal, 1985).

Schneiderman et al., (1992) studied story-arrangement ability to RBD patients. The purpose of the present study was to explore the role of an explicit expression of macrostructure in facilitating performance on a story arrangement task. Subjects were presented with a series of sentences, which they were required to arrange into a coherent paragraph. Half of the items were preceded by a theme sentence containing the framework or macrostructure of the paragraph, while the items without theme sentences required subjects to formulate their own macrostructure in a bottom-up fashion. Results of the study support the hypothesis that the presence of a theme sentence facilitates performance on the story arrangement task for non-brain-damaged individuals (NBDs) and left brain-damaged individuals (NBDs) and left brain-damaged patients (LBDs), but not for right brain-damaged patients (RBDs). This suggested that RBDs were impaired in their ability to recognize and benefit from explicit thematic statements in narratives.

Thus, reasoning, problem solving, thinking, planning, text comprehension and story arrangement abilities are impaired to different extents as a result of TBI. These deficits in turn lead to other problems at several levels of communication and everyday life.

V. Organization and Categorization: These deficits are discussed as :

(a) Organization

(b) Categorization

(a) *Organization* is the attempt to bring order and pattern to the material we learn. Typically, organization is used in connection with large amounts of information that can be recalled in any order and is learned over several trails (Matlin, 1983).

The problem of differences in constructional deficits between patients with lesions in the right and left hemispheres is an old and important issue in neuropsychology, which remains to be solved. According to some authors (McFie, Piercy & Zangwill, 1950; McFie & Zangwill, 1960) constructional disabilities of left hemisphere damaged (LFID) patients are a manifestation of a disturbance at the motor-executive level in the constructional act, whereas those of right hemisphere damaged (RHD) patients are a secondary consequence of a disturbance of spatial orientation and analysis.

Piercy and Smyth (1962) maintain that the basis of constructional disabilities is the same for both groups of patients. Descriptions of these characteristics are mostly based on clinical impressions of the examiner, and not on objective grounds.

Hecaen and Assal (as cited in Hadano,1984) made a more objective contribution-comparing the performances of LHD and RHD patients with performances of LHD and RHD patients in a constructional task which required copying a model of a cube with the help of landmarks previously marked on the paper, these authors found a clear differences in constructional disabilities. Since performance in copying cubes was improved with the help of visual cues in the LHD but not in the RHD group, they concluded that the constructional disability of the LHD patients was a planning disorder, i.e., a deficit of providing a program for the action.

However, Gainotti, Miceli and Caltagirone (1977), who gave tasks quite similar to those of Hecacn and Assal,(1970) could not find any difference between these groups of patients with regard to the effect groups of patients with regard to the effect of visual cues. This result could be explained by the nature of the aids given to patients: the aids used by them, were far more compelling than those used by Hecaen and Assal (1970).

Hadono (1984) studied on block design constructional disability in right and left hemisphere brain damaged patients. Block design tasks without or with special visual cues, tests of reasoning abilities and tests of spatial abilities were administered to 20 right and 20 left hemisphere damaged patients was not confirmed for block design constructional performance. Results of multiple linear regression analysis suggest that left hemisphere damaged patients adopt different strategies for the two different task situations.

In all of the studies the constructional disabilities was defined as failure on tasks of copying figures, especially cubes. From a psychometric point of view, however, the task of copying cubes is problematic because of the wide range of pre-morbid drawing ability and because of the nature of the assessment of the patient's drawings. Furthermore the finding based on copying tasks cannot be generalized to all aspects of constructional disability in so far as correlations between different constructional tasks are not always high (as cited in Hadano, 1984).

(b) *Categorization* - refers to the whole process of organizing human experience into general concepts with their associated linguistic labels (Crystal, 1985).

A recent neuropsychological model of object recognition relates to visual object agnosia to defective categorization Warrington (as cited in Bulla-Hellowing, Ettinger, Downnasen, Eber & Skreezeck, 1992).

Warrington and Taylor (as cited in Bulla-Hellowing, et al., 1992) reported a double dissociation of disorders of visual categorization they found a disorders of perceptual categorization (PC) specific to right-sided brain damage (RBD) and a disorder of semantic categorization (SC) specific to left sided brain damage (LBD), PC was defined as the ability to classify a 'same' in spite of physical differences, SC stood for the ability to classify according to the functional significance of objects. Based on this double dissociation, they proposed a model of object recognition and integrates distinction between aperceptive and associative agnosia.

Bulla-Hellowing et al., (1992) studied impaired visual perceptual categorization in right brain-damaged patients. The association of both perceptual categorization (PC) and semantic categorization (SC) with sensory performance was investigated. 28 RBD, 27 LBD and 21 non-brain-damaged subjects were tested with the PC and SC tasks described by Warrington and Taylor (as cited in Bulla-Hellowing et al., 1992) and with 6 sensory tasks. PC was related to sensory performance in RBD but not in LBD patients. SC was only marginally associated with sensory ability in both lesion groups. RBD and LBD patients differed significantly at neither PC no at SC. Thus the dissociation between PC and SC, described by Warrington and Taylor (as cited in Bulla-Hellowing et al., 1992) was not replicated. Moreover, PC and SC were significantly correlated in both RBD and LBD patients. This suggested that the serial organization of PC and SC was questionable. It was concluded that the associations we obtained between SC, PC and sensory performance were likely to be functional. The contribution of a cognitive factor ("abstraction") to PC and SC was discussed.

Thus, categorization, constructional and organizational deficits exist in patients with TBI in terms of block construction deficits, categorization deficits, etc.

Thus, the review of literature shows that TBI influences the cognitive functioning in the individuals in a marked manner, ranging from mild to severe impairments. Cognitive processes as attention, concentration, discrimination, perception, memory, reasoning, problem solving, thinking, organization, categorization, story arrangement abilities are disrupted to varied extent. All these processes are interrelated and hence, deficit at one level might reflect deficits at other levels also. A combined effect of all these impairments is reflected in the communication, i.e. speech and language of an individual with TBI. Thus, they face several problems in social communication and everyday life.

METHOD

Cognitive linguistic disturbances are most often present as a consequence of TBI. Present study was taken up to investigate the nature of cognitive deficits present in TBI adults. The study also aimed to find out the differences in the performance by left hemisphere damage (LHD) subjects, right hemisphere damage (RHD) and bilateral damage subjects, if any.

The participants selected were Kannada speakers. Kannada is a Dravidian Indian language, a language spoken mainly in the state of Karnataka.

Subjects - A total of 20 subjects participated in the present study (10 in experimental and 10 in control group) in the age range of 16 years to 45 years (mean age= 23 yrs).

Subject selection criteria for TBI individuals

1. 10 subjects with TBI resulting from road traffic accident participated in the study.
2. Individuals with damage to either of the hemisphere were taken, 4 with LHD, 4 with RHD, and 2 with bilateral damage.
3. Subjects had Kannada as their native language and had a minimum of primary schooling.
4. The TBI subjects were evaluated by neurologist and Speech Language pathologist.

5. The subjects were diagnosed as non-aphasics based on the performances on WAB and clinical symptoms.
6. All the subjects included for the study were right handed.
7. Subjects were tested in the post injury period from 8 to 16 months.
8. Both adult males and females were considered for the study (9 males and one female)
9. All the subjects had closed head injury (CHI).
10. All the subjects had post- traumatic amnesia as diagnosed by a neurologist.

The demographic data of TBI subjects is as shown in table-3

Table-3 : Demographic data of TBI subjects

SI. No.	TBI Subjects	Age/ Sex	Education	Severity of head injury	Hemisphere damage	Lesion	Glasgow coma seate	CT/MRI reports
1.	T,	18/ M	BBM Student	Severe	Bilateral	Bilateral frontal	4/15	Fracture of frontal bone with biforntal injury
2.	T_2	17/ M	10th Std. Student	Severe	Right	Frontal parietal	3/15	(R) Fronto-parietal extradural hematoma and contusion
3.	T_3	18/ M	Pre-degree student	Moderate	Left	Frontal and temporal	6-7/15	Left temporal linear fracture with frontotemporal extradual hematoma
4.	T_4	16/ M	11th Std. Student	Moderate	Left	Frontal and temporal	15	(L) frontal extradural hematoma
5.	T_5	18/ M	Engg. Student	Sever	Right	Temporal and Frontal	6/15	(R) Temporal and frontal contusion
6.	T_6	23/F	Engineer	Moderate	Diffuse axonal injury	Diffuse B/L	13/15	Diffuse axonal injury
7.	T_7	20/ M	10th Std	Severe	Right	Temporal and Parietal	8/15	(R) Temporal parietal with temporo-parietal extradural and subdural hematoma
8.	$\mathbf{T_8}$	45/ M	Wipro	Moderate	Left	Temporo-parietal	9/15	(L) Posterior temporal and parietal contusion
9.	T_9	34/ M	Lawyer	Severe	Right	Parietal	13/15 on admission 7/15 before surgery	(R) Parietal with extradural subdural hematoma and contusion
10.	T_{10}	16/ M	II PUC	Moderate	Left	Extradrual hematoma left fronto temporal	Admitted with 14/15 12/15 before surgery	(L) fronto extradural hematoma (R) Frontal contution diffuse cerebral oedema

Subject selection criteria for controls

Equal number of controls matched for age, gender, handedness and educational level were taken. They had history devoid of any psychological, cognitive, peripheral, sensory deficit and alcohol intake.

Tools used for the present study

Western Aphasic Battery (WAB) (Kertesz, 1979), linguistic portion (excluding reading, writing and apraxic subsections) was used to assess aphasic component in the TBI subjects. Cognitive Linguistic Assessment Protocol (CLAP) for adults developed by Kamath (2001) in Kannada was used for assessing the cognitive-linguistic abilities of TBI patients. CLAP consists of the following domains and test items as shown in table-4.

Procedure

The subjects were taken from BGS Apollo Hospital, Mysore. These subjects were tested in the post injury period ranging from 8 months to 16 months. They were seated comfortably and were tested in a clinical situation with minimum external noise. Testing was carried out in one session or two sessions, if required. WAB and CLAP were administered and responses were recorded and scored. The same testing protocol was adopted for control group as well.

Table-4: The various domains of CLAP

	Domain	Test item	Max. Scores
1.	Attention, Discrimination and perception		
	Visual	a. Letter cancellation	10*
		b. Contingent letter cancellation	10*
		c. Word cancellation	10*
	Auditory	a. Sound counts	10
		b. Letter-pair cancellation	5
		c. Word-pair discrimination	5
		d. Months - backward naming	10*
2.	Memory		
	Episodic memory	a. Orientation and recent memory questions	10
		b. Digit forward	5
	Working memory	a. Digit forward	5
		b. Digit backward	5
	Semantic memory	a. Co-ordinate naming	5
		b. Super ordinate naming	5
		c. Word naming fluency	5*
		d. Generative naming	5
		e. Sentence repetition	10
		f. Carry out commands	10
3.	Problem solving	a. Sentence disambiguation	10
		b. Sentence formulation	5
		c. Predicting outcome	10
		d. Compare and contrast	10
		e. predicting cause	10
		f. Why questions	10
		g. Sequential analysis	5
4.	Organization	a. Categorization	10
		b. Analogies	10
		c. Sequential events	40

* Items are timed tasks.

The data obtained was tabulated and subjected to appropriate statistical analysis in order to investigate the aims of the present study.

RESULTS AND DISCUSSION

The aims of the present study were:

a. To investigate the nature of cognitive linguistic deficits in Traumatic Brain Injured (TBI) subjects.

b. To compare the performance of TBI and normal subjects.

c. Comparison of performance of cognitive-linguistic tasks on Cognitive Linguistic Assessment Protocol (CLAP) (Kamath, 2001) across left hemisphere damage (LHD), right hemisphere damage (RHD) and bilateral damage (BD)subjects.

Ten TBI and ten normals, age, sex, education and handedness matched Kannada speaking subjects were taken. Road Traffic Accident (RTA) was the cause of TBI for all the ten subjects and the type of trauma was closed head injury (CHI) in all of them. Subjects were tested in the post injury period ranging from 8 months to 16 months. All the subjects had post-traumatic amnesia (PTA), none of them remembered exactly about the accident. All of the ten subjects taken for the study were right-handed pre as well as post morbidly. Western Aphasia Battery (WAB) (Kertesz, 1979) was administered to rule out for any aphasic component in the TBI subjects.

CLAP was administered and the responses were recorded. The data obtained was subjected to detailed qualitative and quantitative analysis. Mean and standard deviation was obtained. Independent sample two-tailed t-test (in which the means of two extremely separate groups of subjects whose scores are independent of each other, are compared) and one way Analysis of Variance (ANOVA). A technique to find out the relationship of the variation between the sample and the variation within the sample differences), was carried out using SPSS software (version 10) (Garrett & Woodworm, 1979). The results are discussed under the following headings -

I. Comparison of overall performance of TBI and normal subjects.

II. Comparison of performance of TBI and normal subjects on sub-sections of CLAP.

III. Comparison of performance across TBI subjects on various sub-sections of CLAP.

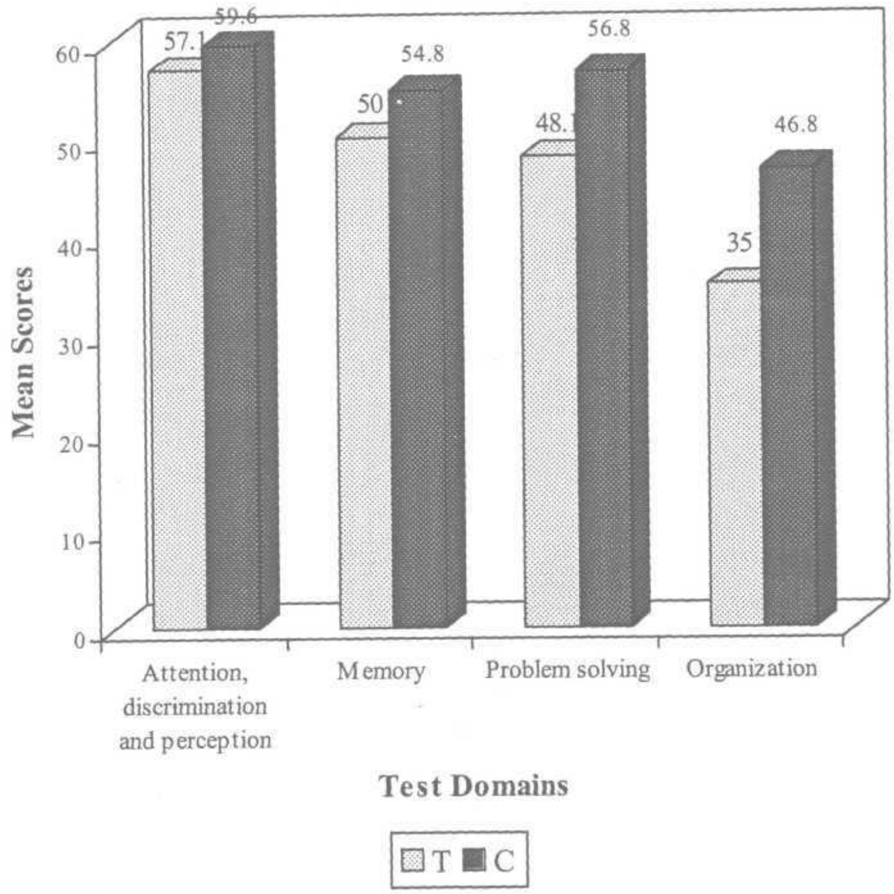
I. Comparison of overall performance of TBI and normal subjects

The performance of TBI subjects with normal subjects were compared as a group for various subsections of CLAP. Table 5 below gives the mean, SD, t-values, and significance for TBI and control group across the domains of CLAP. The performance of the subjects is also shown in graph-1.

Table-5: Comparison of performance of TBI and normal subjects on subsections of CLAP.

Test Domain	Subjects	Mean	SD	t-value	Significance
Attention, discrimination and perception	T	57.10	3.03	2.54	0.021*
	C	59.60	0.70		
Memory	T	50.00	5.48	2.53	0.021*
	C	54.80	2.44		
Problem solving	T	48.10	7.67	3.56	0.002**
	C	56.80	0.92		
Organization	T	35.00	14.94	2.23	0.039*
	C	46.80	7.55		

df=18 T-TBI group C-Control group
n=10 ** PO.01 *p<0.05



Graph-1: Performance of TBI and control group on sub-sections of CLAP

As seen from Table-5 and graph-1, for the attention, discrimination and perception domain of CLAP, the mean score of TBI group was 57.10 and mean score of control group was 59.60. The SD values obtained were 3.03 and 0.70 for TBI and control group respectively. Thus, control group had a higher mean score than that of TBI group. Deviation was however more for TBI group compared to control subjects. Results of t-test showed statistically significant difference in the scores of the two groups, at 0.05 levels.

For memory domain, the TBI group obtained a mean score of 50. Whereas, the control group obtained a mean score of 54.80. SD values obtained were 5.48 for

TBI group and 2.44 for control group. Again, the mean score of control group was higher than that of TBI group and the difference in scores was statistically significant at 0.05 levels.

In the problem solving domain of CLAP, the TBI group scored an average of 48.10 and control group as 56.80. SD values obtained were 7.67 for TBI and 0.92 for control group. Control group performed significantly higher than TBI group, at 0.01 levels.

Similarly, for the organization domain, the TBI group obtained a mean score of 35.00 and SD of 14.94, whereas control group obtained mean scored of 46.80 and SD of 7.55. Here, again the TBI group performed significantly lower compared to control group, at 0.05 levels. Also, the variation of scores was more noticeable in TBI than controls for all the four test domains.

Looking at the total scores, the TBI group obtained a mean total score of 190.20 and total SD of 27.76 whereas controls obtained a mean total of 218.00 and total SD of 9.96. The t-test results showed significantly better performances of control group at 0.01 levels. In total, the variation of scores was much higher in TBI group compared to control group. Thus, there was a significant difference in overall performance of TBI group from control group for all the test domains of CLAP. The average time taken for a few timed tasks was more for TBI group.

The mean scores showed that the difference in performance between the two groups was more evident for organization and problem solving domains, indicating that TBI subjects had more problems on these domains. Deviation of scores was more for organization domain compared to other test domains. This could have been due to the complex nature of the task. The stimuli used in these tasks are more complex, less redundant and not highly semantically loaded.

Overall, TBI subjects needed more repetition of instructions than normals. Also, the time taken to initiate and complete a task was more for subjects with TBI. Self-corrections were seen in most of the subjects in the form of rephrasing the answer or repetition of the answer. Also, they needed cues to initiate the response. Two of the subjects (T5 and T7) had dysfluencies present in their speech. Two of the subjects with RHD (T5 and T7) had evident attention problems. They could not do one or two subsections of the test even with the help of cues. Lots of emotional fluctuations were also noticed in these patients. They exhibited irrelevant responses and their responses were off-target.

They also gave extra information, more than what was asked to them such as when T5 was asked about his accident, he said, "he met with an accident, he was brought to the hospital and doctor operated him and the doctor is a very nice person, he is very friendly. The doctor is just like god for him and that he wants to be a doctor and serve people like him." The results indicate that there was also difficulty in topic maintenance.

The findings of the present study are in accordance with earlier studies reported in literature in terms of

reduced alertness levels.

- reduced sustained attention
- impaired vigilance
- focused and divided attention deficits
- impaired selective attention.
- reduced reaction time in individuals with TBI,

as reported by (Browner & Wolffelar, 1985; Tartaglione, Oneto, Manzino, Favale, 1987; Kennedy & Deruyter,1991; Stablun, Mogentale & Umilta,1996; & Murray, 2000).

Studies have also reported perceptual deficits in terms of

- color vs. orientation discrimination
- visual discrimination
- visual retention etc.

as reported by (Goldstein & Oakley, 1986; Kennedy & Deruyter,1991).

Memory deficits after TBI are also reported in terms of

- immediate or recent memory deficits
- free recall deficits
- word fluency retrieval deficits
- impairment of recognition memory
- impaired visual and verbal memory

- reduced semantic memory
- deficits in episodic memory
- presence of retrograde and anterograde amnesia (RA & AM)
- presence of post traumatic amnesia (PTA)
- short term memory (STM) and long term memory (LTM) deficits.
- impaired digit span
- impaired autobiographical memory

by various authors as (Russell & Nathan, 1946; Fodor, 1972; Brooks, 1974, 1975; Costa, 1975; De Renzi & Nichelli, 1975; Carlesimo, Sabbadini, Loasses & Caltagirone, 1997; Schacter & Crovitz, 1977; Lezak, 1979; Richardson, 1984; Jetter, Poser, Freeman, Markowitch, 1986; Lohman, Ziggars & Pierce, 1989; Kennedy & Deruyter, 1991; Stracciari, Ghidoni, Guarino, Poletti & Pazzaglia, 1994).

Studies have also shown

- impaired planning and execution
- reasoning and problem solving deficits
- defective text comprehension
- story arrangement deficits in TBI individuals

reported by several authors, (Golding, 1981; Brookshire & Nicholas, 1984; Novoa & Ardila, 1987; Villardita Grioli, & Quattropain, 1988; Hough, 1990; Kennedy & Deruyter, 1991 & Schneiderman, Murasugi & Saddy, 1992).

Organization deficits after TBI are also reported in the literature in terms of

- construction deficits
- impaired categorization

by (McFie, Piercy & Zangwill, 1950; McFie & Zangwill, 1960; Hadoro, 1984 ; Kennedy & Deruyter,1991; Bulla-Hellowing, Ettlinger, Dommasch, Ebel & Skreezeck, 1992).

Thus, the findings of the present study correlate with the findings of earlier studies which report the several cognitive linguistic deficits in terms of attention, perception, memory, problem-solving, reasoning, organization, categorization deficits in individuals with TBI.

II. Comparison of performance of TBI and control subjects on each sub-sections of CLAP

The performance of TBI group was compared with control group for each of the four individual test domains of CLAP as (a) attention, discrimination and perception, (b) memory, (c) Problem solving, and (d) organization across the several tasks.

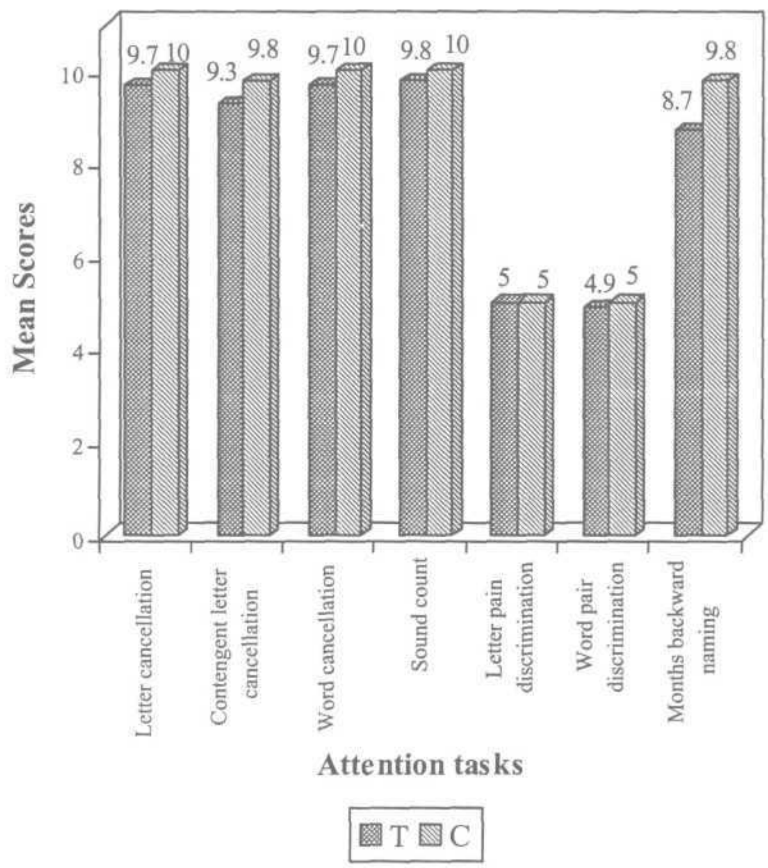
(a) Performance on domain I (Attention, Discrimination and Perception)

Table 6 below, shows the mean, SD, t-values and significance for TBI and control groups for different tasks of attention, discrimination and perception domain.

Table-6: Comparison of performance of TBI and normal subjects on different attention tasks of CLAP

Attention tasks	Subjects	Mean	SD	t-value	Significance
Letter cancellation	T	9.70	0.48	**1.9**	0.065 (NS)
	C	10.00	0.00		
Contingent letter cancellation	T	9.30	0.67	1.99	0.062 (NS)
	C	9.80	0.42		
Word cancellation	T	9.70	0.95	1.00	0.331 (NS)
	C	10.00	0.00		
Sound count	T	9.80	0.42	1.50	0.151 (NS)
	C	10.00	0.00		
Letter pain discrimination	T	5.00	0.00	-	-
	C	5.00	0.00		
Word pair discrimination	T	4.90	0.32	1.00	0.331(NS)
	C	5.00	0.00		
Months backward naming	T	8.70	1.89	1.79	0.089 (NS)
	C	9.80	0.42		

df = 18
n=10 NS = Not significant



Graph-2: Performance of TBI and control subjects on attention tasks of CLAP

(i) Letter Cancellation task

Table-6 and graph-2 shows the performance of TBI and normal subjects on letter cancellation. Results revealed mean score of 9.70 for TBI group and 10.00 for the control group. SD values obtained were 0.48 for TBI and 0.00 for control group. Results of t-test revealed no significant difference in performance of the two groups. However, the mean scores obtained by TBI group were lower than control group. Also the variations of scores were present for TBI group whereas no variations were seen in controls. The average time taken for this task by TBI group was 31.2 seconds and 15.1 seconds by the control group.

The performance of TBI group on letter cancellation task was almost same as control group, except for a few subjects who missed one or two stimuli. T_3, T_6 and T_8 missed out, one stimulus in a set of ten stimuli, probably due to less available cues and non semantic nature of the task and attention deficits in this group.

The finding obtained can be discussed in light of earlier studies reported on attention deficits in patients with TBI. Kennedy and Deruyter (1991), have reported reduced alertness level in individuals with TBI. Similar results were obtained in the present study as seen in the task of letter cancellation. Also impaired and reduced sustained attention was reported by Browner and Wolffelaar (1985) and Kennedy and Deruyter (1991). The reduced performance of TBI group in the task of letter cancellation in the present study could be attributed to reduced alertness level or impaired and reduced sustained attention. The reason for these impaired attentional levels in patients with TBI could be due to impaired frontal lobe functioning as a result of injury or trauma, frontal lobe being the site of attention processes in goal directed fashion, particularly in new or complex situations (Hartely, 1995). However, as seen from above the impairment was not very significant in these patients. This could have been due to the simple nature of the task, cues available, duration of injury, or due to the spontaneous recovery in the patients, which might have taken place post injury (Chapey, 2001).

(ii) Contingent letter cancellation

Table 6, shows mean score of 9.30 for TBI and 9.80 for controls for this task. TBI subjects obtained SD of 0.67 and controls as 0.42. Although the difference in performance of the two groups was statistically not significant, the mean performance of TBI subjects was lower than controls. Also more variation was seen in TBI than control group. Average time taken for this task by TBI group was 30.1 seconds and by control group was 21.3 seconds.

The performance of TBI group on this task was lesser than controls. T_1, T_4, T_6, T_7, T_8 and T_9 missed out one or two stimuli out of ten stimuli set. Even the controls did not obtain 100% scores for this task. This could be due to the confusing nature of the task, which required selective attention.

The finding of the present study is in accordance with the findings of Kennedy and Deruyter (1991) and Stablum et.al., (1996), reported impaired selective attention in individuals with TBI. Impaired selective attention could be again due to insult to the frontal lobe, which controls the focusing and shifting of attention (Hartely, 1995). Again, the difference in performance not being statistically significant could be attributed to the difficulty of the task, and probably neural sprouting resulting in spontaneous recovery of these patients (Chapey, 2001).

(iii) Word cancellation

From table 6, the mean scores of 9.70 were obtained by TBI subjects and 10.00 by the control subjects. TBI and control subjects obtained SD values of 0.95 and 0.00 respectively. The TBI group performed lower than control group; however, the difference was not statistically significant. TBI subjects showed variation of 0.95 whereas controls did not show any variation of scores. Average time taken was .again more for TBI subjects i.e., 31.6 seconds than that of control subjects, who took an average time of 18.1 seconds.

Subjects with TBI performed poorer than controls on this task. T_6 missed out 3 stimuli in the task of ten stimuli. This task was comparatively easier compared to earlier tasks, as it was at word level and more cues were available. Control subjects obtained 100% scores for the same task.

Kennedy and Deruyter (1991) reported reduced alertness levels in individuals with TBI and study by Bronwer and Wolffelaar (1985), found impaired or reduced sustained attention in TBI subjects, support the finding of poorer performance on word cancellation task by TBI subjects. Also, longer reaction times or delayed speed of processing is documented by Tartaglione et al., (1987), and Kennedy and Deruyter (1991). Similar findings were seen in the present study also for this task as well as the earlier two tasks of letter and contingent letter cancellation. Explanation for reduced alertness level impaired sustained attention and increased reaction time in TBI group could be again damage to the frontal lobe, which controls the attention processes (Hartely, 1995). Increased or slow reaction time shows impaired processing of the stimulus, which is again due to impaired alertness or arousal levels. The difference in performance of the two groups was not very evident, which could be due to the simple and semantic nature of the task or neural sprouting or increased excitation level of the existing neurons leading to spontaneous recovery post injury in these TBI subjects. Also the subjects taken in the study were of younger age, which could have resulted in better prognosis (Chapey, 2001). If however these subjects were tested soon after the injury, the performance would have been poor.

(iv) Sound count

As seen from table 6, the mean scores for this task obtained by TBI group were 9.80 and by controls were 10.0. SD values obtained were 0.42 and 0.00 by TBI and control subjects respectively. TBI subjects performed poorer than control subjects, the difference in performance not being significant. Variation of 0.42 was obtained by TBI group whereas no variations were seen in control group.

Poor performances were scored by TBI subjects on this task. T_3 and T_8 missed out one stimulus. This task required sustained and focussed attention as well as auditory processing of the stimuli.

Poor performances on sound count by TBI subjects is according to the reported studies of Bronwer and Wolffelaar (1985), who stated reduced sustained attention and study by Stablun et al., (1996), also found impaired focused attention in patients with TBI. The finding could be explained again as a result of damage to the frontal lobe and hence resulting in impaired attention processes and auditory processing problems (which is again an outcome of attention deficit). However, the difference in performance of the two groups was not significant which could have been due to neuronal masking or some compensatory mechanism as a result of spontaneous recovery of neural structures and functions.

(v) Letter pair discrimination

Table 6 revealed equal mean scores of 5.00 for both TBI and control group. The SD values obtained for the two groups were 0.00, indicating 100% performance by both the groups. Thus, there was no difference in the performances of the two groups for this task of letter pair discrimination.

This task consisted of discriminating two stimuli or letters and hence required sustained and focused attention and also auditory processing as well as retention ability.

Equal performance by TBI subjects with control subjects on this letter pair discrimination task of this study, contradicts the findings of impaired sustained attention reported by Bronwer and Wolffelaar (1985) and findings of focused attention deficits by Stablum et al., (1996). This could be explained as a result of neuronal masking or neuronal sprouting and younger age of the subjects, leading to spontaneous recovery post injury (Chapey, 2001).

(vi) Word pair discrimination

Table 6 shows mean scores of 4.90 for TBI group and 5.00 for control group, with SD values of 0.32 for TBI group and 0.00 for control group. The difference in performance of the two groups was not significant, with TBI group performing slightly poorer compared to control group. No variations in the scores were obtained by controls, however subjects with TBI obtained variations of 0.32.

Subjects with TBI performed little slightly poorer than controls. T_9 got confused between the two different stimuli and judged those as being same.

This task was similar to previous task of letter pair discrimination, with discrimination at word level. Sustained and focused attention with auditory processing and retention ability was required to complete this task.

Poor performance of one of the TBI subjects on word discrimination task could be discussed in the presence of earlier studies reporting reduced sustained attention by Bronwer and Wolffelaar (1985) and impaired focused attention by Stablum et al., (1996). This finding could be explained again on the basis of impaired frontal lobe functioning as a result of attention processes and auditory processing in turn requires intact alertness or arousal (Kennedy & Deruyter, 1991). However, the difference in performance was seen only for one of the subjects, which could have been the due to the simpler nature of the task or due to neural sprouting resulting in spontaneous recovery post injury. Also the younger age and the higher educational level of the subjects could have resulted in better performance by the TBI subjects (Chapey, 2001).

(vii) Months backward naming

From table 2 it is evident that the TBI group obtained mean score of 8.70 and control group obtained mean score of 9.80 for this task. The SD values were 1.89 and 0.42 for the two groups respectively. The TBI group performed poorer than the control group, however the difference in performance of the two groups was not statistically significant. The variation in scores was more noticed in subjects with TBI compared to control subjects.

TBI group performed lesser than control group. T_6 and T_7 performed poorer than the rest of the subjects. They showed omission, repetition and reversal of the order of months. Average time taken by the TBI group was 30.5 seconds whereas it was 15.3 seconds by the control group. Time taken by T_6 and T_7 was again longer than rest of the subjects. The task was difficult and required selective and sustained attention. Even the normals didn't obtain 100% scores for this task.

Poorer performance of subjects with TBI in this task could be compared with the findings of reduced sustained attention by Bronwer and Wolffelaar (1985) and impaired selective attention by Stablum et al, (1996). Longer reaction times or delayed speed of processing is documented by Tartaglione et al., (1987) and Kennedy and Deruyter (1991) and thus supports the finding of longer time taken by TBI subjects for this task. This finding could be explained as a result of damage to the frontal lobe, which is responsible for attention processes (Hartely, 1995). Also the longer time taken by the subjects could be explained as a result of processing deficit due to damage to the neural structures and impaired attention processes. However, the difference in performance of the two groups, not being significant could be explained as a result of neuronal sprouting or additional neural channel generated leading to spontaneous recovery (Chapey, 2001). Apart form this; the younger age would also have resulted in the better performance of the subjects (Kamath, 2001).

Thus as seen from above discussion, individual with TBI performed poorly for the attention, discrimination and perception tasks except for the task of letter pair discrimination, where performance of TBI group and control group was same. The reason for attention deficits seen in these patients could be attributed to the damage of frontal lobes (Hartely, 1995). Perceptual impairment is documented in individuals with TBI by studies of Goldstein and Oakley (1986) and Kennedy and Deruyter (1991). Subjects with TBI found in this study had poor perception skills resulting in poor performance on the different tasks are thus supported by earlier studies. This could have been due to damage to frontal lobe which influences visual spatial processing (Hartely, 1995). However, the performance of the two groups of TBI and controls did not differ significantly for any of the tasks, which could be due to the semanticity of the task, redundancy of stimuli, cues available and spontaneous recovery phenomenon as the subjects taken were in the period from 8 to 16 months post injury. This could have resulted in other compensatory routes or mechanisms leading to almost normal like performance in the subjects with TBI. The younger age of the subjects could also have resulted in better prognosis (Chapey, 2001 and Kamath, 2001).

Out of all subjects, T_5 and T_7 performed poorly for all the tasks, compared to rest of the subjects. This could have been due to the RHD in these subjects. Also these patients had severe degree of head injury. This could have been the reason for poor performance obtained by these subjects and the longer processing time required controls. T_3, T_6, T_7 and T_8 performed poorly compared to the rest of the subjects. They couldn't answer a few questions or gave incorrect responses.

The poor performance obtained by TBI group for this task could be compared with the findings of Brooks (1975); Kennedy and Deruyter (1991), who reported immediate or recent memory deficits as a consequence of TBI. Impaired immediate or recent memory after TBI could be as a result of injury to the frontal lobe which leads to memory deficits (Hartely, 1995) However, the difference in performance of the two groups was not very evident which could be explained as due to the simple nature of the task, semanticity and redundancy of the stimuli. It could have also been due to the age factor and neural channeling as a result of spontaneous recovery and hence would have masked out their memory problem (Chapey, 2001 and Kamath, 2001).

(ii) Digit forward

From table 7 above, it is evident that the TBI group received mean score of 3.20 and control group received mean score of 4.00 for the task of digit forward. The SD values obtained were 1.23 and 0.82 for the two groups respectively. Here again, the subjects with TBI performed poorer than control subjects, the difference in performance not being significant. TBI subjects showed more variation for the scores.

The task consisted of repeating the digits in the same order and hence required sustained attention and recent memory. TBI subjects performed poorer. T_1,

T_3, T_4, T_7, T_8 and T_9 performed poorly compared to the rest of the subjects. They couldn't recollect the order of digits, omitted and reversed the digit order. Most of them could repeat till 3-4 digits and had problems beyond that. Even controls didn't obtain 100% scores for this task.

This finding could be discussed in the light of earlier studies reporting impaired digit span in patients with TBI, by Costa (1975); De Renzi and Nichelli (1975); Black and Strub (1978), and studies reporting impaired recent memory in these individuals, by Brooks (1975); Kennedy and Deruyter (1991). The poorer performance on digit span task could be attributed to damaged frontal lobe in individuals with TBI (Hartely, 1995). This task did not reveal a significant difference in the performance of the two groups which could have been due to the complex nature of the task, age factor and result of neuronal masking leading to spontaneous recovery in these subjects (Chapey, 2001).

(iii) Digit backward

Table 7, shows mean scores of 2.50 and 2.90 for the TBI and control subjects respectively on this task. The SD values for the two groups were 0.85 and 0.74 respectively. TBI subjects performed comparatively poorer than the control subjects, difference not being significant. The subjects with TBI group showed more variation of scores.

This task consisted of repeating the digits in the reverse order and hence required recent memory, sustained and selective attention skills to carry out the command. Subjects with TBI performed poorer than the control subjects. T_1, T_3, T_4,

T_6 and T_7 performed poorly than the rest of the subjects. They could not recollect the order for more than 3-4 digits. They either omitted or reversed the order of the digits. This task was more difficult than the previous task of digit forward. Even the control subjects did not obtain 100% correct scores.

The results of this task could be supported by the earlier findings of impaired digit span following TBI, by Costa (1975); De Renzi and Nichelli (1975); Black & Strub (1978) and also studies reporting impaired recent or immediate memory by Brooks (1975) and Kennedy and Deruyter (1991). The possible cause for this poor performance on digit span noticed in TBI subjects could be due to trauma to the frontal lobe (Hartely, 1995) which in turn effect the immediate and recent memory. It could also result due to attention deficits due to damage to frontal lobe. The difference in the performance of two groups not being significant might be due to the complex nature of the task, low redundancy, lesser cues available, no semantic loading and also the age factor leading to better and faster spontaneous recovery of the structures post injury (Chapey, 2001).

(iv) Co-ordinate naming

From table 7, the mean scores of TBI group was 2.20 and of control group was 3.30 for the task of co-ordinate naming. The SD values obtained were 1.62 and 1.34 respectively for the two groups. Once again the TBI group performed poorly than the control group, although the difference in performance was not significant for the two groups. More variation of scores was seen in TBI subjects.

The task of co-ordinate naming consisted of naming the items / objects required for specific function of writing and hence required free recall and semantic memory. TBI group performed poorer than the control group. T_1, T_3, T_4, T_7 and T_{10} performed poorly compared to rest of the subjects. They answered the questions but the answers were not very relevant to the context. A few of them could not understand the task. This task was difficult even for the normals and they alos did not obtain 100% scores (except for some of them).

This finding supports the earlier studies of free recall deficits by Richardson (1984); Jetter et al., (1986) and the reports of reduced semantic memory by Kennedy & Deruyter (1991) as a consequence of TBI. This reduced performance noticed in TBI subjects could have been as a result of injury to the frontal lobe, which results in poor memory performance (Hartely, 1995). However, non-significant difference of performance could have been as a result of spontaneous recovery (Chapey, 2001).

(v) **Supeordinate naming**

As seen from Table 7 above, mean scores obtained by the TBI and control group were 3.50 and 4.60 respectively. The SD values for the two groups were 1.35 and 0.70 respectively. Results of the t-test revealed significant difference in the performance of the two groups, at 0.05 levels. Subjects with TBI performed poorer than the control subjects. More variation in performance of the TBI group was noticed.

This task of super ordinate naming involved the naming of the category to which a group of objects or nouns were given. This task hence needed semantic memory, recognition memory along with free recall. TBI group performed significantly lower than control group. T_4 and T_6 performed very poorly than the rest of the subjects. They were not able to identify the group to which the different nouns belonged. Most of the subjects needed cues to answer. This task was comparatively easier one, still all the control could not score 100%.

This result obtained in terms of significant difference between the performances of the two groups for this task, could be discussed with the reports of several authors as: reduced semantic memory by impaired recognition memory by Brooks (1974), Levin et. al., (1976), and Kennedy and Deruyter (1991), and free recall deficits by Richardson (1984), Jetter et al., (1986), Carlesimo et al., (1997) as a result of TBI. These memory impairments seen in the subjects with TBI could have been due to insult or injury to the frontal lobe, frontal lobe being responsible for memory processes and damage to it results in memory impairments (Hartely, 1995).

(vi) Word naming fluency

Table 7 shows the mean scores of 4.80 for the TBI group and 5.00 for the control group for this task. The two groups got SD values of 0.42 and 0.00 respectively, t-test results showed poorer performance by subjects with TBI than control subjects, the difference in performance of the two groups not being statistically significant. TBI subjects showed variation in their performance however the control subjects did not show any such variations.

Word naming fluency task consisted of telling different nouns starting with a particular sound given. The time taken by the subjects was recorded. TBI and control group took an average time of 2.7 minutes and 1.78 minutes respectively. This task involved free recall and word fluency retrieval. TBI group performed poorer compared to the control group with T_1 and T_7 performed slightly poorer compared to the rest of the subjects. They could not name the nouns for one sound each. Also, the subjects with TBI took longer time for the task. The task was easier and all the controls obtained 100% scores without any variations.

The finding could be correlated with the reports of free recall deficits by Richardson, (1984), Jetter et al., (1986), Carlesimo et al., (1997) and word fluency retrieval deficits by Levin et.al., (1976); Lohman et al., (1989) as a consequence of TBI. The impairment in word naming fluency task could be due to the damage to the frontal lobe, damage to which results in memory deficits (Hartely, 1995). However, the difference in the performance of the two groups not being significant could be attributed to simpler nature of the task, more cues available, and more redundancy, semantic loading of the task and age factor resulting in spontaneous recovery. They took a longer time for the task compared to controls, which suggests more processing time required by this group.

(vii) Generative naming

Table 7 gives the mean scores of 5.00 for both the TBI and control subjects . Also the two groups didn't show any variation in performance for this task. There was no difference in the performance of the two groups. Both the groups performed equally well.

The task of generative naming, involved naming the noun which was used for a specific action or work. Thus this task required recognition memory and semantic memory. TBI group performed as well as the control group. All the subjects got 100% scores for this task. This task was comparatively easier and thus all the subjects did well. The better performance of the subjects could have been due to simple nature of the task, cues available and semanticity of the linguistic stimuli.

This finding however doesn't go along with the earlier investigations reporting improved recognition memory by Brooks (1974), Levin et al., (1976) and reduced semantic memory by Kennedy and Deruyter (1991) after TBI. This would have been as a result of simple nature of the task, more redundancy, more semantic loading, younger age of the subjects and higher educational level leading to better spontaneous recovery taking place in the subjects (Chapey, 2001). This also indicates that generative naming abilities not always effected in TBI patients. It also depends on the site and post onset period.

(viii) Sentence repetition

As seen from Table 7, the mean scores obtained by TBI and the control group was 10.00 each for this task. Also, both the groups did not show any variation in their performance. Thus this task, like the previous task of generative naming, did not show any difference in the performance of the two groups.

This task consisted of repeating the sentences stated by the examiner. The completion of task assessed semantic and episodic memory of the subjects. Both the groups performed equally well and did not show any difference in the performance. The task was easier and hence all the subjects obtained 100% scores. The results indicated that sentence repetition is intact and also depends on the site and post onset period.

However, the results of this task doesn't correlate with the earlier studies reporting reduced semantic memory by Kennedy and Deruyter (1991) and deficits in episodic memory reported by Brooks (1975), Schacter and Crovitz (1977), as a consequence of TBI. This equal performance shown by the two groups could be explained on the basis of easier nature of the task and due to the spontaneous recovery of the brain structure, which have influenced the functions.

(ix) Carry out commands

Table 7 gives the mean scores for TBI and the control group as 9.60 and 10.00 respectively for this task. The SD values obtained by the two groups were 0.84 and 0.00 respectively. The TBI subjects performed poorer compared to the control subjects, the difference in performance of the two groups not being significant. TBI group showed slight variation in their performance however the control group did not show any variation in performance.

Carry out commands task consisted of execution of the commands according to the sequence in which commands are given. This task also needed semantic memory, verbal memory and episodic memory. TBI group performed poorer than the control group. T_6 and T_7 performed poorly compared to the rest of the subjects. They could not follow the sequence of commands given and missed out few of the commands in between. They also needed the commands to be repeated for them to understand and to remember. The controls did well and got 100% scores for this task.

The results of this particular task are in accordance to the earlier results reporting declined semantic memory by Kennedy and Deruyter (1991); impaired verbal memory by Lezak (1979) and deficits in episodic memory by Brooks (1975), Schacter and Crovitz (1977), after TBI. This could have resulted due to damage to the frontal lobe, damage to which leads to memory impairment (Hartely, 1995). The difference in performance of the two groups not being significant could be attributed to spontaneous recovery and other compensatory strategies such as asking for repetition, used by these subjects.

Hence, the subjects with TBI performed poorly on all memory tasks except for generative naming and sentence repetition tasks, where the two groups performed equally well and obtained 100% scores.

The poorer performance on memory tasks by the TBI subjects is attributed to the injury to the frontal lobe. Frontal lobe has the role of controlling memory processes (Hartely, 1995). He provided a list of memory disorders common to frontal lobe damaged patients as increased susceptibility to interference, poor memory for temporal order, poor short term memory, and difficulty in using imagery mnemonics, poor release from proactive interferences. Wallesh et al., and Risse and co-worker (as cited in Hartely, 1995) also reported similar findings. This poor performance on memory task could also have resulted in attention deficits noticed in these subjects. Even then, the difference in performance for the two groups was not statistically significant except for the task of super ordinate naming. The reason for this could be the spontaneous recovery, taking place in these subjects. Also some of the tasks were very easy. In fact, for two of the tasks, generative naming and sentence repetition, both the groups performed equally well and did not show any variation of scores.

Overall, T_6 and T_7 performed poorer for all the memory tasks compared to the rest. This could be explained due to RHD in these subjects with severe degree of head injury, which could have resulted in difficulty in recalling the information or retaining the information for the desired period of time. In general, subjects with TBI showed poorer performance and took more time for understanding and execution of the task.

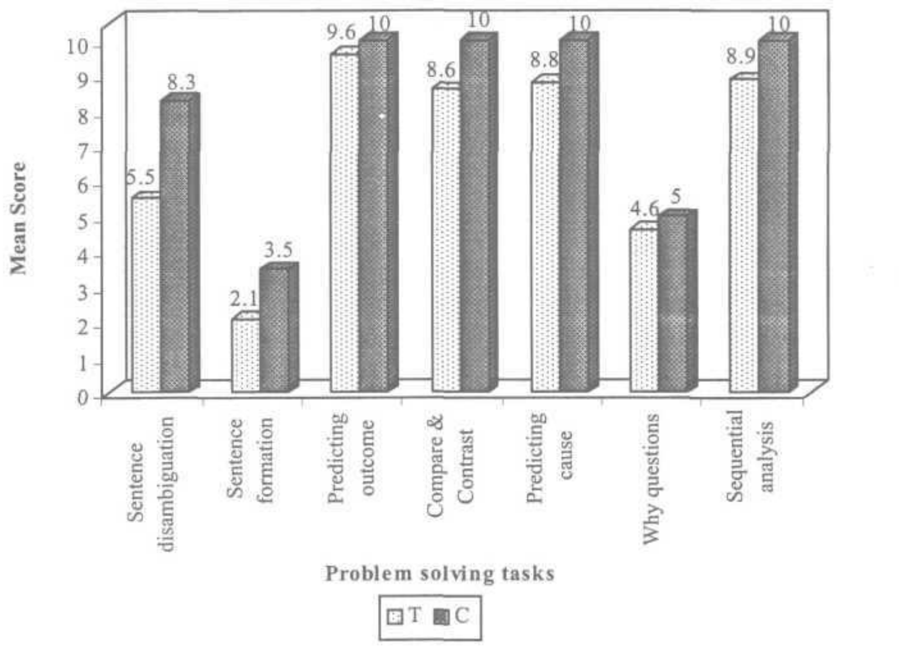
(c) Performance on domain III (Problem solving)

Table 8 given below shows the mean, t-values and significance for TBI and control groups for different tasks of problem solving domain. Figure-4 also shows the comparison of performance of TBI and normal subjects on the different problem solving tasks of CLAP.

Table-8: Comparison of performance of TBI and normal subjects on several problem solving tasks of CLAP

Problem solving tasks	Subjects	Mean	SD	t-value	Significance
Sentence disambiguation	**T**	5.50	2.12	4.07	0.001**
	C	8.30	0.48		
Sentence formation	**T**	2.10	0.74	3.93	0.001**
	C	3.50	0.85		
Predicting outcome	**T**	9.60	0.97	1.31	0.207 (NS)
	C	10.00	0.00		
Compare & Contrast	**T**	8.60	2.37	1.87	0.078 (NS)
	C	10.00	0.00		
Predicting cause	**T**	8.80	1.81	2.09	0.051*
	C	10.00	0.00		
Why questions	**T**	4.60	0.97	1.31	0.207 (NS)
	C	5.00	0.00		
Sequential analysis	**T**	8.90	1.37	**2.54**	0.021*
	C	10.00	0.00		
	C	10.00	0.00		

df=18 **p<0.01 *p<0.05
n=10 NS = Not significant



Graph-4: Performance of TBI and control subjects on different problem solving tasks of CLAP

(i) Sentence disambiguation

Table 8 above shows the mean scores of 5.50 for the TBI group and 8.30 for the control group for this task. The SD values for the two groups were 2.12 and 0.48 respectively. The TBI group performed significantly poorer than the control group, at 0.01 levels. Also more variation of performance was evident in subjects with TBI compared to the control group.

Sentence disambiguation task involved telling the direct as well as the hidden meaning of the given sentences. Thus it required attention, concentration,thinking, reasoning and problem solving skills. TBI subjects performed poorer compared to control subjects. T_3, T_4, T_6, T_7, T_8 and T_9 performed poorer than the rest of the subjects. They had more problems with the hidden or indirect meaning of the sentences. Some of them could not tell the direct meanings. Most of the subjects required cues and requested to repeat the instructions for this task. The control participants also did not obtain 100% scores due to the difficult nature of the task. Varied type responses were obtained from the both groups of subjects.

These results could be discussed in the light of earlier studies reporting, reasoning and problem solving deficits by Golding (1981), Brookshire and Nicholas (1984), Novoa and Ardila (1987), Villardita et al., (1988), Hough (1990) and Schneiderman et al., (1992) and altered ability to interpret intent and abstract information reported by Kennedy and Deruyter (1991) as a result of TBI. This could have been due to damage to the frontal lobe that is associated with the functions of problem solving and abstract thinking (Hartely, 1995). This could also have been due to attention and concentration impairment in these subjects.

(ii) Sentence formulation

As seen from table 8 above, the TBI group and the control group obtained mean scores of 2.10 and 3.50 respectively. The two groups scored SD values of 0.74 and 0.85 respectively. Results of t-test showed, significant difference in the performance of the two groups, at 0.01 levels, with TBI group performing poorer than the control group. However, more variation of scores was seen for control than the TBI group.

This task of sentence formulation involved arranging or organizing the different words to make a meaningful and grammatically correct sentence. Thus it required planning and organizational skills. Subjects with TBI performed significantly lower than control subjects. T_2, T_3, T_5, T_6, T_7, T_8 and T_9 i.e., almost all the subjects performed poorly for this task. Most of them got confused in the correct order of the words or phrases in a sentence and a few of them missed out the stimuli and couldn't complete the task. Even the controls did not obtain maximum scores and showed more variation compared to the TBI subjects.

The findings of this task could be correlated with earlier investigations, stating impaired planning and execution by Kennedy and Deruyter (1991) and organization deficits found by Mc Fie et al., (1950), Mc Fie and Zangwill (1960), Hadono (1984) after TBI. This could have resulted because of damage to the frontal lobe, which controls these functions (Hartely, 1995). Also the attention deficits would have added in poor performances of the subjects.

(iii) Predicting outcome: Table 8 gives the mean scores of 9.60 and 10.00 for the TBI group and the control group respectively for this task. The SD values for the two groups were 0.97 and 0.00 respectively, t-test results showed, poorer performance of TBI group over the control group, however the difference in the performance of the two groups not being statistically significant. Subjects with TBI showed slight variation whereas the controls did not show any variation of scores.

Predicting outcome task involved telling the outcome or the possible reaction for a given situation. Thus it required thinking, reasoning and problem solving skills. TBI subjects performed poorer than the control subjects. T_6 and T_7 performed poorer compared to rest of the subjects. They were not able to predict or think of the possible outcomes even with the help of cues. The controls performed well and received 100% scores without any variation of scores.

The results is supports the earlier findings of impaired ability to interpret intent and abstract information by Kennedy and Deruyter (1991) and impaired reasoning and problem solving by Golding (1981), Brookshire and Nicholes (1984), Cumminap (1985), Novoa and Andila (1987), Villardita et al., (1988), Hough (1990) and Schneiderman et al., (1992) after TBI. This could have resulted after the damage to the frontal lobe which results in problem solving and abstract thinking deficits (Hartely, 1995). Also the impaired concentration would have aggravated the existing condition. However, the difference in performance not being significant for this task could be explained on the basis of compensatory strategies used or neuronal sprouting and the younger age of the subjects taken resulting in better and faster spontaneous recovery in these subjects with TBI (Chapey, 2001).

(iv) **Compare and contrast:** Table 8 shows that the TBI group obtained a mean score of 8.60 and the control group scored mean of 10.00 for this task. The SD values obtained by these two groups were 2.37 and 0.00 respectively. TBI group showed poorer performance for this task also, the difference in the performance of the two groups not being statistically significant. Again variations in scores were present for the subjects with TBI but the control subjects didn't show any variations of the scores.

This task consisted of telling the similarity and difference between the two nouns given. Thus it required thinking, and organization. TBI group performed poorer than the control group. T_4 and T_7 performed poorer than the rest of the subjects. They had problem in both comparing and contrasting. However, a few of them had more problems in telling the similarities than the differences. The controls performed well and obtained 100% scores for this task and also without any variations of the scores.

The finding of the present study goes along with the earlier reports of impaired thinking processes, impaired reasoning and insight by Kennedy and Deruyter (1991) and organization deficits found in patients with TBI and McFie et al., (1950), McFie and Zangwill (1960), Hadono (1984). This could be accounted by the injury to the frontal lobes, which controls the problem solving, abstract thinking functions (Hartely, 1995). Another reason for the poor performance shown by this group could be as a result of impaired attention and memory processes. No significant difference in the performance of the two groups could be explained due to age factor, neuronal masking or the process of spontaneous recovery taking place in the subjects with TBI (Chapey, 2001).

(v) **Predicting cause:** Table 8 gives the mean scores for the two groups of TBI and control subjects as 8.80 and 10.00 respectively for this task. TBI group obtained SD value of 1.81 and the control group of 0.00. The results of t-test revealed statistically significant difference in the performance of the two groups at, 0.05 levels. The TBI group showed more variation in performance and no variation for the control group.

This task of predicting consisted of giving the possible reason for the situation or condition and thus required thinking, reasoning skills. TBI subjects performed significantly poorer than the control subjects, T_1, T_3, T_4, T_6 and T_8 performed poorly and T_7 performed much poorer from the rest of the group. They were not able to give appropriate reasons to the situations even with the help of cues. On the other hand, the controls showed 100% performance with no variations for this task.

The results of this task correlate well with the findings of impaired thinking and reasoning skills reported by Kennedy and Deruyter (1991), impaired ability to interpret intent and abstract information by Kennedy and Deruyter (1991) and impaired reasoning and problem solving as a result of TBI by Golding (1981), Brookshire and Nicholas (1984), Novoa and Ardila (1987), Villardita et al., (1988), Hough (1996), Schneiderman et al., (1992). This could have resulted due to the damage to the frontal lobe which is responsible for these functions (Hartely, 1995). The other possible reasons could have been due to attention and concentration deficits in patients with TBI.

(vi) Why questions: As seen from Table 8, mean scores obtained by the TBI group was 4.60 and that by the control group was 5.00 for this task. The SD values for these two groups were 0.97 and 0.00 respectively. T-test results showed no significant difference in performance of the two groups, although TBI group performed poorer than the control group. Slight variation was noticed in the performance of the subjects with TBI whereas control subjects did not show any variation in their performance.

Why questions task involved telling the reasons for the situations given and thus needed reasoning, thinking and problem solving. The TBI group performed lower than the control group with T_4 T_7 performing poorer. T_7 performed much poorer than the rest of the subjects. He was not able to give the appropriate reason for the given situations. The controls performed well on this task and did not show any variation in their performances.

This finding could be discussed well with the earlier reports of impaired reasoning and problem solving by Golding (1981), Brookshire and Nicholas (1984), , Novoa and Ardila (1987),Villardita et al., (1988), Hough (1990), Schneiderman et al., (1992) and impaired ability to interpret intent and abstract information, after TBI by Kennedy and Deruyter (1991). The poor performance on this task could have resulted due to damage to the frontal lobe, responsible for thinking, reasoning and problem solving (Hartely, 1995). Along with this poor attention concentration would also have increased the problem further. Again, the difference in performance of the two groups not being significant could have been due to relatively easier nature of this task, semanticity, age factor and the mechanism of spontaneous recovery taking place in these subjects after TBI (Chapey, 2001).

(vii) Sequential Analysis: Table 8 above gives the mean scores for the two groups of TBI and controls as 8.90 and 10.00 respectively for this task. The two groups obtained the SD values of 1.37 and 0.00 respectively. T-test results showed significant difference in the performance of the two groups at 0.05 levels, with the TBI group performing lower than the control group. Also the subjects with TBI showed more variation in their performances and control subjects did not show any such variations.

Sequential analysis task consisted of telling the sequence of steps involved in a particular task. Thus, it required planning, and organizational skills. The TBI group performed significantly lower than the control group. T_1, T_4, T_5, T_7 and T_9 performed lower than the rest of the subjects. These subjects couldn't complete the task in the required steps. However, the control group obtained 100% scores and did not show any variations in their performances.

The result obtained could be correlated with the earlier findings of impaired planning and execution by Kennedy and Deruyter (1991) and organization deficits after TBI, reported by McFie et al, (1950), McFie and Zargwill (1960), Hadono (1984). This could be attributed by damage or insult to the frontal lobe, which controls planning, thinking and reasoning processes (Hartely, 1995). This could also be explained as a result of obvious impaired attention and memory processes.

Thus, the TBI group performed significantly lower than the control group on the tasks of problem solving except for three tasks of predicting outcome, compare and contrast and the why questions task, where the two groups obtained the similar scores with no difference in their performance. This poorer performance of TBI subjects on problem solving tasks could be explained due to the injury to the frontal lobe. Frontal lobe is responsible for the processes of thinking reasoning and problem solving (Hartely, 1995). Also the poorer performance on these tasks could have been as an effect on attention, concentration perception and memory deficits in these subjects.

The difference in performance for the two groups was not statistically significant for 3 of the problem solving tasks viz. predicting outcome, compare and contrast and why questions. This could be explained on the basis of younger age range of the subjects and the compensatory strategies used (mainly in the form of request to repeat the command, sub vocal rehearsals, etc.) by such subjects leading to better and faster spontaneous recovery taking place post injury.

Here again, the general most of the TBI subjects showed poorer performance. T_6 and T_7 showed significantly lower scores than the rest of the group, for almost all the tasks. This could be attributed to RHD seen in these subjects along with severe head injury. Overall the TBI subjects showed poor reasoning, thinking and needed more cues and more time for all the tasks.

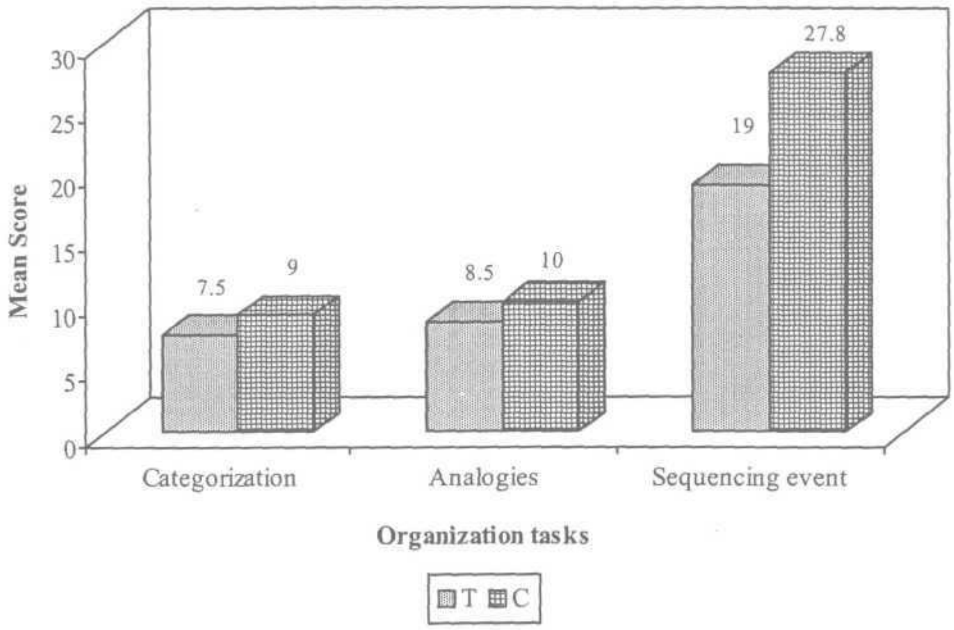
(d) Performance on domain IV (organization)

Table 9 below gives the mean, SD, t-values and significance for TBI and control groups for different tasks of organization domain. Also graph 5 below shows the performance of the two groups on organization tasks of CLAP.

Table-9: Comparison of performance of TBI and normal subjects on several organization tasks of CLAP

Organization tasks	Subjects	Mean	SD	t-value	Significance
Categorization	**T**	7.50	2.95	1.48	0.156 (NS)
	C	9.00	1.25		
Analogies	**T**	8.50	1.08	4.39	0.000*
	C	10.00	0.00		
Sequencing event	**T**	19.00	11.52	2.10	0.05*
	C	27.80	6.49		

df = 18 **p<0.01 *p<0.05
n= 10 NS = Not significant



Graph 5: Comparison of performance of TBI and control group on different organization tasks of CLAP

(i) Categorization: Table 9 shows the mean scores of 7.50 and 9.00 for the TBI group and the control group respectively for this task. The two groups obtained the SD values of 2.95 and 1.25 respectively. The TBI group performed poorer than the control group, difference in performance of the two groups not being statistically significant. Also the subjects with TBI showed more variation of scores compared to the control subjects.

This task of categorization consisted of selecting or categorizing the items belonging to a particular group or category out of several items. Thus this task required organization and categorization skills. Subjects with TBI performed lower than the control subjects. T_1, T_6, T_7 and T_8 performed poorer and T_7 performed much poorer than the rest of the subjects. Most of the subjects got confused between the similar stimuli or items and a few of them could not complete the task. In general almost all of them needed more cues and more time to complete the task. The task was difficult and even the controls did not obtain the 100% score for this task.

The results of this particular task could be discussed with the previous findings stating impaired categorization by Bulla-Hellowing et al., (1992) and organization deficits after TBI found by McFie et al., (1950), McFie and Zangwill (1960), Hadono (1984). This could be attributed to the damage to frontal lobe, which in turns controls the functions of organization (Hartely, 1995). This could have also resulted in attention deficits in subjects with TBI. However the difference in performance of the two groups not being statistically significant could have resulted due to the difficult nature of the task, as controls also did not show maximum scores. It could have also been as a result of age factor, compensatory mechanism or spontaneous recovery in these subjects (Chapey, 2001).

(ii) Analogies: As given in Table 9 above, the mean scores for the TBI group was 8.50 and for the control group was 10.00 respectively for the task. The SD values for these two groups were 1.08 and 0.00 respectively. The subjects with TBI performed significantly poorer than the control subjects at, 0.01 levels. The TBI group showed more variation of the scores in contrary to the control group, who showed no such variation of scores.

Analogies tasks involved telling the analogies for the words given depending on the relation between the two words or stimuli. Thus, it required thinking, reasoning and categorization skills. TBI group performed significantly lower than the control group. T_1, T_3, T_4, T_6, T_7, T_8 performed poorer than the rest. They were not able to find out the appropriate relation or analogy for the two stimuli and a few of then couldn't tell the analogies itself. Also they needed cues for responding obtained full scores without any variation in performance.

This finding can be well discussed in the light of earlier investigations reporting impaired ability to interpret intent and abstract information and impaired thinking insight and reasoning by (Kennedy & Deryuter, 1991) and organization deficits after TBI found by McFie et al., (1950), McFie and Zangwill (1960), Hadono (1984). The reason for these deficits could be the damage to frontal lobe. Frontal lobe, being responsible for the acts of thinking, reasoning and organization (Hartely, 1991). The impairments of attention and memory would have also increased the existing condition of TBI subjects.

(iii) Sequencing events: Table 9 shows the mean scores of 19.00 and 27.80 for the TBI group and the control group respectively for this task. The SD values obtained by these two groups were 11.52 and 6.49 respectively. Results of t-test revealed significant difference in the performance of the two groups at, 0.05 levels, with the TBI group performing poorer than the control group. Also TBI group showed much variation, compared to the controls.

This task consisted of arranging or organization the events in the order of occurrence to make a meaningful paragraph or a short story. The stimuli were given in increasing length and increasing order or complexity. Thus, this task required organizational, story arrangement skills along with the planning skills. TBI group performed significantly poorer than the control group. $T_{1,}$ T_3, T_6, T_7 and T_8 performed poor, with T_6 and T_7 performing much poorer compared to the rest of the subjects. Almost all the subjects had problem with this task. They were not able to sequence or arrange the events in the order of hierarchy and a few of them (T_6 and T_7) could sequence the events at all even with the cues. This task was much difficult compared to the earlier ones and thus even controls did not receive 100% scores. Also variation of performance was seen across the subjects in both the groups. Subjects, performed relatively, better for the earlier events compared to later ones, which were complex in nature. The results revealed as the complexity of linguistic stimuli increased, performance of TBI subjects deteriorated indicating poor retention abilities.

The findings are well supported by the earlier reports of defective text comprehension by Brookshire and Nicholas (1984), Novoa and Ardila (1987), Hough (1990), story arrangement deficits by Schneiderman et al., (1950), McFie and Zangwill (1960), Hadono (1984) and impaired planning and execution as a result of TBI by Kennedy and Deruyter (1991). This could be explained due to the injury to the frontal lobe, which is responsible for the functions of planning and organization (Hartely, 1995). The existing attention and memory deficits would also have added on to these problems and would have resulted in poor performance in this task.

Hence, subjects with TBI performed significantly lower than the control subjects for the tasks of organization except for the categorization task, in which again the TBI subjects scored lower than the control subjects however the difference in the performance of the two groups not being significant. The poorer performances on the organization and categorization tasks could be explained due to the frontal lobe damage due to TBI. Frontal lobe being the seat for these processes (Hadono, 1984). It could also have resulted due to attention memory and planning deficits.

Almost all the subjects with TBI performed poorer for all the tasks. However, for the task of categorization, no significant difference in the performance of the two groups could be attributed to simpler nature of the task and also due to spontaneous recovery taking place in these subjects to some extent.

All the subjects with TBI showed reduced performance compared to the control subjects. Among all the subjects, T_6 and T_7 showed much lower performance than the rest of the group for all the tasks. This could have resulted due to RHD and the severe degree of head injury in these subjects and thus having more significant problems.

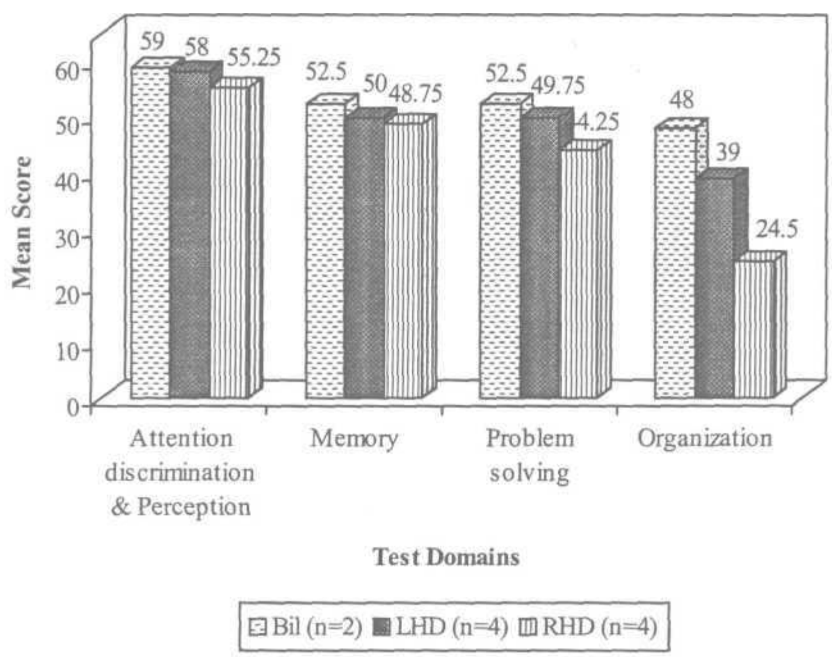
III. Comparison of performance across TBI subjects on various subsections of CLAP

Here, the performance of the TBI subjects with LHD, RHD and bilateral damage was compared with each other for the different subsections of CLAP. Table 10 below gives the mean, SD, t-value and significance of subjects with LHD, RHD and bilateral damage for the subsections of CLAP and graph 6 shows the performance of the two groups on different sub-sections of CLAP.

Table-10: Comparison of performance of TBI sub groups on various subsections of CLAP

Test Domains	Subjects	Mean	SD	f-value	Significance
Attention discrimination & Perception	**BD (n=2)**	59.00	1.41	1.439	0.300 (NS)
	LHD (n=4)	58.00	0.82		
	RHD (n=4)	55.25	4.27		
Memory	**BD (n=2)**	52.50	0.71	0.261	0.777 (NS)
	LHD (n=4)	50.00	5.35		
	RHD (n=4)	48.75	7.41		
Problem solving	**BD (n=2)**	52.50	3.53	0.908	0.446 (NS)
	LHD (n=4)	49.75	5.31		
	RHD (n=4)	44.25	10.37		
Organization^	**BD (n=2)**	48.00	4.24	2.533	0.149
	LHD (n=4)	39.00	9.05		
	RHD (n=4)	24.50	17.33		

df = 9 NS = Not significant
BD - Bilateral hemisphere damage
LHD - Left hemisphere damage
RHD - Right hemisphere damage



Graph 6: Performance of TBI subgroups on subsections of CLAP

(i) Attention, Discrimination and Perception: As seen from Table 10 above, the mean scores obtained by the bilateral group were 59.00, LHD group were 58.00 and RHD group were 55.25 for the domain of attention, discrimination and perception. The SD values for these three groups were 1.41, 0.82 and 4.27 respectively. Results of one-way ANOVA revealed no significant difference in performance of the three subgroups. However looking at the mean scores, bilateral group performed comparatively better than LHD, followed by the RHD group. Also the variation of scores was more noticed for bilateral and RHD group compared to LHD group. Maximum variation was observed for the RHD group.

Thus, RHD group performed poorer than the other two groups. This could be attributed to the severe degree of head injury in these subjects, compared to the moderate degree of head injury in subjects with LDH. More variation in the scores could be due to lesser number of subjects.

(ii) **Memory:** Table 10 depicts the mean scores of the bilateral group as 52.50, LHD group as 50.00 and the RHD group as 48.75 respectively for memory domain of CLAP. Also the SD values for these 3 groups were 0.71, 5.35 and 7.41 respectively. ANOVA result showed no significant difference in the performance of these three TBI subgroups. Although, here again bilateral group performed better than the LHD group, which was followed by the RHD group. Variation of scores also showed maximum value for the subjects with RHD, followed by LHD and then subjects with bilateral damage.

Hence, for the memory domain RHD group showed poorer performance than the other two groups. This can be explained as a result of severe head injury in the RHD group than the moderate degree of head injury in the LHD group. The bilateral group the two subjects had both moderate and severe degree of head injury. The more variations seen in the subjects could be due to the fewer number of subjects. Maximum variation of scores was noticed in the RHD group, which could be due to emotional instability in these subjects, which could have created this condition.

(iii) Problem solving: As seen from Table 10 above, the mean scores for the groups of bilateral damage, LHD and RHD were 52.50, 49.75 and 44.25 respectively for the domain of problem solving. The SD values obtained by these groups were 3.53, 5.31 and 10.37 respectively. ANOVA results did not reveal any significant difference in the performances of the TBI sub-groups. However, scores obtained by RHD group were, poorer than the LHD and then the bilateral damaged group. Here again, more variation was seen for subjects with RHD followed by subjects with LHD and then the subjects with bilateral damage.

Thus for this domain also, RHD group performed poorer compared to LHD and then bilateral damage group. The reason could be the severe head injury in LHD subjects and both moderate and severe head injury in the bilateral damaged subjects. More variations in the subjects could be due to the fewer number of subjects taken in each of the TBI sub groups. Here again subjects with RHD obtained maximum variation of scores, which could have been due to the obvious emotional fluctuations mood swinging behaviors in these subjects.

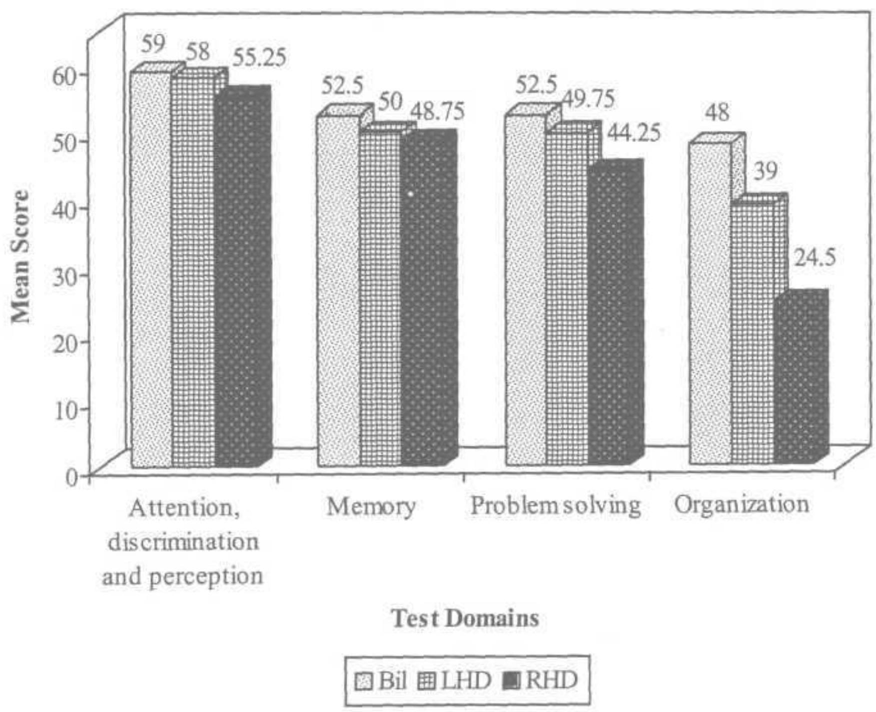
(iv) Organization: Table 10 shows the mean scores of the three TBI sub-groups of bilateral damage, LHD and RHD groups as 48.00, 39.00 and 24.50 respectively for the organization domain. The SD values obtained for the three groups were 4.72, 9.05 and 17.33 respectively. Results of ANOVA showed no significant difference in the performance of these three sub-groups of TBI. However, the RHD group performed poorer compared to LHD followed by bilateral damaged group. Here, again variation is performance highest for the RHD group followed by LHD and the bilateral group.

Hence, for this organization domain again RHD subjects performed poorer than the LHD followed by the bilateral damage group. This could be attributed to the severe degree of head injury in RHD group, compared to moderate degree of head injury in the LHD group. However, the bilateral damaged group had both moderate and severe head injured subjects. However SD or variation could have been due to the fewer or lesser number of subjects. Highest variation noticed in the subjects with RHD could have resulted due to emotional and behavioural fluctuations in this sub-group of TBI.

Table 11 below gives the comparison of mean scores and the SD values of several subjects across the TBI subgroups for the different test domains of CLAP. Graph 7 also gives the comparison of performance of the TBI subgroups on subsections of CLAP.

Table-11: Comparison of performance across different subsections of CLAP for TBI subjects

Test Domains	Mean			SD		
	Bil	LHD	RHD	Bil	LHD	RHD
Attention, discrimination and perception	59.00	58.00	55.25	1.41	0.82	4.27
Memory	52.50	50.00	48.75	0.71	5.35	7.41
Problem solving	52.50	49.75	44.25	3.53	5.31	10.37
Organization	48.00	39.00	24.50	4.24	9.05	17.33



Graph 7: Performance across different sub-sections of CLAP for the TBI subgroups

On comparing the mean scores and SD values of these TBI subjects sub-groups as shown in Table 11 above, it is clear that there is reduction in performance of TBI subjects from attention, discrimination, perception domain to the organization domain. It is true for all the sub-groups of TBI i.e., bilateral damage, LHD and RHD. If we further notice, the mean scores of bilateral group is higher than that of LHD group, which in turn is higher than the RHD group. This holds good for each of four test domains of CLAP. The SD values are also higher for organization domain than the rest three domains, i.e., attention, discrimination, perception, memory and problem solving. Also, the variations in scores is more evident for bilateral group, then LHD and then the RHD group for all the test domains except for attention, discrimination perception domain where the bilateral group showed more SD than LHD group. This discrepancy could be attributed to the fact that only 2 subjects in bilateral group compared to 4 subjects in LHD and RHD group.

Thus, as evident from the above discussion, there is a clear trend obtained in the performance of the different subgroups of TBI. The better performances were seen by bilateral followed by LHD, and the RHD group performed poorest for all the test domains. While discussing these findings one important point to be noted here is that in the LHD group, all the 4 subjects were moderately injured and in RHD group all the 4 subjects were severely injured. However, in the bilateral group, one of the subjects was moderately and the others were severely injured. This factor would also have contributed in the discrepancy of scores obtained for these three sub-groups of TBI.

Thus, the results of the present study showed that TBI group as a whole performed significantly poorer than controls for the different sub-sections of CLAP. The performance of the subjects were more impaired on problem solving and organization domains compared other two test domains, i.e., attention, discrimination, perception and memory, which also show that CLAP may not be very sensitive in tapping attention and memory deficits in patients with TBI. There was not significant difference obtained in performance between the different TBI sub-groups, although, bilateral group showed superior performance followed by LHD and RHD group respectively. The reason accounted for this was the severe degree of injury in subjects with RHD.

SUMMARY AND CONCLUSIONS

Traumatic Brain Injury (TBI) is defined as a blow to the head that results in diminished abilities subsequent to the injury that requires rehabilitation intervention .... (and) is primarily caused by motor vehicle accidents and violent crimes Ellis and Christenson (as cited inGillis,1996). It can be open head injury (OHI) or closed head injury (CHI). Causes of TBI could be penetrating or non-penetrating.

Individuals with TBI exhibit linguistic, extra-linguistic and non-linguistic features. Cognitive impairments are most commonly seen as a result of TBI. Kennedy and Deruyter (1991). Studies have shown impaired cognitive processes following TBI these are:

- Arousal and attention (vigilance, selective attention and attention span)
- Delayed and disordered information processing
- Thought disorganization
- Disorders of sequential analysis and problem solving
- Disorders of memory (particularly storage and retrieval of new information)
- Impaired reasoning and integration

The nature of injury influences the individuals differently and shows varied clinical impression. Also the types of deficits exhibited by left hemispheric damage vary from that exhibited by right hemispheric damage or bilateral damage patients. Thus, there is a need to study the influence of type of injury or damage on the cognitive functioning in the group. This study was aimed to investigate the cognitive deficits in individuals with TBI and to compare the performance of TBI individuals with normal individuals. This study also aimed to compare the performance of subgroups of TBI (Bilateral damage, LHD and RHD).

The data was collected from ten TBI subjects (two with bilateral damage, four with LHD, four with RHD) having closed head injury and ten age gender and educational matched controls. Western Aphasia Battery (Kertesz, 1979) was administered to rule out for aphasic component present in the subjects. Cognitive Linguistic Assessment Protocol for adults (Kamath, 2001) in Kannada was administered to assess the cognitive abilities in TBI subjects. The data obtained was statistically analyzed (mean, standard deviation, t-test, ANOVA) and qualitatively described. The results of the study revealed the following:

- TBI subjects as a group performed significantly poorer than normals on the different test domains of CLAP.
- Subjects with TBI performed showed more deficits on problem solving and organization domains.
- Within the TBI subgroup, bilateral damage performed better than LHD group followed by RHD group all the test domains of CLAP.
- Subjects with TBI on an average took more time for most of the tasks of CLAP, indicating longer processing time required and reflects attention and memory deficits in these subjects.
- TBI subjects showed more variation of performance than controls.

The poorer performance on several cognitive processes observed in this study were similar to the earlier studies. (Kennedy & Deruyter, 1991; Gillis, 1996).

This reduced performance by TBI group was explained as a result of frontal lobe injury. Frontal lobe has its control over the cognitive functions as attention, perception, processing time, memory, thinking, reasoning, organization, categorization etc. (Hartley, 1995) and thus damage to this lobe impairs cognition. However, for some of the tasks, the equal performance by TBI group with the controls is explained based on the simple nature of the task, younger age range of subjects taken and spontaneous recovery in the subjects with TBI.

Implications of the study

- This study highlights on the nature of the cognitive linguistic deficits in individuals with TBI.
- It also gives the information regarding which type of damage or injury would probably lead to more problems in cognitive functioning of TBI patients.
- The findings of this study will help in setting appropriate rehabilitative strategies in individuals with TBI.

Suggestions for further research

- Studies can be carried out taking more number of subjects in the TBI subgroups to see for any significant difference in their performance.

- Studies can be done to compare the performance of subjects with open head injury to subjects with closed head injury.

- Studies can also be done on subjects with different post injury period to see the effect of spontaneous recovery on the performance of the subjects.

- Further studies can be done to compare the performance and recovery patterns in peadiatric and adult group with TBI.

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APPENDIX I

WAB - KANNADA

I. SPONTANEOUS SPEECH:

1. ni:vu ivattu he:giddi:ri?

2. ni:vu illige mo:dalu bandiddi:ra?
athava na:nu nimmannu hinde pari:kisiruve:na?

3. nimma hesare:nu?

4. nimma vila:save:nu?

5. ni:vu e:nu kelasa ma:duttiddi:ri?

6. ni:vu illige e:ke bandiruviri? athava nimage e:nu tondare he:li?

7. i: t(itradalli e:nu nadijuttide embudannu he:li

II Auditory verbal comprehension:
Yes/No questions:

1. nimma hesaru kuppasuami ende:?

2. nimma hesaru ra:makrjna ende:?

3. nimma hesaru (real name) ende:?

4. ni:vu bengalu:rinalli va:sisutti:ra:?

5. ni:vu (real twon) va:sisutti:ra:?

6. ni:vu kalakattejalli va:sisutti:ra:?

7. ni:vu vaidajare:?

8 na:nu gand/ae: /hengl>se: ?

a\ i: ko:nejalli d i : pa hattideje:?

o- ba:gilu mtttf" ide je : ?

1/ idu pa1aha: m maud i rave : ?

idu a:spatreje:?

ni:vu tottiruva batte kempu bannadde:?

|^ karjrndnkke hrnk i tmt 1: i ko 1 J uttada j<: ?

16. ma:rtʃitiŋgalu dzu:n tingaliginta: madalu baruttadaje:?

17. ni:vu ba:lehannannu sippe sulijuva modale tinnuttira:?

18. dzulai tingalinnali malebaruttadeje:?

19. kudure najiginta: doddade:?

20. kodalijinda hullannu katarisutta:reje:?

AUDITORY WORD RECOGNITION:

Real objects	Drawn	Forms	Letters	Numbers
kap	beŋkikaddi	tʃauka	dza	5
beŋkikaddi	kap	triko:na	pa	61
pensil	ba:tʃanige	gundu	ba	500
hu:vu	tʃa:ku	ba:na	ka	1867
batʃanige	pensil	kra:s	ma	32
tʃa:ku	hu:vu	ardhatʃandra	da	5000

Colors	Furniture	Body parts	Fingers	Rt/Lt
ni:li	kitaki	kivi	hebberalu	balabudza
kandu	kurtʃi	mu:gu	unguradaberalu	eda monaka:lu
kempu	me:dzu	kannu	to:ru beralu	eda himmadi
hasiru	di:pa	ede	kiru beralu	bala tode
haladi	ba:gilu	kattu	madjaberalu	bala kenne
kappu	ta:rasi	hane	bala kiwi	

Sequential commande:

- kaitetti
- kannu mutʃi
- kurtʃi torisi
- kitaki to:risi a:mele ba:gilu to:risi
- pennu mattu pustaka to:risi
- pennannu pustakadinda to:risi
- ba:tʃanagejannu penninda to:risi
- pustakadinda ba:tʃanagejannu to:risi
- pennanu pustakada me:littu nantara adannu nanage kodi
- ba:tʃanagejannu pennina pakka ittu pustakarannu tirugisidi

III. Repetition:

1. kai
2. mu:gu
3. ha:sige
4. kitaki
5. kittale
6. ka:mana billu
7. nalavattaidu
8. ʃe:kada tombattaidu
9. aivataiduvare kilo:mi:tar
10. raitanu hola uluttidda:ne
11. avanu hintirugi baruvudilla
12. holeyuvadella banga:ravalla
13. modalaneja ba:rati:ja nauka pade
14. a:dare bandare a:tava mattu illa
15. nanna ga:dijannu ai:du dadzan bili go:dija mu:tegalinda tumbi

IV NAMING:

A. Object Naming:

Stimulus:

duḍḍu : paisa

ba:l (tʃenḍu)

tʃa:ku

kap

pen

kannaḍi

ṭu:ṭbraʃ

pusṭaka

bi:ga

pensil

kattari

bi:gadakai

su:dzi

baḷe

ba:tʃaṇige

kaigaḍija:ra

tʃamatʃa

hu:vu

taṭṭe

beŋkikaḍḍi

(c) Sentence completion:

1. hullina banna__________(hasiru)

2. sakkareju ______________ ide
   (sihi, athva, bili)

3. gula:bi kempu, mallige___________

4. avaru na:ji___________ gala
   taraha katʃa:didaru (bekku)

5. ba:ratada suatantreja dinavannu __________
   tingalinalli a:tʃarisutta:re (a:gast)

D. Responsive speech:

1. ni:vu ja:vudarinda barejuttira?
   (pen/pensil)

2. ha:lu ja:vu banna? (bili)

3. Ondu va:radalli eʃtu dinagalive? (e:lu)

4. vaidajaru elli kelasa ma:dutta:re? (a:spatre)

5. antʃe sta:p elli dorejuttade?
   (antʃektʃe:ri/po:st phis)

APPENDIX

Cognitive -Linguistic Assessment Protocol

Tjnmain T: <u>Attention</u>, p^rrimination and Perception.

Visual subtest:

r

a. Letter cancellation

"ideralli iruva pratyek T akSarannu aDigere yeLedu gurutisi'

ಮ	ಓ	ಎ	ಲ	ವ	ಯ	ಮ	ವ	ಕ	ಲ	ಸ	ಆ
ಡ	ಹ	ತ	ಗ	ಫ	ಎ	ಶ	ಲ	ಝ	ಇ	ಕ	ನ
ಲ	ದ	ಬ	ಯ	ಓ	ಲ	ಉ	ಕ	ಇ	ಜ	ಓ	ರ
ಪ	ವ	ಚ	ಎ	ಯ	ಎ	ಟ	ಲ	ಎ	ವ	ಬ	ಶ
ಓ	ಝ	ಲ	ಇ	ಎ	ಬ	ಥ	ವ	ಯ	ಲ	ಕ್ಷ	ವ
ಥ	ಲ	ಕ	ವ	ಜ	ಪ	ನ	ಬ	ಲ	ಎ	ವ	ಪ

Scoring : ----------- correct out of 10. Note down time taken to complete task

b. Contingent letter cancellation

"i" akSara pakka iruva pratyek 'k' akSarannu aDigere yeLedu gurtisi".

ಪ	ಥ	ಲ	ಸ	ಬ	ಇ	ಕ	ಫ	ರ	ಝ	ಎ	ಕ	ತ	ಹ
ಸ	ಗ	ಕ	ಇ	ಉ	ಕ	ಜ	ಹ	ಕ	ು ಕ	ಡ	ಬ	ಇ	ಕ
ನ	ಶ	ಶ	ಚ	ಇ	ಇ	ಕ	ಉ	ಪ	ಇ	ಕ	ವ	ಜ	ಡ
ಇ	ಕ	ಆ	ಯ	ಚ	ಹ	ಇ	ಕ	ಇ	ಬ	ಇ	ಮ	ಕ	ಫ
ಥ	ಲ	ಇ	ಕ	ವ	ರ	ಗ	ಕ್ಷ	ಇ	ಕ	ಟ	ವ	ಇ	ಕ

Scoring : ---------- correct out of 10. Note down time taken to complete task

c. Word cancellation

"idralli iruva pratyek 'kittLe' Sabdannu aDigere yeLedu gurtisi".

ಚೆರ್ರಿ	ಸೇಬು	ಸೀಬೆ	ಕಿತ್ತಳೆ	ಪೀಚ್	ಹಸಿರು	ಹಳದಿ	ಬಾಳೆಹಣ್ಣು
ಕಿತ್ತಳೆ	ನೇರಳೆ	ಸಪ್ಪೋಟ	ದ್ರಾಕ್ಷಿ	ನಿಂಬೆ	ನಿಂಬೆಹಣ್ಣು	ನೀಲಿ	ಪರಂಗಿ
ಕಿತ್ತಳೆ	ಹಲಸು	ಕಿತ್ತಳೆ	ನಿಂಬೆ	ನಿಂಬೆ	ಕಿತ್ತಳೆ	ಮೊಸಂಬಿ	ಕಿತ್ತಳೆ
ದ್ರಾಕ್ಷಿ	ಕಿತ್ತಳೆ	ನೀಲಿ	ಸಪ್ಪೋಟ	ಸೀಬೆ	ಸೇಬು	ನೇರಳೆ	ನೀಲಿ
ನಿಂಬೆ	ಸೇಬು	ಕಲ್ಲ	ಕಿತ್ತಳೆ	ಸೇಬು	ಬಾಳೆ	ಕೆಂಪು	ಹಸಿರು
ಹಳದಿ	ಬಿಳಿ	ಂಗ್ರಿ	ಸೇಬು	ಸೀಬೆ	ಕಿತ್ತಳೆ	ಕೆಂಪು	ಬಿಳಿ
ನೀಲಿ	ಕಿತ್ತಳೆ	ಹಳದಿ	ನೇರಳೆ	ಕಂದು	ಬೂದು	ಚೆರ್ರಿ	

Scoring :————correct out of 10. Note down time taken to complete task.

Auditory Subtest:

a. sound count

"naanu iiga kelavu akSaragaLu oduteni. YeSTu sari 'b' Sabdha bantu anta keLikonDu heLi".

m b t j b p S v g t b

l b S k r b p f b L c

b j L b b h t s d d l

scoring :————correct out of 10.

-1 for each extra count beyond 10.

b. Letter pair discrimination.

"naanu iiga 2-2 akSaragaLu heLutteni, aa aksaragaLu ondeena, bere bere na anta heLi".

b	p
t	t
1	1
c	j
d	k

Scoring :————correct out of 5

c. Word pair discrimination

"naanu iiga 2-2 padagaLu heLutteni. aa akSaragaLu ondeena, bere bera na anta heLi".

kuri	kuuri
baLe	maLe
niinu	naanu
hoovu	hoovu
cappali	cakkali

Scoring :———correct out of 5.

d. Month background naming

"tingaLa hesani ulTa kramadalli heLi"

Scoring : 1 point for every month named. Eg. "Dec, Nov, Aug, July, June, May, April, March, February, January" = 8 marks

December and November are not scored, as they are used to help the subject begin. Months named in wrong order are not scored.

Eg : Dec, Nov, Oct, Sept, Aug, June, July, May, March, April, February, Jan. = 6 marks.

Note down time taken to complete task.

Total———Correct out of 10.

<u>Domain II</u> : <u>Memory</u>

Episodic memory

a. Orientation and recent memory questions.

1. nimma hesaru eenu? .

   (What is your name)

2. nimma taaiia hesaru eenu?

   (What is your mother's name)

3. niivu uTa yavaga maDuttira? BeLage/ maDhyana/ sanje/ratri.

   (When do you eat food, moming/afternoon/evening/night).

4. idu yavu uuru?

   (What place is this ?)

5. bharatada iigina pradhaanamantri yaru?

   (Who is the present prime minister of India).

6. suuryannu puurvadalli huTuttano pascimadallo?

   (Does the sun rise in the east or in the west)

7. tandeya tandege yenu andu hesaru ? (ajja)

   (A father's father is a - grandfather).

8. Banknalli iTTiruva haNakke prati tingaLu baruva sampadaneege - endu hesaru. (baddii)

(Monthly earnings ins a bank account is called —) (interest).

9. ondu padada arthavannu niivu yelli huDukalu? (nighanTu)

(What do you use to look up the meaning of a word ?) (dictionary)

10. march tingLu, June tingLina munce baratta?

(Does the month of March come before July ?)

Scoring : 1 Mark for every question answered correctly.

Total———Correct out of 10.

Working memory

a. digit forward

"naanu iiga kelavu ankagaLu heLutene. adanna keLiskondu, niivu ade kramadalli punha heL beku".

8 9 6

5 8 1 2

1 4 6 2 7

1 5 9 3 4 7

2 5 8 7 1 7 9

Scoring : 1 point for every correctly repeated sequence. No points if all members repeated but in wrong order. Total 5 points

Total—correct out of 5.

b. digit backward.

"naanu iiga kelavu ankagaLu heLutene. adanna keLiskonDu, niivu ulTa kramadalli heLi".

2	5	7				
9	7	1	8			
5	4	6	1	9		
8	4	3	9	7	6	
7	4	2	9	6	3	5

Scoring: 1 point for every correctly repeated sequence. No points if all numbers repeated but in wrong order.

Total—correct out of 5.

Semantic memory

a. coordinate naming.

"baravaNigeyalli upayogisuva aidu vastugaLannu hesarisi".

Scoring : 1 point for each item named max. 5 points.

no point given for items like 'rubber', 'duster' etc.

Total—out of 5.

b. Superordinate naming

"keLage koTTiruva padagaLu yavu gumpige servuttave aagumpada hesaru heLi".

ಬೆಕ್ಕು, ಮಂಗ, ಹುಲಿ, ನಾಯಿ, ಆನೆ,
ಶೂಗಳು, ಬೂಟುಗಳು, ಚಪ್ಪಲಿಗಳು, ಸ್ಯಾಂಡಲ್‌ಗಳು,
ಪಕ್ಷಿ, ಮೋಡ, ಮಿಾನ, ನಕ್ಷತ್ರಗಳು
ಹಾಲು, ನೀರು, ಸಕ್ಕರೆ, ಚಹಾಪುಡಿ, ಕುಡಿಕೆ, ಅಥವಾ
ಮೇಜು, ಕುರ್ಚಿ, ಡಸ್ಟರ್, ಕಪ್ಪುಹಲಗೆ, ಕಿಟಕಿ

Scoring : 1 point for every correct answer

Total—out of 5.

answers : i. praNigaLu

ii. kaalege haavudu vastugaLu.

iii. aakaSa

iv paaniiya, caha maadvudu .

v. claasrumu.

c. Word naming fluency :

"naanu heLida akSaradinda aidu padagaLu heLi".

i. p.

ii. a

iii. s

iv. i

v. t

Scoring : 1 point for 5 words on every letter.

If unable to name atleast 5 words on a letter, no point given for that item.

Note down time taken to complete task.

Total score————out of 5.

d. Generative naming

"kelavu praSNegaLu keLUttene adanna uttara koDi".

i. baravaNigeyalli eenu upayogistira? (pen)

ii. mhaLe bandre eenu upayogistrira ? (Kode)

iii. samaya noDDakke eenu upayogistira ? (ghaDiyara)

iv. kaalalli eenu haakuttira ? (shu, bootu)

v. signalgaLalli Yavudu baNNa andre 'nillisi' anta? (kempu).

Scoring : 1 point for every correct answer

Total:———out of 5.

e. Sentence repetition

naanu kelavu padagaLu heLutene. adarma vaapas heLi.

i. kiTaki	(1)
ii. nalavattaaidu	(2)
iii. aivattaidu vare kilomeeter	(5)
iv. raitanu hola uLutiddane	(3)

Scoring :———out of 10.

1 point for every morpheme correctly repeated.

Carry out commands

"naanu iiga nimmage kelavu kelasa maDakke heLutene adu yesTaguto austu maadi"

i. kurci torisi	(1)
ii. pennu mattu bukku torisi	(2)
iii. penninda bukku torisi	(3)
iv. kaNNu torisi mattu kaalu torisi	(4)

Scoring :———out of 10

<u>Domain III : Problem solving</u>

a. sentence disambiguation

"naanu kelavu vakya heLutene. ondu vakyage eradu artha ide. adu hege anta niivu tiLis beku".

Eg : Sripati tamma manege hoodaru.

i. tinDi aayita ?

ii. ii ramayaNa yarige beeku ?

iii. aa baNNada biisaNige nanage beDa

iv. huDugi huvu biDisuttidaLe.

v. govinda snana maaDi uuta maDlilla.

Scoring : 1 point for every correct interpretation 2 points given on an item only if both the interpretations are correctly explained.

Total score :__________out of 10.

b. sentence formulation.

"padakramavannu badalaaysida vakyagaLannu naniiga koDtini. niivu ivugaLannu biDisi sariyaada vaakya eenubudannu tiLisi".

1. ಬಾಗಿಲಿಗೆ ಮುಂದಿನ ಹಾಕಿದೆ ಬೀಗ
2. .ಯಾಗಿತ್ತು ತುಂಬಾ ನೀರು ಬಿಸಿ
3. ಹೋಯಿತು ಸೂರ್ಯನ ಐಸ್‌ಕ್ರೀಮ್ ಕರಗಿ ಬಿಸಿಲಿನಿಂದಾಗಿ
4. ದಂತವೈದ್ಯರುಹಲ್ಲನ್ನು ನನ್ನ ತುಂಬಿದರು.
5. ಹತ್ತು ನಿಮಿಷ ಕೈ ಗಡಿಯಾರ ಮುರಿದ ಹಿಂದಿತ್ತು

answers

i. rnundina baagilige biiga haakide.

ii. niiru tumba bisiyagittu.

iii. suuryana bisilinindaagi aiskriim karagi hooyitu.

iv. dantavaidyaru nanna hallannu tumbidaru.

v. murida kaighaDiyaara hattu nimiSa hindittu.

Scoring : 1 point for each correctly arranged sentence.

Total score——out of 5.

c. **predicting cause.**

i. aakasmakavaagi kurrent horaTu hoodare niiveenu maDuviri ?

ii. bereyavarinda keLipaDedu tanda dubaari padaartha kaLedu hoodaga enu maDuviri ?

iii. nimma biigadakai kaLedu hoodaaga enu maaDuviri ?

iv. patrakke stamp haakadeeya poost madibTTireni. aageenu maaDuviri ?

v. nimage huSaaru illadidaaga niivu doktar hattira hoogillavenni aageenaaguvudu ?

Scoring : 2 points if outcome stated clearly and is possible (cohorent answer). 1 point if outcome correct but not explained clearly.

No points scored if answer does not go with the theme of the question.

Total——————out of 10.

d. compare and contrast.

"naaniiga eraDeraDu padagaLannu heLuttene. avu heege hondukoLLuttave athava heege beereyaguttave embuvannu tiLisi.

i. fridge mattu stove

ii. cenDu mattu balloon

iii. taTTe mattu patre.

iv. vruttapatrike mattu magazinu

v. aaroplane mattu hakki.

Scoring : 1 point for a similarity and 1 point for a difference for each item.

Total——————out of 10.

e. **predicting cause**

"naaniiga yaavudaadaru ondu sthitibagge heeLittene. adakke kaaraNaveenirabahudu endu tiLIsi.

i. nimma giDagaLu batti hoodaru.

ii. nimma koThaDiyalli hoge tumbide.

iii. biigada kai ii biigakke honnduttilla.

iv. nimmma aarogya keTTide.

v. nimma gaDiyara kelasa maDuttilla.

Scoring : subject is expected to give atleast two reasons for each problem. Score 1 point for each correct cause stated. Max 2 points per item.

Total——————out of 10.

f. **why questions.**

i. nityavu vyaayaama maaDabeeku, eeke ?

ii. sancaari signalgaLirabeeku, eeke ?

iii. penninalli biLi inkannu upayogisuvudilla, eeke ?

iv. buuTu haakuvudueeke ?

v. giDagaLige.niiru haakabeeku, eeke ?

Scoring : 1 point for every correct answer.

Total__________out of 5.

g. sequential analysis

yaarudaadarondu kelasavannu naanu heeLutteene. niivu aa kelasa maaDuva kramavannu tiLisabeeku.

i. patre toLeyudu.

ii. giDa niiDuvudu.

iii. SarT / siire khariidisuvudu.

iv. Ti maaDuvudu.

v. patravannu ancepTTigege haakuvudu.

Scoring : Subject expected to elaborate atleast 4 steps in each task analysis score 2 point for every correctly analysed item. 1 point for correct analysis, but in less than 4 steps. 0 points if analysis is not temporally correctly sequenced.

Total:__________out 10.

<u>Domain IV : Organization</u>

a. categorization

"naaniiga nimma munde ondu vastuvina hesarannu heeLutteene. keeLikanDa kelavu beere hesaragaLalli modalu heeLida vastuvina gumpige honduvantaha eraDannu aDigere yeLedu gurtisi".

(a) ನಾಯಿ:
ಹೂವು, ಟೊಪ್ಪಿ, ಇಲಿ, ಪೆನ್ಸಿಲ್ಲು, ಸಿಂಹ

(b) ಸಕ್ಕರೆ:
ಗಿಣ್ಣು, ಬೆಲ್ಲ, ಮೆಣಸಿನಕಾಯಿ, ಜೇನುತುಪ್ಪ, ಗುಹೆ

(c) ಗುಂಡಿ:
ಸೇಫ್ಟಿಪಿನ್ನು, ಗಡಿಯಾರ, ಕ್ಲಿಪ್, ಬಳೆ, ಉಗುರು

(d) ಪುಸ್ತಕ:
ಲ್ಯಾಂಪ್, ವೃತ್ತ ಪತ್ರಿಕೆ, ಚಿತ್ರ, ಫೈಲ್, ಮ್ಯಾಗಜೀನು

(e) ಕತ್ತಿ:
ಸೂಜಿ, ಗಾಜು, ಬ್ಲೇಡು, ಚಾಕು, ಬೆಂಕಿಪೊಟ್ಟಣ.

Scoring : 1 point for every correctly identified coordinate category.

Total________out of 10.

b. analogies

"naanu paraspara sambanDhisida eraDu vastugaLu hesaravannu heeLutteene. nantara onde ondu hesarannu heeLutteene. modalina padagaLa joDiyalli sambandhisiruvanteye idakke sambandhisida vastu yaavudirabahudu endu heLi".

Eg. pennu : bare.

Pustaka : (oodu)

i. chatri : maLe	::	sweater:________(chaLi)
ii. aane: ili	::	samudra:________(kere/tore/nadi)
ii. aeroplane : aakaSa	::	car :________(raste)

iv. samaya : ghanTe :: bhara :_________(kg.)

v. doktor : aaspatre :: upadhyaya :_________(skool/Sale)

Scoring : 2 points for every correct answer.

Total__________out of 10.

c. sequencing events.

"vakyakramavannu badalaayisida kelavu kathegaLu illi bardide. Niivu ivugaLannu biDisi/sariyada vakyakramannu bardu, kathe eenubudannu tiLisi.

a)
- ಅದುಮರವೊಂದಕ್ಕೆ ಸಿಕ್ಕಿ ಹಾಕಿಕೊಂಡಿತು.
- ಆದರ್ಶ ಗಾಳಿ ಪಟವನ್ನು ಮಾಡಿದ.
- ಗಾಳಿ ಬಂದಾಗ ಮೇಲಕ್ಕೆ ಬಂತು.

b)
- ವಿದ್ಯಾ ಆ ಬೀಜಗಳನ್ನು ಬಿತ್ತಿದಳು
- ವಿದ್ಯಳಿಗೆ ಒಂದು ತೋಟ ಮಾಡಬೇಕೆನಿಸಿತ್ತು
- ಒಂದುವಾರದ ಹೊತ್ತಿಗೆ ಚಿಕ್ಕ ಹಸಿರು ಮೊಳಕೆಗಳು ಒಡೆಯುವುದನ್ನು ಅವಳು ನೋಡಿದಳು.
- ವಿದ್ಯಳ ತಾಯಿ ಅವಳಿಗೆ ಕೆಲವು ಬೀಜಗಳನ್ನು ತಂದುಕೊಟ್ಟರು.
- ಅವುಗಳಿಗೆ ವಿದ್ಯ ದಿನವೂ ನೀರು ಹಾಕುತ್ತಿದ್ದಳು.

c)
- ಕಾರು ಸ್ಟಾರ್ಟ್ ಆಗುವುದಿಲ್ಲ ಎಂಬುದನ್ನು ಅರಿತ ವಿವೇಕ ಬಸ್ ಹತ್ತಿದ.
- ವಿವೇಕ ಬಹಳ ಲೇಟಾಗಿ ಎದ್ದ.
- ಹೊತ್ತಿಗೆ ಸರಿಯಾಗಿ ಕೆಲಸ ಮಾಡಬೇಕೆಂದುಕೊಂಡ ಮತ್ತು ಇನ್ನು ಮುಂದೆ ಬೇಗ ಏಳುತ್ತೇನೆಂದು ಸಂಕಲ್ಪ ಮಾಡಿಕೊಂಡ
- ಕಾರಿನಲ್ಲಿ ಕುಳಿತಮೇಲೆ ಅದು ಅಷ್ಟು ಸುಲಭವಾಗಿ ಸ್ಟಾರ್ಟ್ ಆಗುವುದಿಲ್ಲ ಎಂದು ಅವನಿಗೆ ಅನ್ನಿಸಿತು.
- ಆದಕಾರಣ, ಅವನು ಬೇಗೆ ಸ್ನಾನ-ಡ್ರೆಸ್‌ಗಳನ್ನು ಮುಗಿಸಿ ತನ್ನ ಕಾರಿನ ಬಳಿ ಓಡಿದ.

d)
- ನನಗೆ ಕಿರುಚಲೂ ಆಗದಷ್ಟು ಭಯ ಆಗಿತ್ತು.
- ಅಂದು ಕಗ್ಗತ್ತಲಿರಾತ್ರಿ.
- ಅಬ್ಬಾ, ಅದೆಂತಹ ಶಬ್ದ
- ಇದ್ದಕ್ಕಿದ್ದಹಾಗೆ ನನ್ನ ಬೆಕ್ಕು ಹಾಸಿಗೆಯ ಮೇಲೆ ಹಾರಿತು.

- ಮನೆಯಲ್ಲಿ ನಾನೊಬ್ಬನೇ ಇದ್ದೆ
- ಹಾಸಿಗೆಯ ಮೇಲೆ ಕುಳಿತು (ಸಾಕಷ್ಟು) ಜೋರಾಗಿಯೇ ಕೇಳಿಸಿಕೊಂಡೆ

- ಬಸ್ ಸ್ಟಾಪ್ ನಲ್ಲಿ ಇನ್ನೂ ಕೆಲವು ಮಕ್ಕಳು ಬಸ್‌ಗಾಗಿ ಕಾಯುತ್ತಿದ್ದರು.
- ಶಾಲೆಯ ಬಳಿ ಇದ್ದ ಸ್ಟಾಪ್ ಬಂತು, ರೀಟಾಳನ್ನು ಬಿಟ್ಟು ಉಳಿದ ಮಕ್ಕಳೆಲ್ಲ ಬಸ್‌ನಿಂದ ಇಳಿದರು.
- ರೀಟಾ ಸ್ಕೂಲಿಗೆ ಬಸ್‌ನಲ್ಲಿ ಹೋಗಬೇಕಿತ್ತು ಆದ್ದರಿಂದ ಅವಳು ಬಸ್‌ಸ್ಟಾಪಿಗೆ ಬಂದಳು.
- ಅವಳು ಕಂಡಕ್ಟರರಿಗೆ ಬಸ್ ನಿಲ್ಲಿಸುವಂತೆ ಕೇಳಿಕೊಂಡು ಬಸ್‌ನಿಂದ ಇಳಿದಳು.
- ಮಕ್ಕಳೆಲ್ಲಾ ಬಸ್ ಹತ್ತಿದರು
- ರೀಟಾ ಇದ್ದಕ್ಕಿದ್ದಹಾಗೆ ಎದ್ದು ಕುಳಿತಳು ಆಗ ಬಸ್ ಸ್ಕೂಲಿನ ಬಳಿ ಇದ್ದ ಬಸ್ ಸ್ಟಾಪ್ ಬಿಟ್ಟು ಮುಂದೆ ಹೋಗಿದೆ ಎಂಬುದು ಅವಳಿಗೆ ತಿಳಿಯಿತು.
- ಶಾಲೆಗೆ ಓಡಿಹೋಗಿ ಸರಿಯಾದ ಸಮಯಕ್ಕೆ ತನ್ನ ಕೊಠಡಿಯನ್ನು (ಕ್ಲಾಸನ್ನು) ತಲುಪಿದಳು.
- ಬಸ್‌ಬಂತು
- ರೀಟಾಳಿಗೆ ಬಸ್‌ನಲ್ಲಿ ನಿದ್ದೆ ಬಂದಿತು.

Scoring : use story (i) as example.

Correct sentence order for other stories are as follows ;

b. 3 1 5 2 4

c. 4 1 5 3 2

d. 4 1 3 6 2 5

e . 2 6 1 8 4 7 9 3 5

The first two items, are given 1 point for every correctly ordered sentence. Therefore item (ii), (iii) 5 points each. Item (iv) carries 2 points for every correctly orders sentence. Total of 12 points Items (v) carries 2 points for every correctly ordered sentence. Total of 18 points.

Total score :——out of 40.