EFFECTIVENESS OF PSYCHOLOGICAL INTERVENTION ON COGNITIVE FUNCTIONS OF BRAIN INJURED

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This is to certify that the thesis entitled “**EFFECTIVENESS OF PSYCHOLOGICAL INTERVENTION ON COGNITIVE FUNCTIONS OF BRAIN INJURED**”, submitted by **Mr. SAJAN M.,** to the Department of Psychology, University of Calicut, is a record of bonafide research work carried out by him under my supervision and guidance. The results embodied in the thesis have not been submitted to any other University or Institution for the award of any degree or diploma.

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DECLARATION

I, **SAJAN M.**, do hereby declare that this work reported in the thesis entitled, "**EFFECTIVENESS OF PSYCHOLOGICAL INTERVENTION ON COGNITIVE FUNCTIONS OF BRAIN INJURED**" is original and carried out by me in the Department of Psychology, University of Calicut, under the guidance and supervision of **Prof: (Dr.) C.B. Asha.** I further declare that this thesis or any part of this has not been submitted for any degree, diploma, recognition or title in this or any other University or Institution.

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07.07.2008 **SAJAN M.**

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LIST OF APPENDICES

As Oedipus approached the city of Thebes, his way was blocked by the Sphinx, who posed this riddle; “What walks on four legs in the morning, two legs at noon and three legs in the evening?” Oedipus replied, “A human”. This was correct and he was allowed to pass, because a person crawls as an infant, walks as an adult and uses a cane when old. The riddle posed by the Sphinx is the riddle of human nature and although Oedipus knew the direct answer to the riddle he perhaps also understood its deeper meaning: “What are humans?” The deeper meaning of the riddle of human nature is still unanswered (Kolb and Whishaw, 1996).

Early views on the function of the brain regarded it as little more than cranial stuffing. In Ancient Egypt, from the late Middle Kingdom onwards, in preparation for mummification, the brain was regularly removed, for it was the heart that was assumed to be the seat of intelligence. According to Herodotus, during the first step of mummification, "The most perfect practice is to extract as much of the brain as possible with an iron hook and what the hook cannot reach is mixed with drugs." Over the next five-thousand years, this view came to be reversed; the brain is now known to be seat of intelligence, although idiomatic variations of the former remain, as in memorizing something "by heart" (*Hendrickson, 2000*).

The brain has evolved to play a particularly significant role, not only in sustaining life, but also in all thought, behaviour and reasoning. It is the only organ that we could not transplant and still maintain the person’s self.

Efforts to understand mind-body relationships and their relative contributions to health and well-being extend back at least to Plato, Descartes and Kant. Like many other sciences, neuropsychology has evolved from related fields, most notably psychology, neurology and neuroscience. Psychology is the study of behaviour; specifically, it seeks to describe, explain, modify and predict human and animal behaviour. Neuropsychology, a subspecialty of psychology, is the study of how complex properties of the brain allow behaviour to occur. Neuropsychologists study relationships between brain functions and behaviour; specifically, changes in thought and behaviour that relate to the brain's structural or cognitive integrity. So neuropsychology is one way to study the brain by examining the behaviour it produces (Zillmer and Spiers, 2001).

NEUROPSYCHOLOGY

The term "neuropsychology" in its English version originated quite recently. According to Bruce (1985), it was first used by William Osler and then later appeared as a subtitle in D.O. Hebb's 1949 book, 'The Organization of Behaviour: A Neuropsychological Theory'. Although neither defined nor used in the text itself, the term was probably intended to represent a study that combined the neurologist's common interests in brain function. By 1957, the term had become a recognized designation for a subfield of the neurosciences, when Heinrich Kluver, in the preface to 'Behaviour Mechanism in Monkeys', suggested that the book would be of interest to neuropsychologists and others. The term was given wide publicity when it appeared in 1960, in the title of a collection of K.S. Lashley's writings- 'The Neuropsychology of Lashley'- most of which were rat and monkey studies edited by Beach (Kolb and Whishaw, 1996).

Neuropsychology is the study of the relation between brain function and behaviour, although the study draws information from many disciplines- for example, anatomy, biology, biophysics, ethology, pharmacology, physiology, physiological psychology and philosophy.

Neuropsychology has had a particularly rich history and the future is promising as well. Philosophical thought, medical practice and religious dogma have shaped human's relationship with the brain. Understanding "where we came from" and "where we are" shows how neuropsychology evolved as a discipline. Knowledge of brain-behaviour relationships is a developing science rather than an absolute fact. In addition, neuropsychology is a paradigm of how to explain and research behaviour, not just a body of knowledge. Neuropsychology is also not a separate area of research to be pursued in isolation from other models of psychology. It is distinct from physiology, however, because its direct concern is not with synapses, but with behaviour. In 1983, Donald Hebb suggested that "The neuropsychologist of the future must be a psychologist as well as a neurologist. The complexities of psychology and the complexities of neurology are the same complexities" (p. 7. cited from Zillmer and Spiers, 2001). Neuropsychology is a natural part of psychology; its central focus is the development of a science of human behaviour based on the function of the human brain.

Neuropsychological Approaches

Experimental Neuropsychology- An approach which uses methods from experimental psychology to uncover the relationship between the nervous system and cognitive function. The majority of work involves studying healthy humans in a laboratory setting, although a minority of researchers may conduct animal experiments. Human work in this area often takes advantage of specific features of our nervous system to make links between neuroanatomy and psychological function.

Clinical Neuropsychology - Clinical neuropsychology is a sub-specialty of clinical psychology that specialises in the diagnostic assessment and treatment of patients with brain injury or neurocognitive deficits (Halligan, Kischka and Marshall, 2003). They bring a psychological viewpoint to treatment, to understand how such illness and injury may affect and be affected by psychological factors. Clinical neuropsychologists typically work in hospital settings in an interdisciplinary medical team, although private practice work is not unknown (Beamont, Kenealy and Rogers, 1999).

Neuropsychologists use models of brain-behavior relationships to determine whether expected neurobehavioral function has changed to a degree that is consistent with impairment. Such relationships are demonstrated through the interpretation of performance that is derived from a variety of specialized assessment procedures. Thus, the domain of neuropsychologists is expressed brain function: for example, reasoning/ problem-solving, learning/recall processes, selective attention/concentration processes, perception, sensation, language processes, controlled/directed movement processes.

Cognitive Psychology

Cognitive psychology is a school of thought in psychology that examines internal mental processes such as problem solving, memory and language. It had its foundations in the Gestalt psychology of Max Wertheimer, Wolfgang

Köhler and Kurt Koffka and in the work of Jean Piaget, who provided a theory of stages/phases that describe children's cognitive development (*Riefer and Batchelder, 1988*).

Ulric Neisser coined the term 'cognitive psychology' in his book published in 1967, wherein Neisser provides a definition of cognitive psychology characterizing people as dynamic information-processing systems whose mental operations might be described in computational terms. Neisser's point of view endows the discipline a scope which expands beyond high-level concepts such as "reasoning", often espoused in other works as a definition of cognitive psychology. Neisser's (1967) definition of *cognition* illustrates this well:

...the term "cognition" refers to all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered and used. It is concerned with these processes even when they operate in the absence of relevant stimulation, as in images and hallucinations... Given such a sweeping definition, it is apparent that cognition is involved in everything a human being might possibly do; that every psychological phenomenon is a cognitive phenomenon. But although cognitive psychology is concerned with all human activity rather than some fraction of it, the concern is from a particular point of view. Other viewpoints are equally legitimate and necessary. **(***Anderson, 2000).*

Cognitive neuropsychology uses techniques and technologies from the wider science of neuropsychology and fields such as cognitive neuroscience. These may include neuroimaging, electrophysiology and neuropsychological tests to measure either brain function or psychological performance.

Cognitive Neuropsychology **-** A relatively new development and has emerged as a distillation of the complementary approaches of both experimental and clinical neuropsychology. It seeks to understand the mind and brain by studying people who have suffered brain injury or neurological illness (Beamont, Kenealy and Rogers, 1999).

The practice of cognitive neuropsychology involves studying the cognitive effects of injury or illness to understand normal psychological function. Because of their day-to-day contact with people with brain impairment, many clinical neuropsychologists are active in these research fields.

COGNITION

The term cognition is used in different ways by different disciplines. In psychology, it refers to an information processing view of an individual's psychological functions. Other interpretations of the meaning of cognition link it to the development of concepts; individual minds, groups, organizations and even larger coalitions of entities, can be modelled as societies which cooperate to form concepts. The autonomous elements of each 'society' would have the opportunity to demonstrate emergent behavior in the face of some crisis or opportunity. Cognition can also be interpreted as "understanding and trying to make sense of the world" (Lycan, 1999). Cognition is a term used to describe the processes of thinking, reasoning, problem solving, information processing and memory.

The term cognition (Latin: *cognoscere*, "to know") is used in several loosely related ways to refer to a faculty for the human-like processing of information, applying knowledge and changing preferences. Cognition or cognitive processes can be natural and artificial, conscious and not conscious; therefore, they are analyzed from different perspectives and in different contexts, in anaesthesia, neurology, psychology, philosophy, systemics and computer science. The concept of cognition is closely related to such abstract concepts as mind, reasoning, perception, intelligence, learning and many others that describe numerous capabilities of the human mind and expected properties of artificial or synthetic intelligence. Cognition is an abstract property of advanced living organisms; therefore, it is studied as a direct property of a brain or of an abstract mind on sub-symbolic and symbolic levels (Lycan, 1999).

In psychology and in artificial intelligence, it is used to refer to the mental functions, mental processes and states of intelligent entities (humans, human organizations, highly autonomous robots), with a particular focus toward the study of such mental processes as comprehension, inferencing, decision-making, planning and learning .Recently, advanced cognitive researchers have been especially focused on the capacities of abstraction, generalization, concretization/specialization and meta-reasoning which descriptions involve such concepts as beliefs, knowledge, desires, preferences and intentions of intelligent individuals/objects/agents/systems.

THE BRAIN

In animals, the brain is the control centre of the central nervous system, responsible for behavior. In mammals, the brain is located in the head, protected by the skull and close to the primary sensory apparatus of vision, hearing, equilibrioception (balance), sense of taste and olfaction (smell).

While all vertebrates have a brain, most invertebrates have either a centralized brain or collections of individual ganglia. Some animals such as cnidarians and echinoderms do not have a centralized brain and instead have a decentralized nervous system, while animals such as sponges lack both a brain and nervous system entirely.

HUMAN BRAIN

The divergence of the human brain from that of other living species has a history of at least 5 million years. The human brain has undergone a major expansion in the past 2 million years. This appears to have taken place in a number of quite quick steps that resulted in a number of human like animals being alive at one time. Today's humans seem to have been around for only about 200,000 years and they have replaced all of their predecessors. The general structure of the human brain is quite similar to that of other animals, even to very simple animals like rats. The way in which it differs is its size, especially the size of the neocortex. The larger size probably occurred in response to demands for many new skills rather than a demand for any single skill or ability. The increase in size in mammals generally and the primate lineage in particular is also associated with the appearance of new cortical areas for mediating new behaviour (Kolb and Whishaw, 1996).

The human brain is vast and complex. It contains some one hundred billion neurons, which are capable of electrical and chemical communication with tens of thousands of other nerve cells (Toga, 2006; Philips, 2006). Nerve cells in turn rely on some quadrillion synaptic connections for their communications.

As life progresses from infancy through childhood, adolescence, adulthood and senescence, so does the body. Likewise the brain changes in a characteristic fashion to correspond with predetermined internal ontogenetic and developmental patterns, as well as to accommodate interactions between the body and the external environment. Developmentally, the brain begins at the most rostral extension of the neural tube; it bends over and convolutes as it expands within the confines of the cranium. The brain's expansion is disproportionate relative to the growth of the spinal cord, the most caudal extension of the central nervous system (Oscar-Berman, 1994).

The human brain is the most complex organ in the body. It controls the central nervous system (CNS), by way of the cranial nerves and spinal cord, the peripheral nervous system (PNS) and regulates virtually all human activity (Toga, 2006). Involuntary, or "lower," actions, such as heart rate, respiration and digestion, are unconsciously governed by the brain, (Toga, 2006; Philips, 2006) specifically through the autonomic nervous system. Complex, or "higher," mental activity, such as thought, reason and abstraction, (Philips, 2006) is consciously controlled.

The structure of the human brain differs from that of other animals in several important ways. These differences allow for many abilities over and above those of other animals, such as advanced cognitive skills. Human encephalization is especially pronounced in the neocortex, the most complex part of the cerebral cortex. The proportion of the human brain that is devoted to the neocortex especially to the prefrontal cortex is larger than in all other mammals (indeed larger than in all animals, although only in mammals has the neocortex evolved to fulfil this kind of function).

Humans have unique neural capacities, but much of their brain structure is similar to that of other mammals. Basic systems that alert the nervous system to stimulus, that sense events in the environment and monitor the condition of the body are similar to those of even non-mammalian vertebrates. The neural circuitry underlying human consciousness includes both the advanced neocortex and prototypical structures of the brainstem.

Anatomically, the brain can be divided into three parts: the forebrain, midbrain and hindbrain; the forebrain includes the several lobes of the cerebral cortex that control higher functions, while the mid- and hindbrain are more involved with unconscious, autonomic functions (Philips, 2006).

During encephalization, human brain mass increased beyond that of other species relative to body mass. This process was especially pronounced in the neocortex, a section of the brain involved with language and consciousness. The neocortex accounts for about 76% of the mass of the human brain; with a neocortex much larger than other animals, humans enjoy unique mental capacities despite having a neuroarchitecture similar to that of more primitive species. Basic systems that alert humans to stimuli, sense events in the environment and maintain homeostasis are similar to those of basic vertebrates. Human consciousness is founded upon the extended capacity of the modern neocortex, as well as the greatly developed structures of the brain stem.

Anatomy of Brain

The normal adult human brain typically weighs between 1 and 1.5 kg and has an average volume of 1.6 litres. The mature human brain consumes some 20-25% of the energy used by the body, while the developing brain of an infant consumes around 60%. Such heavy energy usage generates large quantities of heat, which must be continually removed to prevent brain damage.

The bulbous cerebral cortex is composed of convoluted grey matter internally supported by deep brain white matter. The two hemispheres of the brain are separated by a prominent central fissure and connect to each other at the corpus callosum. The surface of each hemisphere folds in on itself in many places, creating grooves along the surface named sulci (singular, sulcus). Very deep grooves are termed fissures. The irregularly shaped ridges between sulci are known as gyri (singular, gyrus) (Mai, Assheuer and Paxinos, 1997).

A well-developed cerebellum is found at the back of the brain. Brain stem structures are almost completely enveloped by the cerebellum and telencephalon, with the medulla oblongata projecting through the foramen magnum to merge with the spinal cord.

The blood supply to the brain involves the paired carotid arteries that enter the brain and communicate in the circle of Willis before branching out to their destinations. Further blood supply comes via the vertebral arteries. Blood drains from the brain through a network of sinuses that drain into the right and left internal jugular veins.

The brain is suspended in cerebrospinal fluid (CSF), which also fills spaces called ventricles inside it. The dense fluid protects the brain and spinal cord from shock; a brain that weighs 1,500 gm in air weighs only 50 gm when suspended in CSF. Fluid movement within the brain is limited by the blood-brain barrier and the blood-cerebrospinal fluid barrier.

The brain is easily damaged by compression, so the fluid surrounding the central nervous system must be maintained at a constant volume. Humans are estimated to produce about 500 ml or more of cerebrospinal fluid each day, with only about 15 percent of the body's estimated 150 ml of CSF at any given time located in the ventricles of the brain. The remainder fills the subarachnoid space, which separates the soft tissues of the brain and spinal cord from the hard surrounding bones (skull and vertebrae). Elevated levels of CSF are associated with traumatic brain injury and hydrocephalus. Increased fluid pressure can result in permanent brain injury and death.

Neurobiology of Brain

The brain is composed of two broad classes of cells, neurons and glia, both of which contain several different cell types which perform different functions. Interconnected neurons form neural networks (or neural ensembles). These networks are similar to man-made electrical circuits in that they contain circuit elements (neurons) connected by biological wires (nerve fibres). These do not form simple one-to-one electrical circuits like many man-made circuits, however. Typically neurons connect to at least a thousand other neurons (*Junqueira and Carneiro, 2003).* These highly specialized circuits make up systems which are the basis of perception, different types of action and higher cognitive function.

Divisions of the Brain

The brain can subdivide into three major divisions based on the development of the human embryo. As the embryo’s neural tube closes, it begins to differentiate into three bulges. The topmost becomes the forebrain, or proencephalon, the middle is the midbrain (mesencephalon) and the third is the hindbrain (rhombencephalon). The remainder of the neural tube develops into the spinal cord.

The three major subdivisions of the brain further differentiate into five subdivisions: (1) the telencephalon, (2) the diencephalon, (3) the mesencephalon, (4) the metencephalon and, (5) the myelencephalon *(Zillmer and Spiers, 2001)*. Traditionally, neuropsychologists focus on the brain areas of complex processing within the telencephalon, primarily the cerebrum. In fact, the major structures of the telencephalon, including the cerebrum, the basal ganglia and the basal forebrain, comprise about 85% of the brain's weight (Burt, 1993). So although this is only one subdivision of the brain, it covers much area and is of great importance in understanding higher cognitive abilities. Therefore, a common manner of dividing the brain is to differentiate between the telencephalon and the brain stem. The brain stem includes all the subdivisions below the telencephalon (diencephalons, mesencephalon, metencephalon and myelencephalon), except for the cerebellum and mediates many primary regulatory processes of the body *(Zillmer and Spiers, 2001)*.

Four of the major divisions within each hemisphere are the Frontal, Parietal, Temporal and Occipital lobes. The frontal and parietal lobes are separated from the temporal lobe by the lateral fissure. The frontal and parietal lobes are separated by the central sulcus. The parietal and occipital lobes are separated by the parietal-occipital fissure and its imaginary extension across the lateral surface of the hemisphere to the occipital notch. The division and naming of the cortex into four lobes is quite arbitrary and related to the names of the cranial plates that provide protective covering just superior to the lobes (Zillmer and Spiers, 2001).

Frontal Lobe

The frontal lobes are accepted as the primary brain region responsible for executive functions (comprising a variety of processes such as initiation, planning, hypothesis generation, cognitive flexibility, decision-making, regulation, judgment and feedback utilization) (Anderson and Tranel, 2002; Stuss & Benson, 1986; Stuss & Levine, 2002), there is a high probability that people with TBI will experience executive dysfunction, with consequences for outcome (Dawson *et al*., 2004). Executive deficits following TBI include, but are not limited to: impaired mental flexibility, poor adaptation to unique tasks (Dikmen, Reitan, & Temkin, 1983), poor judgement (Prigatano, 1987), reduced capacity for self-evaluation of abilities, impaired monitoring and impaired ability to regulate impulses and formulate realistic plans of action (Levin *et al*., 1987).

The so-called <u>executive functions</u> of the frontal lobes involve the ability to recognize future consequences resulting from current actions, to choose between good and bad actions (or better and best), override and suppress unacceptable social responses and determine similarities and differences between things or events.

The frontal lobes also play an important part in retaining longer term memories which are not task-based. These are often memories with associated emotions, derived from input from the brain's limbic system and modified by the higher frontal lobe centres to generally fit socially acceptable norms. The frontal lobes have rich neuronal input from both the alert centres in the brain-stem and from the limbic regions.

Prefrontal Cortex

The prefrontal cortex is the anterior part of the frontal lobes of the brain, lying in front of the motor and premotor areas. This brain region has been implicated in planning complex cognitive behaviours, personality expression and moderating correct social behavior. The basic activity of this brain region is considered to be orchestration of thoughts and actions in accordance with internal goals.

The most typical neurologic term for functions carried out by the pre-frontal cortex area is executive function. Executive function relates to abilities to differentiate among conflicting thoughts, determine good and bad, better and best, same and different, future consequences of current activities, working toward a defined goal, prediction of outcomes, expectation based on actions and social "control" (the ability to suppress urges that, if not suppressed, could lead to socially-unacceptable outcomes).Many authors have indicated an integral link between a person's personality and the functions of the prefrontal cortex (*Miller and Cohen, 2001).*

Parietal Lobe

The parietal lobe is a lobe in the brain. It is positioned above (superior to) the occipital lobe and behind (posterior to) the frontal lobe. The parietal lobe is defined by four anatomical boundaries: the central sulcus separates the parietal lobe from the frontal lobe; the parieto-occipital sulcus separates the parietal and occipital lobes; the lateral sulcus (sylvian fissure) is the most lateral boundary separating it from the temporal lobe; and the medial longitudinal fissure divides the two hemispheres.

The parietal lobe integrates sensory information from different modalities, particularly determining spatial sense and navigation. For example, it comprises somatosensory cortex and the dorsal stream of the visual system. This enables regions of the parietal cortex to map objects perceived visually into body coordinate positions (Avillac, Deneve, Olivier, Pouget and Duhamel, 2005).

The parietal lobe plays important roles in integrating sensory information from various parts of the body, knowledge of numbers and their relations (Blakemore and Frith, 2005) and in the manipulation of objects. Portions of the parietal lobe are involved with visuospatial processing. Much less is known about this lobe than the other three in the cerebrum.

Occipital Lobe

The occipital lobes are the smallest of four true lobes in the human brain. Located in the rear most portion of the skull, the occipital lobes are part of the forebrain structure.

The occipital lobe is the visual processing centre of the mammalian brain, containing most of the anatomical region of the visual cortex. There are many extra striate regions and these are specialized for different visual tasks, such as visuospatial processing, colour discrimination and motion perception (Murata, Gallese, Kaseda and Sakata, 1996).

Cells on the posterior aspect of the occipital lobes' grey matter are arranged as a spatial map of the retinal field. Functional neuroimaging reveals similar patterns of response in cortical tissue of the lobes when the retinal fields are exposed to a strong pattern.

The function of the occipital lobe is to control vision and colour recognition. It has also been shown to help in hearing. The occipital lobe is divided into several functional visual areas. Each visual area contains a full map of the visual world. Although there are no anatomical markers distinguishing these areas (except for the prominent striations in the striate cortex), physiologists have used electrode recordings to divide the cortex into different functional regions.

If one occipital lobe is damaged, the result can be homonomous vision loss from similarly positioned "field cuts" in each eye. Occipital lesions can cause visual hallucinations. Lesions in the parietal-temporal-occipital association area are associated with colour agnosia, movement agnosia and agraphia.

Temporal Lobe

The temporal lobes are parts of the cerebrum that are involved in speech, memory and hearing. They lie at the sides of the brain, beneath the lateral or Sylvian fissure. The human brain looks something like a boxing glove. The temporal lobes are where the thumbs would be.

The temporal lobe is involved in auditory processing and is home to the primary auditory cortex. It is also heavily involved in semantics both in speech and vision. The temporal lobe contains the hippocampus and is therefore involved in memory formation as well.

EXECUTIVE SYSTEM

The executive system is a theorized cognitive system in psychology that controls and manages other cognitive processes. It is thought to be involved in processes such as planning, cognitive flexibility, abstract thinking, rule acquisition, initiating appropriate actions and inhibiting inappropriate actions and selecting relevant sensory information (Burgess, 1997). It is also referred to as executive function or the central executive or cognitive control and plays a central role in many psychological theories.

Theories of the executive system were largely driven by observations of patients who had suffered frontal lobe damage. They exhibited disorganized actions and strategies for everyday tasks (a group of behaviours now known as dysexecutive syndrome) although they seemed to perform normally when clinical or lab based tests were used to assess more fundamental cognitive functions such as memory, learning, language and reasoning (Burgess, 1997).

EXECUTIVE FUNCTIONS

Executive functioning refers to higher level cognitive functions that are primarily mediated by the frontal lobes and its connections throughout the brain. Executive functioning includes insight, awareness, judgment, planning, organization, problem solving, multi-tasking and working memory. The frontal lobes and subsequent sub cortical connections tend to be one of the brain areas most likely to be injured following traumatic brain injury and it is common for a brain injured patient to present with cognitive and behavioural deficits in the absence of substantial physical impairment (Rees, Marshall, Hartridge, Mackie and Weiser, 2007).

Damage to the frontal lobe can affect planning, organizing and problem solving skills, resulting in a subtle set of deficits which have been called 'Dysexecutive Syndrome'. This covers problems in making long-term plans, goal setting and initiating steps to achieve objectives. The ability to stand back and take an objective view of a situation may be lacking, as may the ability to see anything from another person's point of view.

The prefrontal lobes are unique in organization and function among all other areas of the cortex. The functions of the temporal, parietal and occipital lobes follow straightforward principles of organization built around sensory system processing. But the frontal lobes seemed ‘silent’, largely because injury did not result in obvious disability. Frontal lobe pathology does not result in primary disorders of sensation or perception, motor disability, memory, or language. But the frontal lobes are richly interconnected with all posterior and subcortical areas. If the brain is a symphony, the frontal lobes act as a conductor. It deals with planning, flexible problem solving and at the highest levels, the self-monitoring and self-assessment of behaviour. Executive functioning is not a single behaviour but a category of behaviour that is orchestrated primarily by different aspects of the frontal systems on the rest of the brain. Executive functioning impairments become most evident in the most complex aspects of human conscious activity, or those activities of higher problem solving, reasoning, abstraction, critical self-awareness and social interaction that makes us human (Zillmer and Spiers, 2001).

BRAIN INJURY

When a brain injury occurs the functions of the neurons or sections of the brain can be affected. If the neurons and nerve tracts are affected, they can unable or have difficulty carrying the messages that tell the brain what to do. This can change the way the person thinks, acts, feels and moves the body. Brain injury can also change the complex internal functions of the body, such as regulating body temperature; blood pressure; bowel and bladder control. These changes can be temporary or permanent.

Traumatic Brain Injury

A traumatic brain injury (TBI) is an injury to the brain caused by the head being hit by something or shaken violently. This injury can change how the person acts, moves and thinks. The TBI can cause changes in one or more areas, such as: thinking and reasoning, understanding words, remembering things, paying attention, solving problems, thinking abstractly, talking, behaving, walking and other physical activities, seeing and/or hearing and learning.

Traumatic injuries to the brain, also called intracranial injury or simply head injury, occurs when physical trauma causes brain damage. TBI can result from a closed head injury or a penetrating head injury and is one of two subsets of acquired brain injury (ABI). The other subset is non-traumatic brain injury, or injuries that do not involve external mechanical force (e.g. stroke, meningitis, anoxia). Parts of the brain that can be damaged include the cerebral hemispheres, cerebellum and brain stem (*Rao and Lyketsos, 2000).* TBI can be mild, moderate, or severe, depending on the extent of the damage to the brain. TBI can cause a host of physical, cognitive, emotional and social effects. Outcome can be anything from complete recovery to permanent disability or death *(Rao and Lyketsos, 2000).*

Traumatic brain injury (TBI) is a major public health problem, especially among male adolescents and young adults ages 15 to 24 and among elderly people of both sexes 75 years and older. Children aged 5 and younger are also at high risk for TBI. Most serious injuries to the brain resulted in death due to bleeding or infection. Today, we understand a great deal more about the healthy brain and its response to trauma, although science still has much to learn about how to reverse damage resulting from head injuries. Survivors of TBI are often left with significant cognitive, behavioural and communicative disabilities and some patients develop long-term medical complications, such as epilepsy (*D'Ambrosio and Perucca, 2004).*

Causes of Traumatic Brain Injury

Half of all TBIs are due to transportation accidents involving automobiles, motorcycles, bicycles and pedestrians. These accidents are the major cause of TBI in people under age 75. For those 75 and older, falls cause the majority of TBIs.

Signs and Symptoms of Traumatic Brain Injury

Symptoms of a (traumatic brain injury) TBI can be mild, moderate, or severe depending on the extent of the damage to the brain. Some symptoms are evident immediately while others do not surface until several days or weeks after the injury. A person with a mild TBI may remain conscious or may experience a loss of consciousness for a few seconds or minutes. The person may also feel dazed or not like himself for several days or weeks after the initial injury. Other symptoms of mild TBI include headache, confusion, light headedness, dizziness, blurred vision or tired eyes, ringing in the ears, bad taste in the mouth, fatigue or lethargy, a change in sleep patterns, behavioural, personality or mood changes and trouble with memory, concentration, attention, thinking, problem solving and creativity *(Rao and Lyketsos, 2000).*

A person with a moderate or severe TBI may show these same symptoms, but may also have a headache that gets worse or does not go away, repeated vomiting or nausea, convulsions or seizures, inability to awaken from sleep, dilation of one or both pupils of the eyes, slurred speech, weakness or numbness in the extremities, loss of coordination and/or increased confusion, restlessness, or agitation. Small children with moderate to severe TBI may show some of these signs as well as signs specific to young children, such as persistent crying, inability to be consoled and/or refusal to nurse or eat. Anyone with signs of moderate or severe TBI should receive medical attention as soon as possible. Some symptoms are evident immediately, while others do not surface until several days or weeks after the injury.

Classification and Subtypes of Brain Injury

Focal vs. Diffuse

The damage from TBI can be focal, confined to one area of the brain, or diffuse, involving more than one area. Diffuse trauma to the brain is frequently associated with concussion (a shaking of the brain in response to sudden motion of the head); diffuse axonal injury, or coma (*Hoge et al., 2008*).

Types of focal brain injury include bruising of brain tissue called a contusion and intracranial haemorrhage or haematoma, heavy bleeding in the skull. Hemorrhage, due to rupture of a blood vessel in the head, can be extra-axial, meaning it occurs within the skull but outside of the brain, or intra-axial, occurring within the brain (*Hoge et al., 2008*).

Open vs. Closed

TBI can result from a closed or penetrating head injury. A closed injury occurs when the skull is not breached, while a penetrating injury occurs when an object pierces the skull and enters brain tissue (*Hoge et al., 2008*).

As the first line of defence, the skull is particularly vulnerable to injury. Skull fractures occur when a bone in the skull cracks or breaks. A depressed skull fracture occurs when pieces of the broken skull press into the tissue of the brain. A penetrating skull fracture occurs when something pierces the skull, such as a bullet, leaving a distinct and localized traumatic injury to brain tissue. Skull fractures can cause cerebral contusion (*Hoge et al., 2008*).

Severity

Head injuries can be subdivided into mild, moderate and severe TBI to help predict outcome. One common classification system determines severity based on the Glasgow Coma Scale (GCS) and duration of post-traumatic amnesia (PTA) and loss of consciousness (LOC) (*Rao and Lyketsos, 2000).*

Mild**:** Loss of consciousness lasting 15 minutes or less, post-traumatic amnesia lasting less than one hour. No apparent brain injury on MRI scan or CT scan.

Moderate**:** Loss of consciousness or coma lasting up to 6 hours, post-traumatic amnesia lasting up to twenty-four hours OR presence of a depressed skull fracture or apparent contusion (bruise) or localised swelling of brain tissue on MRI scan or CT scan.

Severe**:** Coma for 6 hours or more, post-traumatic amnesia of twenty-four hours or more OR any bleeding within the skull or generalised brain swelling on MRI scan or CT scan (Cicala, 1999).

Disabilities Resulting From Traumatic Brain Injury

Disabilities resulting from a TBI depend upon the severity of the injury, the location of the injury and the age and general health of the patient. Some common disabilities include problems with cognition (attention, calculation, problem solving, memory, judgment, insight and reasoning), sensory processing (sight, hearing, touch, taste and smell), communication (language expression and understanding), social function (empathy, capacity for compassion, interpersonal social awareness and facility) and mental health (depression, anxiety, personality changes, aggression, acting out and social inappropriateness) (Tolias and Sgouros, 2005).

The results of traumatic brain injury vary widely in type and duration. A head injured patient may experience physical effects of the trauma such as headaches, movement disorders (e.g. Parkinsonism), seizures, difficulty in walking, sexual dysfunction, lethargy, or coma. Cognitive symptoms include changes in judgment or ability to reason or plan, memory problems and loss of mathematical ability. Emotional problems include mood swings, poor impulse control, agitation, low frustration threshold, self-centeredness, clinical depression and psychotic symptoms such as hallucinations and delusions (*Jorge, 2005).*

Sensory Deficits

Many TBI patients have sensory problems, especially problems with vision. Also, TBI patients often have difficulty with hand-eye coordination. Because of this, TBI patients may seem clumsy or unsteady. Other sensory deficits may include problems with hearing, smell, taste or touch. These conditions are rare and hard to treat *(Jorge, 2005)*.

Emotional and Behavioural Problems

TBI may cause emotional or behavioural problems that fit under the broad category of psychiatric health including personality changes. Psychiatric problems that may persist for one half year to two years after the injury may include irritability, suicidal ideation, insomnia and loss of the ability to experience pleasure from previously enjoyable experiences *(Rao and Lyketsos, 2000)*. Other problems include apathy, anxiety, anger, paranoia, confusion, frustration, agitation and mood swings. About one quarter of people with TBI suffer from clinical depression and about 9% suffer mania *(Rao and Lyketsos, 2000).* Different behavioural problems are characteristic of the location of injury; for instance, frontal lobe injuries often result in disinhibition and inappropriate or childish behavior and temporal lobe injuries often cause irritability and aggression *(Folzer, 2001).*

Problem behaviours may include violence, impulsivity, acting out, non-compliance, social inappropriateness, emotional outbursts, impaired self-control, impaired self-awareness, inability to take responsibility or accept criticism, egocentrism, inappropriate sexual activity and alcohol or drug abuse or addiction. Some patients' personality problems may be so severe that they are diagnosed with organic personality disorder, a psychiatric condition characterized by many of these problems. Sometimes TBI patients suffer from developmental stagnation, meaning that they fail to mature emotionally, socially, or psychologically after the trauma. This is a serious problem for children and young adults who suffer from a TBI, because attitudes and behaviours that are appropriate for a child or teenager become inappropriate in adulthood *(Folzer, 2001).* TBI patients who show psychiatric or behavioural problems may be helped with medication and psychotherapy, although the effectiveness of psychotherapy may be limited by the residual neurocognitive impairment. Technological improvements and emergency care have diminished the incidence of devastating TBI while increasing the numbers of patients with mild or moderate TBI. Such patients are more adversely affected by their emotional problems (such as post traumatic stress disorder) and neurocognitive difficulties than by their residual physical disabilities (*Jorge, 2005*).

COGNITIVE IMPAIRMENT

Cognition is a term used to describe the processes of thinking, reasoning, problem solving, information processing and memory. Most patients with severe TBI, if they recover consciousness, suffer from cognitive disabilities, including the loss of many higher level mental skills. The most common cognitive impairment among severely head-injured patients is memory loss, characterized by some loss of specific memories and the partial inability to form or store new ones. Some of these patients may experience post-traumatic amnesia (PTA), either anterograde or retrograde. Anterograde PTA is impaired memory of events that happened after the TBI, while retrograde PTA is impaired memory of events that happened before the TBI (Hall and Chapman, 2005).

Many patients with mild to moderate head injuries who experience cognitive deficits become easily confused or distracted and have problems with concentration and attention. They also have problems with higher level, so-called executive functions, such as planning, organizing, abstract reasoning, problem solving and making judgments, which may make it difficult to resume pre-injury work-related activities. Recovery from cognitive deficits is greatest within the first 6 months after the injury and more gradual after that (Tolias and Sgouros, 2005).

Patients with moderate to severe TBI have more problems with cognitive deficits than patients with mild TBI, but a history of several mild TBIs may have an additive effect, causing cognitive deficits equal to a moderate or severe injury (Tolias and Sgouros, 2005). Language and communication problems are common disabilities in TBI patients. Some may experience aphasia, defined as difficulty with understanding and producing spoken and written language; others may have difficulty with the more subtle aspects of communication, such as body language and emotional, non-verbal signals. These language deficits can lead to miscommunication, confusion and frustration for the patient as well as those interacting with him or her (Jorge, 2005).

Most TBI patients have emotional or behavioural problems that fit under the broad category of psychiatric health. Family members of TBI patients often find that personality changes and behavioural problems are the most difficult disabilities to handle. Psychiatric problems that may surface include depression, apathy, anxiety, irritability, anger, paranoia, confusion, frustration, agitation, insomnia or other sleep problems and mood swings. Problem behaviours may include aggression and violence, impulsivity, disinhibition, acting out, non-compliance, social inappropriateness, emotional outbursts, childish behaviour, impaired self-control, impaired self awareness, inability to take responsibility or accept criticism, egocentrism, inappropriate sexual activity and alcohol or drug abuse/addiction. Some patients' personality problems may be so severe that they are diagnosed with borderline personality disorder, a psychiatric condition characterized by many of the problems mentioned above. Sometimes TBI patients suffer from developmental stagnation, meaning that they fail to mature emotionally, socially, or psychologically after the trauma. This is a serious problem for children and young adults who suffer from a TBI. Attitudes and behaviours that are appropriate for a child or teenager become inappropriate in adulthood. Many TBI patients who show psychiatric or behavioural problems can be helped with medication and psychotherapy (Tolias and Sgouros, 2005).

The cognitive effects of a brain injury affect the way a person thinks, learns and remembers. Different mental abilities are located in different parts of the brain, so a head injury can damage some, but not necessarily all, skills such as reasoning, attention, memory, problem solving and creativity.

BRAIN PLASTICITY

The human brain is functionally altered through experience, a phenomenon known as plasticity. Relevant experiences may be negative, as in brain injury. Adult brain injury results in permanent impairment. However, it has been assumed that early injury leads to substantial functional recovery. Animal studies suggest several predictions regarding whether this principle generally holds true. These studies indicate that the timing of brain injury, relative to the expected course of neurodevelopment, impacts the extent of recovery. Injuries occurring during the period of cell migration are particularly detrimental. However, outcome must be assessed longitudinally because apparent recovery in childhood may reverse as the brain matures. Moreover, recovery of one function may come at the expense of others. Whether these findings characterize outcome following preterm birth is the focus of this review. Preterm birth is associated with high rates of neurodevelopmental disability, primarily due to hypoxic-ischemic events. Periventricular brain structures and white matter tracts are particularly vulnerable to damage. Through school age, preterm children exhibit diminished levels of global intellectual function, attention, memory and reasoning skills relative to full-term peers. It is questionable whether these deficits persist. Because few studies have followed recent cohorts into young adulthood, it is argued that outcome cannot be reliably described based on the available literature. Moreover, important contributors to later development have been neglected, including both genetic and experiential factors. With improved assessment, it may be possible to develop interventions based on the individual child's constellation of genetic, biological and sociodemographic risks (Luciana, 2003).

The brain attempts to repair itself after a trauma and is more successful after mild to moderate injury than after severe injury. Scientists have shown that after diffused axonal injury neurons can spontaneously adapt and recover by sprouting some of the remaining healthy fibres of the neuron into the spaces once occupied by the degenerated axon. These fibres can develop in such a way that the neuron can resume communication with neighbouring neurons. This is a very delicate process and can be disrupted by any of a number of factors, such as neuroexcitation, hypoxia (low oxygen levels) and hypotension (low blood flow). Following trauma excessive neuroexcitation, that is the electrical activation of nerve cells or fibres, especially disrupts this natural recovery process and can cause sprouting fibres to loose direction and connect with the wrong terminals (*Rao and Lyketsos2000)*.

REHABILITATION

Rehabilitation is a process of change through which a brain injured person goes, seeking to regain former skills and to compensate for skills lost. Its aim is always to achieve the optimum levels of physical, cognitive and social competence followed by integration into the most suitable environment.

During the acute stage of rehabilitation, moderately to severely injured patients may receive treatment and care in an intensive care unit of a hospital followed by movement to a step-down unit or to a neurosurgical ward. Once medically stable, the patient may be transferred to a sub acute unit of the medical centre, to a long-term acute care (LTAC) facility, to a rehabilitation inpatient treatment unit contained within the acute trauma centre or to an independent off-site rehabilitation hospital. Some inpatient treatment units have a specialty focus in brain injury rehabilitation (*Rao and Lyketsos, 2000).*

The greatest visible progress occurs in the first 6 months, after which improvement is often more subtle and less obvious. But it is important to bear in mind that progress does not stop after 2 years, as has been suggested in the past. Rather people continue to improve even 5, 10 or more years after a head injury (*Sohlberg and Mateer, 1989).*

Rehabilitation has two stages, the first being the formal intervention to improve the individual and the second stage is when the family and carers work to maintain that improvement (*Sohlberg and Mateer, 1989).* Research suggests that patients who make the best recovery are those whose family is actively involved and can maintain this informal rehabilitation at home.

Rehabilitation is an important part of the recovery process for a TBI patient. During the acute stage, moderately to severely injured patients may receive treatment and care in an intensive care unit of a hospital. Rehabilitation therapy is an important part of the recovery process of TBI patients. It is important for the family to provide social support for the patient by being involved in the rehabilitation program. It is important for TBI patients and their families to select the most appropriate setting for rehabilitation. There are several options including home-based rehabilitation, hospital outpatient rehabilitation, inpatient rehabilitation centres, comprehensive day programmes at rehabilitation centres, supportive living programmes, independent living centres, club-house programmes, school based programmes for children and others. The TBI patient, the family and the rehabilitation team members should work together to find the best place for the patient to recover (*Rao and Lyketsos, 2000).*

Neuropsychological rehabilitation is concerned with the amelioration of cognitive, emotional, psychosocial and behavioural deficits caused by an insult to the brain. Major changes in neuropsychological rehabilitation have occurred over the past decade or so (*Rao and Lyketsos, 2000)*. Neuropsychological rehabilitation is now mostly centered on a goal-planning approach in a partnership of survivors of brain injury, their families and professional staff who negotiate and select goals to be achieved. There is widespread recognition that cognition, emotion and psychosocial functioning are interlinked and all should be targeted in rehabilitation (*Rao and Lyketsos, 2000).*

PSYCHOLOGICAL INTERVENTION

A number of basic assumptions and well established principles for ethic and effective rehabilitation have been established. Interventions that address cognitive impairments must be seen as a collaborative enterprise involving patients, family, professionals and communities. Interventions must be goal oriented and address practical and meaningful aspects of the person’s everyday life. Cognitive interventions are dynamic and often involve a combination of activities designed to maximise areas of cognitive functioning, to increase insight and awareness and to identify and implement internal and external compensatory strategies. Cognitive abilities are interlinked with behavioural, emotional and psychosocial functioning and must be addressed in many effective treatment programmes. Effective neuropsychological rehabilitation relies on a broad theoretical base incorporating frameworks, models and methodologies from many different fields of scientific, medical, neuropsychological, social and ethical inquiry (Mateer, 2002).

Most of the recovery takes place in the first three months, with the rate of recovery levelling off at the nine month mark and reaching an asymptote after an interval of about one year. While many individuals do show this kind of recovery pattern, there are a number of positive and negative factors that can undermine and distort the normal progression of recovery from brain damage. There is often a rapid recovery in the first few months after brain insult unless brain damage is severe (Andrews, 2001).

Flexible thinking is made up of both divergent thinking (thinking outwards or generating ideas from a single point) and convergent thinking

(thinking inwards, taking ideas and summarizing them). Exercises which practice these skills not only improve ability but also help to identify difficulties and improve awareness (Burgess, 1997).

Diminished self confidence, negative self reference, inflexibility, desire for withdrawal, slower thinking, emotional unpredictability, frustration and intolerance may stem from the injury. Educating the patient, building up self confidence, preparing the patient to cope with the injured condition, providing adequate training, creating awareness in the family, etc. are some of the intervention which are compulsorily recommended in this condition. Treatment can be variable, but typically includes counselling and education and potentially use of medications and/or specific therapy, including cognitive therapy and psychological counselling.

REASONING

Cognitive science sees reasoning by the analogy to a data processing, where relations between observed properties of reasoning are used in numerous models leading to evident logically correct conclusions in different circumstances. The complexity and efficacy of reasoning is considered the critical indicator of cognitive intelligence. Therefore it is the inevitable component of cognitive decision-making (Copeland, 1993).

Definitions

Sternberg (2004, c f Eysenck, 2006) pointed out, “reasoning is not encapsulated (enclosed or isolated). It is part and parcel of a wide array of cognitive functions….. many cognitive processes, including visual perception contain elements of reasoning in them”.

Reasoning is just the continuation of comprehension by other means (Johnson-Laird**,** 1999).

Reasoning is the mental process of deriving consequences from given information (Johnson-Laird, 2000).

Reasoning is a method of thinking by which changes that occur across dimensions of space can be chartered (Mukundan, 2007).

Reasoning is the cognitive process of looking for reasons for beliefs, conclusions, actions or feelings (Kirwin, 1995).

Humans have the ability to engage in reasoning about their own reasoning using introspection. Different forms of such reflection on reasoning occur in different fields. Psychologists and cognitive scientists, tend to study how people reason, which brain processes are engaged and how the reasoning is influenced by the structure of the brain (Kirwin, 1995).

Scientific research into reasoning is carried out within the fields of psychology and cognitive science. Psychological research into reasoning falls into two general areas of research. First, the biological functioning of the brain is studied by neurophysiologists and neuropsychologists. Research in this area includes research into the structure and function of normally functioning brains and of damaged or otherwise unusual brains. Second, psychologists carry out research on reasoning behaviour. Such research may focus, for example, on how people perform on tests of reasoning, such as intelligence or I.Q. tests, or on how well people's reasoning matches ideals set by logic (Manktelow, 1999). In addition to carrying out research into reasoning, some psychologists, for example, clinical psychologists and psychotherapists work to alter people's reasoning habits when they are unhelpful.

Reasoning and the Brain

The famous Russian neuropsychologist Luria once remarked, ‘‘the cerebral organization of thinking has no history whatsoever.’’ Fodor, the distinguished philosopher of mind, predicted that it has no future either because thinking depends on general processes rather than separate brain modules, such as those that underlie perception or motor control. Nevertheless, a start has been made in the study of the neuropsychology of reasoning. The results so far have been largely at the level of ‘these areas of the brain underlie reasoning,’ and their interpretations are at best tentative (Marie, 1997).

Logical Reasoning and Personal Reasoning

Clinical studies in the early 20th century often reported the loss of ‘abstract thinking’ as a result of brain damage. Such accounts, however, suffered from two irremediable problems. On the one hand, they never succeeded in characterizing a principled difference between abstract and concrete thinking. On the other hand, they failed to pin down the particular effects of lesions in different parts of the brain. This shortcoming is understandable given that many regions of the brain are likely to underlie reasoning. Modern neuropsychological investigations suggest that the real distinction is between logical reasoning with neutral materials and personal reasoning that engages individuals’ beliefs and knowledge. Some studies suggest that logical reasoning depends on the left cerebral hemisphere, whereas personal reasoning implicates the right hemisphere and bilateral ventromedial frontal cortex. Positron emission tomography scans show greater left hemisphere activity when individuals evaluate syllogisms or judge the plausibility of inductive inferences. The control task was to judge how many of the sentences had people as their subjects. The effects of brain damage also appear to support the dissociation between logical and personal reasoning. For example, left hemisphere lesions impair simple relational inferences, such as:

Mary is taller than John.
John is taller than Anne
Is Mary taller than Anne?

People who live in nonliterate cultures are happy to carry out personal reasoning, but they balk at logical reasoning when the content is outside their experience. Analogous effects have been obtained using electroconvulsive therapy (ECT), which suppresses cortical activity for 30 minutes or more. Before ECT, the patients (depressives and schizophrenics) tended to justify their responses to deductive problems on logical grounds. They also did so more rapidly and confidently after ECT had suppressed their right hemispheres. However, after the suppression of their left hemispheres, they tended to respond on grounds of personal experience in ways similar to members of nonliterate cultures, often rejecting a logical task based on unfamiliar content as impossible because it was outside their knowledge. Similar effects of brain damage occurred in a study of the selection task with a neutral conditional. Patients with left hemisphere damage, like control subjects, tended to err in the characteristic way. Surprisingly, however, half the patients with right hemisphere damage made the correct selections. Perhaps the right hemisphere impedes logical reasoning because it allows knowledge and probabilistic considerations to influence performance. Certainly, the right hemisphere seems to play a role in automatic implicit inferences. Patients who have had a right-hemisphere lobectomy are also poorer at reasoning from false premises than those with a left hemisphere lobectomy. In general, right hemisphere damage seems to impair the ability to ‘get the point’ of a story, to make implicit inferences establishing coherence and to grasp the force of indirect illocutions such as requests framed in the form of questions. It is tempting, but erroneous, to conclude that the left hemisphere is the seat of logic, whereas the right hemisphere is the seat of personal reasoning. Damage to the right hemisphere can lead to semantic difficulties in the interpretation of words and so it may also impair the comprehension of discourse (Goldstein, 2005).

A recent functional magnetic resonance imaging (fMRI) study confirmed the existence of dissociable networks for logical and personal reasoning, which share circuits in common in the basal ganglia, cerebellum and left prefrontal cortex. However, the activation suggested that personal reasoning recruits the left hemisphere linguistic system, whereas logical reasoning even in inferences of an identical form recruits the parietal spatial system. Also, when reasoning elicits a conflict between logic and belief, right prefrontal cortex becomes active, perhaps to resolve the incongruence. Another recent fMRI study established that deductive reasoning activates right dorsolateral prefrontal cortex whereas mental arithmetic from the same premises does not (Wilson and Keil, 1999).

Clinical and imaging studies of the brain have yet to establish how reasoners make deductions. There is evidence for separate systems mediating logical inferences with neutral content and personal inferences with a content that engages knowledge and beliefs. Future studies may determine whether separate brain mechanisms underlie the control of different deductive strategies, the use of diagrams as opposed to verbal premises and the construction and evaluation of multiple models. Modern logic has developed both proof theory and model theory for systems powerful enough to cope with all the deductive inferences that human beings make. What is lacking is a systematic method for translating such inferences into formal logic. Psychologists continue to investigate deductive reasoning. Their two main theoretical accounts are based on rules of inference and on mental models, respectively a distinction that parallels the one between proof theory and model theory in logic. Rule theorists emphasize the automatic nature of simple deductions and postulate rules corresponding to them. More complex inferences, they assume, call for sequences of simple deductions. In contrast, model theorists emphasize that reasoning is the continuation of comprehension by other means. The system for implicit inferences based on knowledge aids the process of constructing models of discourse. In deliberative reasoning, individuals tend to focus on possibilities in which the premises are true. However, they can grasp the force of counterexamples. The evidence suggests that people have a modicum of deductive competence based on mental models. Rules of inference and mental models, however, are not incompatible. Advanced reasoners may construct formal rules for themselves a process that ultimately leads to the discipline of logic.

ATTENTION

Attention is the cognitive process of selectively concentrating on one aspect of the environment while ignoring other things (Strayer, Drews and Johnston, 2003). Sometimes attention shifts to matters unrelated to the external environment, a phenomenon referred to as mind wandering or 'spontaneous thought'. Attention is one of the most intensely studied topics within psychology and cognitive neuroscience. Of the many cognitive processes associated with the human mind (decision-making, memory, emotion, etc), attention is considered the most concrete because it is tied so closely to perception.

Defining the concept attention is similar challenge to defining such broad topics as intelligence. The neuropsychology of attention is heavily influenced by a long-standing literature of studies carried out on subjects without brain damage (Andrews, 2001).

Definitions

One of the first major psychologists, William James, defined attention as follows:

> "Everyone knows what attention is. Focalizations, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others and is a condition which has a real opposite in the confused, dazed, scatterbrained state." (1890, cited from *Knudsen, 2007)*.

Attention can be defined as a readiness on the part of the organism to perceive stimuli that surround it (Urbina, 1994).

Herman von Helmholtz a German physiologist says that attention refers to concentrating upon a particular aspect of the external environment, although it is possible to attend one's own thought and other internal states (Chastain, 1996).

Attention refers to a person's selection of only some of a number of things of which a person could be conscious (Chastain, 1996).

Titchner explains attention as the state of sensory clearness and vividness; state of consciousness in which one mental content stands out clearly from the rest (Wolman, 1973).

Weiten (1998) has defined attention as focusing awareness on a narrowed range of stimuli or events.

Moving about the world, people confront a flood of information that the nervous system cannot treat equally. Our brain must target or ‘spotlight’ specific material to process and tune the irrelevant out. In this way attention operates as a gateway for information processing. Attention allows orienting to, selecting and maintaining focus on information to make it available for cortical processing (Zillmer and Spiers, 2001).

The term attention can refer to general level of alertness or vigilance; a general state of arousal; orientation versus habituation to stimuli; the ability to focus, divide, or sustain mental effort; the ability to target processing within a specific sensory arena (such as visual attention or auditory attention); or a measure of capacity. Attentional processing does not imply a unified system, but a multifaceted concept that implies multiple behavioural states and cortical processes that various subsets of cerebral structures control (Zillmer and Spiers, 2001).

Attention may be differentiated according to its status as 'overt' versus 'covert'. Overt attention is the act of directing sense organs towards a stimulus source. Covert attention is the act of mentally focusing on one of several possible sensory stimuli. Covert attention is thought to be a neural process that enhances the signal from a particular part of the sensory panorama (Treisman and Gelade, 1980).

Attentional Processes

The attentional issues of most interest to human neuropsychology generally concern the higher levels of attentional processing coordinated by the cerebrum, including focused attention, the ability to alternate and divide attentional processes and the ability to sustain attention.

Focused attention: This is the ability to respond and pick out the important elements or ‘figure’ of the attention from the ‘ground’ or background of external and internal stimulation. Focused attention also implies a measure of concentration or effortful processing.

Alternating attention: It refers to the capacity for mental flexibility that allows individuals to shift their focus of attention and move between tasks having different cognitive requirements. People are frequently called on to alternate and divide attention in the course of daily activities.

Divided attention: This is the highest level of attention and it refers to the ability to respond simultaneously to multiple tasks or multiple task demands. Divided attention requires partialing out attentional resources at the same time rather than switching back and forth, however quickly.

Sustained attention: This refers to the ability to maintain a consistent behavioural response during continuous and repetitive activity. It is related to the ability to persist and sustain a level of vigilance.

Selective attention: This level of attention refers to the capacity to maintain a behavioural or cognitive set in the face of distracting or competing stimuli. Therefore it incorporates the notion of ‘freedom from distractibility’.

The posterior attentional network centres on the parietal lobe, the lateral pulvinar of the posteriolateral thalamus and the superior colliculus. This system plays a role in conscious attention to portions of our visual-spatial field and then directs the attention to our eyes to the point in space. The posterior parietal lobe mediates conscious attention to spatial targets, the superior colliculus plays a role in directing the eyes from one position to another and the pulvinar of the thalamus is an that, like the basal ganglia, helps select and filter important sensory information for processing. The superior colliculus plays a role in directing visual attention; the inferior colliculus plays a similar role in auditory attention. People with lesions to the posterior parietal lobe frequently fail to attend to the opposite visual field, although they can detect visual input (Posner and Petersen, 1990).

The role of frontal cortex in attention relates to aspects of attentional planning, shifting of attentional set (alternating and dividing attention) and sustaining attention versus becoming distracted. Patients with frontal lobe damage often complain of being upset or easily led off track by distractions (Zillmer and Spiers, 2001).

Attentional dysfunction is often a concomitant of more generalized cerebral impairment. Patients with neurologic disease, as well as patients who have suffered a closed head injury, often complain of mentally wearing out when engaged in tasks that require persistent effortful attention (Zillmer and Spiers, 2001).

A reduced concentration span is very common after head injury, as is a reduced ability to pay attention to more than one task at the same time. These problems are usually caused by damage to the frontal lobe. Attentional problems tend to get worse when the person is tired, stressed or worried.

When there are problems with concentration, other skill areas can be affected. It is difficult to follow instructions, plan ahead, be organised and so on, when there is a problem concentrating. Working in a place with as few distractions as possible can help and, as concentration improves, distractions can be increased.

Attention and the Brain

Neuropsychological theories of attentional processing usually consider the role of the reticular activating system in cortical arousal, subcortical and lymbic system structures (particularly the cingulate gyrus) in regulation of information to be attended to, the posterial parietal lobe system in focusing conscious attention and the frontal lobes in directing attentional resources. They also give the right hemisphere prominence as an attentional processor. Theorists have not yet worked out any one-to-one correspondence between levels of attentional behaviour and brain structures or networks. Rather, they can describe general subsets of brain systems related to attentional functioning (Cohen, 1993).

The reticular activating system (RAS) regulates the level of cortical activation or arousal -a necessary first step in attentional processing. With its genesis in the midbrain and its ability to project to large cortical areas, the RAS sets a general cortical tone. In a general way, sensory input ‘charges’ the RAS. If the brainstem is processing sensory input, the RAS maintains high cortical activation. However, lack of sensory input does not necessarily make one drowsy. In fact, even with constant sensory input there can be habituation (Zillmer and Spiers, 2001).

MEMORY

Traditional studies of memory began in the realms of philosophy, including techniques of artificially enhancing the memory. The late nineteenth and early twentieth century put memory within the paradigms of cognitive psychology. In recent decades, it has become one of the principal pillars of a branch of science called cognitive neuroscience, an interdisciplinary link between cognitive psychology and neuroscience.

Memory is not one thing or one skill on its own. It is easily damaged by brain injury because there are several structures within the brain that are involved in processing information, storing it and retrieving it. Damage to those parts of the brain on which these abilities depend can lead to poor memory.

Short-term memory loss is the most common and troublesome type of memory problem. This can manifest itself in a variety of ways. Examples of this are forgetting what has been just said, having difficulty in learning a new skill, repeating the same question over and over, forgetting people's names, getting details mixed up, forgetting a change in routine and forgetting where things have been placed.

Definitions

The term memory implies the capacity to encode, store and retrieve information (Baddeley, 1999).

‘Memory is the mental function of retaining information about stimuli, events, images, ideas and so on after the original stimuli are no longer present’(Penguin Dictionary of Psychology, p.309).

‘Memory is the ability to keep things in one’s mind or recall them it will’ (The Oxford Dictionary, p.554).

Memory forms the basis of experience and perceptions of self. It is dynamic and malleable. Memory pervades most aspects of human experience. Stories of our personal and cultural past are stored in memory, so it is a necessary foundation of social communication (Zillmer and Spiers, 2001).

Processes

There are several ways to classify memories based on duration, nature and retrieval of information. From an information-processing perspective there are three main stages in the formation and retrieval of memory:

Encoding or registration - processing and combining of received information.

Storage - creation of a permanent record of the encoded information.

Retrieval or *recall* -calling back the stored information in response to some cue for use in a process or activity.

Classification

A basic and generally accepted classification of memory is based on the duration of memory retention and identifies three distinct types of memory: sensory memory, short term memory and long term memory.

Sensory Memory

Sensory memory corresponds approximately to the initial 200-500 milliseconds after an item is perceived. The ability to look at an item and remember what it looked like with just a second of observation, or memorization, is an example of sensory memory. With very short presentations, participants often report that they seem to 'see' more than they can actually report. Sensory memory is fleeting, lasting only milliseconds, but its capacity is essentially unlimited in what may be taken in (Zillmer and Spiers, 2001).

Short-Term Memory

Some of the information in sensory memory is then transferred to short-term memory. Short-term memory allows one to recall something from several seconds to as long as a minute without rehearsal. Its capacity is also very limited: George A. Miller, conducted experiments showing that the store of short term memory was 7±2 items. Modern estimates of the capacity of short-term memory are lower, typically on the order of 4-5 items and the memory capacity can be increased through a process called chunking.

People can remember a great deal more letters. This is because they are able to chunk the information into meaningful groups of letters. Short-term memory is believed to rely mostly on an acoustic code for storing information and to a lesser extent a visual code. Short-term memory (STM) is of limited capacity (7+2 bits of information) and degrades quickly over a matter of seconds if necessary information is not held via a means such as rehearsal or transferred to long-term memory.

Long-Term Memory

The storage in sensory memory and short-term memory generally has a strictly limited capacity and duration, which means that information is available for a certain period of time but is not retained indefinitely. By contrast, long-term memory can store much larger quantities of information for potentially unlimited duration (sometimes a whole life span). Long-term memory (LTM), theoretically, is of unlimited capacity and relatively permanent except for models that suggest that loss of information through forgetting is possible. Neuropsychologists are most concerned with long-term memory and its disorders because there are the problems most evidenced by patients (Zillmer and Spiers, 2001).

Short-term memory is supported by transient patterns of neuronal communication, dependent on regions of the frontal lobe (especially dorsolateral prefrontal cortex) and the parietal lobe. Long-term memories, on the other hand, are maintained by more stable and permanent changes in neural connections widely spread throughout the brain. The hippocampus is essential to the consolidation of information from short-term to long-term memory, although it does not seem to store information itself. Rather, it may be involved in changing neural connections for a period of three months or more after the initial learning.

Anderson (1976) divides long-term memory into declarative (explicit) and procedural (implicit) memories. Declarative requires conscious recall, in that some conscious process must call back the information. It is sometimes called explicit memory, since it consists of information that is explicitly stored and retrieved. Declarative memory can be further sub-divided into semantic memory, which concerns facts taken independent of context; and episodic memory, which concerns information specific to a particular context such as a time and place. Autobiographical memory - memory for particular events within one's own life - is generally viewed as either equivalent to, or a subset of, episodic memory. Visual memory is part of memory preserving some characteristics of our senses pertaining to visual experience (Cardwell and Flanagan, 2005). In contrast, procedural memory (or implicit memory) is not based on the conscious recall of information, but on implicit learning. Procedural memory is primarily employed in learning motor skills and should be considered a subset of implicit memory. Procedural memory involved in motor learning depends on the cerebellum and basal ganglia (Cardwell and Flanagan, 2005).

Physiology

Overall, the mechanisms of memory are not completely understood. Brain areas such as the hippocampus, the amygdala, the striatum or the mammillary bodies are thought to be involved in specific types of memory. The hippocampus is believed to be involved in spatial learning and declarative learning, while the amygdala is thought to be involved in emotional memory. Damage to certain areas in patients and animal models and subsequent memory deficits is a primary source of information. However, rather than implicating a specific area, it could be that damage to adjacent areas or to a pathway travelling through the area is actually responsible for the observed deficit. Further, it is not sufficient to describe memory and its counterpart learning as solely dependent on specific brain regions. Learning and memory are attributed to changes in neuronal synapses, thought to be mediated by long-term potentiation and long-term depression (Kalat, 2001).

Hebb distinguished between short-term and long-term memory. He postulated that any memory that stayed in short-term storage for a long enough time would be consolidated into a long-term memory. Later research showed this to be false. Research has shown that direct injections of cortisol or epinephrine help the storage of recent experiences. This is also true for stimulation of the amygdala. This proves that excitement enhances memory by the stimulation of hormones that affect the amygdala. Excessive or prolonged stress (with prolonged cortisol) may hurt memory storage. Patients with amygdalar damage are no more likely to remember emotionally charged words than nonemotionally charged ones. The hippocampus is important for explicit memory. The hippocampus is also important for memory consolidation. The hippocampus receives input from different parts of the cortex and sends its output out to different parts of the brain also. The input comes from secondary and tertiary sensory areas that have processed the information a lot already. Hippocampal damage may also cause memory loss and problems with memory storage (Kalat, 2001).

PROBLEM SOLVING

The famous mathematician George Polya made the following comment in his book Mathematical Discovery:

> Solving a problem means finding way out of a difficulty, a way around an obstacle, attaining an aim that was not immediately understandable. Solving problems is the specific achievement of intelligence and intelligence is the specific gift of mankind. Solving problems can be regarded as the most characteristically human activity (Reed, 2000).

Definitions

Problem solving refers to the achievement of a goal within a set of constraints (Haberlandt, 1997).

Problem solving involves moving from a problem situation to a solution, overcoming obstacles along the way (Sternberg, 2000).

Problem solving is the process involved in the determination of the correct sequence of alternatives leading to a desired goal (Wolman, 1973) and it is active efforts to discover what must be done to achieve a goal that is not readily available (Weiten, 1998).

Problem solving forms part of thinking. Considered the most complex of all intellectual functions, problem solving has been defined as higher-order cognitive process that requires the modulation and control of more routine or fundamental skills (Goldstein and Levin, 1987). It occurs if an organism or an artificial intelligence system does not know how to proceed from a given state to a desired goal state. It is part of the larger problem process that includes problem finding and problem shaping.

Beginning with the early experimental work of the Gestalts in Germany and continuing through the 1960s and early 1970s, research on problem solving typically conducted relatively simple, laboratory tasks (e.g. Ewert & Lambert's 'disk' problem, later known as Tower of Hanoi) that appeared novel to participants (Mayer, 1992). The researchers made the underlying assumption, of course, that simple tasks such as the Tower of Hanoi captured the main properties of 'real world' problems and that the cognitive processes underlying participants' attempts to solve simple problems were representative of the processes engaged in when solving 'real world' problems. Thus researchers used simple problems for reasons of convenience and thought generalizations to more complex problems would become possible.

In essence, there are three aspects to problem solving:

1. It is purposeful in the sense of being goal-directed (trying to achieve something).
2. It involves controlled cognitive processes rather than autonomic ones.
3. A problem only exists when someone lacks the relevant knowledge to produce an immediate solution. Thus, a mathematical calculation may be a problem for most of us but not for a professional mathematician.

Types of Problem Solving

Routine versus Nonroutine Problems

It is customary in the problem-solving literature to distinguish between routine and nonroutine problems. A routine problem is a problem for which the problem solver knows a solution method. Routine problems can also be called exercises because they involve exercising procedures that the problem solver already knows. Routine problems depend on reproductive thinking; in reproductive thinking, problem solvers must reproduce responses that they have used in the past. A nonroutine problem is a problem for which the problem solver does not know the solution method. Nonroutine problems depend on productive thinking in which problem solvers create a novel solution that they have never produced before. The cognitive processes involved in solving nonroutine problems may be different from those involved in solving routine problems, which may be reflected in different patterns of brain activity (Shallice, 1988).

Well-Defined versus Ill-Defined Problems

It is also customary to distinguish between well defined and ill-defined problems. A well-defined problem has a clearly stated given state, a clearly stated goal state and clearly stated set of operations. In an ill-defined problem, the given state, goal state and/or operators are not clearly stated. Well-defined problems can be either routine or nonroutine; ill-defined problems can be either routine or nonroutine.

Processes in Problem Solving

Problem Representation

There are two major processes in problem solving: problem representation and problem solution. In problem representation, a problem solver builds an internal mental representation of the problem based on a statement or presentation of the problem. In short, the problem solver comprehends the problem. Cognitive psychologists have further analyzed problem representation into two sub processes: translation and integration. Translation involves mentally representing each sentence or portion of the problem. Integration involves putting knowledge together into a coherent structure that can be called a situation model; the situation model is the problem solver’s mental model of the problem situation.

Problem Solution

In problem solution, the problem solver devises and carries out a plan for solving the problem. In short, the problem solver produces a solution to the problem. The process of problem solution includes the sub processes of planning, executing and monitoring. Planning involves devising a solution plan, that is, a method for solving the problem. Monitoring involves awareness and control of one’s cognitive processing, including determining the extent to which the problem solution phase is successful and altering one’s course if necessary. Monitoring is a metacognitive process because it involves awareness and control of one’s cognitive processing (Halpearn, 2002).

Approaches to Problem Solving

Associationist

In the early 1900s, associationist theory developed as psychology’s first large-scale account of how the human mind works. The approach received a large boost from the landmark work of Edward L. Thorndike, including his classic book, ‘Animal Intelligence’, which was published in 1911. According to this view, knowledge is a network consisting of nodes and associations among them. The strength of the association between two nodes depends on the experience of the learner. Problem solving involves beginning at one of the nodes and following a chain of associations to other nodes, always taking the association that is the strongest. According to the associationist view, problem solving is simply a matter of exercising existing associations. One of the major criticisms of this approach to problem solving is that it fails to adequately account for creative problem solving.

Gestalt

In the 1930s and 1940s, Gestalt theory provided an important alternative to associationist theory, culminating in psychology's second account of how the human mind works. The approach is reflected in the work of the Gestalt psychologists such as Wolfgang Kohler's *The Mentality of Apes* and Max Wertheimer's *Productive Thinking*. According to this view, problem solving occurs when the problem solver mentally reorganizes the problem situation in a new way. Problem solving is not a matter of following pre-existing associations but rather requires structural insight seeing how the parts of the problem fit together to achieve the goal. Insight occurs when a problem solver suddenly moves from a state of not knowing how to solve a problem to a state of knowing how to solve a problem. A major criticism of the Gestalt approach is that it is too imprecise.

CREATIVITY

Creativity (or 'creativeness') is a mental process involving the generation of new ideas or concepts or new associations between existing ideas or concepts. From a scientific point of view, the products of creative thought (sometimes referred to as divergent thought) are usually considered to have both originality and appropriateness. An alternative, more everyday conception of creativity is that it is simply the act of making something new.

Creativity has been attributed variously to divine intervention, cognitive processes, the social environment, personality traits and chance ('accident', 'serendipity'). It has been associated with genius, mental illness and humour. Some say it is a trait we are born with; others say it can be taught with the application of simple techniques.

Although popularly associated with art and literature, it is also an essential part of innovation and invention and is important in professions such as business, economics, architecture, industrial design, science and engineering.

Definitions of Creativity

More than 60 different definitions of creativity can be found in the psychological literature **(**Taylor, 1988). The etymological root of the word in English and most other European languages comes from the Latin *creatus*, literally ‘to have grown.’

Creativity is the ability to create something new that goes beyond ordinary modes of thought (Shaughnessy, 1996). It is the generation of ideas that are original, novel and useful (Weiten, 1998).

Theories of Creativity

Psychodynamic approach

The psychodynamic approach to understanding creativity was proposed by Sigmund Freud who suggested that creativity arises as a result of frustrated desires for fame, fortune and love with the energy that was previously tied up in frustration and emotional tension in the neurosis being sublimated into creative activity. Freud later retracted this view.

Graham Wallas

Graham Wallas & Richard Smith, in their work *Art of Thought*, published in 1926, presented one of the first models of the creative process (*Albert and Runce, 1999)*. In the Wallas stage model, creative insights and illuminations may be explained by a process consisting of 5 stages:

(i) ***Preparation*-**preparatory work on a problem that focuses the individual's mind on the problem and explores the problem's dimensions,

(ii) ***Incubation*-**where the problem is internalized into the unconscious mind and nothing appears externally to be happening,

(iii) ***Intimation*-** the creative person gets a 'feeling' that a solution is on its way,

(iv) ***Illumination*-**or insight where the creative idea bursts forth from its preconscious processing into conscious awareness; and

(v) ***Verification*-**where the idea is consciously verified, elaborated and then applied.

Wallas considered creativity to be a legacy of the evolutionary process which allowed humans to quickly adapt to rapidly changing environments.

J.P. Guilford

Guilford performed important work in the field of creativity, drawing a distinction between convergent and divergent production (commonly renamed convergent and divergent thinking). Convergent thinking involves aiming for a single, correct solution to a problem, whereas divergent thinking involves creative generation of multiple answers to a set problem. Divergent thinking is sometimes used as a synonym for creativity in psychology literature. Other researchers have occasionally used the terms flexible thinking or fluid intelligence, which are roughly similar to creativity (*Albert and Runce, 1999)*.

Geneplore Model

In 1992 Finke, Ward and Smith proposed the 'Geneplore' model in which creativity takes place in two phases: a generative phase, where an individual constructs mental representations called pre-inventive structures and an exploratory phase where those structures are used to come up with creative ideas.

Conceptual Blending

In the 90s, various approaches in cognitive science that dealt with metaphor, analogy and structure mapping have been converging and a new integrative approach to the study of creativity in science, art and humour has emerged under the label conceptual blending.

Creativity and the Brain

Highly creative people who excel at creative innovation tend to differ from others in three ways:

- they have a high level of specialized knowledge,
- they are capable of divergent thinking mediated by the frontal lobe and
- they are able to modulate neurotransmitters such as norepinephrine in their frontal lobe.

Thus, the frontal lobe appears to be the part of the cortex that is most important for creativity. In 2005, Alice Flaherty (2005) presented a three-factor model of the creative drive. Drawing from evidence in brain imaging, drug studies and lesion analysis, she described the creative drive as resulting from an interaction of the frontal lobes, the temporal lobes and dopamine from the limbic system. The frontal lobes can be seen as responsible for idea generation and the temporal lobes for idea editing and evaluation. Abnormalities in the frontal lobe (such as depression or anxiety) generally decrease creativity, while abnormalities in the temporal lobe often increase creativity. High activity in the temporal lobe typically inhibits activity in the frontal lobe and vice versa. High dopamine levels increase general arousal and goal directed behaviours and reduce latent inhibition and all three effects increase the drive to generate ideas (Flaherty, 2005).

OPERATIONAL DEFINITIONS

Reasoning: Reasoning is just the continuation of comprehension by other means in order to derive consequences from given information.

Attention: Attention refers to a person’s selection of only some of a number of things of which a person could be conscious and the readiness on his part to perceive stimuli that surround it.

Memory: Memory is the mental function of retaining information about stimuli, events, images, ideas and so on after the original stimuli are no longer present. It is the capacity to encode, store and retrieve information.

Problem solving: It is the ability to reach from a problem situation to a not readily available solution using limited sequences which are correct.

Creativity: It is the ability to become sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies and so on or identifying the difficulty, searching for solutions, making guesses, testing them and finally communicating the results.

SIGNIFICANCE OF THE STUDY

Psychology in today’s era is heading towards a direction where it is making its presence felt in all walks of life. Earlier psychologists were supposed to be counsellors but today with the developments happening in the field this subject is applied in all areas. The developments in biopsychology have given a platform for psychologists to enter a very trying field of rehabilitation of the brain injured.

Head injuries are extremely common. The most common are closed-head injuries, the majority of which occur in association with motor vehicle accidents. Virtually all studies of head injury suggest a peak incidence in the 15 to 24 years of age group. Coarse measures of outcome suggest that the very young and the elderly have poorer outcomes. Because of improved acute care, however, a large number of young, otherwise healthy patients are surviving head injuries with a variety of profound neuropsychiatric sequelae (McAllister, 1992).

Cognitive impairment is often diffuse with more prominent deficits in rate of information processing, attention, memory, cognitive flexibility and problem solving. Prominent impulsivity, affective instability and disinhibition are seen frequently, secondary to injury to frontal, temporal and limbic areas. In association with the typical cognitive deficits, these sequelae characterize the frequently noted ‘personality changes’ in brain injured patients (McAllister, 1992).

The complexity of the neurologic mechanisms operating in normal thought processes is obvious as is their impact on the quality of human life. The efficient performance of intellectual activity, that is, thinking and reasoning, assumes an awake, alert state and encompasses the interplay of fundamental mental operations such as attention, memory, spatial orientation, language and higher order functions of insight, calculation and abstract reasoning. Systematic assessment of the full range of operations is required to accurately diagnose alterations in thought processes because the identification of specific impairments may facilitate the localization of brain injury as well as focus nursing intervention (Glick, 1993).

Brain injury could happen in any walk of life. With the increasing pace of today’s world accidents are, unfortunately, extremely common. Brain injury may occur from places like schools, buildings, roads, natural calamities, playgrounds, to anywhere possible. Besides accidents brain injury can occur from infection and disease of the brain.

Whatever be the cause of brain injury, the plight of the brain injured is extremely pathetic. The brain injured patients suffer mentally, physically, socially and most of the times financially. A psychologist could play a crucial role in bringing back the brain injured to normal life. Psychological brain exercises, which boost mental functions are found to be rehabilitative and increase the chances of recovery. This research is a step taken in this direction to help the brain injured attain a healthy and improved life style.

The title of the thesis reads as “Effectiveness of Psychological Intervention on Cognitive Functions of Brain Injured”.

REVIEW OF LITERATURE

A number of studies have been conducted by many researchers with regard to the nature of brain injury and its related variable such as Attention, Memory, Problem solving, Reasoning and Creativity. A brief review of research findings related to the present study is given in this chapter.

REASONING

Adolescents sustaining mild closed head injury were evaluated for mental functioning immediately following injury. Evaluation of their neuropsychological performance in comparison with healthy adolescents and adolescents sustaining severe closed head injury revealed a pattern distinct from the other two groups. Mildly injured patients exhibited dysfunction in reasoning (Bassett and Slater, 1990), while appearing unimpaired on measures of attention, motor speed and visual memory.

MacDonald and Johnson (2005) evaluated the subtle cognitive-communication deficits of individuals with brain injury. Individuals with brain injury were slower and less accurate in reasoning (McDonald, Flashman and Saykin, 2002) and presented fewer adequate rationales for their decisions.

The assessment of neurobehavioural outcome after head injury in older patients (> 60 year old) has met with difficulties, due to the obstacles in finding subjects who would constitute an appropriate control group. In a study conducted by Aharon-Peretz, *et al* (1997), survivors of closed head injury (CHI) of this age group were compared to two control groups: (1) orthopaedic patients (OP) who were injured in similar circumstances but did not sustain head injury and (2) healthy, age-matched volunteers (HC). Compared with HC, CHI and OP were impaired on reasoning. This result indicates that, rather than resulting only from the head injury brought about by falling, the cognitive decline may predate the injury and increase the risk of accidents in old age.

Goverover and Hinojosa (2002) examined the predictive relationship of categorization and deductive reasoning abilities to performance of instrumental activities of daily living (IADL) among adults with brain injury. The results of this study indicate that assessments of categorization and deductive reasoning abilities of persons with brain injury may be good predictors of IADL functional performance.

Salazar, *et al* (1986) compared the neurologic and cognitive performance of 15 young veterans who suffered unilateral penetrating missile wounds to the basal forebrain 15 years ago in the Vietnam War with uninjured controls and patients with lesions elsewhere in the brain. The subjects performed worse on tests of reasoning and arithmetic and had more prolonged unconsciousness after injury.

Executive dysfunction is among the most common and disabling aspects of cognitive impairment following traumatic brain injury (TBI) and may include deficits in reasoning, planning, concept formation, mental flexibility, aspects of attention and awareness and purposeful behaviour (McDonald, Flashman and Saykin, 2002). These impairments are generally attributed to frontal systems dysfunction, due either to direct insult to the frontal lobes or to disruption of their connections to other brain regions. Rehabilitation programs emphasizing cognitive-behavioural approaches to the retraining of planning and problem-solving skills can be effective in ameliorating identified executive deficits.

The post injury cognitive functioning of a sample of active duty, retired and military beneficiaries who received traumatic brain injuries were recorded. The scores on a major component of this evaluation, the Wechsler Adult Intelligence Scale, third edition, were summarized. The findings are consistent with the formulation that stable verbal skills are most resistant to brain injury, followed by nonverbal reasoning and visuospatial ability and then working memory with speed of information processing being the most vulnerable to the effects of brain injury (Clement and Kennedy, 2003).

Inferential reasoning in language involves the ability to deduce information based on context and prior experience. This ability has been generally studied as a right-hemisphere function. Recent research, however, has suggested that inferencing involves anterior regions of both the left and right hemispheres. Keil, Baldo, Kaplan, Kramer and Delis (2005) further explored this idea by testing a group of non-aphasic, focal frontal patients (right and left hemisphere) on a new test of inferencing, the Word Context Test. Results show that patients with frontal lobe lesions were significantly impaired on this task relative to a group of age- and education-matched controls. Contrary to earlier research focusing on a special role for the right hemisphere in inferencing, there was considerable overlap in performance of right- and left-frontal patients, with right-frontal patients performing better.

Disruptions to executive function (EF) may occur as a result of traumatic brain injury (TBI), in the context of direct damage to frontal regions or in association with disruption of connections between these areas and other brain regions. Little investigation of EF has occurred following TBI during childhood and there is little evidence of possible recovery trajectories in the years post-injury. Children sustaining severe TBI at a young age are particularly vulnerable to impairments in EF (Anderson and Catroppa, 2005). While these difficulties do show some recovery with time since injury, long-term deficits remain and may impact on ongoing development.

ATTENTION

Attention is a basic cognitive function and a prerequisite for other cognitive processes and is frequently impaired after traumatic brain injury (Hart, Whyte, Kim and Vaccaro, 2005; Mc Allister, 1992). Attentional deficits in patients suffering from traumatic brain injury (TBI) can occur with minor to severe impact to the brain (Donkelaar, Langan, Halterman, Osternig and Chou, 2004). In a study by Rios, Perianez and Munoz-Cespedes (2004), 29 severe traumatic brain injury patients and 30 control subjects completed a battery of three neuropsychological tests of attention (WCST, TMT, Stroop). The aim was to clarify the attentional mechanisms underlying tests performance and to explore the types of attentional impairment after severe traumatic brain injury. Significant differences were found between the control and clinical groups in almost all measures.

Global cognitive impairment following traumatic brain injury (TBI) is common, with some abilities more significantly affected than others (Sanders, Dietrich and Green, 1999). However, due to difficulties in estimating premorbid intelligence, there has been no systematic evaluation of the extent of decline in different cognitive abilities following TBI. A review by Johnstone, Hexum and Ashkanazi (1995) reveals that recent studies suggesting that the deficiency in attention and cognitive flexibility with TBI.

Human attention is now studied with a variety of methods, ranging from neuroimaging to behavioural studies of normals and brain-damaged patients. Recent results obtained using these methods converge on several conclusions. First, attention can affect early stages of perception (Park, Moscovitch and Robertson, 1999). Second, in low-load conditions, unattended stimuli can be processed to high levels, albeit in a tacit manner. Third, the distribution of attention depends on an interplay between reflexive and voluntary factors (Wilson *et al*., 1999). Finally, there are strong attentional links between the sensory modalities and between perception and action (Finset *et al*., 1999). These links might be exploited to remediate attentional deficits after brain injury (Driver and Mattingley, 1995; Anderson, Kaplan and Felsenthal, 1990).

Attention deficits are a prominent aspect of cognitive dysfunction after mild traumatic brain injury (MTBI) (Laidlaw, 1993). Patients frequently complain of distractibility and difficulty attending to more than one thing at a time and several neuropsychological studies have found evidence for a specific attention deficit without general neuropsychological impairment. Cicerone (1996) examined the nature of attentional disturbance after MTBI. The results are consistent with findings that patients with MTBI exhibit attention deficits.

Neuroradiological and neuropathological investigations have found evidence of diffuse brain damage in the frontal and temporal lobes (Godefroy, Lhullier and Rousseaux, 1996), corpus callosum and fornices in patients who have sustained a mild traumatic brain injury (TBI) (Comerford, Geffen, May, Medland and Geffen, 2002). Mathias, Beall and Bigler (2004) assessed a group of mild TBI patients and a matched control group on a number of standard neuropsychological tests of selective and sustained attention. In the 1st month after sustaining their injury, the mild TBI group demonstrated deficits in attention.

A retrospective study by Gross, Kling, Henry, Herndon and Lavretsky (1996) of 20 patients with mild traumatic brain injury (MTBI) claimed that specific brain areas might correlate with deficits in daily neurobehavioral functioning and neuropsychological test findings, most specifically, with inconsistent attention/concentration and overall neuropsychological test results (Pavlovi, Oci, Stefanova, Filipovi and Djordjevi, 1994). Clinicians report that patients with traumatic brain injury (TBI) often have difficulty with tasks requiring sustained attention (Rees, Marshall, Hartridge, Mackie and Weiser, 2007) and there are neuroanatomical and neurophysiological reasons to expect such deficits (Miller, 2001). Twenty-six patients with recent TBI and 18 control subjects were tested and results revealed significantly different patient and control performance overall. Initial level of performance (vigilance level) was slower and more variable for patients than controls (Whyte, Polansky, Fleming, Coslett and Cavallucci, 1995).

Segalowitz and Lawson, (1995) conducted a survey on the relationship between mild head injury incidence and a variety of psychological and educational symptoms in a sample of 1,345 high school and 2,321 university students. It has been found that significant relationships between the incidence of such mild head injury and gender, sleep difficulties, social difficulties, handedness pattern and diagnoses of attention deficit, depression and speech, language and reading disorders.

Thirty adults with traumatic brain injury (TBI) (20 males and 10 females, mean age 40 years) and a non-injured control group (12 males and 13 females, mean age 41 years) were tested on 16 tests of attention. Mild to moderate deficits of attention were seen in the TBI group relative to controls on the Vigilance and Distractibility tasks (Burg, Burright and Donovick, 1995). The results support the utility of the Vigilance and Distractibility tasks for assessment of attention in a mild to moderately injured population (Whyte, Rose, Glenn, Gutowski, Wroblewski and Reger, 1994).

Jonsson, Horneman and Emanuelson (2004) investigated the impact of time since injury on neuropsychological and psychosocial outcome after serious TBI in childhood or adolescence. Eight patients with serious TBI sustained at a mean age of 14 years who had been assessed neuropsychologically at 1, 7 and 14 years after TBI. Results showed that the performance of attention and working memory is low and that verbal learning is the cognitive domain, which exhibits the largest impairments.

Beers, Goldstein and Katz (1994) administered a comprehensive battery of neuropsychological, psychological and academic achievement tests to college students with learning problems and a control group and completed a series of discriminant function analyses. A combination of six neuropsychological and psycho educational test variables produced statistically significant differences among the three groups. The students with MHI showed cognitive deficits in visual-spatial skills and in the areas of attention, memory and novel problem solving (Tiller and Persinger, 1998).

The influence of severity of closed head injury and age on attentional functioning was prospectively investigated in 36 children (age range, 7 to 16 years) 6 months after injury. Children were placed into mild, moderate and severe injury groups using established neurologic criteria. Each child received the Wechsler Intelligence Scale for Children-Revised Digit Span subtest and a continuous performance test. Results showed the persistence of attentional impairments. Closed head injury is not associated with preferential sparing of sustained attention in younger children 6 months after injury.

There is much debate on the nature and duration of cognitive deficits and post concussive symptoms (PCS) after mild head injury. Most studies performed so far have compared head-injured patients with subjects who had not suffered a concussion, instead of directly comparing patients with and without persistent PCS. Bohnen, Jolles and Twijnstra (1992) examined whether patients with PCS about 6 months after an uncomplicated mild head injury performed less well on selected neuropsychological tests than patients with mild head injuries who did not have PCS and healthy controls. It has been found that patients with PCS performed less well on tests of divided and selective attention than both patients without PCS and healthy controls.

Research in the field of selective visual attention has recently seen substantial progress in several areas. Neuroimaging and electrical recording results have indicated that selective attention amplifies neural activity in prestriate areas concerned with basic visual processing. Imaging and cellular studies are delineating the networks of anatomical areas that serve as the source of attentional modulation and have suggested that these networks are anatomically distinct from the sites of the resulting amplifications. Attentional effects in normal subjects and their disruption following brain injury, have revealed the mental representations upon which attention operates (Posner and Driver, 1992).

Thirty-seven former soccer players of the National Football Team of Norway were individually examined with an extensive battery of psychological tests. The neuropsychological examination demonstrated mild to severe deficits regarding attention, concentration, memory and judgment in 81% of the players. This may indicate some degree of permanent organic brain damage, probably the cumulative result of repeated traumas from heading the ball (Tysvaer and Lochen, 1991).

Anderson and Catroppa (2005) examined executive functions in a group of 69 children who had sustained a mild, moderate or severe TBI. Four components of executive functions were assessed: (i) attentional control; (ii) planning, goal setting and problem solving; (iii) cognitive flexibility; and (iv) abstract reasoning. The results showed that, while children with severe TBI performed most poorly during the acute stage post-injury, they exhibited greatest recovery of executive functions over a 24-month period. Regardless, functional deficits remained most severe for this group 2 years post-injury. Results demonstrated the multi-dimensional nature of executive functions and the differential recovery of skills, following childhood TBI.

A prospective study was conducted using 25 brain-injured patients with cognitive dysfunction who were provided with a comprehensive day treatment program. Significant improvements in speech intelligibility, problem solving, memory, attention and social integration scores were noticed. These results demonstrate the effectiveness of this program in helping to rehabilitate patients with brain injury (Hashimoto, Okamoto, Watanabe and Ohashi, 2006; Van't Hooft, Andersson, Sejersen, Bartfai and Von Wendt, 2003).

Attention difficulties are in many cases one of the greatest impediments to successful rehabilitation, because attention problems frequently underlie other cognitive deficits (Uomoto, 1992; Chen, Thomas and Glueckauf, 1997). Logically, it could be argued that the remediation of cognitive deficits should begin in the area of attention. Cicerone (2002) and others (Cicerone *et al*., 2000; Sohlberg and Mateer, 1987; Sturm, Willmes and Orgass, 1997) found that specific attention training was more effective than non-specific during the post-acute phase. Attention is commonly integrated in the training of range of cognitive functions and there are also specific treatment programmes for training attention (Sohlberg and Mateer, 2001; Neistadt, 1994; Sturm, Willmes and Orgass, 1997). A series of studies has reported significant post-treatment improvement after training with Attention Process Training (APT) on standard measures of attention (Park, 1999; Ben-Yishay, Piasetsky and Rattock, 1987; Wood and Fussey, 1987).

MEMORY

Memory disorders are frequently seen in survivors of brain injuries, remediation of patients with severe memory disorders is still relatively neglected in clinical practice due to pessimism by clinicians regarding the efficacy of such remediation. The patients with severely impaired memory abilities can learn the present system when care is taken to individualize journals, conduct proper needs assessments and provide structured training exercises geared to the strengths of memory-impaired persons (Donaghy and Williams, 1998).

Traumatic brain injury (TBI) affects a significant portion of individuals and can have lasting consequences. One of the most common and persistent difficulties experienced post-TBI is deficits in memory, which impact up to

80% of TBI survivors. Early memory rehabilitation research concentrated on the direct retraining approach. In recent years, the focus of rehabilitative efforts has shifted to teaching compensatory strategies and optimizing residual abilities, with the most recent efforts focussing on group-format rehabilitation and integration of technologies (e.g. cellular phones) as a means of compensation. A review by Barker-Collo and Feigin (2008) examined the evidence for these various approaches to memory rehabilitation, concluding that there remains a need for full scale randomised clinical trials to determine their efficacy in improving independence.

Memory and learning entail the recruitment of a number of neural areas, including the medial temporal lobes, temporal association areas and prefrontal cortices. Catroppa, Anderson, Ditchfield and Coleman (2008) examined the effects of injury severity on long-term memory function in 55 children who sustained traumatic brain injury 5 years earlier and compared this with 17 healthy controls. Results indicated that injury severity affected aspects of complex memory and the implementation of diffuse axonal injury as an index of injury may assist in predicting memory outcome after childhood traumatic brain injury.

Individuals sustaining mild traumatic brain injuries often report a constellation of physical, cognitive and emotional/behavioural symptoms referred to as post concussion symptoms (PCS). The most commonly reported post concussion symptoms are headache, dizziness, decreased concentration, memory problems, irritability, fatigue, visual disturbances, sensitivity to noise, judgment problems, depression and anxiety. Although these PCS often resolve within one month, in some individuals PCS can persist from months to years following injury and may even be permanent and cause disability. When this cluster of PCS is persistent in nature, it is often called the post concussion syndrome or persistent PCS. Both physiological and psychological etiologies have been suggested as causes for persistent post concussion symptoms and this has led to much controversy and debate in the literature. Most investigators now believe that a variety of pre-morbid, injury-related and post-morbid neuropathological and psychological factors contribute to the development and continuation of these symptoms in that sustaining mild traumatic brain injury (Ryan and Warden, 2003).

A longitudinal study of verbal learning and memory processes after traumatic brain injury by Ferri-Campos *et al* (2008) resulted as more than 75% of patients presented learning, immediate memory and delayed memory deficits at baseline, with an important effect of retroactive interference (69%). At 6-month follow-up, 34.6% showed learning difficulties, 46.2% immediate memory deficits and 53% delayed memory problems, with 34.6% of the patients showing retroactive interference. Prominent verbal memory problems developed, not only during the first months after TBI but also over time are mostly due to impaired consolidation related to an intense retroactive interference. The impact of time since injury is an important factor when assessing outcome after TBI in childhood and adolescence (Jonsson, Horneman and Emanuelson, 2004). The students with head injury showed cognitive deficits in visual-spatial skills and in the areas of attention, memory and novel problem solving (Beers, Goldstein and Katz, 1994).

Ratcliff *et al* (2007) examined the relationship between gender and cognitive recovery 1 year following traumatic brain injury (TBI). Result proved that females performed significantly better than males on test of memory. Gender remained significantly associated with performance in this area. This result suggests a better cognitive recovery of females than males following TBI.

Farmer and Eakman (1995) examined the ecological validity of neuropsychological tests relative to instrumental activities of daily living (IADLs) among 55 participants in a post-acute brain injury rehabilitation programme. Stronger intellectual abilities, visual memory, delayed memory, verbal learning and cognitive flexibility were significantly associated with success on the IADL tasks.

Bourgeois, Lenius, Turkstra and Camp (2007) evaluated the effects of an errorless training approach, Spaced Retrieval (SR) training delivered over the telephone, on the reported everyday memory problems of adults with chronic traumatic brain injury (TBI). Results indicate that the SR treatment delivered by phone produced significantly more treatment goal mastery/ strategy use and maintenance (Vant Hooft, Andersson, Sejersen, Bartfai and Von Wendt (2003).

An article by Jodzio (1995) basing on experimental analysis and clinical observations focuses on the role of sub cortical structures in memory processes. It explained terminological problems and defined terms of memory: immediate, delayed, recent, remote, declarative and procedural. He pointed out functional hemispheric specialization as a predicator of material-specific forms of memory. Neuroanatomical basis was revealed, especially limbic system with its connections to prefrontal, cortical and brain stem regions. Term of dementia was defined, according to Cummings and Benson, (1983) as syndrome of acquired intellectual dysfunction when three of the following mental functions are impaired: language, memory, visuospatial skills, emotion and cognition (abstraction, calculation, judgement). Review of the literature suggests that rapid forgetting and retrieval deficits are most often symptoms of memory deficits observed after subcortical brain injuries.

Traumatic brain injury (TBI) is often associated with enduring impairments in high-level cognitive functioning, including working memory (WM) (Mathias, Beall and Bigler, 2004; McAllister, 1992; Reader and Logue, 1995). Perlstein *et al* (2004) examined WM function in predominantly chronic patients with mild, moderate and severe TBI and healthy comparison subjects behaviourally and, in a small subset of moderate-to-severe TBI patients, with event-related functional magnetic resonance imaging (fMRI), using a visual n-back task that parametrically varied WM load. TBI patients showed severity-dependent and load-related WM deficits in performance accuracy. Performance of mild TBI patients did not differ from controls; patients with moderate and severe TBI were impaired, relative to controls and mild TBI patients. fMRI results show that TBI patients exhibit altered patterns of activation in a number of WM-related brain regions, including the dorsolateral prefrontal cortex and Broca's area.

Global cognitive impairment following traumatic brain injury (TBI) is common, with some abilities more significantly affected than others (Johnstone, Hexum and Ashkanazi, 1995). Many individuals complain of memory difficulty shortly after MTBI (Tysvaer and Lochen, 1991; Guilmetle and Resile, 1995). Memory performance in these individuals can be normal despite these complaints. McAllister *et al* (1999) assessed the patterns of regional brain activation in response to varying working memory loads shortly after mild traumatic brain injury. Brain activation patterns in response to a working memory task (auditory n-back) were assessed with functional MRI in 12 MTBI patients within 1 month of their injury and in 11 healthy control subjects. MTBI patients differed from control subjects in activation pattern of working memory circuitry in response to different processing loads despite similar task performance. This suggests that injury-related changes in ability to activate or to modulate working memory processing resources may underlie some of the memory complaints after MTBI (Carney, Chesnut, Mann, Patterson and Helfand, 1999).

PROBLEM SOLVING

Traumatic brain injury (TBI) frequently leads to the development of a 'dysexecutive syndrome' (Hewitt, Evans and Dritschel, 2006). The associated difficulties with problem solving (including specific impairments in planning, initiation/plan-implementation and self-monitoring) represent a major challenge to functional recovery and adaptation following brain injury and serve as an important target for rehabilitation. Previous research suggests that one reason people with TBI are poor at everyday planning is that they fail to spontaneously use specific autobiographical memories to support planning in unstructured situations. In a study, Dritschel (1991) examined whether a self-instructional technique involving self-cueing to recall specific autobiographical experiences would improve performance on a planning task.

Due to the mechanisms involved in traumatic brain injury (TBI), the frontal lobes are often impacted. As the frontal regions of the brain are believed to subsume executive functioning, then it follows that post-TBI deficits may be seen in this domain. Executive functioning broadly refers to a set of inter-related skills necessary to maintain an appropriate problem-solving set for the attainment of a future goal and may include areas such as attentional control, planning, problem-solving, cognitive flexibility, abstraction and information processing (Catroppa and Anderson, 2006; Beers, Goldstein and Katz, 1994). The literature available on interventions for executive difficulties following TBI is minimal, with that focused on the paediatric population even more limited. From the few evaluation studies available, results tend to suggest that specific types of intervention lead to positive outcomes.

Cazalis *et al* (2006) conducted a study to assess the cerebral correlates of the dysexecutive syndrome after diffuse severe traumatic brain injury (TBI). Ten patients with sub-acute/chronic severe TBI without detectable focal cortical contusion and 11 matched healthy subjects were included in a parametric fMRI study using a planning task, the Tower of London. The results showed that the problem-solving deficits after severe diffuse TBI could be related to an impaired activation of the Dorsolateral Pre-frontal Cortex and of the Anterior Cingulate Cortex.

Janusz, Kirkwood, Yeates and Taylor (2002) examined the effects of childhood traumatic brain injury (TBI) on social problem-solving were examined in 35 children with severe TBI, 40 children with moderate TBI and 46 children with orthopaedic injuries (OI). Children in the severe TBI group defined the social dilemmas and generated alternative strategies to solve those dilemmas at the same developmental level as did children in the OI group. However, they articulated lower-level strategies as the best way to solve the dilemmas and used lower-level reasoning to evaluate the effectiveness of the strategies. The findings indicate that children with severe TBI demonstrate selective, long-term deficits in their social problem-solving skills.

An inter-related study examined the construct of problem solving as it relates to the assessment of deficits in higher-level outpatients with traumatic brain injury (TBI). Sixty-one persons with TBI and 58 uninjured participants completed measures of problem solving and conceptually related constructs, which included neuropsychological tests, self-report inventories and role-played scenarios. The largest between-group differences were found on psychosocial and problem-solving self-report inventories (Rath *et al.,* 2004). The findings reflect intrinsic differences in measurement approaches to the construct of problem solving and suggest the importance of using a multidimensional approach to assessment.

Oh, Kim, Seo and Seo (2005) conducted a study to develop a comprehensive cognitive rehabilitation program that can be easily applied to brain injured patients by family members or nurses in community or hospital settings through the literature review analysis. Based on the results of the literature review the problem solving rehabilitation program included a task of games or plays, which stimulated the patients' curiosity and interest. The training tasks for problem solving were to encourage the process of deriving reasonable solutions for a problematic situation resembling real problems that the patients were faced with in their everyday life.

People with brain injuries must often deal with cognitive problems, including social problem solving and can use the successful problem-solving experiences obtained in the training programmes with different delivery modes to solve daily living problems that are similar in nature. The analogy problem-solving skill training could effectively improve self-efficacy in problem solving of person with brain injury (Man, Soong, Tam and Hui-Chan, 2005; 2006).

Ability for problem solving and executive functioning within 2 years after Traumatic Brain Injury (TBI) was examined in 35 conscious survivors (Leon-Carrion *et al*, 1998). Two groups were formed. One group consisted of 13 patients who needed neurosurgery. The other group was made up of 22 patients without neurosurgical treatment. It is found that a severe traumatic brain injury, whatever the treatment applied in the acute phase, impairs the executive functioning of the patients (Mc Allister, 1992); this impairment is related to acute pathophysiological events. The neurosurgical intervention does not improve the executive functioning. It is suggested that the Tower of Hanoi/Sevilla could be a good tool to evaluate the executive functioning routinely in TBI patients as outcome.

In higher-level cognitive rehabilitation settings, the evaluation of functional problem-solving deficits in individuals with brain damage can be facilitated by augmenting neuropsychological test data with results from social problem-solving measures. The brain damage group demonstrated significant deficits on problem solving measures; however, neither conventional neuropsychological measure detected significant deficits in the brain damage group, relative to control and normative groups (Rath, Simon, Langenbahn, Sherr and Diller, 2000).

CREATIVITY

Creative innovation (CI) is defined as the ability to understand and express novel orderly relationships. Heilman, Nadeau and Beversdorf (2003) reviewed and developed some theories about the neurobiological basis of creative innovation. A high level of general intelligence, domain-specific knowledge and special skills are necessary components of creativity. Specialized knowledge is stored in specific portions of the temporal and parietal lobes. Some anatomic studies suggest that talented people might have alterations of specific regions of the posterior neocortical architecture. Intelligence, knowledge and special skills, however, are not sufficient for CI. Developing alternative solutions or divergent thinking has been posited to be a critical element of CI and clinical as well as functional imaging studies suggest that the frontal lobes are important for these activities (Levine and Prueitt, 1989). The frontal lobes have strong connections with the polymodal and supramodal regions of the temporal and parietal lobes where concepts and knowledge are stored. These connections might selectively inhibit and activate portions of posterior neocortex and thus be important for developing alternative solutions. Although extensive knowledge and divergent thinking together are critical for creativity they alone are insufficient for allowing a person to find the thread that unites (Colombo-Thuillard and Assal, 2007).

Howard-Jones, Blakemore, Samuel, Summers and Claxton (2005) made a fMRI investigation to identify those areas of the brain associated with approaching a story generation task creatively and to investigate the effects upon these correlates of incorporating a set of words that were unrelated to each other-a strategy considered to encourage semantic divergence. The results support the notion that areas of the right prefrontal cortex are critical to the types of divergent semantic processing involved with creativity.

Most neurological lesion studies emphasize performance deficits that result from focal brain injury. In a study by Seeley *et al* (2008), Neuroimaging analyses revealed that, despite severe degeneration of left inferior frontal-insular, temporal and striatal regions. It has been showed that increased grey matter volume and hyperperfusion in right posterior neocortical areas implicated in heteromodal and polysensory integration. The structural and functional enhancements in non-dominant posterior neocortex may give rise to specific forms of visual creativity that can be liberated by dominant inferior frontal cortex injury

Evidence is drawn from functional imaging, drug studies and lesion analysis. Temporal lobe changes, as in hypergraphia, often increase idea generation, sometimes at the expense of quality. Frontal lobe deficits may decrease idea generation, in part because of rigid judgments about an idea's worth. These phenomena are clearest in verbal creativity and roughly parallel the pressured communication of temporal lobe epilepsy, mania and Wernicke's aphasia-compared to the sparse speech and cognitive inflexibility of depression, Broca's aphasia and other frontal lobe lesions. The phenomena also shape non-linguistic creativity, as in that of frontotemporal dementia (Flaherty, 2005). A talented artist developed a progressive aphasia syndrome associated with frontotemporal dementia (FTD). As her disease progressed, language and executive skills declined, but her paintings became freer and more original (Mell, Howard and Miller, 2003).

Neurological diseases in artists provide a unique opportunity to study brain-creativity relationships, in particular through the stylistic changes which may develop after brain lesion (Bogousslavsky, 2005). Evidence emphasizes global brain functioning in artistic creativity and output, but critical steps which link perception processing to execution of a work, such as extraction-abstraction, as well as major developments of non-aesthetic values attached to art also underline complex activation and inhibition processes mainly localized in the frontal lobe.

The differences in brain cerebral blood flow (CBF) between highly creative individuals (scientists and/or artists socially recognized for their contributions to their fields with creativity indexes corresponding to the 99% percentile) and average control subjects while performing a verbal task from the Torrance Tests of Creative Thinking. Subjects with a high creative performance showed greater CBF activity in right precentral gyrus, right culmen, left and right middle frontal gyrus, right frontal rectal gyrus, left frontal orbital gyrus and left inferior gyrus and cerebellum; confirming bilateral cerebral contribution (Chovez-Eakle, Graff-Guerrero, Garcoa-Reyna, Vaugier and Cruz-Fuentes, 2007). These structures have been involved in cognition, emotion, working memory and novelty response. The score on the three creativity dimensions- fluency, originality and flexibility- correlated with CBF activation in right middle frontal gyrus and right rectal gyrus. Moreover, fluency and flexibility strongly correlated with CBF in left inferior frontal gyrus and originality correlated with CBF in left superior temporal gyrus and cerebellar tonsil. These findings suggest an integration of perceptual, volitional, cognitive and emotional processes in creativity. The higher CBF found in particular brain regions of highly creative individuals during the performance of a creative task provides evidence of a specific neural network related to the creative process (Mashal, Faust, Hendler and Jung-Beeman, 2007).

A study conducted by Geva, Eshel, Leitner, Valevski and Harel (2006) showed that children with intrauterine growth restriction had lower intelligence quotient and more frequent neuropsychological difficulties. Difficulties in executive functioning, inflexibility-creativity and language, indicative of frontal lobe dysfunction, were typically affected by intrauterine growth restriction and were rarely identified in the control group. Learning difficulties accompanied by lower academic achievements were more prevalent in the intrauterine growth restriction group, particularly when anthropometric catch-up was incomplete. The longitudinal findings reaffirm that functional coherence depends on pre-established structural growth and reorganization of the central nervous system. The neuropsychological profile at 9 years of age indicates that late-onset intrauterine growth restriction compromises frontal network functioning.

Gomez Beldarrain, Garcia-Monco, Astigarraga, Gonzalez and Grafman (2005) studied 18 patients with prefrontal cortex lesions that the prefrontal cortex (PFC) is crucial only for self-generated counterfactual reflections. They did not detect counterfactual thoughts (CFT) generation differences based on lesion location within the PFC. CFT performance correlated positively with measures of attention, creativity, verbal skills, conscientiousness and self-esteem and negatively with depression and dysexecutive symptoms. An impairment in counterfactual thinking may contribute to the lack of regret and insight often observed in patients with frontal lobe lesions.

It was predicted that highly creative subjects would show a bilateral frontal activation on the divergent thinking task (Brick), while low creative subjects were expected to have a unilateral increase (Carlsson, Wendt and Risberg, 2000). Calculations were made of differences in blood flow levels between the word fluency (FAS) and the Brick measurements in the anterior prefrontal, frontotemporal and superior frontal regions. In accordance with the prediction, the creativity groups differed significantly in all three regions. The highly creative group had increases, or unchanged activity, while the low creative group had mainly decreases. The highly creative group had higher trait anxiety than the low creative group. On the intelligence tests, the low creative group was superior both on logical-inductive ability and on perceptual speed, while the groups were equal on verbal and spatial tests.

McKenna and Haste (1999) investigated the clinical effectiveness of a short course of drama therapy delivered in a one-to-one interaction, in a sample of 10 patients in a neuro-rehabilitation unit. Qualitative analysis of the taped interviews elicited how the therapy contrasted and complemented the rest of the rehabilitation setting and therapies and how it helped psychological adjustment to severe disabilities resulting from neurotrauma. There were four ways in which it appeared to empower the participants and nurture their self esteem. It provided them with a sense of personal space in an otherwise institutional setting; it allowed escapism and enjoyment; it awakened creativity and a sense of potency; and it provided a metaphor to explore personal issues. Drama therapy made an important contribution to the healthy adjustment of some patients both to hospital life and to acquired disability. The reports from the patients indicated that this approach to rehabilitation should be further incorporated and developed in neuro-rehabilitation.

COGNITIVE IMPAIRMENT

Neuropsychological examinations of patients with TBI show a significant portion of variables like attention, concentration, learning, memory, conceptual thinking, problem solving and language are impaired (Popovic, 2005).

Cognitive impairments are usually the most disabling sequelae of head injury (HI) (Capruso and Levin, 1992). The earliest stage of recovery from moderate to severe closed head injury is a period of PTA that typically includes memory loss for events preceding and surrounding the injury and memory loss for events occurring since the injury. Memory and attention/ information processing speed and efficiency are typically the cognitive domains most severely affected by head injury. Following mild head injury, impairments of memory and information processing may be apparent within the first week of recovery. The long-term cognitive effects of HI are typically more severe for younger children than older children. Neuropsychological assessment provides an objective way to measure the presence and severity of cognitive impairment.

Neurobehavioral disorders after severe traumatic brain injury (TBI) are poorly correlated with focal lesions detected by structural neuroimaging techniques such as CT scan or MRI. A close link was found between cognitive and behavioural disorders and decreased cortical metabolism in prefrontal and cingulate cortex. Tests of memory and executive functions significantly correlated with regional metabolism in the mesial and lateral prefrontal cortex and the cingulate gyrus. Behavioural disorders correlated significantly with mesial prefrontal and cingulate metabolisms. A predominant role of prefrontal and cingulate dysfunction in cognitive and behavioural disorders of patients with severe traumatic brain injury, even in the absence of focal structural lesion of the brain was recorded (Fontaine, Azouvi, Remy, Bussel and Samson, 1999).

Cognitive deficits, particularly of attention, memory, information-processing speed and problems in self-perception, are very common following severe TBI. Lippert-Groner, Kuchta, Hellmich and Klug (2006) examined 41 patients who were admitted to the intensive care unit after severe TBI. Subjects after severe TBI showed relatively high overall scores on the Neurobehavioral Rating Scale (NRS), reflecting a high degree of overall neurobehavioral dysfunction. There was a tendency of improvement for inattention, somatic concern, disorientation, guilt feelings, excitement, poor planning and articulation deficits. For conceptual disorganization, disinhibition, memory deficit, agitation, inaccurate self-appraisal, decreased initiative, blunted affect and tension even a tendency for further deterioration in the post-traumatic follow-up was detected. Changes between 6 and 12 months post-TBI were statistically significant for disorientation (improvement), inattention/reduced alertness (improvement) and excitement (deterioration).

The frontal lobes are particularly vulnerable to injury during trauma. The syndrome commonly attributed to frontal lobe dysfunction includes problems with impulsivity, perseveration, disinhibition, amotivation, attention, planning and problem solving (Kraus and Maki, 1997). Executive dysfunction is among the most common and disabling aspects of cognitive impairment following traumatic brain injury (TBI) and may include deficits in reasoning, planning, concept formation, mental flexibility, aspects of attention and awareness and purposeful behaviour (McDonald, Flashman and Saykin, 2002; Kehle, Clark and Jenson, 1996). These impairments are generally attributed to frontal systems dysfunction, due either to direct insult to the frontal lobes or to disruption of their connections to other brain regions.

Age is assumed to be a negative prognostic factor in recovery from moderate-to-severe traumatic brain injury (TBI). Little is known on cognitive performance after mild TBI in relation to age in the sub-acute stage after injury. Age did not add significantly to the effect of mild TBI on cognitive functioning. Patients suffering from mild TBI are characterized by subtle neurocognitive deficits in the weeks directly following the trauma (Stapert, Houx, de Kruijk, Ponds and Jolles, 2006).

Hart, Whyte, Kim and Vaccaro (2005) investigated the relationship between executive function and awareness of real-world behavioural and attentional dysfunction in persons with moderate and severe traumatic brain injury (TBI) and uninjured controls. Participants with TBI scored significantly worse on the Executive Composite (EC) than control participants and exhibited impaired self-awareness (ISA) compared to controls. Control participants agreed closely with their Significant Other (SO) ratings on both the Dysexecutive (DEX) Questionnaire and Cognitive Failures Questionnaire (CFQ), whereas the SOs of TBI participants reported significantly greater degrees of difficulty on both scales than was endorsed by participants with TBI. Low-EC scorers within the TBI group had significantly worse ISA than controls, lending support to the hypothesis that executive function is related to ISA in chronic, moderate to severe TBI.

Dou, Man, Tam and Hui-Chan (2004) explored the need for cognitive rehabilitation services (CRS) in the community for persons with brain injuries and to understand the level of knowledge and attitudes towards cognitive rehabilitation of health care professionals, including their use of innovative CRS. They identified four areas as those for which CRS is most urgently needed: language, memory, orientation and attention rehabilitation. The relative appropriateness of settings for such CRS delivery was ranked, from most to least, as the home, hospital and community, respectively. Home-based intervention was ranked top among the service treatment settings. The respondents also showed a preference for the innovative online mode, which they felt should be conducted in a home rather than a hospital setting.

Cognitive deficits following lesions in parieto occipital areas tend to cause, among others, visuospatial and visuoperceptive alterations. Alisente, Laprediza and Cespedes, (2004) examined several patients who present visuospatial impairment after different brain injuries, not only those affecting the areas typically involved in these deficits, such as parieto occipital cortex. Neuropsychological evaluation showed some difficulties not previously described together with these deficits, related to attention, working memory and executive functions, as well as topographic disorientation, lack of visuospatial coordination, distances perception disorders and difficulty to mentally rotate objects.

Geusgens, Winkens, van Heugten, Jolles and van den Heuvel (2007) made a review to investigate the occurrence of transfer of cognitive strategy training for persons with acquired brain injury and the way in which transfer is measured. Transfer outcome measures could be classified into 3 groups: non-trained items, standardized daily tasks and daily life. Most studies reported at least one type of transfer; however, the methodological quality of the studies was low. Cognitive strategy training in the evaluated studies focused on 7 domains of functioning: information processing, problem solving/executive functioning, memory/attention, language, neglect, apraxia and daily activities.

REHABILITATION

Rehabilitation has an important role in the management of traumatic brain injured patients. Rehabilitation goals after traumatic brain injury are improving function, increasing the level of independence as high as possible, preventing complications and providing an acceptable environment to the patient (Irdesel, Aydiner and Akgoz, 2007). In its first decade, cognitive rehabilitation has emerged from infancy with the energy and much of the turmoil of youth. It has become an established speciality in brain-injury rehabilitation and has inspired many neuropsychologists to broaden their expertise beyond diagnosis and address their efforts to intervention (Gianutsos, 1991). Restoration, although controversial, is an important and valid goal at the outset of cognitive rehabilitation, whereas the substitution of other means of goal achievement and environmental redesign are significant components of a comprehensive neuro-rehabilitative treatment programme.

The cognitive rehabilitation could help patients having difficulty in their every day life, due to a reduced cognitive ability resulting from brain injury, to effectively adapt to every day life (Oh, Kim, Seo and Seo, 2005). Carney, Maynard, Mann, Patterson and Mark (1999) evaluated evidence for the effectiveness of cognitive rehabilitation methods to improve outcomes for persons with traumatic brain injury (TBI). Two randomized controlled trials and one observational study provided evidence that specific forms of cognitive rehabilitation reduce memory failures and anxiety and improve self-concept and interpersonal relationships for persons with TBI.

Boman, Lindstedt, Hemmingsson and Bartfai (2004) examined the efficacy of cognitive rehabilitation in the patient's home or vocational environment. Ten outpatients with acquired attention and memory problems received cognitive training three times weekly, for 3 weeks. The patients received individual attention training with Attention Process Training, training for generalization for everyday activities and education in compensatory strategies for self-selected cognitive problems. Treatment effects were evaluated with neuropsychological and occupational therapy instruments before and after the training and after 3 months on impairment, activity and participation levels. The results indicated a positive effect on some measures on impairment level, but no differences on activity or participation levels at follow-up. This indicates that home-based cognitive training improves some attentional and memory functions and facilitates learning of strategies.

A patient with MTBI and deficits in attention, executive functioning, memory, reasoning and problem solving participated in a 4-month treatment programme. The interactions between the patient's cognitive deficits and problematic activities of daily living were identified. Treatment focused on teaching the patient compensatory strategies to offset the cognitive deficits following a cognitive framework within the context of hierarchically arranged activities of daily living. At the end of the programme, the patient consistently used his compensatory strategies to independently complete activities of daily living that were problematic prior to the receipt of treatment (Walker, 2002).

A systematic review of the literature from 1998 through 2002 by Cicerone, *et al* (2006) using the terms attention, awareness, cognition, communication, executive, language, memory, perception, problem solving and reasoning combined with each of the terms rehabilitation, remediation and training showed that, there is substantial evidence to support cognitive rehabilitation for people with TBI, including strategy training for mild memory impairment, strategy training for post acute attention deficits and interventions for functional communication deficits. The overall analysis of 47 treatment comparisons reveals a differential benefit in favour of cognitive rehabilitation in 37 of 47 (78.7%) comparisons, with no comparison demonstrating a benefit in favour of the alternative treatment condition.

van't Hooft, *et al* (2007) assessed in greater detail the sustained effects of a broad-based cognitive training programme on the neuropsychological performance of children with acquired brain injury. In particular, the long term (6 months) effects on cognitive functions, as well as how various moderators (gender, age at the time of injury/diagnosis, time since injury/diagnosis, age at the training) might influence outcome were investigated. The treatment group exhibited significantly more persistent improvements with respect to complex tasks of attention and memory in comparison to the control group. It was concluded that the long term effects on cognitive functions of this neuro-cognitive training is encouraging.

Several studies have reported beneficial effects of treatments for attentional deficits following traumatic brain injury and suggest greater benefits of training more complex forms of attention (Cicerone, 2002). Godefroy and Rousseaux, (1996) assessed the divided and focused attention in patients with prefrontal damage. This shows that patients with a prefrontal lesion suffer from divided and focused attention deficits that correspond to behavioural changes.

Brain injury rehabilitation emphasizes nonphysiologic interventions (e.g. cognition, behaviour, social integration issues) and therefore is less amenable to study via accepted scientific methods (Hall and Cope, 1995). Description and analysis of neuropsychological deficits following brain trauma with diffuse lesion probably corresponding to diffuse axonal injury (DAI). DAI leads to neuropsychological impairment dominated by executive and memory dysfunction (Fork, Bartels, Ebert, Grubich, Synowitz and Wallesch, 2005).

Rehabilitation of the adult with severe head-injury is of great interest in the clinical community. However, a dearth of data in the literature makes it difficult to evaluate existing rehabilitation programs. Scherzer (1986) provides a cross-cultural validation of one of the most widely cited rehabilitation programs, Institute of Rehabilitation Medicine, New York University. Three groups of adults (n = 10, n = 11, n = 11; average age, 27) with severe head trauma (average duration of coma, 46 days) were enrolled in a comprehensive rehabilitation program while in their chronic stage (average post coma interval, 59 months). Treatment lasted 30 weeks for each group and included cognitive and perceptual remediation, problem-solving learning, personal counselling, physical exercise and relaxation, social skills and prevocational training. The measures that showed the greatest improvements for the three groups were noted in the psychomotor tests of attention, in visual information processing, memory and complex reasoning. Most measures of manual dexterity, verbal IQ and basic academic skills did not change (Neistadt, 1994). Subjects with motor system damage gained cognitively as much as those whose motor system was undamaged. The improvements noted in the three groups were robust and were evident 3 to 12 months post treatment.

Hashimoto, Okamoto, Watanabe and Ohashi (2006) assessed the effectiveness of a day treatment program with a comprehensive team approach for treating outpatients with acquired brain injury. The 25 enrolled patients had treatment sessions lasting 2-4 hours for 2 days a week over a 3-6 month period. Significant improvement has been seen in problem solving. The result demonstrates the effectiveness of the program in helping to rehabilitate patients with acquired brain injury (Gordon, Cantor, Ashman and Brown 2006).

An examination done by Boman, Lindstedt, Hemmingsson and Bartfai (2004) to find out the efficacy of cognitive rehabilitation in the patient's home or vocational environment using Pre-post-follow-up design. Ten outpatients with attention and memory problems received cognitive training three times weekly, for 3 weeks. Subjects received individual attention training with Attention Process Training, training for generalization for everyday activities and education in compensatory strategies for self-selected cognitive problems. Treatment effects were evaluated with neuropsychological and occupational therapy instruments before and after the training and after 3 months on impairment, activity and participation levels. The results indicated that home-based cognitive training improves some attentional and memory functions and facilitates learning of strategies.

During recent years, extensive reviews were published on the efficacy of cognitive rehabilitation (Carney, Chesnut and Maynard, 1999; Cicerone *et al*., 2000). Several reports have described the effectiveness of using compensatory strategies and the use of devices, particularly for patients with mild-to-moderate memory impairment (Glisky and Schacter, 1986; Wilson, Evans and Emslie, 1997). Studies that have examined the effectiveness of compensatory strategies suggest that external aid is effective if the intervention is individually adapted and if the patient is actively involved in identifying the memory problem to be treated and motivated to use the aids (Ownsworth and McFarland, 1999; Carney, Chesnut and Maynard, 1999).

Middleton, Lambert and Seggar (1991) designed to investigate the contribution of cognitive rehabilitation therapy delivered by computer within an educationally based treatment program for brain-injured adults. The effectiveness of two forms of computer-assisted neuropsychological treatment was examined. Their findings did not support the hypothesis that computer-assisted neuropsychological rehabilitation programs which differ in both content and focus can produce specific effects on cognitive functioning of brain-injured adults.

Three young men with attentional problems after severe head injury were given microcomputer-based training involving a variety of tasks designed to ameliorate attentional problems. A multiple baseline across function single case experimental design showed these procedures to be effective in producing change specifically in the targeted function (Gray and Robertson, 1989; Niemann, Ruff and Baser, 1990).

In patients with severe cerebral injuries, attentional dysfunction may cause greater difficulties for rehabilitation than neurological deficits. These functions seem to be controlled by catecholaminergic neural systems in the central nervous system. Andersson, Berstad, Finset and Grimsmo (1992) observed improvement of cognitive functions such as visual attention, speed of information processing, attentional span, learning capacity and alertness.

Geusgens, Winkens, van Heugten, Jolles and van den Heuvel (2007) made a review to investigate the occurrence of transfer of cognitive strategy training for persons with acquired brain injury. Results showed that the transfer outcome measures could be classified into 3 groups: non-trained items, standardized daily tasks and daily life. Most studies reported at least one type of transfer; however, the methodological quality of the studies was low. Cognitive strategy training in the evaluated studies focused on 7 domains of functioning: information processing, problem solving/executive functioning (Schweizer, *et al.*, 2008) memory/attention, language, neglect, apraxia and daily activities (Cicerone, *et al*., 2000). Most studies reported the occurrence of transfer of training effects, although some serious remarks can be made concerning the methodological quality of the studies.

Disruptions to executive function (EF) may occur as a result of traumatic brain injury (TBI), in the context of direct damage to frontal regions or in association with disruption of connections between these areas and other brain regions. Children sustaining severe TBI at a young age are particularly vulnerable to impairments in EF (Anderson and Catroppa, 2005). While these difficulties do show some recovery with time since injury, long-term deficits remain and may impact on ongoing development.

A review of outcome studies about remedial perceptual retraining like construction of puzzles, for adults with diffuse acquired brain injury suggests that those learning assumptions hold true only for clients with localized lesions and preserved abstract reasoning who have been explicitly taught to transfer learning across a variety of treatment activities (Neistadt, 1994).

Memory disturbance, deficient concentration and fatigue are symptoms seen in amnestic mild cognitive impairment (MCI) as well as in mild traumatic brain injury (TBI). Londos, Boschian, Lindén, Persson, Minthon and Lexell (2008) studied to assess if an established rehabilitation program commonly used in TBI can aid MCI patients to develop compensatory memory strategies that can improve their cognition, occupational performance and quality of life. Significant improvements were seen in cognitive processing speed, occupational performance and in some of the quality of life domains by the goal-oriented rehabilitation program.

The efficacy of computer-assisted attention and memory retraining was evaluated with 15 severely head-injured patients (Ruff, Mahaffey, Engel, Farrow, Cox and Karzmark, 1994). Training with selected exercises tailored to the individual's needs was provided from the THINKable program for up to 20 hours in both the attention and memory remediation modules. Significant results were documented on the computerized tasks, psychometric measures and on patient and observer ratings of everyday behaviours of attention and memory.

Disorders of attention and concentration showed widespread influence on other neuropsychological functions as a nonspecific factor, especially in spontaneous recovery that stresses the importance of specific rehabilitation measures for attention and concentration (Pavlovi, Oci, Stefanova, Filipovi and Djordjevi, 1994). Luria-Nebraska Neuropsychological Battery showed great opportunities for assessment of wide spectrum of neuropsychological functions both in initial and later phases and also in planning of cognitive and social rehabilitation.

Middleton, Lambert and Seggar, (1991) investigated the contribution of cognitive rehabilitation therapy delivered by computer within an educationally based treatment program for brain-injured. The effectiveness of two forms of computer-assisted neuropsychological treatment was examined, 36 head-injured adults received the treatment targeting either attention and memory skills or reasoning and logical thinking skills. Both groups were assessed on three measures of attention and memory and three measures of reasoning before and after the 8-week treatment. Analysis indicated significant improvement on five of six measures by both groups.

Brain injury has been studied in many ways by different disciplines all over the world. These studies revealed that cognitive dysfunctions are found to be common in the brain injured patients. Rehabilitation of these patients has been attempted combining techniques related to discipline of medicine and other fields of therapies.

The review of studies in this field has reported hardly any studies that have been utilized only psychological intervention for rehabilitative purposes. In the light of the studies reviewed it may be assumed that there exists a void, which could be filled by psychological therapies to better the affected cognitive skills. This study attempts to utilize psychological techniques in order to improve the cognitive performances of the brain injured patients.

METHOD

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. Research methods refer to the behaviour and instruments used in selecting and constructing observations, recording data, techniques of processing data and the like (Kothari, 2004). The methodology may differ from problem to problem, yet the basic approach remains the same.

DESIGN

A research design may be regarded as the ‘blue print’ of those procedures, which are adopted by the researcher for testing the relationship between the dependent variable and the independent variable (Singh, 2004). It is the “arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure” (Selltiz, Jahoda, Deutsch and Cook, 1959).

As stated by Kerlinger (1995) research design is the plan and structure of investigation so conceived as to obtain answers to research questions. The plan is the overall scheme of program of the research. It includes an outline of what the investigator will do from writing the hypothesis and their operational implications to the final analysis of data (Kothari, 2004).

According to Manheim (1997), a research design is the overall plan of an investigation. The plan should describe the research question or questions, the methods of observation and measurement, the different conditions of observation and manipulation, procedures of collecting data under different experimental arrangements and the method of data analysis. In essence, a research design refers to the methods and procedures of an investigation.

The present study is intended to examine the cognitive functions of brain injured persons and to develop an effective psychological intervention package to bring them back to normal life.

This research work is an intervention study. Pretest-post test control group design is used for this purpose, which is one among 16 experimental designs as per the classification of Campbell and Stanley (1963).

SAMPLE

A sample is a set of elements selected in some way from a population. The aim of sampling is to same time and effort, but also to obtain consistent and unbiased estimates of the population status in terms of whatever is being researched (Schofield, 1996). In the present study 'purposive sampling' is used which is of the non-probability sampling techniques. This method is characterized by the use of judgment and a deliberate effort to obtain representative samples by including presumably typical areas or groups in the sample. As an aid to ensure ease in the purposive sampling, the following inclusion and exclusion criteria were chalked out.

Inclusion Criteria

(1) The subjects should meet the criteria of being frontal lobe injured. To ensure the frontal lobe injury the experimenter sought help from the neurosurgeons of the concerned hospitals.

(2) The present study selected subjects who suffered moderate level of injury.

(3) The Mini-Mental State Examination (MMSE) was administrated by the experimenter as the screening test. The individuals scoring within the range of 10-20 were included as subjects.

(4) The patient was included as a subject in the study after an interview of the family members about the subject's condition before the injury. The patient was included as subject only if he/she did not have any cognitive difficulty before this brain injury.

Exclusion Criteria

1) Patients with all other lobe injuries were excluded because the present study focuses on the role of frontal lobe in higher cognitive functions.

2) The severely brain injured patients were excluded because interaction with them is difficult and time consuming. Whereas the mild brain injured patients had chance of recovery without any intervention due to the plasticity of the brain. Therefore the severe and mild brain injured patients were excluded.

3) This study involved only adults (above 18 years) because the child's brain is vastly different from the brain of an adult.

The sample of the present study was grouped into two-the experimental group and the control group. The two groups were further divided into two-one month and three months after injury. The sample was selected from different hospitals of Kannur and Kozhikode districts. The sample included adults between the age group of 18 years to 52 years.

For each subject a personal data sheet was filled by the experimenter by collecting the information verbally reported either by the subjects or by the immediate family member. An informed consent was obtained from the subject or immediate family members for being involved in the present study.

The number of subjects in each group is given in Table 3.1.

Table 3.1: Group wise distribution of the sample

Sl. No.	Group	Males	Females	Total
1.	Experimental Group – I (One month after injury)	13	1	14
2.	Experimental Group – II (Three months after injury)	14	2	16
3.	Control Group – I (One month after injury)	15	2	17
4.	Control Group – II (Three months after injury)	17	2	19
	Total	**59**	**0**	**0**

TOOLS USED

The following tools were used in the present study

1. Mini- Mental State Examination (MMSE)
2. Digit Span Sub Test of WAIS
3. Memory Test
4. Standard Progressive Matrices (SPM)
5. Tower of Hanoi
6. Tests of Creative Thinking Abilities (TCTA)

Description of the Tools

1. Mini- Mental State Examination (MMSE)

The mental status examination is a loosely structured interview that usually precedes other forms of psychological and medical assessment. The purpose of the evaluation is to provide an accurate description of the patient's functioning in the realms of orientation, memory, thought, feeling and judgment (Gregory, 2000).

There are number of screening tests for diffuse cognitive impairment. The most widely used mental status tool is the Mini-Mental State Examination (MMSE), a 5 to 10 minute screening test that yields an objective global index of cognitive functioning (Folstein, Folstein and Mc Hugh, 1975). The MMSE has become the most widely used cognitive screening test in many countries and will be generally familiar to many trained clinicians (Taylor, 1999). The test contains 30 score-able items having to do with orientation, immediate memory, attention, calculation, language production, language comprehension and design copying. A score of 23 or lower is indicative of cognitive impairment.

Validity and Reliability

Since its creation in 1975, the MMSE has been validated and extensively used in both clinical practice and research (Kurlowicz and Wallace, 1999). The reliability of this instrument is excellent. Folstein, Folstein and Mc Hugh**,** (1975) report a 24-hour test-retest reliability of 0.89 for 22 patients with varied depressive symptoms. Reliability over a 28-day period for 23 clinically stable patients with diagnoses of dementia, depression and schizophrenia was an impressive 0.99 (c.f. Gregory, 2000).

Administration and Scoring

The MMSE was administered with the following instructions:

"I am gong to ask some questions regarding day to day life. When I ask the question you have to give the first answer which comes to your mind”. The other instructions for specific questions were given as per the direction given in the test.

Scoring

The responses were scored by assigning one mark for each correct response. The maximum score is 30. The lesser the score, the more the cognitive impairment.

Digit Span Sub Test of WAIS

This sub-test is use to assess span of attention. Attention is the process that controls the flow of information processing. There are many aspects to attention that may be derived from their neuroanatomical localization (Siegel, 2000). Of all the stimuli that impinge on our senses and find their way into sensory memory, only some register consciously, enter into memory and engage other cognitive functions. Attention refers to the process of selecting only certain stimuli and concentrating cognitive processes on them (Kellog, 1995).

A survey conducted by Gordon and Zillmer (1997) over 2000 members of the National Academy of Neuropsychology and reviewed the west frequently administered neuropsychological tests. The survey result indicates that Digit span from WAIS-R was used 90% in the function of Attention/Concentration. Digit span is a measure of immediate auditory recall for numbers. Facility with numbers, good attention and freedom from distractibility are required.

In the present study the experimenter used Digit Span sub test of WAIS-R (Wechsler, 1981) to assess the attention of the subjects. Digit Span consists of two separate sections, Digits Forward and Digits Backward. The test needs the patient to attend to various verbal stimuli and repeat them. They become progressively more complex. In this manner, it is possible to evaluate a patient's span of attention for unfamiliar combinations of stimuli.

Reliability and Validity

The Wechsler scales provide split-half reliability coefficients for each age group on each subtest score, index score and IQ. Except those for which split-half reliability is inappropriate-Digit Span and Digit symbol. For Digit Span the correlation coefficient between Digits Forward and Digits Backward scores was corrected for full length of the tests. For the age groups 18-19, 25-34 and 45-54 the reliability coefficients were 0.71, 0.66 and 0.66 respectively.

When the WAIS-R was published, the manual itself had no validity data on the instrument (Anastasi and Urbina, 1997).

Administration and Scoring

Digits Forward- The instructions for the subject were as follows "I am going to say some numbers. Listen carefully and when I am finished repeat them after me". The digits were read out one per second with clarity. If the subject repeats trial 1 of a series then he/she goes on to the next higher number in the same series. If the subject fails then he/she will be given a second chance. If the subject fails on both the trials of a given series then the testing was discontinued.

Scoring **-** The subject's score is the highest number of digits repeated without error. The maximum score is 9.

Digits Backward - The instructions for the subject were as follows:

"Now I am going to say some more numbers, but this time when I finish, I want you to say them backwards" An example was given to the subject was let to try. If the subject failed in the trial I, then trial II was given. If the subject succeeded then the subject was allowed to proceed to the higher series. If the subject failed in trial II then the testing was discontinued.

Scoring – The score is the maximum number of digits repeated in backward series without error in trial I or II. The highest score is eight.

The total score for the Digit Span test is the sum of scores on Digits forward and Digits backward. The maximum score for Digit Span is 17. Higher score indicates more attention.

Memory Test

Neuropsychologists assess general memory and new learning skills in a variety of modalities. There are immediate and delayed memory tasks in both verbal and visual formats. Performance of free recall and recognition tasks can help identify different aspects of memory function and dysfunction (Zillmer and Spiers, 2001).

For the present study the test for memory included eighteen pictures of things used in daily life (watch, phone, bicycle, shirt, T.V., shoes, ceiling fan etc). The items were selected keeping in mind the condition of the subjects.

A preliminary try out among normal persons was conducted before finalizing the number and nature of items, duration of testing, etc. before the selection of items. All the items were found to have face validity. Standardized psychological tests in memory were seen to be time consuming and difficult for administration to this group of brain injured subjects.

Hence items generally and popularly used in standard books and magazines were exclusively included.

Administration and Scoring

The instructions for the subject were as followed:

“I will show you a chart with a few pictures of things which you are familiar with and use in your daily life. You will be given one minute to look at these pictures”. After this each subject was given a 10-minute interval, during which the subject was engaged in stimulating conversation. After this 10-minute break, the subject was asked to recall the things, which were displayed in the chart.

Scoring

One mark was assigned for each correct response. The maximum score is 18. The higher the score, better the memory skill of subject.

Standard Progressive Matrices (SPM)

Raven’s Progressive Matrices is a nonverbal test of inductive reasoning based on figural stimuli. This test has been very popular in basic and is also used in some institutional settings for purposes of intellectual screening (Gregory, 2000).

The Standard Progressive Matrices is a test of a person’s capacity at the time of the test to apprehend meaningless figures presented for his observation, see the relations between them, conceive the nature of the figure completing each system of relations presented and by so doing, develop a systematic method of reasoning.

The scale consists of 60 problems divided into five sets of 12. In each set, the first problem is as nearly as possible self-evident. The problems, which follow, become progressively more difficult. The order of the tests provides the standard training in the method of working. The scale is intended to cover the whole range of intellectual development from the time a child is able to grasp the idea of finding a missing piece to complete a pattern and to be sufficiently long to assess a person's maximum capacity to form comparisons and reason by analogy without being unduly exhausting or unwieldy (Raven, 1960).

In the present study, this scale was used for assessing the reasoning ability of the subjects. For this purpose, sets A and B were used, because the completion of whole sets takes more time and that would affect both the physiological and psychological health of the subjects.

Reliability and Validity

Retest reliability in groups of older children and adults that were moderately homogeneous in age ranges approximately from 0.70 to 0.90. Internal consistency coefficients are mostly in the 0.80s and 0.90s (Anastasi and Urbina, 1997).

Validity measures involving the correlation of the Raven Matrices with the Stanford-Binet and the Wechsler scales range from 0.54 to 0.86 (Raven, Court and Raven, 1983). Studies with mentally retarded persons and with different occupational and educational groups indicate fair concurrent validity (Anastasi and Urbina, 1997).

Administration and Scoring

The subject was given the set A and B of the SPM booklet. The instructions for the subject were as follows: “On every page in your book there is a pattern with a bit missing. You have to decide which of the bits below would be the right one to complete the pattern above. Just point at the piece which you consider is the right one”. The answer was recorded by the investigator in the answer form, taking the subject’s condition into consideration, thus not causing much of inconvenience for the subject.

Scoring was done by using scoring key given in the manual. High scores indicate high power of reasoning.

Tower of Hanoi

The Tower of Hanoi or Towers of Hanoi is a mathematical game or puzzle. The French mathematician Edouard Lucas invented the Tower of Hanoi puzzle in 1883. It consists of three pegs and a number of disks of different sizes, which can slide onto any peg. The puzzle starts with the disks neatly stacked in order of size on one peg, the smallest at the top, thus making a conical shape. The Tower of Hanoi is frequently used in psychological research on problem solving, assessment of working memory, anticipatory planning and ability to inhibit responding (Welsh, 2001). There also exists a variant of this task called Tower of London for neuropsychological diagnosis and treatment of executive functions.

The objective of the puzzle is to move the entire stack to another peg, obeying the following rules:

- Only one disk may be moved at a time.
- Each move consists of taking the upper disk from one of the pegs and sliding it onto another peg, on top of the other disks that may already be present on that peg.

- No disk may be placed on top of a smaller disk.

Reliability and Validity

In a study among 50 college students, the internal consistency reliability (Cronbach alpha) was 0.77. When Tower of Hanoi (TOH) and Tower of London (TOL) was administered the convergent of TOH and TOL was 0.53.

Administration and Scoring

The subject was given the instrument to perform this test. The instructions given were as follows: “You have to move these four discs to the extreme right peg. This has to be done as quickly as possible. Keep in mind that while passing from left to the right peg you are not supposed to place larger disc on the smaller ones”. The time taken by the subject was recorded by the researcher.

Scoring

The time taken to solve the problem was considered as the score of the test. The time was recorded in seconds. Minimum time taken indicates finer problem solving ability.

Test of Creative Thinking Abilities –TCTA (Asha, 1993)

Creative people are seen to excel in the specific cognitive process called divergent thinking. As the name suggests divergent thinking is thinking in different directions. It leads to problem solving which is a result of diversity of answers (Guilford, 1959). All this is possible only through creative thinking. Patients with frontal lobe lesions show little of the imagination or innovative thinking that is essential to creativity (Zangwill, 1966).

In the present study the adapted version of Wallach and Kogan's Tests of Creative Thinking Abilities (TCTA) was used to assess the creativity of the subjects. The test consists of five sub-tests of which three are verbal and two are non-verbal or visual in nature.

The verbal tests are:

i) **Instances**

This sub-test is one of the three verbal techniques used to assess creativity. This consists of four items. However, in the present study only two items were used. The subjects are asked to generate possible instances of a class concept that is specified in verbal form.

ii) **Alternate uses**

From this instrument, we used two objects. The subjects are to generate possible uses for these verbally specified objects.

iii) **Similarities**

From this sub-test, we used only two pairs of objects. The subjects are to generate possible similarities between two verbally specified objects.

The non-verbal or visual stimulus tests are:

i) Pattern Meanings

This sub test consists of two verbal stimuli, materials, each in a separate card. Each stimulus is a pattern of lines. The subjects are to generate meanings or interpretations relevant to the pattern in question.

ii) Line Meanings

This sub-test consists of two visual stimulus materials, each in a separate card. Each stimulus is mere lines of some form. The subjects are to generate meanings or interpretations relevant to the form of lines in question.

The TCTA short scale was used for the present study. The short scale consists of the first two items of each of the five sub-tests in the full scale viz., Instances, Alternate uses, Similarities, Pattern Meanings and Line Meanings.

Reliability and Validity

The reliability of the short scale was estimated by Spearman-Brown Split-Half method. The reliability coefficients obtained for the five sub-tests of the short scale are given in the Table 3.2

Table 3.2: Spearman-Brown Split-Half Responsibility of the Five Sub-Tests of TCTA Short Scale for the Scoring on 'Number' and 'Uniqueness'

Variables		Boys (N=110)	Girls (N=104)
Instances	Uniqueness	0.73	0.69
	Number	0.86	0.84
Alternate Uses	Uniqueness	0.68	0.61
	Number	0.71	0.68
Similarities	Uniqueness	0.63	0.59
	Number	0.66	0.64
Pattern Meanings	Uniqueness	0.69	0.68
	Number	0.74	0.71
Ling Meanings	Uniqueness	0.63	0.62
	Number	0.75	0.73

The validity of the short scale was determined by correlating the total creativity scores on this scale with the scores on the scale of creativity included in the HSPQ, the adapted form of Wallach and Kogan's Battery of creativity and the full scale of TCTA. The correlation coefficients are given in the Table 3.2.

Administration and Scoring

The administration of TCTA short scale included the following procedures for each subtests.

1. Instances – "I will read out the quality of some object you will have to tell me as many as things that are like what is read out".
2. Alternate Uses – "I will read out the name of an object and you have to tell me the different ways in which the object can used".
3. Similarities – "I will read out the name of two objects you will have to tell me all the possible ways these two objects are similar".
4. Pattern meanings –"I will show you a pattern on a card. You have to tell me all the things you think that reach complete drawing could be. You can turn the pattern the way you want".
5. Line meanings – "I will show you some lines drawn on a card. You have to tell me what the whole lines make you think of. You can turn the line the way you want.

The subjects were told that they could take as much as time they want and the researcher himself recorded all the responses given by the subjects.

In the case of creativity instrument two types of scores viz., number and uniqueness may be obtained. Scoring was done as given in the manual. High scores indicate that the subject is more creative.

INTERVENTION

Clinical neuropsychology is an applied science with the behavioural expression of brain dysfunction. Its rapid revolution in recent years reflects a growing sensitivity among clinicians to the practical problems of identification, assessment and rehabilitation of brain-damaged patients. Neurologists and neurosurgeons are increasing their requests for behavioural evolutions to aid in diagnosis and to document the course of brain disorders as the effects of treatment (Lezak, 1983).

The goal of rehabilitation is to return a patient to a level of function that approximates that person's pervious level of function. From a practical point of view, knowing what goes on in the brain is not essential in this endeavour. It is more important to know what procedures may be useful to restore the functions.

There are three major experimental therapeutic approaches to brain damage:

1. Rehabilitation procedures that consist of a variety of behavioural and psychological therapies.
2. Pharmacological therapies that can be used to promote recovery in the immediate post surgery period.
3. Transplantation techniques that can be used to restore normal brain function (Kolb and Whishaw 1996).

The concerned family also needs to know the patients psychological condition in order to deal with him/her appropriately. Family members need to understand the patient's state, which may consist of puzzling mental changes, how these affect his cognitive status and what may be their psychosocial repercussions. Even quite subtle defects in motivation, inabilities to plan, organise and carry out activities and in self monitoring can compromise a patient's capacity to earn a living and may render him socially dependent as well (Lezak, 1982). More over many brain damaged patients no longer fit easily in to family life as their irritability, self-centeredness, impulsivity, or apathy creates awesome emotional burdens on family members; generate conflicts between family members and with the patient and strain family ties, often beyond endurance (Malone, 1997; Rosenbaum and Najenson, 1976).

Brain injury rehabilitation involves 2 essential procedures: restoration of functions that can be restored and learning how to do things differently when functions cannot be restored to pre-injury level. Brain injury rehabilitation is based on the nature and scope of neuropsychological symptoms identified on special batteries of test designed to measure brain functioning following brain injury.

While practice in various cognitive tasks - doing arithmetical problems, solving logic puzzles, concentration skills or reading may help brain rehabilitation.

The intervention used in this study comprised of:

1. relaxation
2. stimulating conversation
3. brain storming
4. puzzles
5. counselling

RELAXATION

Relaxation has been an integral part of meditation practices for centuries especially in Eastern religions. Its development and increasing popularity in the West during the 20th century falls in to three general phases.

1. Edmond Jacobson's pioneer work beginning in 1908 and publication of his 'Progressive Relaxation' in 1929.
2. Joseph Wolpe's use of relaxation in systematic desensitisation therapy outlined in his 1958 book 'Psychotherapy By Reciprocal Inhibition' ; and
3. Herbert Benson's research in to common effective elements of relaxation/ meditation techniques and the physiological and psychological benefits from them, published in his 1975 book 'The Relaxation Response'.

Relaxation training helps the parasympathetic rebound to occur and thus avoids chronic triggering and maintenance of high level sympathetic arousal. A number of systems of relaxation are available most of them evolving in some way from Jacobson's progressive relaxation systems (Moore, 1994).

For this study, Dr. Krishna Prasad Sreedhar's (1996) relaxation technique was used. This relaxation training involves 5 basic activities such as drawing the subject's attention to the appropriate muscle groups, instructing the subject to tense the muscles, asking them to feel the tension, teaching them to relax and finally to feel the comfort and enjoy the pleasant feelings of the relaxed state.

The patient was met by the researcher for initial training. Relaxation procedure was taught to them individually and they were asked to practise this regularly. The bystander and family members were asked to help and support them in this.

The relaxation training was used as one of the techniques to relieve the subject from mental stress his condition may cause. The relaxation training was also given to prepare the subject for the succeeding interventions. Relaxation helps to calm the mind, which would help the future interventions to be effective.

STIMULATING CONVERSATION

Exercising the mind is possible through engaging in stimulating conversation. This is possible for all ages and it helps in activating the neurons of the brain (Arden, 2002). This intellectual exercise helps in stimulating memory and activates memory skills.

In this study, stimulating conversation between the subject and the researcher included topics related to the subject's interest. For e.g. sports, politics etc. the researcher met the subject and helped the subject to engage in stimulating conversation, asking thoughtful questions and being a good listener and moderator.

BRAINSTORMING

Brainstorming is generally a creativity technique popularised by Alex Faickney Osborn in the 1930's. This technique is used to generate a large number of ideas to solve a problem. Brian storming is a lateral thinking process. It asks people to come up with ideas and thoughts that seem at first to be a bit shocking or even crazy. The benefit of this method is that this method results in the most stunningly original solution. The method involves presenting a group with a problem to which the group has to generate ideas which focuses only on the quantity of solutions and not the quality. There must be no criticisms and the most absurd and unpractical idea is welcome. The best solution is extracted by combining or modifying these ideas.

In this study, the subjects were instructed to say what ever comes to their mind when they are given a situation, which needs to be facilitated. Whether the idea seems relevant or not the subject was not corrected or criticised. They were also allowed to take a break or terminate the session as and when they wished. Individual sessions were done in the present study.

This is a very enjoyable technique and at the same time, it stimulates and invigorates the nerve cells of the brain. Studies have shown that this type of stimulation accelerates the repair of damaged brain cells and tissues.

READING

Reading is an activity, which needs attention and concentration. Reading requires memory skills in order to associate one letter from another, word from word, sentence from sentence, so on and so forth. Comprehending what has been read is a decisive function, which is very necessary in reading. Reading promotes the capacity of visualising and imagining. It is one of the activities that use a large number of higher cognitive functions. Reading has been used in this study as an intervention keeping this fact in mind. The subject was instructed to read any material of their choice for at least 15 minutes a day, which was to be handled by the bystander.

PUZZLES

Puzzles are means to enhance one's ability to solve problems and improve reasoning skills. In this research, the subjects were individually met and asked to solve 2 types of puzzles:

1. ***Path finding or maze puzzles***

Path finding or maze learning is a popular psychological method to animals (like rats, etc.) and humans. This is an effective method to exercise the brain areas for thinking, reasoning, problem solving memory and attention.

2. ***Mathematical puzzles***

Mathematical problem solving is useful to work out and strengthen brain circuits for higher cognitive skill improvement. Sudoku puzzles were used for this purpose. Sudoku is a mental exercise that uses numbers and groups of numbers that has to be placed in a particular order. Since there is, only one way to complete a Sudoku puzzle correctly it does require thinking. Sudoku has been used to improve cognitive functioning and to slow down the mental effect of aging.

COUNSELLING

The subjects in this study were given counselling and emotional support in order to motivate them and bring them back to normal life. They were given adequate attention and psychological help in overcoming stress, depression and anxiety states that they are likely to be suffering of.

Counselling was given to the family members and the bystanders separately. The family members were trained towards motivating the subject attempt exercises to enhance his/her cognitive skills. They were told about the subject's condition in simple words. The difficulties faced by the subject were explained to them and they were asked to be empathetic and not sympathetic to the subject.

The bystanders were told to motivate the subject to attempt the tasks and help the subject complete the course of interventions. They were also asked to monitor certain interventions like relaxation and reading.

The family members and bystanders were asked to be supportive of the subject's endeavours in attempting to do new tasks and encourage them to come out of their dependent state by trying to do things with out the help of any one.

OBJECTIVES

The study was planned with the objective to test the efficacy of psychological intervention in improving the cognitive functions of reasoning, attention, memory, problem solving and creative thinking of brain injured patients.

HYPOTHESES

The following hypotheses were examined in the present study:

1. Psychological intervention designed is effective in improving the cognitive abilities viz., reasoning, attention, memory, problem solving and creative thinking.
2. Psychological intervention helps to improve the cognitive functions of reasoning, attention, memory, problem solving and creative thinking in brain injured patients trained one month after injury.
3. Psychological intervention is not effective to improve cognitive functions targeted in brain injured patients trained three months after injury.
4. Early intervention is more effective than delayed intervention in improving and the cognitive functions studied.

STATISTICAL ANALYSES

Both quantitative and qualitative techniques were used to test the hypotheses formulated. Statistical procedures used include percentage analysis and t-test. Profile analysis was also used to assess the data qualitatively.

The results of statistical analyses are presented and discussed in the next chapter.

RESULTS AND DISCUSSION

This chapter presents the results of the analyses and discussion of the results obtained. There are two sections in this chapter. In the first section sample characteristics are analysed in detail and in the second section results of intervention are discussed and interpreted.

Section I

In a clinical study characteristics of the sample are crucial with respect to the outcome of intervention used in it. Therefore as a preliminary step in the analyses, an overview of the sample characteristics is provided with the help of tables and pictorial or graphical representations. These tables while presenting the frequency distributions and percentages of subjects in different subgroups of samples of brain injured individuals give a critical appraisal of the significant features of these groups of subjects.

Table 4.1: Age Group - Frequency Distribution

Age	Frequency	Percentage
18-25 years	13	19.70
25-40 years	37	56.06
40- and above	16	24.24
Total	**66**	**100.00**

Table 4.1 shows the frequency distribution of the subjects according to the age group. The subjects are categorized into three groups namely 18-25 years. 25-40 years and 40 years and above according to the vulnerability to brain injury like motor vehicle accident etc. As seen in the table, 13 subjects (19.7%) belong to the age group of 18-25 years, 37 subjects (56.06%) belong

to the age group of 25-40 years and 16 subjects (24.24%) belong to the age group of 40 years and above category. This may be due to the fact that the individuals of the age ranging from 25 to 40 use motor vehicle especially motor bikes to travel regularly from home to work place and back. Because of heavy unruly traffic and poor roads this group is more likely to be prone to road accidents and thus to brain damage. Another possible reason may be workplace accidents that lead to brain injuries. Younger groups' risk taking attitude may also lead to more accidents and injuries to head.

Figure 1: Age Group

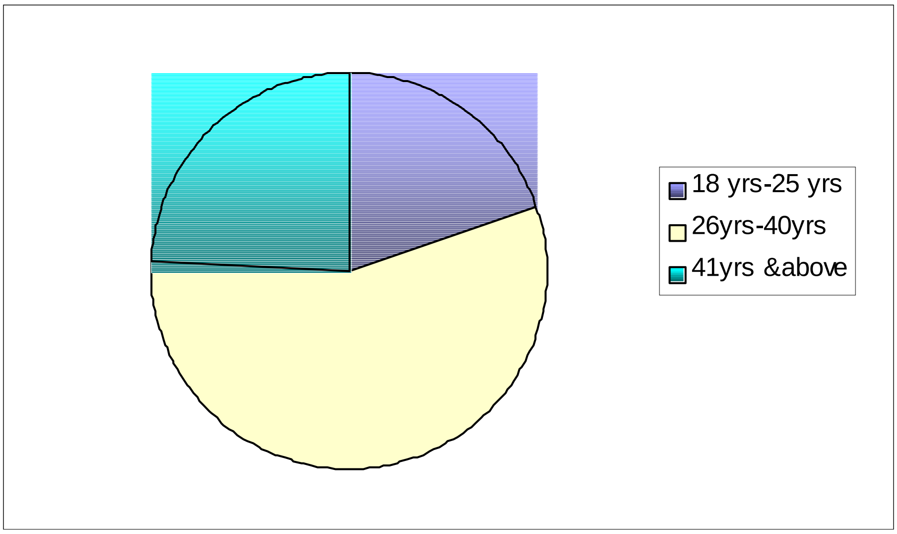
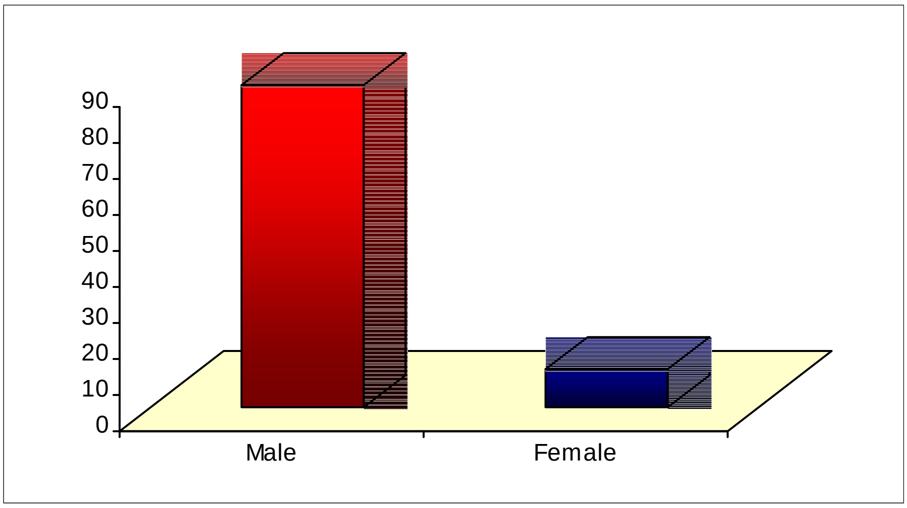


Table 4.2: Sex wise Frequency Distribution

Sex	Frequency	Percentage
Male	59	89.39
Female	7	10.61
Total	**0**	**0.00**

Distribution of subjects in terms of gender is given in Table 4.2. It is observable from the table that there are 59 male subjects (89.39%) and 7 female subjects (10.61%). There is supremacy of male subjects compared to female subjects. This is because men drive most of the vehicles and women are usually passengers.

Figure 2: Sex Wise Distribution



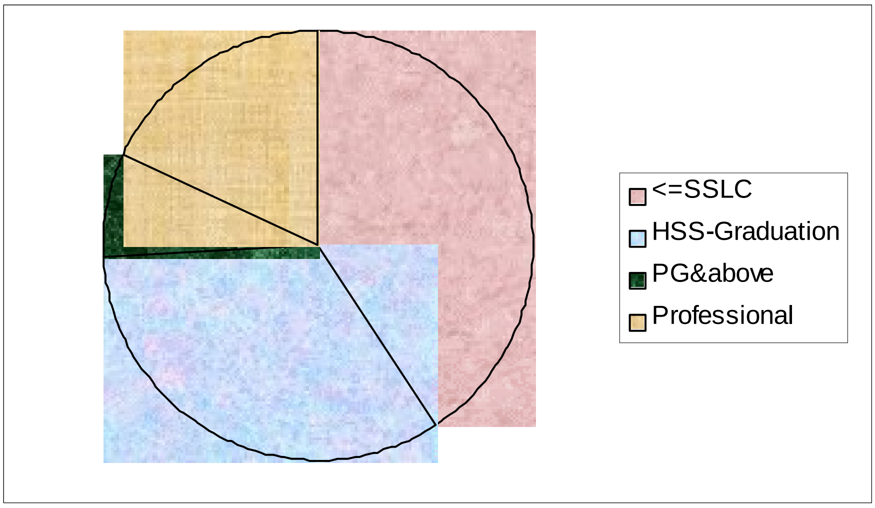
In our society men are entitled to do most of the travelling and fulfil the outdoor requirements. This too may contribute towards more accidents among men and hence more head injuries in them.

Table 4.3: Educational Qualification

Educational Qualification Groups	Frequency	Percentage
SSLC and Below	27	40.91
HSS – Degree	22	33.33
PG and above	05	7.58
Professional Education	12	18.18
Total	**66**	**100.00**

The frequency distribution of subjects based on their educational qualification is given in the Table 4.3. 27 subjects (40.91%) posses only secondary education. 22 subjects (33.33%) hold higher secondary to graduation level qualification. Out of 66 subjects only 5 subjects (7.58%) have higher education qualification, that is, post graduation and above. Among the subjects 18.18% (12) have professional education qualification such as B.Ed, IT, and Engineering degrees.

Figure 3: Educational Qualifications



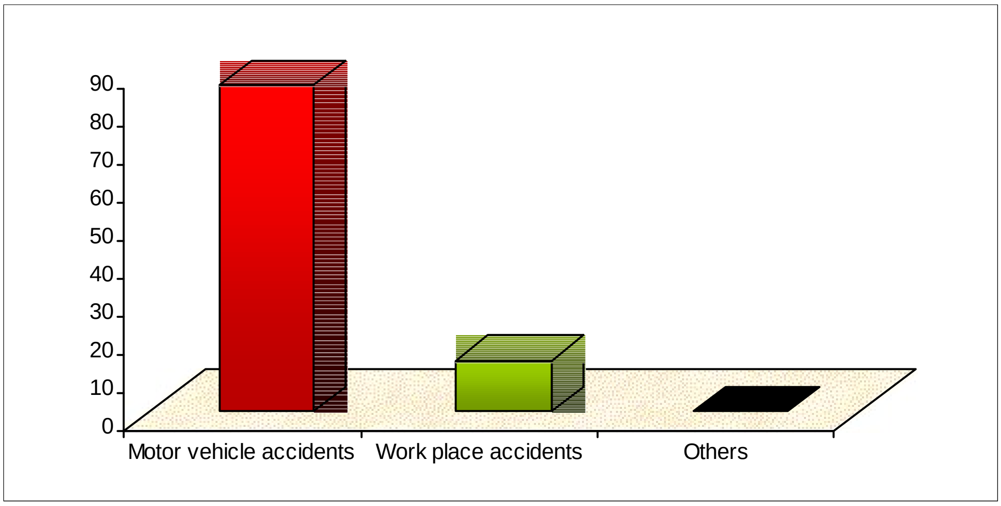
The frequency distribution clearly indicates that lower qualified subjects are more vulnerable to accidents. This may due to ignorance of traffic rules and regulations and their mode of work.

Table 4.4: Cause of Injury

Cause of Injury	Frequency	Percentage
Motor Vehicle Accidents	57	86.36
Work Place Accidents	09	13.64
Others	00	00
Total	**66**	**100.00**

Table 4.4 illustrates the frequency distribution of causes of brain injury. It is evident from the above table that 57 subjects (86.36%) our of 66 subjects acquired brain injury due to motor vehicle accidents. Only 9 subjects (13.64%) are victimized due to accidents at work places. There are no cases reported as brain injured due to other reasons in the present study.

Figure 4: Cause of Injury



Majority of the cases of brain injury indicate motor vehicle accidents as a causative factor. This may be due to the problem of the landscape in Kerala, which consists of hilly areas and slopes. The roads do not suit this geographical speciality, thus causing hinderence to the smooth movement of traffic. Another cause may be the high density of population in Kerala. Kerala is on one hand prone to reckless drivers who do not abide by the traffic rules and on the other by pedestrians who are not bothered about following road rules.

Table 4.5: Shows the Frequency distribution of Domicile

Domicile	Frequency	Percentage
Urban	14	21.21
Sub-Urban	29	43.94
Rural	23	34.85
Total	**66**	**100.00**

Table 4.5 describes the geographical area of residence of the subjects. 14 subjects (21.21%) belong to urban area, 29 subjects (43.94%) belong to sub-urban area and 23 subjects (34.85%) belong to rural area. This shows that subjects of sub-urban area are more vulnerable to motor accidents which lead to brain injury. People of sub-urban area travel frequently than others because they are more or less dependent on cities and need to travel to and fro from the cities. Most of them work in the cities.

Figure 5: Domicile

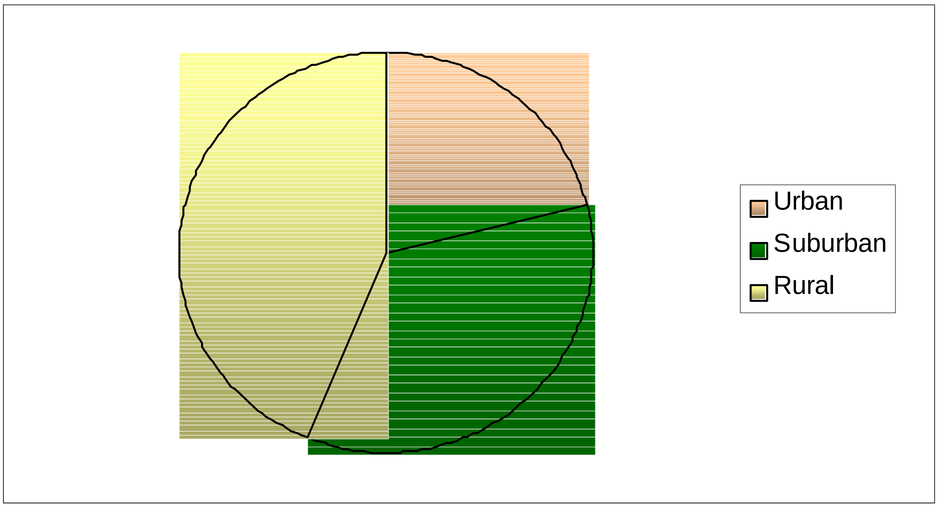
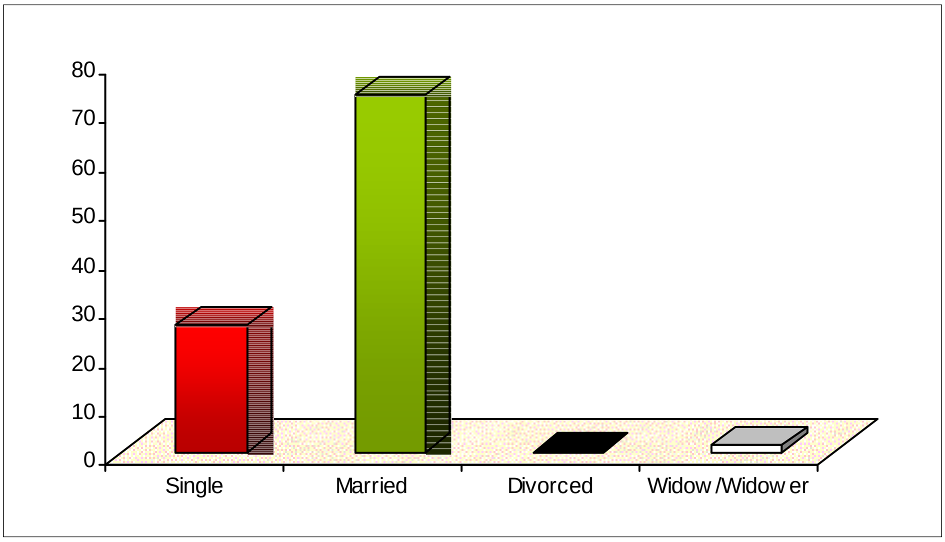


Table 4.6: Frequency Distribution of Marital Status

Marital Status	Frequency	Percentage
Single	17	25.76
Married	48	72.73
Divorced	-	-
Widow/Widower	01	01.51
Total	**66**	**100.00**

The frequency distribution of subjects' marital status is depicted in table 4.6. From the table it can be understood that preponderance of subjects are married (72.73%). 17 subjects (25.76%) are single one subject (1.51%) is a widower and there is no divorced person involved in the present study.

Figure 6: Marital Status



The increase in the number of married subjects may be due to the fact that the study focused on adult individuals.

Table 4.7: Frequency Distribution of Occupational Status

Occupational Status	Frequency	Percentage

Employed	53	80.30
Unemployed	07	10.61
Students	06	09.09
Total	**66**	**100.00**

Table 4.7 describes the occupational status of the subjects. 53 subjects (80.30%) are employed in a private or government institutions. Only 7 subjects (10.61%) are unemployed and all of them are housewives and 6 subjects (09.09%) are students.

Figure 7: Occupational Status

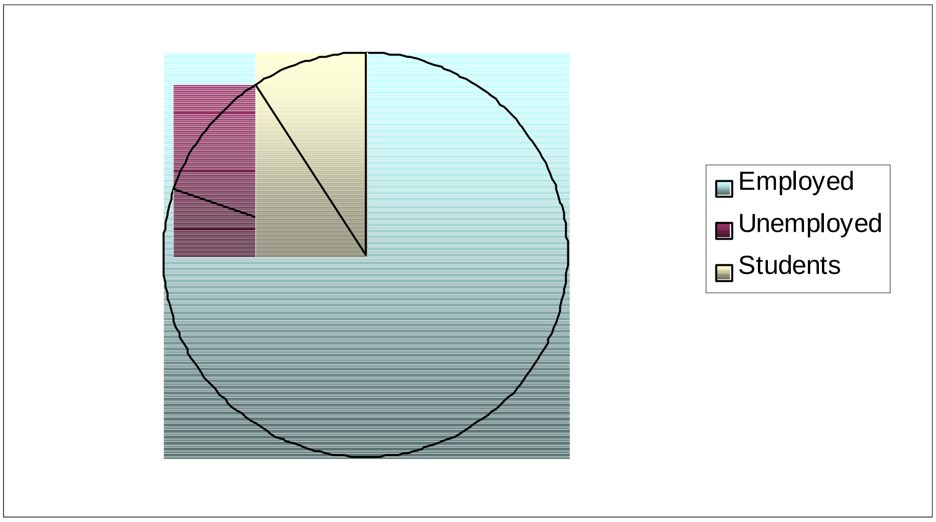
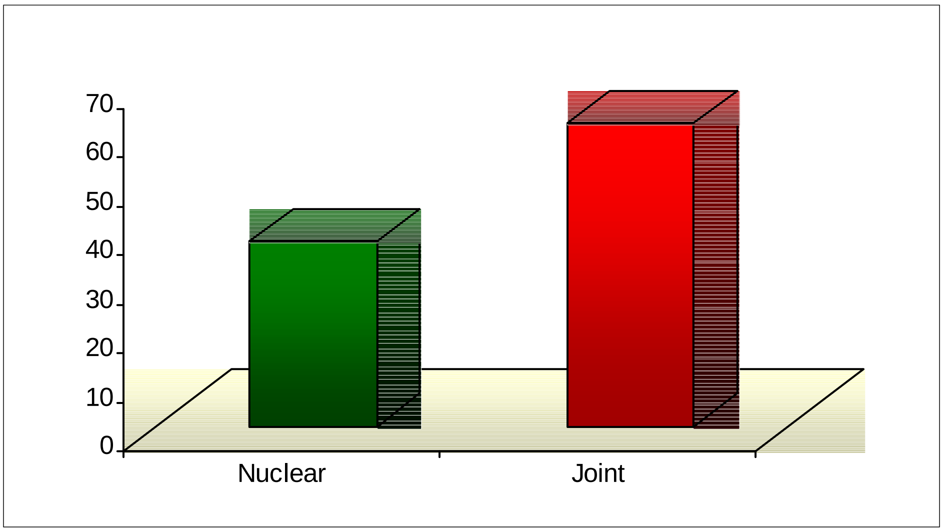


Table 4.8: Shows Frequency distribution of Family Types

Family Type	Frequency	Percentage
Nuclear Family	25	37.88
Joint Family	41	62.12
Total	**66**	**100.00**

Table 4.8 displays the type of family of the subjects. 41 subjects (62.12%) are members of joint families and 25 subjects (37.88%) are members of nuclear families.

Figure 8: Family Types



In the present social set up nuclear families are increasing due to the social change of industrialization and urbanization. But, in the present study majority of the subjects come from joint families.

The details provided in Table 4.1 to 4.8 seem to highlight some of the salient features of the sample. Majority of the subjects are males of the age range between 25 to 40, employed and comparably less educated. Most of them belong to sub-urban areas, are bike riders and commute between home and work place regularly for day-to-day work.

EFFICACY OF INTERVENTION: Total Sample

To examine the efficacy of intervention package designed for the present study the data collected from the experimental and control groups of brain injured patients at pre-intervention, post-intervention and follow-up sessions were analysed using t-test. First, the total sample of 30 experimental subjects and 36 control subjects were compared on cognitive functions namely reasoning, attention, memory, problem solving and creative thinking abilities.

The results are presented in the following pages.

Table 4.9: Means and SDs of the Scores in Reasoning at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients

Experimental Group				**Control Group**		
Sessions	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Pre	30	9.50	1.89	36	8.47	1.52
Post	30	12.77	1.89	36	9.19	1.35
Follow up	30	13.83	2.67	36	10.03	1.25

Table 4.10: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Reasoning at Pre, Post and Follow up Sessions

Groups Compared	**Sessions Compared**	**t-value**	**Level of Significance**
E and C	Pre-Pre	1.54	NS
E and C	Post-Post	2.42	0.05
E and C	Follow up – Follow up	3.27	0.01
E and E	Pre-Post	6.70	0.01
E and E	Pre-Follow up	7.10	0.01
E and E	Post – Follow up	1.79	NS
C and C	Pre-Post	2.13	0.05
C and C	Pre-Follow up	4.73	0.01
C and C	Post-Follow up	2.72	0.01

Tables 4.9 and 4.10 display the Means, SDs and t-values of the reasoning scores of the experimental and control groups of brain injured

patients at pre, post and follow-up sessions of intervention. The results indicate no significant difference in the mean base line scores of the two groups. Comparison of the post intervention scores of the experimental and control groups shows significant difference in reasoning and the experimental group shows superiority over the control group. A similar trend is seen in the follow up scores of the two groups, the experimental group exhibiting higher scores in reasoning tasks.

When the experimental group is considered independently, it is found that significant difference exists between pre and post intervention scores as well as between pre intervention and follow-up scores. But no significant difference was evident in the mean reasoning scores of the experimental group between post intervention and follow up sessions.

Independent assessment of the control group shows difference in scores between pre and post, pre and follow-up as well as between post and follow-up sessions. The improvement in the scores of the control group seems less in comparison of the improvement noted in the case of the experimental group. Results of the experimental group strongly suggest the effectiveness of intervention programmes in improving the reasoning ability of the brain injured patients.

The results are in line with those reported by Middleton, Lambert, and Seggar (1991),Walker (2002) and Cicerone et al (2006). Their studies categorically state that there is substantial evidence to support cognitive improvement in brain injured patients as a result of intervention.

Table 4.11: Means and SDs of the Scores in Attention at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients

Experimental Group				Control Group		
Sessions	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Pre	30	6.90	1.94	36	7.53	1.36
Post	30	9.20	1.96	36	8.28	1.09
Follow up	30	9.87	1.11	36	8.94	1.17

Table 4.12: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Attention at Pre, Post and Follow up Sessions

Groups Compared	Sessions Compared	t-value	Level of Significance
E and C	Pre-Pre	1.60	NS
E and C	Post-Post	2.36	0.05
E and C	Follow up – Follow up	0.81	NS
E and E	Pre-Post	4.58	0.01
E and E	Pre-Follow up	7.24	0.01
E and E	Post – Follow up	1.63	NS
C and C	Pre-Post	2.58	0.01
C and C	Pre-Follow up	4.70	0.01
C and C	Post-Follow up	2.51	0.05

The results of analysis of the scores in attention of the experimental and control groups at pre, post and follow up sessions (Tables 4.11 & 4.12) show no significant difference between the baseline scores of the experimental and control groups. Similarly no significant difference is seen between follow-up scores. But the experimental group differs significantly from the control group in post intervention attention scores.

A comparison of the pre, post and follow up scores of attention of the experimental group reveals that there exists significant differences in the mean attention scores between pre and post, pre and follow up sessions. But no significance is noticed in the mean scores of post intervention and follow up scores.

Again, an examination of the pre, post and follow up scores of the control group suggests significant differences between the sessions compared.

The results clearly indicate that intervention is effective in improving attention of the brain injured persons. The results also suggest that after the injury attention may improve without special training, but to a limited extent. However, with proper training improvement of this cognitive function is rapid and pronounced, as is evident in the case of the experimental subjects.

The present results are similar to the findings of Middleton, Lambert, and Seggar (1991), Anderson, Kaplan, and Felsenthal, (1990), Boman, Lindstedt, Hemmingsson, and Bartfa (2004) and Cicerone et al (2006).

Table 4.13: Means and SDs of the Scores in Memory at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients

Experimental Group				Control Group		
Sessions	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**

Pre	30	5.20	1.50	36	5.08	1.11
Post	30	6.80	1.75	36	5.44	1.30
Follow up	30	7.13	1.80	36	6.00	1.24

Table 4.14: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Memory at Pre, Post and Follow up Sessions

Groups Compared	Sessions Compared	t-value	Level of Significance
E and C	Pre-Pre	1.54	NS
E and C	Post-Post	2.42	0.05
E and C	Follow up – Follow up	3.27	0.01
E and E	Pre-Post	3.81	0.01
E and E	Pre-Follow up	4.39	0.01
E and E	Post – Follow up	0.73	NS
C and C	Pre-Post	1.27	NS
C and C	Pre-Follow up	3.29	0.01
C and C	Post-Follow up	1.86	NS

Memory is found to improve as a result of intervention given to the brain injured patients (Tables 4.13 and 4.14). When experimental and control groups are compared, no significant difference is noticed between baseline scores. But significant differences are seen between post-post scores and follow-up-follow-up scores of memory.

When experimental group's performance is assessed, it is revealed that there is significant difference between pre and post as well as between pre and follow-up scores of memory. However no significance is evident between post and follow up scores.

In the case of the control group, pre and post intervention memory scores show no significant difference. This trend is seen in the case of post intervention and follow up memory scores also. But there is difference between the memory scores of pre intervention and follow up sessions.

On the whole, the results reveal the importance of intervention in improving memory of the brain injured patients. The experimental group seems to excel in memory. From the results of the control group it is possible to infer that brain improves its function naturally with medical intervention. But, however, the results of experimental group are a clear indication of the efficacy of training provided to the brain injured.

The above results are supported by Carney, Chesnut, and Maynard, (1999) who have reported a reduction in memory failures as an outcome of cognitive rehabilitation of brain injured patients. The present findings are also similar to those reported by Middleton, Lambert, and Seggar, (1991), Walker (2002) and Boman, Lindstedt, Hemmingsson, and Bartfai (2004).

Table 4.15: Means and SDs of the Scores (in seconds) in Problem Solving at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients

Experimental Group				Control Group		
Sessions	**N**	**Mean (in seconds)**	**SD**	**N**	**Mean (in seconds)**	**SD**
Pre	30	372.83	170.35	36	302.08	53.78
Post	30	254.10	98.52	36	285.06	56.15
Follow up	30	253.07	91.70	36	267.78	54.72

Table 4.16: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Problem Solving at Pre, Post and Follow up Sessions

Groups Compared	Sessions Compared	t-value	Level of Significance
E and C	Pre-Pre	0.36	NS
E and C	Post-Post	3.61	0.01
E and C	Follow up – Follow up	3.02	0.01
E and E	Pre-Post	3.31	0.01
E and E	Pre-Follow up	3.33	0.01
E and E	Post – Follow up	0.04	NS
C and C	Pre-Post	1.31	NS
C and C	Pre-Follow up	2.64	0.01
C and C	Post-Follow up	1.32	NS

Tables 4.15 and 4.16 present the results related to problem solving of the experimental and control groups of brain injured patients. Mean scores show no significant difference between the two groups in base line scores. The experimental and control groups differ significantly at 0.01 level in problem solving at post-intervention sessions as well as at follow up sessions.

When the performance of the experimental group is considered, the results indicate significant difference between pre- post and pre- follow up scores. But no significance is seen for the difference in scores of the post and follow up sessions.

In the case of the control group a significant difference is noted only between pre and follow-up scores.

The results indicate that intervention helps the patients to improve their performance. After intervention the experimental group is found to take less time to solve problem when compared to pre intervention performance. This group seems to take less time in problem solving than the control group also.

The results firmly suggest that intervention package is effective in helping brain injured patients to improve certain cognitive functions.

The results that intervention helps to improve problem solving ability of the brain injured patients are found in line with the results reported by Walker (2002), Cicerone et al (2006) and Hashimoto, Okamoto, Watanabe, and Ohashi (2006).

Table 4.17: Means and SDs of the Scores in Creative Thinking at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients

Experimental Group				Control Group		
Sessions	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Pre	30	49.90	9.11	36	49.56	3.70
Post	30	65.90	11.15	36	51.50	4.32
Follow up	30	59.50	9.24	36	55.44	4.12

Table 4.18: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Creative Thinking at Pre, Post and Follow up Sessions

Groups Compared	Sessions Compared	t-value	Level of Significance
E and C	Pre-Pre	0.36	NS
E and C	Post-Post	3.61	0.01
E and C	Follow up – Follow up	3.02	0.01
E and E	Pre-Post	6.09	0.01
E and E	Pre-Follow up	3.98	0.01
E and E	Post – Follow up	2.42	0.05
C and C	Pre-Post	2.05	0.05
C and C	Pre-Follow up	6.32	0.01
C and C	Post-Follow up	3.96	0.01

The results of analysis of the scores in creative thinking of the groups of experimental and control subjects at pre, post and follow up sessions of intervention are given in Tables 4.17 and 4.18. Baseline scores do not appear to differ in the case of experimental and control groups. But these two group differ from each other in post-intervention creativity scores as well as in follow up creativity scores.

In the case of the experimental group pre- post intervention difference and pre-intervention-follow-up difference in mean creativity scores are significant at 0.01 level. Again post intervention and follow-up scores also seem to differ from each other at 0.05 level.

A more or less similar trend is seen in the case of control group also.

Creativity scores are found to improve from pre intervention session to follow up session both in the case of experimental and control group. In the case of the experimental subjects improvement in creativity is fast and more pronounced than that in the control group subjects. The results indicate that intervention is effective in bringing about rapid change in creative thinking ability of the brain injured patients.

Hypothesis that psychological intervention is effective in improving cognitive functioning of the brain injured patients is accepted.

EFFICACY OF INTERVENTION-Group -I

After assessing the effectiveness of the intervention package for the total sample of brain injured patients, a second attempt was to examine the two groups of patients namely Group I (experimental and control) consisting of patients at month after injury and Group II (experimental and control) consisting of patients at three months after injury independently. For this purpose, the scores obtained by the different groups on the cognitive abilities of reasoning, attention, memory, problem solving and creative thinking at pre-intervention, post-intervention and follow-up sessions were analysed using t-test and compared with the performance of corresponding control groups.

The results are presented in Tables 4.19 to 4.28 (Group I) and Tables 4.29 to 4.38 (Group II).

Table 4.19: Means and SDs of the Scores in Reasoning at Pre, Post and Follow up Sessions by Experimental and Control Group of Brain Injured Patients (1 month after injury)

Experimental Group					Control Group			
Group Label	**Sessions**	**N**	**Mean**	**SD**	**Group Label**	**N**	**Mean**	**SD**
E_1	Pre	14	9.50	2.31	C_1	17	8.41	1.66
E_1	Post	14	12.86	2.35	C_1	17	9.24	1.52
E_1	Follow up	14	15.43	2.88	C_1	17	10.18	1.38

Table 4.20: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Reasoning at Pre, Post and Follow up Sessions of after One Month Group

Groups Compared	Sessions Compared	t-value	Level of Significance
E_1 and C_1	Pre-Pre	1.43	NS
E_1 and C_1	Post-Post	4.83	0.01
E_1 and C_1	Follow up – Follow up	6.03	0.01
E_1 and E_1	Pre-Post	3.81	0.01
E_1 and E_1	Pre-Follow up	5.81	0.01
E_1 and E_1	Post – Follow up	2.59	0.01
C_1 and C_1	Pre-Post	1.51	NS
C_1 and C_1	Pre-Follow up	3.28	0.01
C_1 and C_1	Post-Follow up	1.89	NS

The results presented in Tables 4.19 and 4.20 show the scores in reasoning of the experimental (E_1) and control (C_1) groups at pre, post and follow up sessions of intervention. No significant difference is seen in the base line reasoning scores of the two groups. When post intervention scores of the two groups are compared, the results show significant difference in the mean scores of experimental and control groups. The mean scores of the two groups show that there is considerable improvement in the reasoning scores of the experimental group. A similar trend is been with respect to the follow up sessions of the experimental and control groups. The experimental group shows improvement when compared to the control group. The results suggest that the intervention programme is effective and it helps to enhance the reasoning ability of the brain injured patients.

Performance of experimental groups at pre, post and follow up sessions is shown in Table 4.20. Significant difference in mean scores is seen between pre-post, pre-follow-up and post-follow up sessions. The results indicate that there is an increase in the reasoning scores of the experimental group from session to session.

The reasoning scores of the control group, when compared between sessions, show no significant difference at pre-post and post-follow-up sessions. But significant difference is noted between pre and follow up stages. This shows that a gradual change occurs, however, it could be seen that with intervention the improvement is more pronounced and faster.

Table 4.21: Means and SDs of the Scores in Attention at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients of after One Month Group

Experimental Group					Control Group			
Group Label	**Sessions**	**N**	**Mean**	**SD**	**Group Label**	**N**	**Mean**	**SD**
E_1	Pre	14	5.79	2.12	C_1	17	7.12	1.54

E_1	Post	14	8.29	2.23	C_1	17	8.06	1.20
E_1	Follow up	14	9.36	1.22	C_1	17	9.00	1.28

Table 4.22: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Attention at Pre, Post and Follow up Sessions of after One Month Group

Groups Compared	Sessions Compared	t-value	Level of Significance
E_1 and C_1	Pre-Pre	1.87	NS
E_1 and C_1	Post-Post	0.32	NS
E_1 and C_1	Follow up – Follow up	0.78	NS
E_1 and E_1	Pre-Post	3.04	0.01
E_1 and E_1	Pre-Follow up	5.25	0.01
E_1 and E_1	Post – Follow up	1.58	NS
C_1 and C_1	Pre-Post	1.99	0.05
C_1 and C_1	Pre-Follow up	3.76	0.01
C_1 and C_1	Post-Follow up	2.22	0.05

Tables 4.21 and 4.22 provide the results of intervention with respect to attention of brain injured patients, tested one month after injury. The results show no significant difference between experimental (E_1) and Control (C_1) groups at pre, post and follow up phases.

When the performance of experimental group is considered it seems that attention improves from session to session. Baseline score of attention is 5.79 and at post intervention the score is 8.29. Significant difference in mean scores of pre and post intervention sessions is noticed. Similarly, there is significant difference in the mean scores of attention between pre intervention and follow-up sessions. This suggests improvement in attention as a result of intervention among experimental subjects.

A comparison of the scores in attention of the control group at pre, post and follow-up sessions reveal a change from the base line scores at different stages. This shows that brain registers natural improvement with respect to attention. But this is likely to be enhanced as a result of training. The results indicate effectiveness of intervention in improving attention of brain injured patients.

Table 4.23: Means and SDs of the Scores in Memory at Pre, Post and Follow up Sessions by Experimental and Control Group of Brain Injured Patients of after One Month Group

Experimental Group					Control Group			
Group Label	**Sessions**	**N**	**Mean**	**SD**	**Group Label**	**N**	**Mean**	**SD**
E_1	Pre	14	4.36	1.28	C_1	17	4.59	1.12
E_1	Post	14	5.71	1.20	C_1	17	4.71	0.92
E_1	Follow up	14	6.14	1.35	C_1	17	5.24	0.83

Table 4.24: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Memory at Pre, Post and Follow up Sessions of after One Month Group

Groups Compared	Sessions Compared	t-value	Level of Significance
E_1 and C_1	Pre-Pre	0.50	NS
E_1 and C_1	Post-Post	2.50	0.05
E_1 and C_1	Follow up – Follow up	2.14	0.05
E_1 and E_1	Pre-Post	2.89	0.01

E_1 and E_1	Pre-Follow up	3.42	0.01
E_1 and E_1	Post – Follow up	0.89	NS
C_1 and C_1	Pre-Post	0.33	NS
C_1 and C_1	Pre-Follow up	1.86	NS
C_1 and C_1	Post-Follow up	1.76	NS

Results of analysis of the scores on memory of the experimental (E_1) and control (C_1) groups of brain injured patients are given in Tables 4.23 and 4.24. The two groups do not seem to differ in base line scores. Memory scores of the experimental and control groups are found to differ significantly at the post intervention phases as well as in the follow-up phases. In both cases the memory scores of the experimental groups show improvement over the scores of the control group. The results suggest the efficacy of intervention package in improving the memory of brain injured persons.

An examination of the performance of the experimental group at pre, post and follow up sessions show improvement of memory from session to session. After intervention at the follow up also the patients could maintain a high score in memory.

Pre-intervention, post-intervention and follow-up scores of the control group indicate no significant change in memory from pre-intervention stage.

The results indicate significant effect of intervention with regard to improvement in memory of brain injured subjects.

Table 4.25: Means and SDs of the Scores (in seconds) in Problem Solving at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients of after One Month Group

Experimental Group					**Control Group**			
Group	**Sessions**	**N**	**Mean (in**	**SD**	**Group**	**N**	**Mean (in**	**SD**

Label			seconds)		Label		seconds)	
E_1	Pre	14	504.36	165.98	C_1	17	345.65	27.66
E_1	Post	14	336.21	76.53	C_1	17	330.94	35.05
E_1	Follow up	14	331.36	68.19	C_1	17	311.24	38.04

Table 4.26: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Problem Solving at Pre, Post and Follow up Sessions of after One Month Group

Groups Compared	Sessions Compared	t-value	Level of Significance
E_1 and C_1	Pre-Pre	3.41	0.01
E_1 and C_1	Post-Post	0.23	NS
E_1 and C_1	Follow up – Follow up	0.95	NS
E_1 and E_1	Pre-Post	3.44	0.01
E_1 and E_1	Pre-Follow up	3.48	0.01
E_1 and E_1	Post – Follow up	0.18	NS
C_1 and C_1	Pre-Post	1.36	NS
C_1 and C_1	Pre-Follow up	2.93	0.01
C_1 and C_1	Post-Follow up	1.57	NS

Tables 4.25 and 4.26 present the results of t-tests of the scores (in seconds) of the problem solving tasks by brain injured subjects tested one month after injury. The results show that the experimental and control groups differ significantly in base line scores. However, these two groups do not seem to differ significantly at post-post and follow-up-follow-up comparisons.

But when the scores of the experimental groups are compared, the results show significant differences in problem solving scores between pre-post as well as pre-follow up sessions. In the case of the experimental group, intervention seems to facilitate problem solving ability. The subjects seem to take less time to solve problems at the post intervention and follow up sessions.

In the case of the control group, there is significant difference in the time taken by the subjects in pre intervention and follow up stages. The differences between pre and post sessions as well as between post and follow up sessions are not significant. This suggests that a gradual improvement in problem solving ability may occur with medical intervention but without special training. However, improvement at a fast rate may occur with proper intervention.

Table 4.27: Means and SDs of the Scores in Creative Thinking at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients of after One Month Group

Experimental Group					Control Group			
Group Label	**Sessions**	**N**	**Mean**	**SD**	**Group Label**	**N**	**Mean**	**SD**
E_1	Pre	14	41.57	4.13	C_1	17	48.47	1.84
E_1	Post	14	56.36	5.09	C_1	17	49.41	2.79
E_1	Follow up	14	51.50	3.82	C_1	17	54.82	2.92

Table 4.28: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Creative Thinking at Pre, Post and Follow up Sessions of after One Month Group

Groups Compared	Sessions Compared	t-value	Level of Significance
E_1 and C_1	Pre-Pre	5.61	0.01
E_1 and C_1	Post-Post	4.43	0.01
E_1 and C_1	Follow up – Follow up	2.59	0.01
E_1 and E_1	Pre-Post	8.44	0.01
E_1 and E_1	Pre-Follow up	6.37	0.01
E_1 and E_1	Post – Follow up	2.86	0.01
C_1 and C_1	Pre-Post	1.16	NS

C_1 and C_1	Pre-Follow up	7.38	0.01
C_1 and C_1	Post-Follow up	5.53	0.01

Results of analysis of the scores in creative thinking at pre, post and follow up sessions by the experimental (E1) and control (C1) groups are given in Tables 4.27 and 4.28. t-values obtained show that experimental and control groups differ significantly in baseline scores, the experimental group being low in creativity. The two groups seem to differ significantly in post intervention scores. After intervention it is found that creativity improves faster in experimental groups than in control group. While the experimental group gets a mean score of 56.36, the mean score of the control group is 49.4 and the difference in mean scores between the groups is significant at 0.01 level. The experimental and control groups also differ significantly in creativity scores obtained at follow-up sessions. A relapse is seen in the case of experimental group. The training does not help them maintain creativity. But the control group seems to show a steady increase in creativity scores the increase is greater than in the case of experimental group.

Analysis of pre-post, pre-follow-up and post-follow up scores of the experimental group shows significant differences between the sessions compared. The results clearly indicate the effectiveness of intervention. After intervention the creativity scores of the subjects show a sharp increase.

When the scores of creativity of the control group are compared among various sessions, the results indicate no significant difference between pre and post session scores. However, significant differences are noticed in scores between pre and follow up sessions as well as between post and follow up sessions. The results suggest that with time the brain could automatically restore some of its abilities that are lost as a result of injury. A possible reason for this is the medical help patients receive.

The hypothesis that psychological intervention helps to improve the cognitive functions of reasoning, attention, memory, problem solving and creative thinking in patients trained one month after injury is accepted.

EFFICACY OF INTERVENTION-Group –II

The results of analyses to examine the effectiveness of intervention with Group II are discussed in the following pages.

Table 4.29: Means and SDs of the Scores in Reasoning at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients (three months after injury)

Experimental Group					Control Group			
Group Label	Sessions	N	Mean	SD	Group Label	N	Mean	SD
E_2	Pre	16	9.50	1.51	C_2	19	8.53	1.43
E_2	Post	16	12.69	1.45	C_2	19	9.16	1.21
E_2	Follow up	16	12.44	1.46	C_2	19	9.89	1.15

Table 4.30: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Reasoning at Pre, Post and Follow up Sessions of after three months of injury groups.

Groups Compared	Sessions Compared	t-value	Level of Significance
E_2 and C_2	Pre-Pre	1.73	NS
E_2 and C_2	Post-Post	7.06	0.01

E_2 and C_2	Follow up – Follow up	5.20	0.01
E_2 and E_2	Pre-Post	6.10	0.01
E_2 and E_2	Pre-Follow up	5.07	0.01
E_2 and E_2	Post – Follow up	0.49	NS
C_2 and C_2	Pre-Post	1.47	NS
C_2 and C_2	Pre-Follow up	2.96	0.01
C_2 and C_2	Post-Follow up	1.92	NS

Tables 4.29 and 4.30 give the results of analysis of the reasoning scores of the experimental and control groups (3 months after injury) at pre, post and follow up sessions. The experimental and control groups seem to have homogenous baseline scores in reasoning. The two groups do not seem to differ from one another. After intervention the experimental group seems to score higher than the control group and the difference in mean reasoning score is found significant at 0.01 level. The follow up scores of the experimental and control groups also seem to differ significantly. The experimental group is found to dominate the control group.

Comparison of the reasoning scores of the experimental group at pre, post and follow up sessions indicate pre and post intervention and pre-intervention and follow up scores as differing significantly between the groups compared. No difference is noted between post intervention and follow up scores.

Similarly when pre and post intervention as well as follow up scores of the control group are considered no significant difference is noted between pre and post intervention scores as well as between post-intervention and follow up scores. However, pre intervention and follow up scores indicate significant difference between them.

The results suggest that intervention package is effective in improving the reasoning ability of the brain injured though given at a later period.

Table 4.31: Means and SDs of the Scores in Attention at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients (three months after injury).

Experimental Group					**Control Group**			
Group Label	**Sessions**	**N**	**Mean**	**SD**	**Group Label**	**N**	**Mean**	**SD**
E_2	Pre	16	7.88	1.09	C_2	19	7.89	1.10
E_2	Post	16	10.00	1.27	C_2	19	8.47	0.96
E_2	Follow up	16	10.31	0.79	C_2	19	8.89	1.10

Table 4.32: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Attention at Pre, Post and Follow up Sessions of after three months of injury group.

Groups Compared	**Sessions Compared**	**t-value**	**Level of Significance**
E_2 and C_2	Pre-Pre	0.02	NS
E_2 and C_2	Post-Post	3.64	0.01
E_2 and C_2	Follow up – Follow up	3.94	0.01
E_2 and E_2	Pre-Post	5.10	0.01
E_2 and E_2	Pre-Follow up	6.57	0.01
E_2 and E_2	Post – Follow up	0.84	NS
C_2 and C_2	Pre-Post	1.73	NS
C_2 and C_2	Pre-Follow up	2.50	0.05
C_2 and C_2	Post-Follow up	1.26	NS

Tables 4.31 and 4.32 show the results of analysis of the scores in attention of the experimental and control group II at pre, post and follow up

sessions of intervention. The results show no significant difference between the two groups in base line scores. Significant difference is evident in post-post intervention scores. Again there is significant difference in mean attention scores of the experimental and control groups II obtained in follow-up sessions.

Comparison of the scores of experimental group II at pre, post and follow up sessions indicate significant difference between pre intervention and post intervention scores as well as between pre intervention and follow up sessions but post intervention and follow up scores do not seem to differ.

Results of the control group II at pre, post and follow up sessions show difference in attention scores as significant only between pre and follow up scores. This may be due to medical help received by the patients.

The results suggest the effectiveness of intervention programmes in improving attention of the brain injured patients.

Table 4.33: Means and SDs of the Scores in Memory at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients (three months after injury).

Experimental Group					Control Group			
Group Label	**Sessions**	**N**	**Mean**	**SD**	**Group Label**	**N**	**Mean**	**SD**
E_2	Pre	16	5.94	1.29	C_2	19	5.33	0.91
E_2	Post	16	7.75	1.61	C_2	19	6.11	1.24
E_2	Follow up	16	8.00	1.71	C_2	19	6.68	1.16

Table 4.34: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Memory at Pre, Post and Follow up Sessions of after three months of injury group.

Groups Compared	Sessions Compared	t-value	Level of Significance
E_2 and C_2	Pre-Pre	0.98	NS
E_2 and C_2	Post-Post	2.98	0.01
E_2 and C_2	Follow up – Follow up	2.40	0.05
E_2 and E_2	Pre-Post	3.51	0.01
E_2 and E_2	Pre-Follow up	3.49	0.01
E_2 and E_2	Post – Follow up	0.43	NS
C_2 and C_2	Pre-Post	1.64	NS
C_2 and C_2	Pre-Follow up	3.19	0.01
C_2 and C_2	Post-Follow up	1.49	NS

A similar trend is evident from the analysis of the scores in memory. Memory of the brain injured subjects is found to improve as a result of intervention. The experimental group II exhibits an increase in the memory scores over that of the control group II at post intervention and follow-up sessions. Memory of the experimental group II seems to improve from session to session at a greater rate than that of the control group II. Minimum improvement in memory is noticed from session to session in the case of Control Group II. But this seems gradual and not pronounced and may be due to medical attention received by the control subjects.

Table 4.35: Means and SDs of the Scores (in seconds) in Problem Solving at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients (three months after injury group).

Experimental Group					Control Group			
Group Label	**Sessions**	**N**	**Mean (in seconds)**	**SD**	**Group Label**	**N**	**Mean (in seconds)**	**SD**
E_2	Pre	16	257.75	44.24	C_2	19	263.11	39.32
E_2	Post	16	182.25	43.46	C_2	19	244.00	35.64
E_2	Follow up	16	184.56	38.73	C_2	19	228.89	33.99

Table 4.36: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Problem Solving at Pre, Post and Follow up Sessions of after three months of injury group.

Groups Compared	Sessions Compared	t-value	Level of Significance
E_2 and C_2	Pre-Pre	0.34	NS
E_2 and C_2	Post-Post	4.12	0.01
E_2 and C_2	Follow up – Follow up	3.24	0.01
E_2 and E_2	Pre-Post	4.87	0.01
E_2 and E_2	Pre-Follow up	4.49	0.01
E_2 and E_2	Post – Follow up	0.16	NS
C_2 and C_2	Pre-Post	1.57	NS
C_2 and C_2	Pre-Follow up	2.63	0.01
C_2 and C_2	Post-Follow up	1.34	NS

Performance scores in problem solving of the experimental and control groups II at pre, post and follow up sessions are given in Tables 4.35 and 4.36. A comparison between experimental control groups indicates superiority of experimental subjects over the control subjects in all the sessions. The former group takes less time to do the problem solving tasks than the latter group. A decrease in time taken is noticed in both groups from session to session. And this reduction in time to complete the tasks is more in the case of experimental subjects in spite of a relapse noticed at the follow up session.

In the case of the experimental group II base line scores seem to improve with intervention and the difference between baseline and post intervention scores is significant at 0.01 level. Similarly there is a significant difference between base line and follow up scores of problem solving. But the difference between post-intervention and follow up scores is not seen significant.

Pre, post and follow up comparisons of the control group II suggest difference in problem solving scores as significant only between pre intervention and follow up scores. This shows a gradual improvement in problem solving ability of the brain injured patients and this may be attributed to medical intervention. However, psychological intervention is found to have beneficial effects and to facilitate improvement at a faster rate as seen in the case of experimental subjects.

Table 4.37: Means and SDs of the Scores in Creativity at Pre, Post and Follow up Sessions by Experimental and Control Groups of Brain Injured Patients (three months after injury)

Experimental Group					Control Group			
Group Label	Sessions	N	Mean	SD	Group Label	N	Mean	SD
E_2	Pre	16	57.19	4.92	C_2	19	50.53	4.62
E_2	Post	16	74.25	7.64	C_2	19	53.37	4.65
E_2	Follow up	16	66.50	6.37	C_2	19	56.00	4.98

Table 4.38: Results of t-tests on the Scores of Experimental and Control Groups of Brain Injured Patients in Creativity at Pre, Post and Follow up Sessions of after three months of injury group.

Groups Compared	Sessions Compared	t-value	Level of Significance
E_2 and C_2	Pre-Pre	3.72	0.01
E_2 and C_2	Post-Post	8.63	0.01
E_2 and C_2	Follow up – Follow up	4.86	0.01
E_2 and E_2	Pre-Post	7.51	0.01
E_2 and E_2	Pre-Follow up	4.17	0.01
E_2 and E_2	Post – Follow up	3.12	0.01
C_2 and C_2	Pre-Post	1.89	NS
C_2 and C_2	Pre-Follow up	3.22	0.01
C_2 and C_2	Post-Follow up	1.69	NS

With reference to creative thinking, the results (Tables 4.37 and 4.38) reveal significant difference between the scores at pre and post intervention, pre intervention and follow up as well as between post intervention and follow up sessions of the experimental and control subjects. In all comparisons the experimental group exhibits superiority over the control group. Experimental subjects show improvement in creative thinking abilities as a result of intervention.

In the case of the experimental group improvement in creative thinking is at a faster rate. This is evident from the mean scores at pre-intervention (57.19) and post intervention (74.25) sessions. However, a relapse is noticed at follow up session. There is a reduction in creativity scores (66.50) at the follow up. This suggests that the group finds it difficult to maintain creativity in the absence of continued training.

In the case of the control group a marginal increase in the creativity scores could be seen. A significant difference is noted between the scores at pre-intervention and follow up sessions only. This shows that improvement of this cognitive function is slower without adequate post injury intervention.

The results reveal the effect of intervention package to improve creative thinking abilities of the brain injured patients.

The hypothesis that psychological intervention is not effective to improve cognitive functions targeted in brain injured patients trained three months after injury is rejected.

EFFICACY OF INTERVENTION-Comparison between Group I and Group II

Another research question was whether the time factor has anything to do with recovery of the patients. The interval between the incident and the beginning of treatment might influence the rate of improvement. The earlier the better may prove right in the case of many brain injured patients. Based on this assumption yet another analysis is made to find out the differential effect of intervention among the patients who are trained one month after injury and three months after injury.

The results are presented from Tables 4.39 to 4.43.

Table 4.39: Means, SDs and Results of t-tests on the Scores of Experimental Groups I and II and Control Groups I and II of Brain Injured Patients in Reasoning at Pre, Post and Follow-up Sessions

Experimental Groups							
Sessions	**Experimental Group I**			**Experimental Group II**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**t-value**
Pre	14	9.50	2.31	16	9.50	1.51	0.00
Post	14	12.86	2.35	16	12.69	1.45	0.23
Follow-up	14	15.43	2.88	16	12.44	1.46	3.36**
Control Groups							
Sessions	**Control Group I**			**Control Group II**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**t-value**
Pre	17	8.41	1.66	19	8.53	1.43	0.23
Post	17	9.24	1.52	19	9.16	1.21	0.17
Follow-up	17	10.18	1.38	19	9.89	1.15	0.66

*** Significant at 0.01 level*

Table 4.39 presents the results of experimental groups I and II as well as that of control groups I and II with respect to reasoning ability.

The two groups do not seem to differ from one another significantly in the pre intervention as well as in the post intervention session scores of reasoning. Follow-up scores show significant difference between experimental groups I and II. Group I has obtained a higher mean score of 15.43 when compared to 12.44 of the group II. The results suggest that early intervention is more effective in helping the brain injured patients to improve their reasoning ability.

Table 4.40: Means, SDs and Results of t-tests on the Scores of Experimental Groups I and II and Control Groups I and II of Brain Injured Patients in Attention at Pre, Post and Follow-up Sessions

Experimental Groups							
Sessions	Experimental Group I			Experimental Group II			
	N	Mean	SD	N	Mean	SD	t-value
Pre	14	5.79	2.12	16	7.88	1.09	3.17**
Post	14	8.29	2.23	16	10.00	1.27	2.44*
Follow-up	14	9.36	1.22	16	10.31	0.79	2.44*
Control Groups							
Sessions	Control Group I			Control Group II			
	N	Mean	SD	N	Mean	SD	t-value
Pre	17	7.12	1.54	19	7.89	1.10	1.64
Post	17	8.06	1.20	19	8.47	0.96	1.11
Follow-up	17	9.00	1.28	19	8.89	1.10	0.27

*** Significant at 0.01 level*

** Significant at 0.05 level*

Results with respect to attention of the experimental groups I and II and control groups I and II are displayed in Table 4.40. The t-values show that the two groups differ significantly in all the sessions compared. An examination of the mean scores reveals that experimental group II has obtained a higher score indicating their superiority over experimental group I. Here, lapse of time in starting the intervention does not seem to affect the performance of the group. This may be because they experience less bodily discomfort and hence are likely to have their attention enhanced. Another reason may be that medical attention received regularly could help them to maintain their power of attention.

Table 4.41: Means, SDs and Results of t-tests on the Scores of Experimental Groups I and II and Control Groups I and II of Brain Injured Patients in Memory at Pre, Post and Follow-up Sessions

Experimental Groups							
Sessions	**Experimental Group I**			**Experimental Group II**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**t-value**
Pre	14	4.36	1.23	16	5.94	2.29	2.29**
Post	14	5.71	1.20	16	7.75	1.61	3.85**
Follow-up	14	6.14	1.35	16	8.00	1.71	3.26**
Control Groups							
Sessions	**Control Group I**			**Control Group II**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**t-value**
Pre	17	4.59	1.12	19	5.53	0.91	2.61**
Post	17	4.71	0.92	19	6.11	1.24	3.78**
Follow-up	17	5.24	0.83	19	6.68	1.56	3.43**

*** Significant at 0.01 level*

Table 4.41 displays the results of analysis of the memory scores of the experimental groups I and II and control groups I and II. The groups differ significantly from one another in the scores obtained in all the sessions compared. The results indicate that the group II exhibit more improvement than the group I. Intervention is found to have a more facilitating effect in the case of experimental group II.

It is curious to note that control group’s performance also suggest improvement in memory. This shows that automatic restoration of memory is possible to a limited extent with adequate medical help. Here also the patients trained three months after injury seem better than those trained one month after injury.

The results further affirm the earlier findings that intervention helps the patient improve at a faster rate and delayed intervention seems more beneficial

Table 4.42: Means, SDs and Results of t-tests on the Scores (in seconds) of Experimental Groups I and II and Control Groups I and II of Brain Injured Patients in Problem Solving at Pre, Post and Follow-up Sessions

Experimental Groups							
Sessions	**Experimental Group I**			**Experimental Group II**			
	N	**Mean (in seconds)**	**SD**	**N**	**Mean (in seconds)**	**SD**	**t-value**
Pre	14	504.36	165.97	16	257.75	44.24	5.20**
Post	14	336.21	76.53	16	182.25	43.46	6.41**
Follow-up	14	331.36	68.19	16	184.56	38.73	6.90**
Control Groups							
Sessions	**Control Group I**			**Control Group II**			
	N	**Mean (in seconds)**	**SD**	**N**	**Mean (in seconds)**	**SD**	**t-value**
Pre	17	345.65	27.66	19	263.11	39.32	7.14**
Post	17	330.94	35.05	19	244.00	35.64	7.16**
Follow-up	17	311.24	38.04	19	228.89	33.99	6.63**

*** Significant at 0.01 level*

A similar trend, as in the case of memory, is evident with respect to problem solving also. The second experimental group is found to improve faster than the first. Here also, though the intervention has been started comparably later the results obtained are promising. It appears that, with a month's training, problem solving ability of both the groups have improved considerably and they are found to take less time to solve problems than that in the pre intervention sessions.

The control groups also show difference between sessions compared. Control Group II exhibits more improvement. But, when compared to the experimental groups, the change noted in the control groups are comparably less. The results suggest that medical intervention aids in recovery process but timely intervention with psychological strategies may be highly helpful to brain injured patients for rapid and positive changes in cognitive functioning such as problem solving.

Table 4.43: Means, SDs and Results of t-tests on the Scores of Experimental Groups I and II and Control Groups I and II of Brain Injured Patients in Creativity at Pre, Post and Follow-up Sessions

Experimental Groups							
Sessions	**Experimental Group I**			**Experimental Group II**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**t-value**
Pre	14	41.57	4.13	16	57.19	4.92	9.13**
Post	14	56.36	5.09	16	74.25	7.64	7.39**
Follow-up	14	51.50	3.82	16	66.50	6.37	7.65**
Control Groups							
Sessions	**Control Group I**			**Control Group II**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**t-value**
Pre	17	48.47	1.84	19	50.53	4.62	1.75
Post	17	49.41	2.79	19	53.37	4.65	3.05**
Follow-up	17	54.82	2.92	19	56.00	4.98	0.86

*** Significant at 0.01 level*

Results of analysis of creativity scores presented in Table 4.43. The t-values obtained indicate significant difference between experimental groups I and II in all the sessions compared. The results suggest that group II is better in creativity than group I. Time of starting the intervention does not seem to affect the process of improvement. In both cases post intervention scores are higher than the pre-intervention scores. In both the groups a relapse is seen at the follow up phase. This shows that without intervention both the groups are unable to maintain the higher scores in creative thinking. The results further affirm the effectiveness of intervention.

In the case of the control group there is a gradual increase in the creativity scores. This shows that even without intervention creativity of the brain injured persons may change in the positive direction. But this is found to be minimal. The change may be attributed to medical intervention given to them and associated general bodily improvement. The results of experimental groups when compared with that of the control groups prove that psychological intervention is more effective in bringing about positive change in cognitive functioning.

The hypothesis that early intervention is more effective than delayed intervention is only partially accepted. Among the five cognitive functions studied, delayed intervention seems to have beneficial effects in the case of four abilities. This may be because of the medical intervention received by the brain injured patients for an extended period.

The results obtained on comparing experimental groups I and II as well as control groups I and II further reveal that the time of starting psychological intervention is not very influential with regard to the improvement in cognitive functioning of the brain injured patients. In the case of reasoning early training seems to bring about more sustainable change in patients. On the contrary, in attention, memory, problem solving and creative thinking later trained groups are found to excel. This may be partially attributed to the effect of medical intervention. But however, when compared to the control groups which receive only medical attention the experimental groups are superior in all the cognitive functions studied. This clearly suggests the efficacy of psychological intervention in facilitating the improvement of such functions.

A profile analysis of the groups (Experimental Groups I and II and Control Groups I and II) is attempted. The results are presented graphically.

Figure 9

Experimental Group I-Reasoning

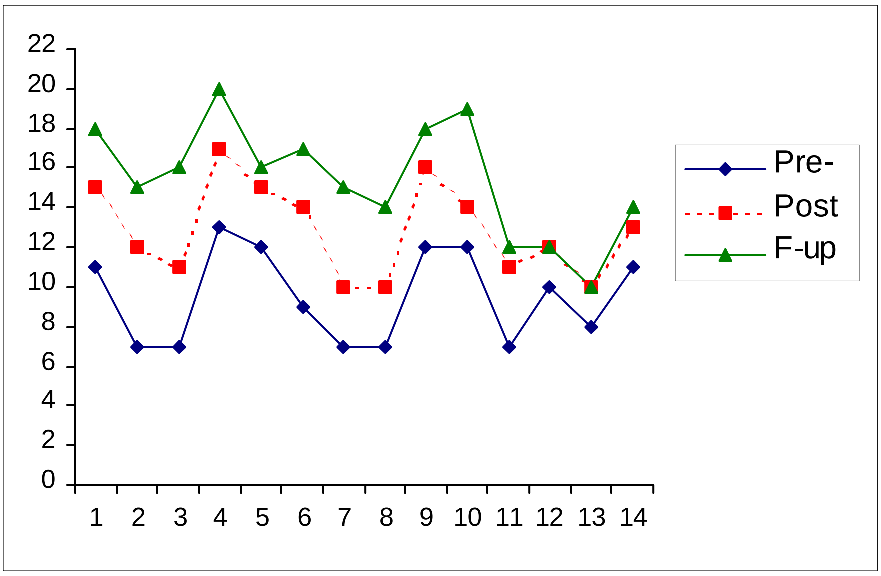
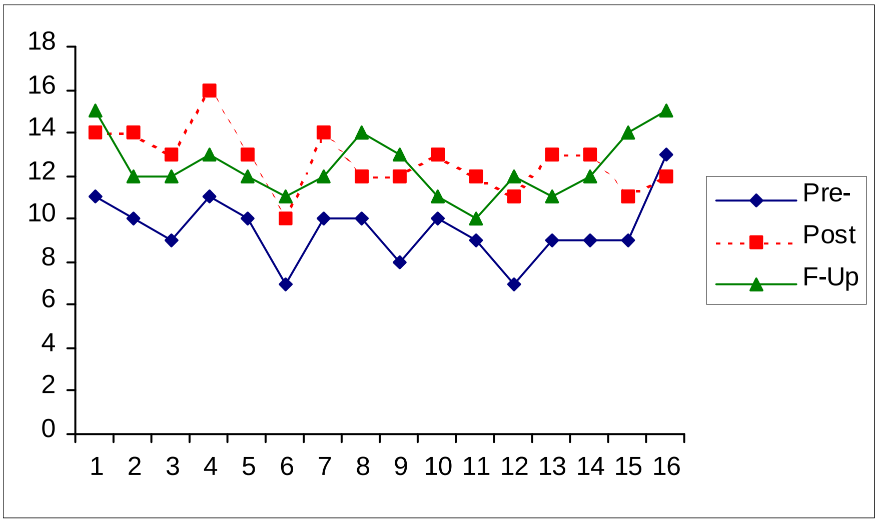


Figure 10

Experimental Group II-Reasoning


18
16
14
12
10
8
6
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2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Pre-
Post
F-Up

Figure 11

Control Group I-Reasoning

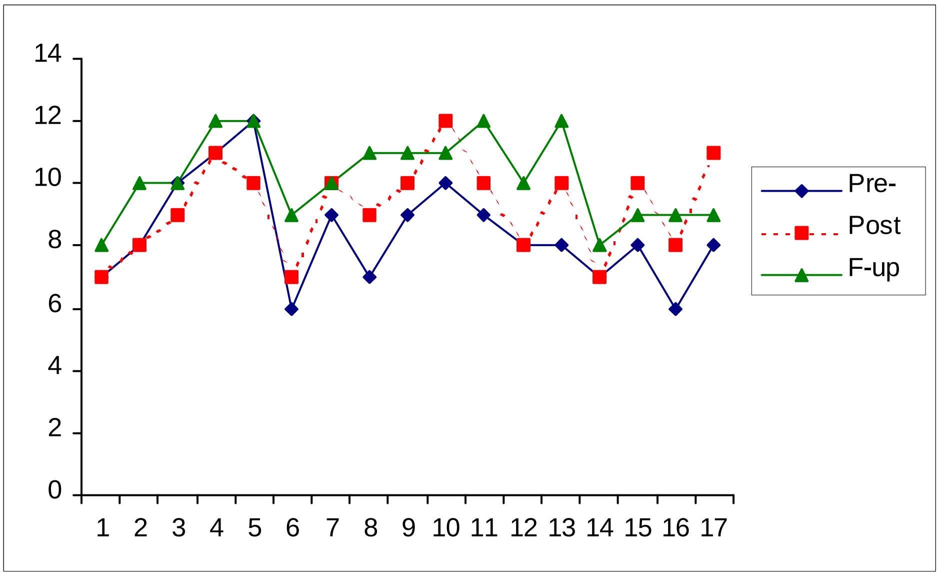
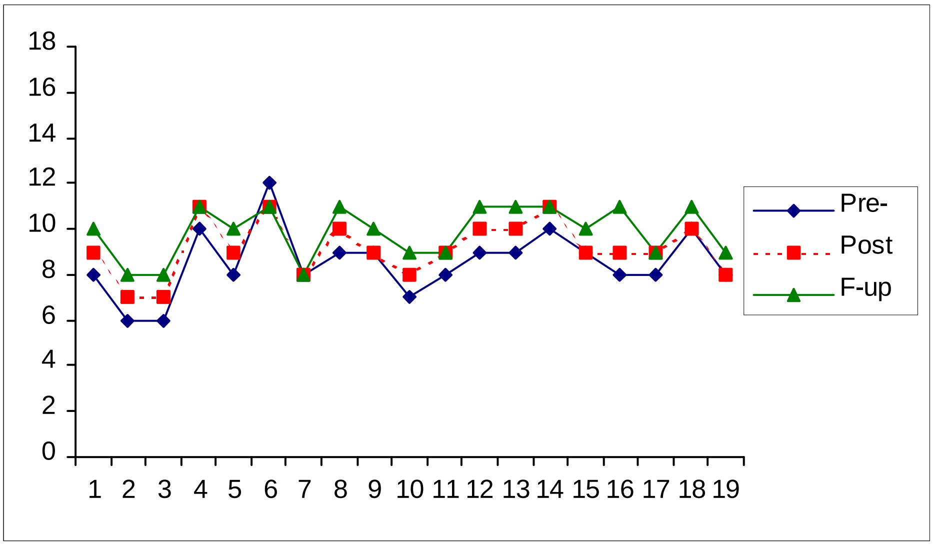


Figure 12

Control Group II-Reasoning



An examination of the Figures 9 to 12 which depict the individual scores in reasoning of the Experimental Group I, show that all the subjects improve considerably as a result of psychological intervention. No case of relapse is seen at the follow-up phase.

In the case of experimental Group II one patient does not show change. There were 9 cases of relapse at the follow-up.

Graphical representation of the control Groups I and II indicates marginal improvement. In Group I relapses are comparatively less than in Group II.

Figure 13

Experimental Group I-Attention

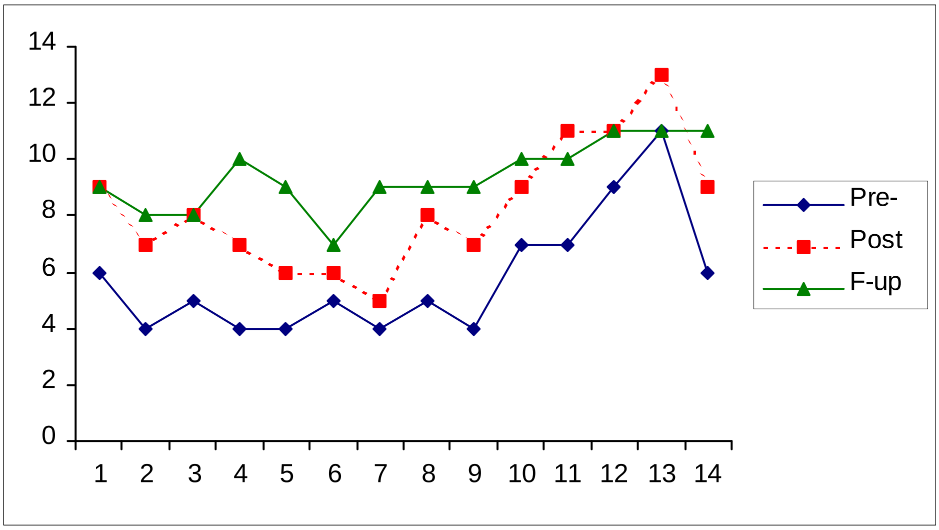
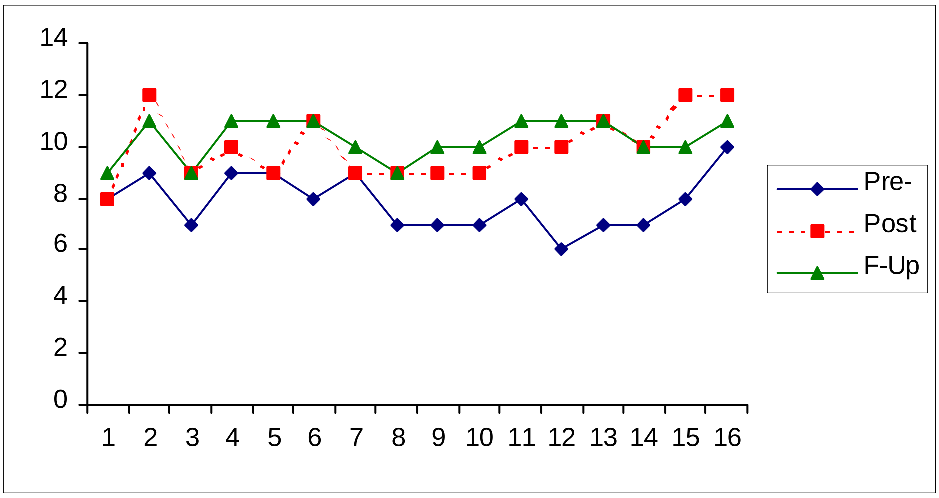


Figure 14

Experimental Group II-Attention



Figures 13 to 16 show graphical representation of the scores on attention at pre, post and follow up sessions of the brain injured patients. The profiles of Group I indicate improvement in all the patients as a result of intervention. Only two cases of relapse are found at the follow-up session.

In the case of Experimental Group II no change is noticed in two patients and three relapses are found at the follow up session.

Figure 15

Control Group I-Attention

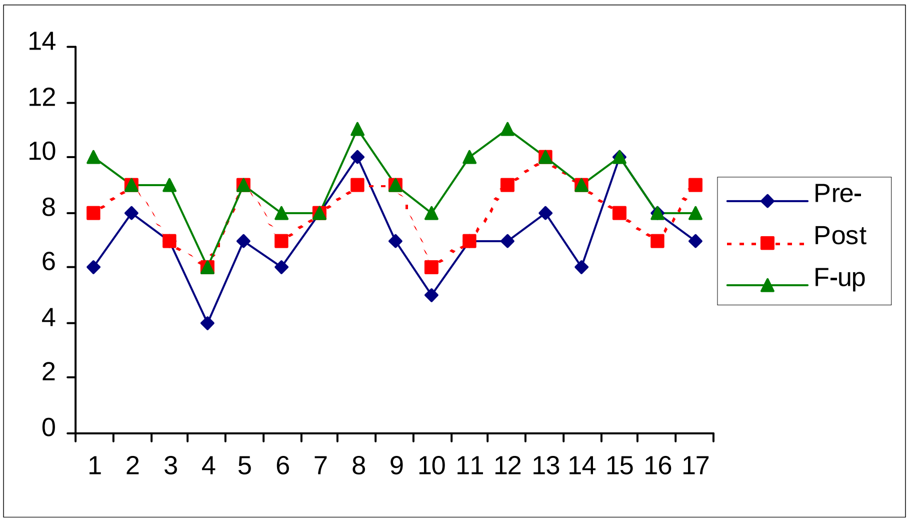
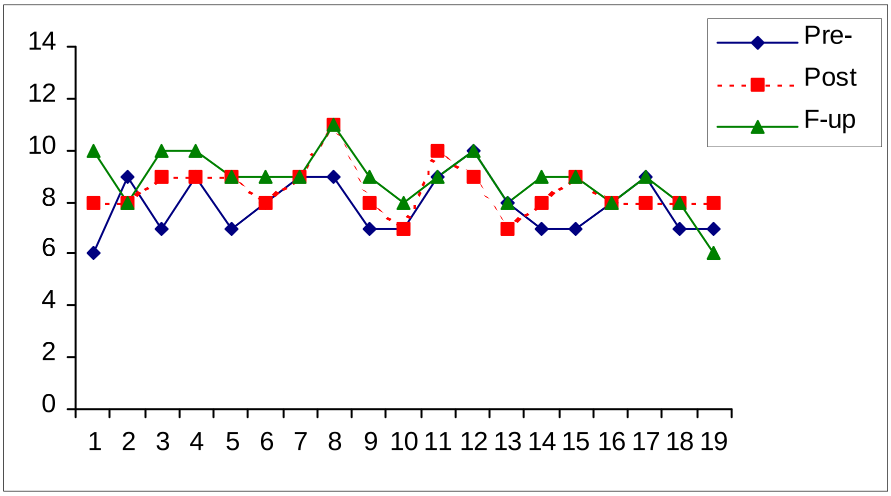


Figure 16

Control Group II-Attention



Data of the Control Groups I and II show many cases of relapse.

Figure 17

Experimental Group I-Memory

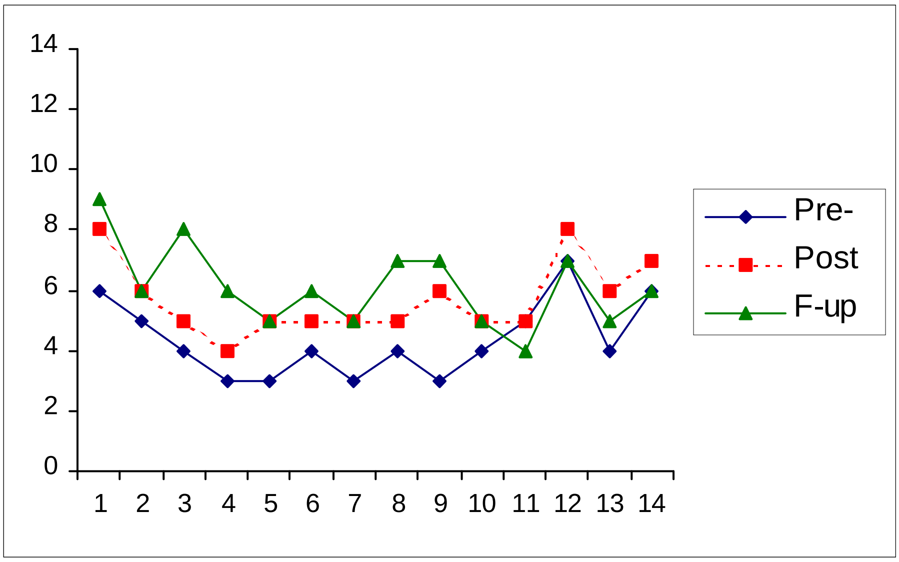
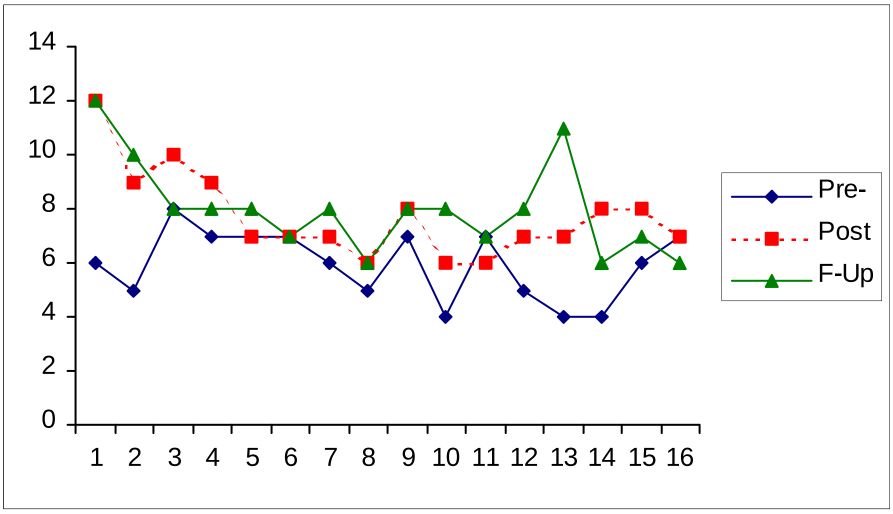


Figure 18

Experimental Group II-Memory



The scores of the Experimental Group I suggest improvement in memory in all patients except two as a result of intervention. One case of relapse is noticed.

In the case of Group II four cases are found to remain stable with no improvement in memory. Four cases of relapses are also recorded.

Figure 19

Control Group I-Memory

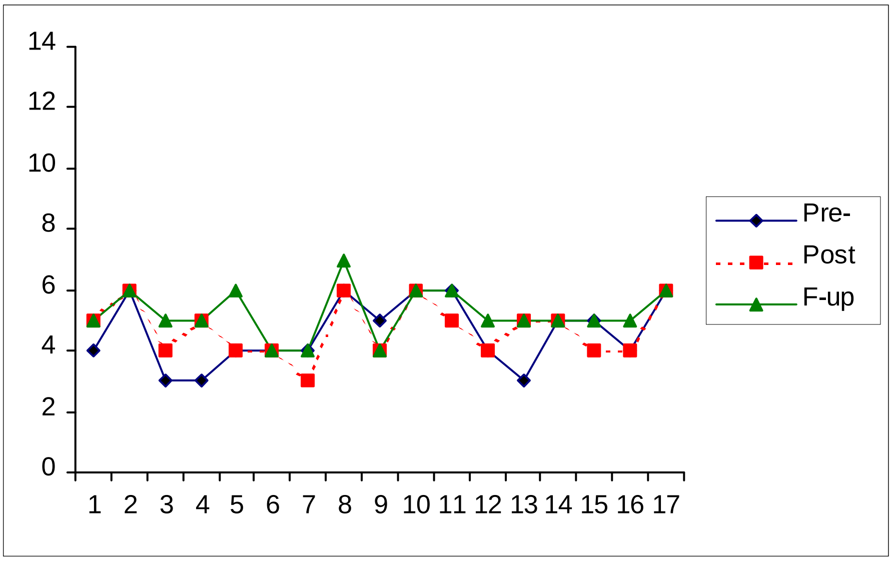
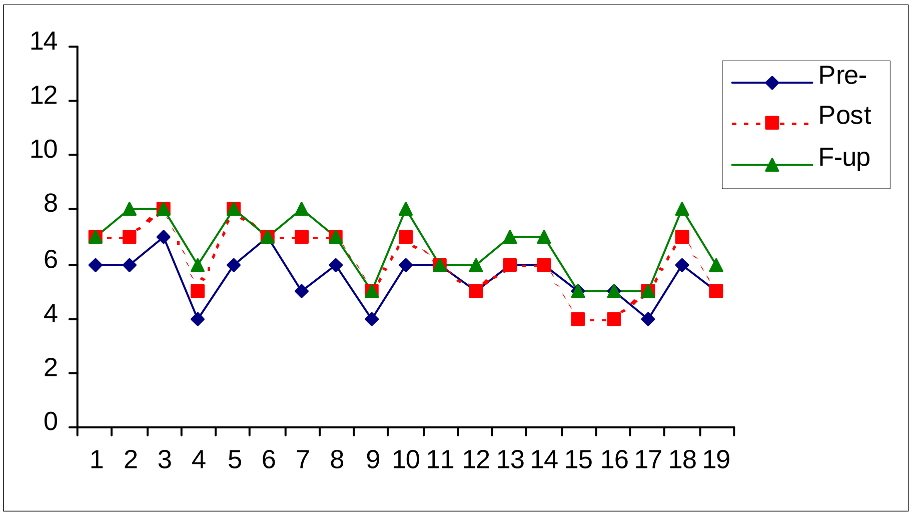


Figure 20

Control Group II-Memory



The graphs of memory (Control Group I) depicts nine patients as stable with no improvement or reduction in the baseline scores. Four of them show a reduction in memory at the post intervention session. Comparatively better status is seen in the case of Group II.

Figure 21

Experimental Group I-Problem Solving

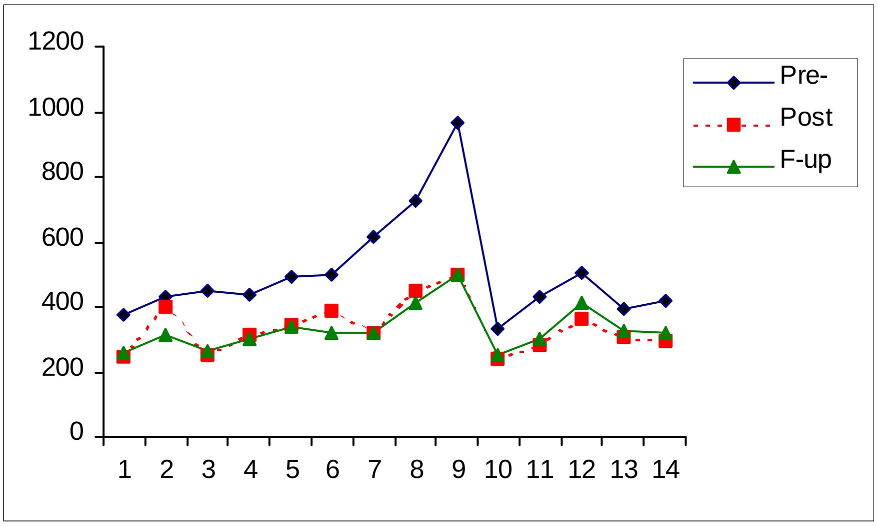
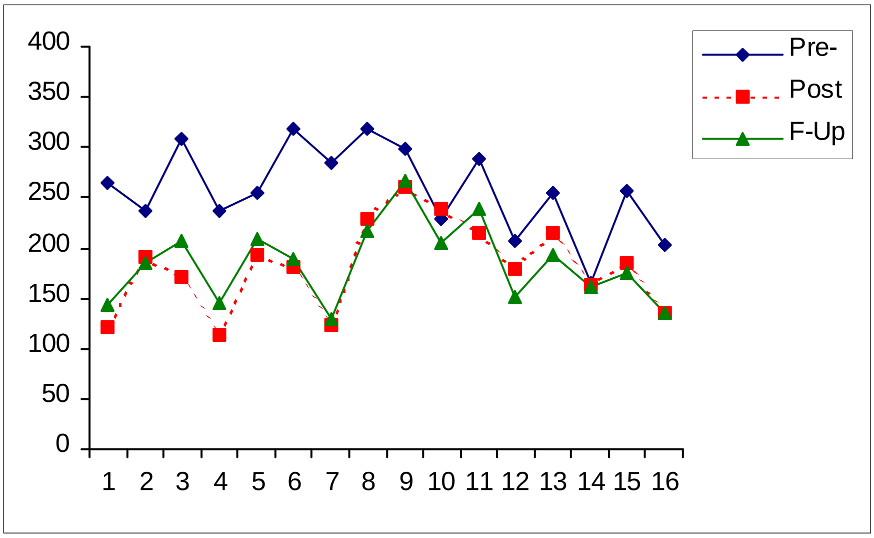


Figure 22

Experimental Group II-Problem Solving



Improvement in problem solving ability is evident in all the brain injured patients (Group I) who have undergone psychological intervention. Very fast improvement could be seen in the case of experimental subjects in Group I.

In the case of Group II also intervention seems to be effective in helping the patients improve their problem solving skills. However, this change is not as pronounced as in the case of Group I.

Figure 23

Control Group I- Problem Solving

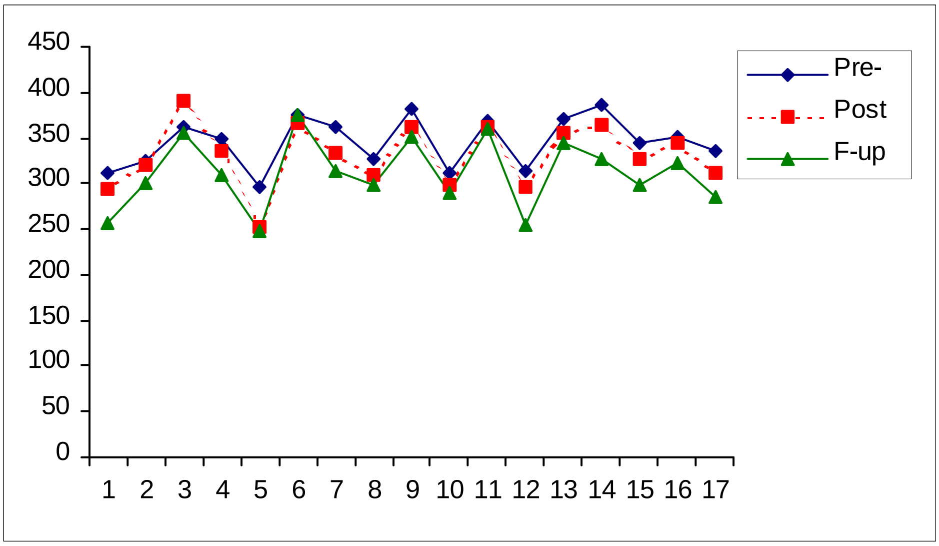
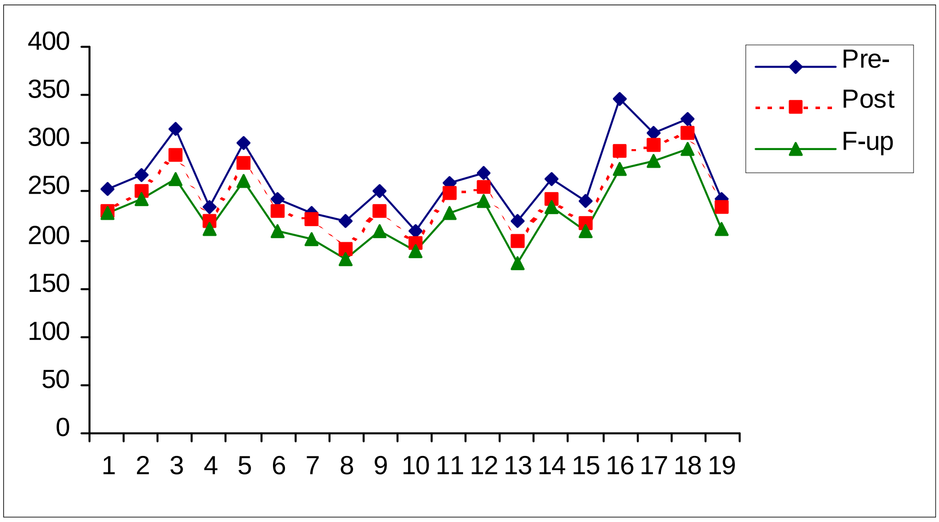


Figure 24

Control Group II-Problem Solving



Only minimal improvement is seen in Control Group patients, both Group I and Group II.

Figure 25

Experimental Group I-Creativity

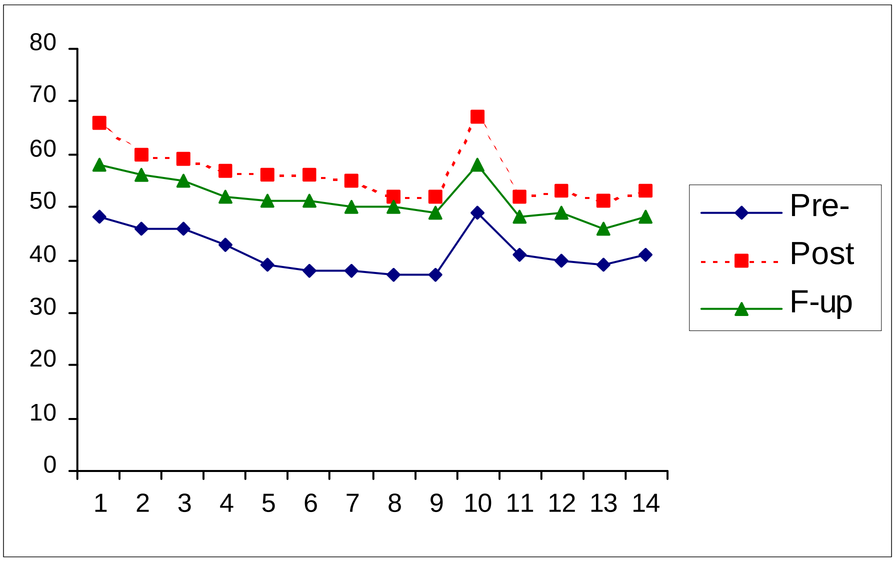
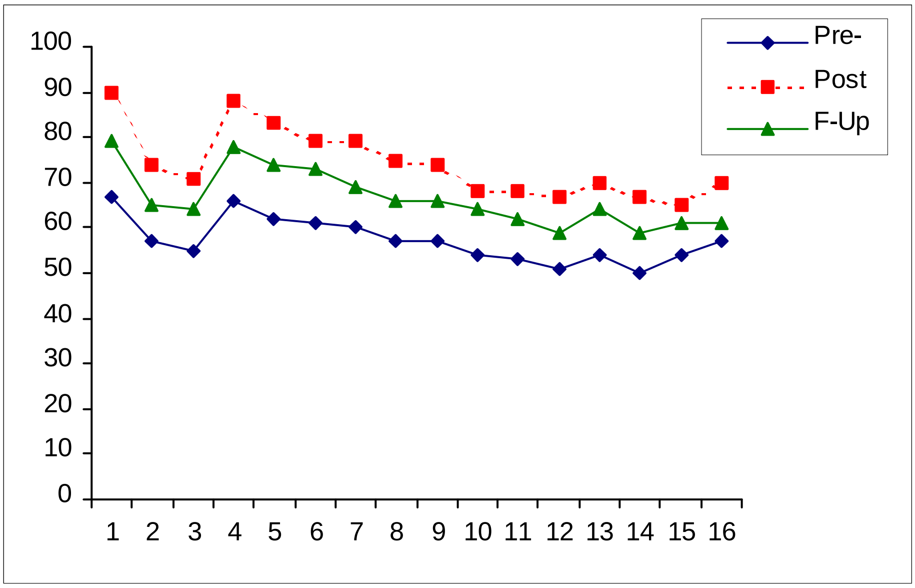


Figure 26

Experimental Group II-Creativity



Figures 25 shows improvement of creativity in all the patients as a result of intervention. However, after the termination of training a relapse, though minimal, is seen in all the patients.

A similar trend is seen in Group II also. Relapse is noticed in all the patients to higher degree.

Figure 27

Control Group I-Creativity

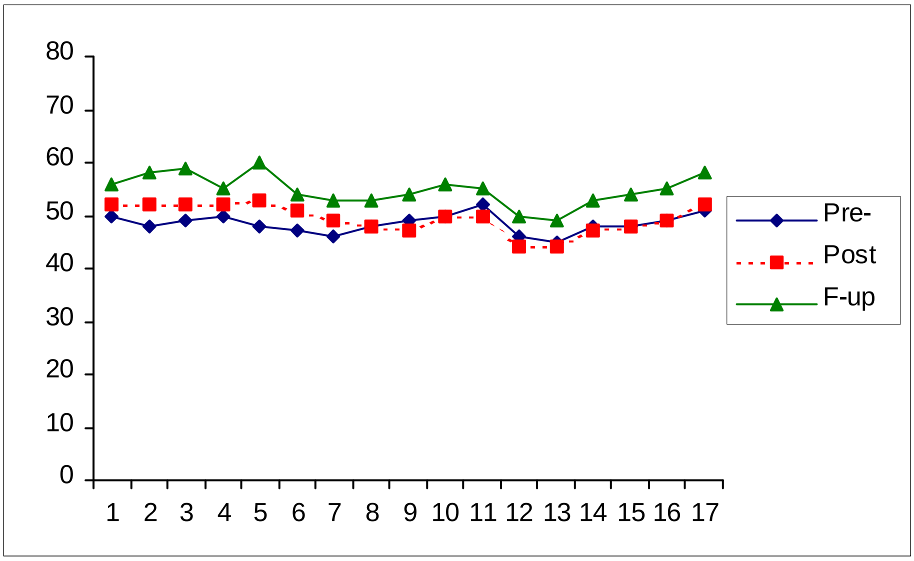
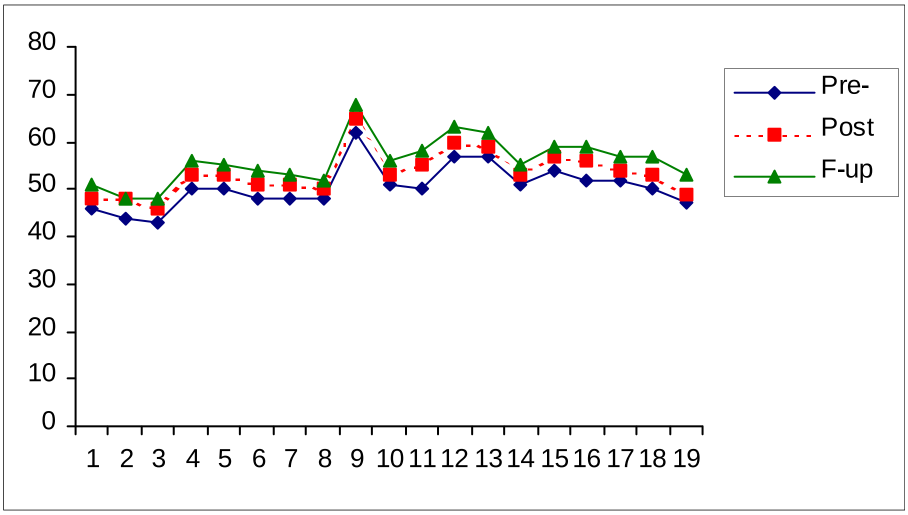


Figure 28

Control Group II-Creativity



The graphs show a stable pattern of creativity scores in the case of Group I. Not much improvement is seen but minimal relapse is found in all the cases.

The same trend is seen in the case of Group II also with respect to creativity.

The profiles of individual patients in Experimental and Control Groups suggest that psychological intervention is very effective in helping brain injured patients to improve their abilities of reasoning, attention, memory, problem solving and creativity. In all the abilities studied the post intervention scores are indicative of definite improvement in cognitive functioning. The present findings are further substantiated by the results of the Control Groups. The Control Groups of patients are found to improve in some cognitive abilities like reasoning, memory and problem solving to some extent. And this may be attributed to the medical intervention they receive from the time of admission to the hospitals.

A comparison of the performance of the experimental and control subjects is likely to reveal that the improvement of cognitive functioning demonstrated in the case of the experimental subjects is more rapid and pronounced than that is evident in control patients. And this proves the efficacy of psychological intervention in helping brain injured patients improve cognitive abilities impaired by brain injury.

From the graphical representation of the results obtained it is seen that earlier the intervention more the improvement in individual patients. Delayed intervention does help but seems to have some limitations with regard to individual subjects. It is found that chances of relapse are more with experimental subjects in whose cases intervention was started at 3 months after injury than in the case of patients who were subjected to intervention at month after injury.

The results of the present study may be summarized as follows:

The findings prove beyond doubt that the psychological intervention package designed for the study is very effective to improve cognitive functions of the brain injured patients. Intervention helps to enhance reasoning ability, memory, power of attention, problem solving ability and creative thinking. The post intervention scores of the total sample in all the targeted functions are significantly superior to the corresponding baseline scores and of the scores of the Control Group total in the corresponding areas cognitive functioning.

A more or less similar trend is visible with the patient group which was trained one month after injury and the group trained three months after injury. In both the instances intervention brings about positive changes in cognitive functions. This is evident from the significantly better post intervention scores of the Experimental Groups of subjects in all the functions compared and from the low scores obtained by the groups of control subjects in the corresponding areas of skills.

A comparative analysis of the performance of the two Experimental Groups viz., the group trained one month after injury and the group trained three months after injury explains the efficacy of early and delayed intervention for the brain injured persons as specific groups. The results suggest that early training improves the reasoning ability of the brain injured persons. Attention, memory, problem solving and creative thinking are benefited from delayed cognitive training. In all the cases the baseline scores are higher in the delayed trained group in the early trained group. This may be because of the medical attention, along with psychological intervention, received by this group on a regular basis and for an extended period of time. When the performance of the groups of control subjects (who received only medical attention) is compared to that of the groups of experimental subjects (who received psychological training and medical attention) it is found that the cognitive changes occurred in the experimental subjects who are trained three months after injury are more pronounced and rapid than in the control groups. This again affirms the efficacy of early cognitive training received by the brain injured patients.

Profile analysis done based on the scores of individual patients, however, provides a different but encouraging picture regarding the effectiveness of early and delayed intervention. An examination of individual profiles show that unlike in the case of the groups, early intervention is found more beneficial to individual patients to improve cognitive functioning. Though delayed training is capable of bringing about positive changes in cognitive skills, chances for relapse are seen more among patients who receive delayed intervention than any patients who get trained early with psychological strategies.

Based on the findings of the present study it is concluded that (i) psychological intervention is very effective to improve the cognitive functions of the brain injured patients (ii) early intervention is more effective to deal with the impaired cognitive skills of the patients and (iii) long term interventions are needed for the brain injured patients to maintain the skills for longer periods.

SUMMARY AND CONCLUSIONS

The human brain is vast and complex. It contains some one hundred billion neurons which are capable of electrical and chemical communication with tens of thousands of other nerve cells. Anatomically, the brain can be divided into three parts: the forebrain, midbrain and hindbrain. The forebrain includes the lobes (frontal, temporal, parietal and occipital) of the cerebral cortex that control higher functions, while the midbrain and hindbrain are more involved with unconscious autonomic functions. A slight difference in the intricate circuits in the brain can result in gross changes in the injured.

The person with brain injury experiences some deficits of cognitive, social and emotional functioning that are not apparent at pre-injury. Cognitive impairments may include difficulties on tasks requiring attention, memory, organisations, reasoning and problem solving. Emotional impairments may include apathy, irritability, anxiety, fearfulness and depression. Social impairments may include withdrawal, anger and aggression. The degree of intervention needed depends, in part, upon the stage of recovery, with more advanced recovery requiring less intensity of support. In most cases, however, interventions that target specific aspects disability assist the patient's reintegration into his environment.

A traumatic brain injury (TBI) is an injury to the brain caused by the head being hit by something or shaken violently. This injury can change how the person acts, moves and thinks. The TBI can cause changes in one or more areas, such as: thinking and reasoning, understanding words, remembering things, paying attention, solving problems, thinking abstractly, talking, behaving, walking and other physical activities, seeing and/or hearing and learning.

Rehabilitation is indispensable to bring back the brain injured to normal life. It is a process of change through which a brain injured person goes through seeking to regain former skills and to compensate for skills lost. Its aim is always to achieve the optimum levels of physical, cognitive and social competence followed by integration into the most suitable environment. The greatest visible progress occurs in the first six months, after which improvement is often more subtle and less obvious. Rehabilitation has two stages, the first being the formal intervention to improve the individual and the second stage is when the family and carers work to maintain that improvement. Research suggests that patients who make the best recovery are those whose family is actively involved and could maintain this informal rehabilitation at home.

Neuropsychological rehabilitation is concerned with the amelioration of cognitive, emotional, psychosocial and behavioural deficits caused by an insult to the brain. Neuropsychological rehabilitation is now mostly centred on a goal-planning approach in a partnership of survivors of brain injury, their families and professional staff who negotiate and select goals to be achieved. There is widespread recognition that cognition, emotion and psychosocial functioning are interlinked and all should be targeted in rehabilitation.

The present study correlates cognitive impairments and psychological intervention and aims at a different means of treatment. The study also aims to give the psychologists a new field to work in where by psychological intervention is a major means to enliven the dysfunctioning or paralysed neuron centres.

AIM AND OBJECTIVES

The aim of the study was to test the efficacy of a package psychological intervention in brain injured patients. The study assess the effectiveness of psychological intervention in improving the cognitive functions of reasoning, attention, memory, problem solving and creative thinking of brain injured patients.

DESIGN

This research work is an intervention study. Pre test-post test control group design is used for this purpose, which is one among 16 experimental designs as per the classification of Campbell and Stanley (1963).

METHOD

Sample

The sample consisted of 66 brain injured patients between the age group of 18 years to 52 years. They were selected from different hospitals of Kannur and Kozhikode districts. The sample of the study was randomly grouped into two-the Experimental Group and the Control Group. The two groups were further divided into two-one month and three months after injury. The Experimental Group – 1 (One month after injury) consisted of 13 males and 1 female subject. The Experimental Group – II (Three months after injury) consisted of 14 males and 2 female subjects. The Control Group – I (One month after injury) consisted of 15 males and 2 females subjects. And the Control Group – II (Three months after injury) consisted of 17 males and 2 females subjects.

Description of the Tests Used

1. MINI- MENTAL STATE EXAMINATION (MMSE)

There are number of screening tests for diffuse cognitive impairment. The most widely used mental status tool is the Mini-Mental State Examination (MMSE), a 5 to 10 minute screening test that yields an objective global index of cognitive functioning. The MMSE has become the most widely used cognitive screening test in many countries. The test contains 30 score-able items having to do with orientation, immediate memory, attention, calculation, language production, language comprehension and design copying. A score of 23 or lower is indicative of cognitive impairment.

Administration and Scoring

The MMSE was administered individually. The instructions for each question were given as per the direction given in the test.

The responses were scored by assigning one mark for each correct response. The maximum score is 30.

DIGIT SPAN- SUB TEST OF WAIS

The Digit Span sub test of WAIS-R assess span of attention. Digit span is a measure of immediate auditory recall for numbers. Facility with numbers, good attention and freedom from distractibility are required. Digit Span consists of two separate sections, Digits Forward and Digits Backward.

Administration and Scoring

Digit Forward - The subject was instructed to repeat some numbers after the researcher said them. The digits were read out one per second with clarity.

Digits Backward - The subject was instructed to repeat some numbers backward after the researcher said them. The digits were read out one per second with clarity. An example was given to the subject and he/she was let to try.

The total score for the Digit Span test is the sum of scores on Digits forward and Digits backward. The maximum score for Digit Span is 17. Higher score indicates more attention.

MEMORY TEST

The test for memory included eighteen pictures of things used in daily life (watch, phone, bicycle, shirt, T.V., shoes, ceiling fan etc). This test was designed by the researcher for this study and used after assessing its feasibility.

Administration and Scoring

The subject was asked to look at the pictures in the chart for one minute after which he/she had to recall the items after a 10-minute interval.

One mark was assigned for each correct response. The maximum score is 18. The higher the score the better the memory skill of subject.

STANDARD PROGRESSIVE MATRICES (SPM)

Standard Progressive Matrices is a nonverbal test of inductive reasoning based on figural stimuli. The scale consists of 60 problems divided into five sets of 12. The problems, which follow, become progressively more difficult. Sets A and B were used for assessing the reasoning ability of the subjects because completion of whole sets takes more time and that would affect both the physiological and psychological health of the subjects.

Administration and Scoring

The subjects were given the set A and B of the SPM booklet. The instructions for the subject were given as per the instructions given in the manual. The answer was recorded by the investigator in the answer form.

Scoring was done by using scoring key given in the manual. The maximum score is 24. High scores indicate high power of reasoning.

TOWER OF HANOI

The Tower of Hanoi is a mathematical game or puzzle and is frequently used in psychological research on problem solving, assessment of working memory, anticipatory planning and ability to inhibit responding.

Administration and Scoring

The subject was given the instrument to perform this test. The subject was instructed to move the four discs to the extreme right peg as quickly as possible without placing the larger disc on the smaller ones. The time taken by the subject was recorded by the researcher.

The time taken to solve the problem was considered as the score of the test. The time was recorded in seconds. Minimum time taken indicates finer problem solving ability.

TEST OF CREATIVE THINKING ABILITIES –TCTA

The adapted version of Wallach and Kogan’s Tests of Creative Thinking Abilities (TCTA) was used to assess the creative thinking of the subjects. The test consists of five sub-tests of which three are verbal and two are non-verbal or visual in nature. The verbal tests are: Instances, Alternate

Uses and Similarities. The non-verbal or visual stimuli tests are: Pattern Meanings and Line Meanings.

The TCTA short scale was used for the study. The short scale consists of the first two items of each of the five sub-tests in the full scale.

Administration and Scoring

After giving the general information regarding the nature of the tests, the tests were given one by one with specific instructions provided in the manual to answer each test. The subjects were told that they could take as much time they want and the researcher himself recorded all the responses given by the subjects.

Scoring was done as given in the manual. High scores indicate that the subject is more creative.

INTERVENTION

Intervention procedures consisted of a variety of behavioural and psychological therapies. The intervention used in this study comprised of:

1. Relaxation: Relaxation helps to reduce stress and calm the mind, which would help the future interventions to be effective.
2. Stimulating conversation: Helps in activating the neurons of the brain, helps in stimulating memory and activates memory skills.
3. Brain storming: Stimulates and invigorates the nerve cells of the brain and accelerates the repair of damaged brain cells and tissues.
4. Reading: Reading promotes the capacity of attention and concentration, memory skills, visualising and imagining.

5. Puzzles: This is an effective method to exercise the brain areas for thinking, reasoning, problem solving, memory and attention. It strengthens brain circuits for higher cognitive skill improvement.
6. Counselling: The subjects in this study were given counselling and they were given adequate attention and psychological help in overcoming stress, depression and anxiety states that they are likely to be experiencing of. The family members were trained towards motivating the subject to attempt exercises to enhance his/her cognitive skills.

ANALYSES OF DATA

Both quantitative and qualitative techniques were used to test the hypotheses formulated. Statistical procedures used include percentage analysis and t-test. Profile analysis was also used to assess the data qualitatively.

MAJOR FINDINGS

1. Psychological intervention package designed for the study is very effective to improve cognitive functions of the brain injured patients.
2. Intervention is very effective to improve the reasoning ability of the brain injured groups of patients.
3. Intervention package helps to enhance the memory of brain injured patient groups.
4. Power of attention of brain injured patient groups improves as a result of psychological intervention.
5. Problem solving ability of the brain injured patient groups improves as a result of intervention.

6. Psychological intervention is very effective to enhance creative thinking ability of the brain injured groups of patients.
7. Brain injured patients trained at one month after injury show improvement in reasoning after intervention.
8. Intervention is effective with patients trained at one month after injury for improving attention.
9. Intervention improves the memory of patients trained at one month after injury.
10. Intervention enhances the problem solving ability of patients trained at one month after injury.
11. Brain injured patients at one month after injury show improvement in creative thinking ability after intervention.
12. Psychological intervention is effective for patients trained at three months after injury to enhance their reasoning ability.
13. Attention of brain injured patients trained at three months after injury improves with psychological intervention.
14. Intervention improves the memory of brain injured patients trained at three months after injury.
15. Intervention is effective to improve the problem solving ability of brain injured patients trained at three months after injury.
16. Brain injured patients trained at three months after injury improve their creative thinking ability as a result of psychological intervention.
17. Early intervention seems more effective than delayed intervention to improve the reasoning ability of brain injured patients as groups.
18. Delayed intervention is found more effective than early training to improve the power of attention of brain injured patient groups.

19. Delayed intervention seems more effective than early intervention for improving memory of the brain injured patients as groups.
20. Brain injured patient groups show more positive changes in problem solving ability with delayed intervention than early intervention.
21. Delayed intervention is more effective than early intervention to improve creative thinking ability of brain injured patients as groups.
22. Early intervention is more effective than delayed intervention in improving the cognitive functions of brain injured patients when assessed individually.
23. Delayed intervention, though helpful to enhance the cognitive functioning of brain injured patients, results in more cases of relapse, when patients are assessed individually.

CONCLUSIONS

Based on the present study it is concluded that:

(i) Psychological intervention is very effective to improve the cognitive functions of the brain injured patients

(ii) Early intervention is more effective to deal with the impaired cognitive skills of the patients and

(iii) Long term interventions are needed for the brain injured patients to maintain the skills for longer periods.

IMPLICATIONS

- The understanding gained from the study is expected to be useful in planning treatment policies.
- The findings of this study may be used to design appropriate rehabilitation programmes to help the patient community.

SCOPE FOR FURTHER RESEARCH

- Studies could be planned which use psychological interventions for a longer duration of time and effectiveness of long term therapies may be assessed.
- A similar study could be conducted using a larger sample of brain injured patients with proportional representation of age and sex.
- Studies could be conducted by considering the problems of each age group and then providing them appropriate and adequate intervention.

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