COGNITIVE DEFICIENCY AMONG MARIJUANA USERS IN MANIPUR: A PSYCHOLOGICAL STUDY

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Thesis Submitted for the Degree of
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Certificate

This is to certify that the present piece of Thesis titled, "Cognitive Deficiency among Marijuana Users in Manipur: A psychological study" is the bonafide research conducted by Mr. Laishram Devraj under my supervision. He worked methodologically for his dissertation being submitted for the Doctor of Philosophy in Psychology under the Mizoram Universality.

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DECLARATION

I, Laishram Devraj, hereby declare that the subject matter of this Thesis is the record of work done by me, that the contents of this Thesis did not form basis for the award of any previous degree to me or to the best of my knowledge to anybody else, and that the Thesis has not been submitted by me for any research degree in any other University or Institute.

This is being submitted to Mizoram University for the Degree of Doctor of Philosophy in Psychology.

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Dedicated to my loving Mother

CHAPTER-I

INTRODUCTION

Introduction:

Cannabis is one of the most commonly abused illicit drugs all over the globe. The World Health Organization (2011) reports that almost 3% of the world's adult population abuses cannabis, with many more individuals reporting less frequent use. Adolescents in particular consume high levels of cannabis, starting generally between 12 and 16 years of age. Research have examined the effects of cannabis on neurocognition and have supported an evidence that episodic memory problem is one of the most consistent findings reported with several other neurocognitive domains that appear to be adversely affected by cannabis use under various conditions.The abundance of cannabinoid receptors in the hippocampus, amygdala, basal ganglia, and pre-frontal cortex (Mackie, 2005; Piomelli , 2003) suggests that psychoactive compound in cannabis have important implications for various neurobehavioral processes, including mood and anxiety regulation (Crippa, *et al*. 2011, 2009), learning, memory, motivation, motor control, reward processing, and executive functions (Crean, *et al*. 2011; Gonzalez, 2007; Solowij and Pesa, 2010). Frontal-limbic neurocircuitry is most prominently affected by cannabis use (Martin-Santos, *et al*. 2010) than other structures in the brain such as brain stem, occipital lobe, and parietal lobe. Cannabis use is of important consideration in light of its recognized acute and long-term health effects (Sethi, *et al*. 1981). Majority of studies have suggested a significant cognitive decline in cannabis abusers compared to non-abusers and healthy controls (Solowij, 1988), detrimental effect on prospective memory ability in young (Bartholomew, *et al*. 2010), substantial acute effects on human cognition and visuomotor skills (Huestegge, 2010), effect severity depend on onset time (Dragt, 2010).Cannabis use may have a negative impact on some aspects of neurocognition, especially those mediated principally by frontal-limbic systems but a high degree of inconsistency related to the exact nature and chronicity or reversibility of these deficits (Crane, *et al.* 2013).

Research on the neurocognitive effects of cannabis continues to grow rapidly because cannabis continues to be the most widely used illicit substance worldwide (UNODC, 2011), cannabis use has surpassed that of cigarette use among adolescents (Johnston, *et al*. 2012). Cannabis use is associated with negative health outcomes (Kalant, 2004), psychosocial and cognitive impairments (Kalant, 2004; Solowij and Pesa, 2010), and other neurobehavioral consequences such as an increased risk of an automobile crash when driving while intoxicated (Asbridge, *et al*. 2012; Drummer, *et al*. 2003; Li, *et al*. 2012). On the other hand, societal acceptance of cannabis use for medicinal applications continues to increase (Cohen, 2010) and there is a growing body of literature suggesting medical benefits from cannabis use (Elikkottil, *et al*. 2009; Ellis, *et al*. 2009).

Cognition - The term ‘Cognition’ (Latin: cognoscere, "to know", "to conceptualize" or "to recognize") refers to a faculty for the processing of information, applying knowledge, and changing preferences. Cognition, or cognitive processes, can be natural or artificial, conscious or unconscious. These processes are analysed from different perspectives within different contexts, notably in the fields of linguistics, anesthesia, neurology, psychology, philosophy, anthropology, systemic and computer science. Within psychology or philosophy, the concept of cognition is closely related to abstract concepts such as mind, intelligence, cognition is used to refer to the mental functions, mental processes (thoughts) and states of intelligent entities (humans, human organizations, highly autonomous machines), speed, attention, learning and memory, comprehension, executive functions. Ulric Neisser (1985) coined the term "cognitive psychology" in his book Cognitive Psychology; there he provides a definition of cognitive psychology characterizing people as dynamic information-processing systems whose mental operations might be described in computational terms.

The sort of mental processes described as cognitive are largely influenced by research which has successfully used this paradigm in the past, likely starting with Thomas Aquinas, who divided the study of behavior into two broad categories: cognitive (how we know the world), and affect (feelings and emotions). Consequently, this description tends to apply to processes such as memory, association, concept formation, language, attention, perception, action, problem solving and mental imagery (Lycan, 1999).

Cognitive deficiency affects the ability to think, concentrate, formulate ideas, reason and remember. It is distinct from a learning disability in so far, as it may have been acquired later in life as a result of an accident or illness or drug dependence. Cognitive psychology is also making important contributions to understanding of brain disorders that reflect abnormal functioning, such as schizophrenia (Cohen and Servan-

Schreiber, 1992) or those are the result of brain damage such as amnesia (Baddeley, Wilson and Watts, 1995).

Our species is referred to as Homo sapiens, or “human, the intelligent”. This term reflect the general belief that intelligence is what distinguishes us from other animals. The goal of Cognitive psychology is to understand the nature of human intelligence and how it works. One reason for the studying Cognitive psychology is the same one that motivates any scientific inquiry- the desire to know. Herbert Simon, who won the 1978 Nobel Prize for his theoretical work in economics, has spent the last forty years studying cognitive psychology. Cognitive psychology is thus the foundation on which all other social sciences stand, in the same way that physics is the foundation for other physical sciences (Feigenbaum., & Simon, 1984).

Cognitive function is the common denominator in the association of cannabis with psychosis and schizophrenia (Rey, 2002) especially in the domains of attention, memory and executive functions, and that the worsening of performance may exceed the acute and sub-acute intoxication that early onset in age and duration of consumption is possibly more specifically related to cognitive impairment (Dekker, *et al*. 2010). Cognitive deficits associated with specific parameters of cannabis use and interactions with neurodevelopment stages and neural substrates will better inform our understanding of the nature of the association between cannabis use and psychosis. Further research in this field will enhance our understanding of underlying pathophysiology and improving treatments for substance abuse and mental illness (Solowij and Michie, 2007). Cognitive functions may provide a guide to treating marijuana addiction (Jager and Ramsey, 2008) and further, more insight in the cognitive-motivational processes related to cannabis use in schizophrenia may inform treatment strategies (Raphael, 2005).

Marijuana (Cannabis)

Cannabis (**Marijuana / Cannabis Sativa) -** is known as ***Marijuana*** *or ganja* (from Hindi/Sanskrit: *gānj*ā, *hemp*) has been used as an agent for achieving euphoria since ancient times; it was described in a Chinese medical compendium traditionally considered to date from 2737 BC its use spread from China to India and then to N Africa and reached Europe at least as early as AD 500 (Tauwn, 1981). Cannabis and Marijuana are the two terms used interchangeably to refer to the world's most common illicit substance. Cannabis is the abbreviated name for the hemp plant CANNABIS SATIVA. All Parts of the plant contain psychoactive cannabinoids of which:

(-) -Δ^9 tetrahydrocannabinol (Δ^9-THC)

is the most abundant (Mechoulam, 1975). The most potent form of Cannabis comes from the flowering tops of the plants or from the dried, black-brown resinous exudates from the leaf, which is referred to as 'Hashish or Hash'. The cannabis plant is usually cut, dried, chopped and rolled into cigarettes for smoking, and the plant produces high quality derivative. It is used in different popular terms viz. ***Grass, pot, weed, tea and mary Jane, Charas, bhang, ganja, dagga and sinsemilla*** (Kaplan and Sadock, 2007). According to the text revision of the fourth edition of Diagnostic and Statistical Manual of Mental Disorder IV TR (DSM-IV TR; APA, 2000), there is a 5 % lifetime rate of cannabis abuse or dependence.

Marijuana related clinical features- The most common physical effects of cannabis are dilation of the conjunctive blood vessels (red eye) and mild tachycardia. At high doses, orthostatic hypotension may appear. Increased appetite and dry mouth are common effects of cannabis intoxication and some data indicate that heavy cannabis users are at risk for chronic respiratory diseases such as lung cancer, cerebral atropy, seizure susceptibility, chromosomal damage, birth defects, impaired immune reactivity, alterations in testosterone concentrations and dysregulation of menstrual cycles. (Kaplan and Sadock, 1998).When marijuana is smoked, its active ingredient, THC, travels throughout the body including the brain to produce various effects. THC attaches to sites called 'Cannabinoid' receptors on nerve cells in the brain affecting the way those cells work. Cannabinoid receptors are abundant in parts of the brain that regulate movement, coordination, learning and memory, higher eleven cognitive functions such as judgment, and pleasure (Joy, *et al*. 1999).

Brain Region	**Functions Associated With Region**
Brain regions in which cannabinoid receptors are abundant	
Cerebellum	Body movement coordination
Hippocampus	Learning and memory
Cerebral cortex, especially cingulated frontal and Parietal regions	Higher cognitive functions
Nucleus accumbens	Reward
Basal ganglia ☐ Substantianigra pars reticulata ☐ Entopeduncular nucleus ☐ Globus pallidus ☐ Putamen	Movement control

Brain regions in which cannabinoid receptors are moderately concentrated	
Hypothalamus	Body housekeeping functions (body temperature regulation, salt and water balance , reproductive function)
Amygdala	Emotional response, fear
Spinal cord	Peripheral sensation, including pain
Brain stem	Sleep and arousal, temperature regulation motor control
Central gray	Analgesia
Nucleus of the solitary tract	Visceral sensation, nausea and vomiting

Sources: Based on reviews by Pertwee (1997) and Herkenham (1995)

Cannabis induced disorders are:

(i) Cannabis intoxication: Commonly heightens users' sensitivities to external stimuli, reveals new details, makes colors seem brighter and richer than in the past and subjectively slows the appreciation of time.

(ii) Cannabis intoxication delirium: Characterized by marked impairment on cognition and performance tasks. Even modest doses of cannabis impair memory, reaction time, perception, motor coordination and attention.

(iii) Cannabis-induced psychotic disorder with delusion: Cannabis induced psychotic disorder is rare, transient paranoid ideation is more common.

(iv) Cannabis-induced psychotic disorder with hallucinations: When cannabis-induced psychotic disorder does occur, it may be correlated with a preexisting personality disorder in the affected person.

(v) Cannabis - induced anxiety disorder: Panic attacks may be induced based on ill-defined and disorganized fears. Inexperienced users are much more likely to experience anxiety symptoms than the experienced users.

(vi) Cannabis-related disorders not otherwise specified: These are the disorders associated with the use of cannabis that are not classifiable as cannabis dependence, cannabis abuse, cannabis intoxication, cannabis intoxication delirium, cannabis-induced psychotic disorder or cannabis-induced anxiety disorder.

Marijuana use Disorders - Dr. Bridget Grant had mentioned that the American Psychiatric Association's DSM-IV was not published until 1998, but proposed diagnostic criteria for marijuana abuse and dependence and had been circulated. These criteria were incorporated in their entirety into the structured interview used in survey. Survey respondents were considered to be suffering a marijuana-related disorder if they met DSM-IV diagnostic criteria for either abuse or dependence.

Cannabis used disorders (DSM IV TR):

1. Cannabis dependence
2. Cannabis abuse

Criteria for Cannabis dependence:

A. A maladaptive pattern of substance use, leading to clinically significant impairment or distress, as manifested by three (or more) of the following, occurring at any time in the same 12- month period:

1. Tolerance, as defined by either of the following:
   a) A need for markedly increased amounts of the substance to achieve intoxication or desired effect.
   b) Markedly diminished effect with continued use of the same amount of the substance.
2. Withdrawal, as manifested by either of the following:
   a) The characteristic withdrawal syndrome for the substance (refer to criteria A and B of the criteria sets for withdrawal from the specific substances.
   b) The same (or a closely related) substance is taken to relieve or avoid withdrawal symptoms.
3. The substance is often taken in larger amounts or over a longer period than was intended.
4. There is persistent desire or unsuccessfully efforts to cut down or control substance use.
5. A great deal of time is spent in activities necessary to obtain the substance (e.g., visiting multiple doctors or driving long distances), use the substance (e.g. chain smoking), or recover from its effects.
6. Important social, occupational, or recreational activities are given up or reduced because of substance use.
7. The substance use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the substance(e.g., current cocaine use despite recognition of cocaine-induced depression, or continued drinking despite recognition that an ulcer was made worse by alcohol consumption).

Specify if: With physiological dependence: evidence of tolerance or withdrawal (i.e. either item 1 or 2 is present).

Without physiological dependence: No evidence of tolerance or withdrawal (i.e. neither item 1 nor 2 is present).

Criteria for Cannabis Abuse

A. A maladaptive pattern of substance use leading to clinically significant impairment or distress, as manifested by one (or more) of the following, occurring within a 12 month period:

1. Recurrent substance use resulting in a failure to fulfill major role obligations at work, school, or home (e.g., repeated absences or poor work performance related to substance use; substance-related absences, suspensions, or expulsions from school; neglect of children or household).
2. Recurrent substance use in situations in which it is physically hazardous (e.g., driving an automobile or operating a machine when impaired by substance use).
3. Recurrent substance-related legal problems (e.g., arrests for substance-related disorderly conduct).
4. Continued substance use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance (e.g., arguments with spouse about consequences of intoxication, physical fights).

B. The symptoms have never met criteria for substance dependence for this class of substance.

The ability of prolonged cannabis administration to produce tolerance and withdrawal symptoms in animals has been the topic of several recent reviews (Gonzalez, *et al*. 2005). In humans, mounting evidence supports a withdrawal syndrome among long-term frequent cannabis users undergoing abstinence. Budney, *et al*. (2004) report that findings from several well-controlled inpatient laboratory and outpatient studies demonstrate that chronic daily cannabis smokers reliably display unfavorable symptoms upon abstinence that emerge by 48 h after cessation of use,peak between two and six days, and remit within one to two weeks. Based on evidence from 20 studies, they proposed criteria for a cannabis withdrawal syndrome that is characterized by “significant distress or dysfunction” from at least four of the following symptoms: anger and aggression, decreased appetite or weight loss, irritability, nervousness/anxiety, restlessness, sleep difficulties, chills,depressed mood, stomach pain, shakiness, and sweating.

Neuropsychology - Neuropsychology is the basic scientific discipline that studies the structure and function of the brain related to specific psychological processes and overt behaviours. The term neuropsychology has been applied to lesion studies in humans and animals. It has also been applied to efforts to record electrical activity from individual cells (or groups of cells) in higher primates (including some studies of human patients) (Arnold, 1984). It is scientific in its approach and shares an information processing view of the mind with cognitive psychology and cognitive science. It is one of the most eclectic disciplines of psychology, overlapping at times with areas such as neuroscience, philosophy (particularly philosophy of mind), neurology, psychiatry and computer science (particularly by making use of artificial neural networks).

In practice neuropsychologists tend to work in academia (involved in basic or clinical research), clinical settings (involved in assessing or treating patients with neuropsychological problems), forensic settings (often assessing people for legal reasons or court cases or working with offenders, or appearing in court as expert witness) or industry (often as consultants where neuropsychological knowledge is applied to product design or in the management of pharmaceutical clinical-trials research for drugs that might have a potential impact on CNS functioning).

Neuropsychology has different Approaches such as:

Experimental neuropsychology is 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 (for example that visual information presented to a specific visual field is preferentially processed by the cortical hemisphere on the opposite side) to make links between neuroanatomy and psychological function.

Clinical neuropsychology is the application of neuropsychological knowledge to the assessment, management and rehabilitation of people who have suffered illness or injury (particularly to the brain) which has caused neurocognitive problems. In particular they bring a psychological viewpoint to treatment, to understand how such illness and injury may affect and be affected by psychological factors. They also can offer an opinion as to whether a person is demonstrating difficulties due to brain pathology or as a consequence of emotional or other (potentially) reversible cause. Clinical neuropsychologists often work in hospital settings in an interdisciplinary medical team; others work in private practice and may provide expert input into medico-legal proceedings.

Cognitive neuropsychology is 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. One model of neuropsychological functioning is known as functional localization. This is based on the principle that if a specific cognitive problem can be found after an injury to a specific area of the brain, it is possible that this part of the brain is in some way involved. A more recent but related approach is cognitive neuropsychiatry which seeks to understand the normal function of mind and brain by studying psychiatric or mental illness.

General Health and cognitive functions:

General health - is the level of functional or metabolic efficiency of a living organism. In humans, it is the general condition of a person's mind and body, usually meaning to be free from illness, injury or pain (Merriam-Webster, 2011).The World Health Organization (WHO) defined health in its broader sense in 1946 as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity"(World Health Organization, 1946, 2006). Psychological well-being can be useful in understanding various sources of distress for workers, as well as any predisposing factors. Such assessments are not used in isolation, but rather in combination with other information which is indicative of distress or psychological problems such as sickness absence, poor productivity or increased turnover (Goldberg, 1978).

One of the issues that associated with general health is quality of life. The application of positive behavioral pattern in life is effective in promoting individual health. Generally, quality of life is one's perception about life conditions in the cultural arena and values systems that he/she lives in and is associated with his/her goals, expectations and important affairs (Mesgarani, *et al*. 2013). Quality of life has two dimensions; physical and mental.Previous studies have identified associations between the components of health status and cognitive functioning (Jorm, 2000; McNeal, *et al*. 2001). For example, complaints about depressed mood have been associated with a decline in speed of information processing over a 3-year period in healthy older adults (Comijs, Jonker, Beekman, & Deeg, 2001). Poor physical function, as indexed by self-rated health (Hultsch, Hammer, & Small, 1993; Tabbarah, Crimmins, & Seeman, 2002), was found to be related to poor performance on neuropsychological tests in a healthy population.

It was suggested that physical functioning may influence basic biological mechanisms, such as limb strength and aerobic capacity, and as a consequence may affect basic cognitive processes, such as speeded task performance, in particular (Hultsch, *et al*. 1993).A high level of general functioning is suggested to be positively associated with high cognitive functioning (Berkman, *et al*. 1993; Rowe & Kahn, 1997). It is not clear to what extent the cognitive and psychological effects of long term cannabis use might impact upon daily life, although cannabis users themselves complain of problems with memory, concentration, loss of motivation, paranoia, depression, dependence and lethargy.

Executive Functions - Executive functions are an umbrella term for a various cognitive processes and sub-processes. It consists of components such as anticipation, goal selection, planning and monitoring (Stuss and Benson, 1986). They are also defined as the “ability to maintain an appropriate problem solving set for the attainment of future goals. Executive functions involve an intention to inhibit a response or to defer it to a later appropriate time; a strategic plan of action sequence; a mental representation of the task, including the relevant stimulus information encoded into memory and the desired future goal state” (Pennington and Ozonoff, 1996). Executive functions mediate goal directed behaviour, i.e. those aspects of behaviour, which are regulated and occur to fulfill the motivational goals of the individual. Executive functions include Fluency, Working Memory, Planning, Set Shifting Ability, Response Inhibition, Error Detection, Abstraction, and Organization. THC has been found to impair healthy young adults' performance on a reasoning task (but not a verbal fluency task; Morrison, *et al*. 2009) and significantly increased total errors and no preservative errors in regular cannabis users on a task of abstract reasoning (Weinstein, *et al*. 2008), problems with cognitive flexibility (Anderson, *et al*. 2010). In contrast, most current evidence suggests that acute intoxication does not negatively impact decision -making or risk-taking in occasional, regular, or heavy cannabis users (D'Souza, *et al*. 2008; Ramaekers, *et al*. 2009, 2011; Vadhan, *et al*. 2007; Weinstein, *et al*. 2008), but it may slow decision-making (Vadhan, *et al*. 2007).

Intelligence: "Intelligence is the ability to face problems in an unprogrammed (creative) manner." Stephen Jay Gould "The Mismeasure of Man"1981.The first intelligence test for school children was developed in Paris by Alfred Binet between 1905 and 1916 (Binet and Simon, 1916). It was adapted by Stanford psychologist L. M. Terman (1877-1956) as The Stanford-Binet test, and termed an intelligence quotient (IQ) test. It was the first important test, has been revised through the years, and is the one most widely used. Pope and colleagues (Pope, *et al*. 2001) recruited individuals aged 30 to 55 years in 3 groups: (1) 63 current heavy cannabis users who had smoked cannabis at least 5000 times in their lives and who were smoking daily at study entry; (2) 45 former heavy users who had also smoked at least 5000 times but fewer than 12 times in the last 3 months; and (3) 72 control subjects who had smoked no more than 50 times in their lives. Subjects underwent a 28-day abstinence from cannabis use, monitored by observed urine samples. On days 0, 1, 7, and 28, they completed a complex neuropsychological test battery. Results revealed that at days 0, 1, and 7, current heavy users scored significantly below control subjects on recall of word lists, no significant differences among the three groups on 28 days. Some cognitive deficits appear detectable at least 7 days after heavy cannabis use but appear reversible and related to recent cannabis exposure rather than irreversible and related to cumulative lifetime use.

Peter Fried and colleagues (2002) studied the marijuana use among seventy 17- to 20-year-olds whose intelligence quotient (IQ) had been determined at the age of 9-12 years and compared the difference in IQ scores of current heavy users (at least 5 joints per week), current light users (less than 5 joints per week), former users (who had not smoked regularly for at least 3 months) and non-users (who never smoked more than once per week and no smoking in the past two weeks). Results showed that Current marijuana use had a negative effect on global IQ score only in subjects who smoked 5 or more joints per week. A negative effect was not observed among subjects who had previously been heavy users but were no longer using the substance and concluded that marijuana does not have a long-term negative impact on global intelligence.

The cognitive process most clearly affected by marijuana is short-term memory that subject under the influence of marijuana have no trouble remembering things they learned previously but may display diminished capacity to learn and recall new information, may concluded that long-term marijuana use causes significant permanent harm to intellectual ability (Zimmer and Morgan, 1997) . Bolla and colleagues (2002) found that IQ interacted with dose on several measures (e.g., Symbol-Digit Paired Associate Learning, but not RAVLT performance) whereby lower IQ individuals were significantly more impaired with increasing number of joints smoked per week. This suggests that perhaps higher IQ individuals are better able to compensate for cannabis related cognitive impairment.

Motor Speed: Tests of speed may be categorized into those of motor speed and mental speed. Motor speed is dependent on reaction time, such that speed is greater wherever the reaction is faster. There are several brain structures mediating motor speed (Joseph, 1996). The prefrontal cortex mediates motor planning, the supplementary motor area mediates initiation of motor acts and the premotor cortex, basal ganglia and the cerebellum mediate fine motor control (Kandel& Schwartz, 1981). Motor speed, therefore requires integration among the multiple centers, which mediate movement. Motor speed reflects the efficiency of this integration.Other neurobehavioral consequence such as an increased risk of an automobile crash when driving while intoxicated (Asbridge, *et al*. 2012; Drummer, *et al*. 2003; Li, *et al*. 2012).

Impair psychomotor performance (D'Souza, *et al*. 2008; Hunault, *et al*. 2009; Ramaekers, *et al*. 2009).Interestingly, Ramaekers and colleagues (2009) found THC administration impaired psychomotor control in occasional cannabis users, but not in heavy cannabis users, suggesting a potential tolerance effect. Hunault and colleagues (2009) found THC to significantly decrease response time and increase errors in a dose-dependent manner in heavy cannabis users on a motor control task. Adolescent cannabis users had impairments in psychomotor performance compared to controls, and there was a negative, dose-dependent association between performance and lifetime cannabis use episodes (Medina, *et al*. 2007).

Mental speed: Mental speed is a composite measure, which requires rapid processing of information. In any given modality, even at low levels of stimulus complexity, information processing speed requires coordination of different areas of the brain. The measures of speed are useful to document the efficiency of motor processes and the rate of information processing. Marijuana users display significantly slowed information-processing speeds (longer ITs) compared to controls. Paradoxically, this deficit appears to be normalized whilst users are in the acute state (Kelleher, 2004).Cannabis had detrimental effect on prospective memory ability in young (Bartholomew, et al. 2010).Cannabis users were slow in decision-making (Vadhan, *et al*. 2007), and poorer performance on measures of immediate and delayed episodic memory, as well as source memory (Morgan, *et al*. 2012). In contrast, acute intoxication does not negatively impact decision-making or risk-taking in occasional, regular, or heavy cannabis users (D'Souza, *et al*. 2008).

Sustained Attention: Attention is an essential element of cognition. Attention has been characterized in two ways, as a resource / capacity or as a skill of resource deployment. There are three different types of attention: these are *focused attention, sustained attention and divided attention* (Posner, 1978). The first, focused attention refers to the capacity to perform a task in the presence of distracting stimuli. The capacity to listen to conversation in a train station, to identify a friend in a crowd, to be able to study in a noisy hostel is some examples of focused attention. The second, sustained attention refers to the capacity to attend to a task on hand for a required period of time. Sustained attention is closely associated with task difficulty or task complexity. While sustenance of attention is easier for simple tasks, it is more difficult for complex tasks. Thus, sustenance of attention is closely associated with the mental effort required by the task on hand. The capacity to study or the capacity to listen a lecture for an extended length of time is examples of sustained attention. The third parameter of attention, divided attention, is the capacity to attend to two or more tasks simultaneously. The concept of divided attention explains dual tasking, wherein two tasks require effort and attention. The multiple resource model of attention formulated by Kinsbourne (1988) conceptualizes attention as a resource that can be divided into three parameters. These parameters are the modality of the stimulus, the nature of processing, and the type of the response. When attention has to be divided, as in dual tasking, division is easy if the two tasks do not overlap on any of the three parameters. As overlap among the parameters increases, the difficulty of dividing attention also increases.

Different brain structures mediate attention depending on the type of attention. Focused attention requires the capacity to withstand distracters. Orbitofrontal area (OFC) in the prefrontal cortex mediates the capacity to inhibit responding to stimuli irrelevant to the task at hand. Hence it is hypothesized that OFC mediates focused attention. Lesion studies have shown that damage to this area results in distractibility. A right fronto parietal network mediates sustained attention. Damage to the right prefrontal cortex is associated with poor sustained attention (Rueckert & Graffman, 1991). Divided attention is closely related to the central executive function of working memory. Discrimination of shape, color and speed of a visual stimulus under conditions of divided attention activated the anterior cingulated and the dorsolateral prefrontal cortex (Corbetta, Miezin, Dobmeyer, Shulman & Petersen, 1991). Bilateral dorsolateral prefrontal cortices mediate the central executive, which was tested by the dual task paradigms (D’Esposito, Detre, David, Shin, Atlas, Grossman, 1995).

Most studies document impairments in attention and concentration following administration of small (i.e., 2.5 mg) and large (i.e., 0.5 mg/kg) doses of THC in cannabis users and non-users compared to placebo administration (Anderson, *et al*. 2010; D’Souza, *et al*. 2008; Hunault, *et al*. 2009; Ramaekers, *et al*. 2009, 2011; Theunissen, *et al*. 2011).Some evidence for a dose-dependent relationship between amount of THC smoked and degree of impairment (Hunault, *et al*. 2009) while two studies found no differences in performance on measures of auditory selective attention and concentration in regular cannabis users after smoking cannabis standardized to 20 mg THC (O’Leary, *et al*. 2007) or on a measure of sustained attention in occasional cannabis (Sugarman, *et al*. 2011) compared to placebo.

Harvey and colleagues (2007) reported an investigation of attention functions in adolescent cannabis users. Memory-related subtests included: Rapid Visual Information Processing (RVIP) – a test of sustained attention with a working memory component; Spatial Working Memory (SWM) – assessing strategy use and memory updating ability for different spatial locations; Paired Associates Learning (PAL) – testing associative learning of patterns and spatial locations of increasing difficulty; and, Spatial Span – spatial memory span for order and location. Regular cannabis users differed significantly from non-regular users a test of sustained attention with working memory component errors. Cannabis use was a significant independent predictor of SWM and Rey Auditory Verbal Learning Test (RAVLT) performance.

Category Fluency: Refers to intrinsic generation of responses or alternatives, typically within a set of constituents. It is a measure of the capacity to generate alternatives in a regulated manner (Spreen and Strauss, 1998). It is an aspect of mental flexibility. It exhibits a spontaneous flexibility that requires a ready flow of ideas and answers, often in response to a single constituent (Eslinger and Grattan, 1993). Fluency is measured in both verbal and visual modalities. Imaging studies show that verbal fluency activates frontal lobes, particularly the prefrontal cortex in the language dominant hemisphere, while design fluency produces bilateral prefrontal activations (Pujol, 1996, Elfgren and Risberg, 1998). Lesion studies have shown deficits in phonemic fluency following damage to the left frontal lobe (Benton and Hamsher, 1989). Neuroimaging studies have shown temporal lobe involvement in category fluency (Frith, 1991).Design fluency is mediated by the right frontal and right frontal central regions (Jones-Gotman and Milner, 1977).

Verbal fluency refers to the capacity to generate new words in a regulated manner. Asking the subject to generate words beginning with a consonant or to generate words belonging to a category imposes the regulation. The former is known as phonemic fluency and the latter as category fluency. The combined THC and Cannabidiol (CBD), but not THC alone, impaired psychomotor control in cannabis users (Roser, *et al*, 2009), poorer performance on immediate and delayed episodic memory but not verbal and category fluency (Morgan, *et al*, 2010)

Working Memory: A concept put forth by Baddeley (1986), refers to the capacity to hold and manipulate the information for ongoing processes. This capacity is required to integrate information with long term memory and with other information being processed either serially or in parallel. The three major components of working memory are verbal working memory, visuo-spatial working memory, and a central executive. The verbal working memory system involves a phonological loop, consisting of a limited duration passive store for phonological codes (the phonological buffer) and an articulatory rehearsal process that refreshes the buffer. The visuo-spatial sketchpad is a buffer responsible for the initial registration of non-verbal material. The sketchpad contains an imagistic mechanism through which the spatial-spatial information is rehearsed. The central executive coordinates the two slave systems, focuses and switches attention and activates representations in long-term memory (Baddeley, 1986; Logie, Zucco and Baddeley, 1990).

Lesion studies have shown that unilateral frontal excisions affect working memory. Left frontal excisions impair both verbal and visual parts while the right frontal excision impair only the visual part of internally guided working memory as measured by self ordered pointing test (Petrides and Milner, 1982). Prefrontal lesions also disrupt performance on delayed response task that is another measure of working memory (D'esposito and Postle, 1999). Verbal working memory using N-back tasks activated Broca's area and the left supplementary motor and premotor areas (Smith and Jonides, 1999). The verbal items appear to be represented in the left posterior temporal areas, short term storage of phonological information is in the left supra marginal gyrus, the left dorsolateral prefrontal cortex maintains the temporal order and the Broca's area supports articulatory processes (Henson, Burgess and Frith, 2000). Several review articles have been found intoxicated individuals performed more poorly in the domain of episodic memory, especially recall of newly acquired information (Ferraro, 1980).

Recent research on acute effects of cannabis showed acute administration of THC to impair episodic memory, including immediate (D'Souza, *et al*. 2008; Dumont, *et al*.

2011) and delayed recall (D'Souza, *et al*. 2008); procedural memory (Dumont, *et al*. 2011); and associative learning and memory (Ballard , *et al*. 2012) among occasional and regular cannabis users as well as non-users. D'Souza and colleagues (2008) also found that, compared to non-using controls, frequent cannabis users showed blunted THC-related impairments in verbal episodic memory, suggesting negative influence on memory, impaired accuracy in regular cannabis users (Weinstein, *et al*. 2008), visuospatial memory (Anderson, *et al*. 2010), associative memory (Bossong, *et al*. 2012), verbal episodic memory (Sugarman ,*et al*. 2011). Hart and colleagues (2010) suggesting a deleterious impact of cannabis on retrieval-based memory. Regular adolescent cannabis users demonstrate poorer immediate (Hanson *et al*. 2010; Harvey, *et al*. 2007; Solowij, *et al*. 2011) and delayed recall (Harvey, *et al*. 2007; Solowij, *et al*. 2011), as well as impaired recognition (Solowij, *et al*. 2011). However, one of these studies found no difference in recognition between regular and occasional cannabis users (Harvey, *et al*. 2007), cannabis users made more recall intrusions than controls, while other studies found no differences between groups on any measure of episodic memory (Jacobsen, *et al*. 2007; Mahmood, *et al*. 2010; Medina, *et al*. 2007), adult cannabis users also demonstrate poorer immediate (Battisti, *et al*. 2010; Gonzalez, *et al*. 2012; Hadjiefthyvoulou, *et al*. 2011; Korver, *et al*. 2010; Nestor, *et al*. 2008; Wagner, *et al*. 2010; Yucel, *et al*. 2008) and delayed recall (Gonzalez, *et al*. 2012; Wadsworth, *et al*. 2006; Yucel, *et al*. 2008), but have intact recognition (Gonzalez, *et al*. 2012; Nestor, *et al*. 2008; Wadsworth, *et al*. 2006).

Other evidence suggests that recall performance is negatively associated with amount of past year (Jager, *et al*. 2007) and lifetime cannabis use (Indlekofer, *et al*. 2009; Jager, *et al*. 2007; Murphy, *et al*. 2011; Solowij, *et al*. 2011), duration of cannabis use (Solowij, *et al*. 2011; Wadsworth, *et al*. 2006), frequency of cannabis use, and age of first cannabis use (Solowij, *et al*. 2011).

In a longitudinal study of young adults, trajectories of performance on measures of episodic memory in non-users, former users, and current users were different, such that non-users and former users immediate and delayed recall improved over a period of 8 years, while performance on these measures worsened over time in light and heavy current users (Tait, *et al*. 2011).Adolescent cannabis users who were abstinent between

12 to 24 h demonstrated intact associative learning (Harvey, *et al*. 2007; Jager, *et al*. 2010). After longer periods of abstinence (28 days), adolescent cannabis users exhibited deficits on a story memory task (Medina, *et al*. 2007), but had intact visuospatial memory (Mahmood, *et al*. 2010; Medina, *et al*. 2007; Schweinsburg, *et al*. 2010). In recently abstinent adult cannabis users, some studies report visuospatial memory deficits (Hermann, *et al*. 2007; McHale and Hunt, 2008), but others do not (Chang, *et al*. 2006; Gruber, *et al*. 2012). Recently abstinent adult cannabis users have demonstrated intact associative learning (Fisk and Montgomery, 2008) and semantic memory (Wadsworth, *et al*. 2006). Evidence for prospective memory deficits is split with one study reporting deficits (Montgomery, *et al*. 2012) and another no deficits (Hadjiefthyvoulou, *et al*. 2011).

Lesion studies have shown that unilateral frontal excisions affect working memory. Left frontal excisions impair both verbal and visual parts while the right frontal excision impair only the visual part of internally guided working memory as measured by self ordered pointing test (Petrides and Milner, 1982).Prefrontal lesions also disrupt performance on delayed response task that is another measure of working memory (D'esposito and Postle, 1999). Verbal working memory using N-back tasks activated Broca's area and the left supplementary motor and premotor areas (Smith and Jonides, 1999).

Several review articles have been found which indicated that intoxicated individuals performed more poorly in the domain of episodic memory, especially recall of newly acquired information (Ferraro, 1980). Harvey and colleagues (2007) reported an investigation of working memory.

Fletcher and Honey (2006) also cite evidence for difficulties in manipulating the contents of working memory, failure to use semantic processing and organisation to optimise episodic memory encoding, and impaired retrieval performance.

Egerton, *et al*. (2006) and Solowij & Michie (2007) clearly demonstrate deficits in short-term and working memory and reversal-learning after acute and chronic administration of cannabinoids to rodents and monkeys, implicating hippocampal and prefrontal cortical dysfunction.

Working memory is disrupted by acute cannabis use (D'Souza, *et al*, 2004). There is a substantial animal literature reporting impaired working memory following acute and chronic administration of cannabinoids (Solowij & Michie, 2007), including an impaired delayed matching to sample (DMTS) task performance that resembles lesions or removal of the hippocampus (Hampson, 2000).

Kanayama and colleagues (Kanayama, 2004) used functional magnetic resonance imaging (fMRI) to investigate spatial working memory in long-term heavy cannabis users employing a relatively simple task. Users made nonsignificantly more errors on the task, although very few errors in both groups reflected the simplicity of the task and it has been suggested that performance deficits in chronic cannabis users are more likely to be elicited in complex tasks (Solowij, 1998) or tasks with a greater memory load (Jager, 2006).

Planning: It has been defined as the identification and organization of the steps and elements needed to carry out an intention or achieve a goal (Lezak, 1995). Planning is the ability to set goals, to monitor performance so as to reach the goals, and to make corrections in the course adopted, in order to ensure that the goal is attained. Goal setting involves not only identifying the final goal, but also identifying the intermediate goals which have to be attained in order to achieve the final goal. The essence of planning consists of attaining a goal through a series of intermediate steps. The subject plans in advance the complete sequence of moves required to solve the problem, and in order to do so anticipates the consequence of one or another course of action (Baker, 1996). The supervisory attentional system is involved in planning. It is a central multi-component process which is mediated by the prefrontal cortex and is involved in the execution of non-routine actions (Shallice, 1988). It a strategic plan of action sequence; a mental representation of the task, including the relevant stimulus information encoded into memory and the desired future goal state” (Pennington and Ozonoff, 1996).

Lesion studies have shown that the left frontal lesions are associated with deficits of planning (Shallice, 1982). Moreover, the studies have found that the inappropriate organizational strategies associated with poor planning are greater in bilateral prefrontal lesions (Owen, Bownes, Shakan, Poltrey and Robbins, 1990). Imaging studies have found that increased activation of the left prefrontal cortex is associated with more efficient planning in terms of longer time to plan and less number of moves. Planning using the Tower of London Test (Morris, Ahmed, Syed and Toone, 1993) activates a wide network consisting of the dorsal prefrontal cortex, premotor and parietal cortex and the cerebellum. The dorsolateral prefrontal cortex is associated with the components of generating, selecting and / or remembering mental moves (Rowe, Owern, Johnsrude and Passingham, 2001). Planning is a complex function with many components such as speed of processing, mental flexibility, working memory, regulation of thought, error correction ability.

Set Shifting Ability - It is the ability to change a mental set in response to environmental contingencies (Spreen and Strauss, 1998). It is the ability to adapt responses to a changing environment. Set shifting ability regulates attention, thought, speech, emotion, and social behaviour. It requires cognitive flexibility both in the formation of a mental set and in the subsequent shifting of the set. A mental set is formed when the environment does not change, that is a situation that calls for a standard response to a standard stimulus leads to the formation of a mental set. Since the mental set can be considered a precursor to habit, creating a response to a standard stimulus becomes easy when a mental set is formed. However, the mental set cannot persist for long as the environmental contingency changes; a change in the environment has to be perceived and changes in the response pattern have to be made accordingly. The mental state must once again be formed in order to speed up the response for the new environmental contingency. The capacity to adapt mental sets to the environment is essential for regulating behaviour. It requires strategic planning, organized searching, and utilizing environmental feedback to shift cognitive sets, directing behaviour towards the goal and modulating impulsive responses.

Set shifting ability is assessed using the Wisconsin Card Sorting Test (WCST). Frontal lobe lesions impair set shifting ability (Heaton, 1993). Lesions of the dorsolateral prefrontal cortex impair set shifting ability and increases preservative responses (Milner, 1963). Frontal lobe lesions have been associated with increased number of errors. Increased preservative responding was reported in patients with lesions in the right frontal cortex. Left frontal lesions have been associated with poor performance on most of the scores. Medial frontal lesions have been associated with poorer concept formation ability (Drewe, 1974). Bilateral dorsolateral prefrontal and superior medial lesions significantly impair the performance on the WCST (Struss, 2001)

Imaging studies have found that bilateral activation is predominantly in the right hemisphere during the WCST in normal volunteers. The network of regions activated by this test as seen on Positron Emission Tomography (PET) include the bilateral dorsolateral prefrontal cortices, inferior parietal lobule, visual association and inferior temporal cortices, cerebellum in addition to the prefrontal cortex (Berman, 1995).

Response inhibition: It measures the ease with which a perceptual set can be shifted both to conjoin changing demands and by suppressing a habitual response in favor of an unusual one. The prefrontal areas are essential for response inhibition. Lesions studies have shown that damage to bilateral superior medial prefrontal regions impair performance on the Stroop Color Word test (Alexander, Benson and Stuss, 1989) which measures response inhibition. Patients with bilateral superior medial prefrontal damage showed increased errors and slowness in congruent condition wherein the color name had to be read when it was printed in the ink of another color. (Stuss, Floden, Alexander, Levine and Katz, 2001). Imaging studies with PET have shown activation of the anterior right hemisphere regions and the medial frontal structures in the Stroop task (Bench *et al*.1993). The anterior cingulate is active during responses to the incongruent stimuli (Macdonald, Cohen, Stenger and Carter, 2000). THC was found to negatively influence inhibitory control, as evidenced by increased stop reaction time and decreased accuracy of responses in occasional and heavy cannabis users during a stop signal task in two studies (Ramaekers, *et al*. 2009; Theunissen, *et al*. 2011), impair psychomotor performance (D'Souza, *et al*. 2008; Hunault, *et al*. 2009; Ramaekers, *et al*. 2009).

THC was found to negatively influence inhibitory control, as evidenced by increased stop reaction time and decreased accuracy of responses in occasional and heavy cannabis users during a stop signal task in two studies (Ramaekers, *et al*. 2009; Theunissen, *et al*. 2011), Among recently abstinent adolescent cannabis users, regular and non-regular users showed no difference in inhibition or psychomotor control (Harvey, *et al*. 2007). After 28 days of abstinence, adolescent cannabis users demonstrated intact inhibition and motor impulsivity (Tapert, *et al*. 2007).

In recently abstinent adult cannabis users, some studies report impairments in inhibition and motor impulsivity (Battisti, *et al*. 2010; Clark, *et al*. 2009; Cunha, *et al*. 2010; Fontes, *et al*. 2011; Scholes and Martin-Iverson, 2010), with some evidence for a dose dependent relationship between amount of past 30 days use and performance (Cunha, *et al*. 2010; Piechatzek, *et al*. 2009)

Mason and colleagues (2012) found recently abstinent adult cannabis users were able to successfully inhibit proponent responses on a simple task of inhibition, but their performance became significantly more impaired compared to normative data as the task became more complex. Performance on measures of psychomotor control are also mixed, with one investigation finding deficits in psychomotor control across several measures among adult cannabis users abstinent for 12 h (King, *et al*. 2011), but others suggesting intact psychomotor control in recently abstinent cannabis users (Chang, *et al*. 2006; Korver, *et al*. 2010; Wadsworth, *et al*. 2006) and after 28 days of abstinence (Pillay, *et al*. 2008). Relatedly, Gonzalez and colleagues (2011) found poorer complex psychomotor performance (but no procedural learning deficits) among polydrug-using individuals with a history of cannabis dependence compared to those without a history of cannabis dependence and this deficit was exacerbated in the context of HIV.

Verbal Comprehension: Verbal Comprehension is the ability to understand spoken speech. It can be assessed clinically through an interview. Aphasia batteries also measure verbal comprehension among a multitude of language functions. Wernicke's area mediates verbal comprehension (Joseph, 1996).Children of cannabis users scored more poorly included parental ratings of behaviour problems, visual-perceptual tasks, language comprehension, and distractibility (Colleen, *et al*. 1991). Previous work provided evidence that chronic cannabis use leads to long-term deficits of the oculomotor control system (Huestegge, *et al*. 2009), cannabis group exhibited increased sentence reading times associated with reduced text comprehension (Huestegge, *et al*. 2010) .

Verbal learning and memory (Verbal immediate recall): Learning and Memory are the capacities by which a person is able to gain experience and retain it. Learning is the means of acquisition of new information about the environment and memory is the process of retaining it. Learning and memory are interdependent processes. Memory processes are divided into short-term and long-term memories. Long-term memory is a system of theoretically unlimited capacity enduring over the lifetime of an individual (Baddeley, 1990). One of the important aspects of memory is declarative or explicit memory, i.e. memory that can be brought to conscious awareness. Memory for events, figures, words, scenes and facts are in the domain of explicit memory. Encoding and retrieval of personally experienced events is termed as episodic memory. Knowledge of facts and concepts is termed as semantic memory (Tulving, 1999). A gradual acquisition process from episodic to semantic memory is likely as semantic memory would at some stage have been encoded as episodic memory (Fletcher, Frith, Grasby, Shallice, Frackowiak and Dolan, 1995). Learning and memory for verbal and visual material are two important domains of explicit memory.

Lesion studies have shown that acquisition of new information is mediated by a wide network of structures including the anterior temporal cortex, amygdala, hippocampus, enterorhinal cortex, prefrontal cortex and retrosplenial cingulate cortex (Habib, Macintosh, Wheeler and Tulving, 2003). The left prefrontal lobe is involved to a greater extent in the encoding into episodic memory and retrieval from semantic memory. The right prefrontal lobe is involved to a greater extent in retrieval from episodic memory, which has been termed as the Hemisphere Encoding retrieval Asymmetry (HERA) model (Tulving, 1999). It is hypothesized that the prefrontal cortices are important for the organization of the material, verification of recalled material and formulating heuristic strategies for learning, while the hippocampal structures are important for associations between events discrete in time and space. Regions in the ventral temporal cortex mediate form and color knowledge, regions in the lateral temporal cortex mediate motion knowledge; and regions in the parietal cortex mediate size, knowledge and in the premotor cortex mediate action knowledge. Anterior areas of the temporal cortex are involved in the representation of verbal conceptual knowledge organized categorically (Thompson-Schill, 2003). Lesions in the left temporal lobe disrupt verbal memory and lesions of the right temporal lobe disrupt visuo-spatial memory (Smith and Milner, 1981). Excisions of left hippocampal structures impair verbal memory to a greater extent. The impairment of Visuo-spatial memory is less clearly lateralized (Jones-Gotman, *et al*. 1997).

Lundqvist (2005) found cannabis users exhibit difficulties in coding information into long-term memory, display impaired verbal learning, are more easily distracted, and are less efficient at focusing attention on complex tasks. The degree of executive impairment increases with the severity of use, and the impairments are relatively lasting over time.

Notably, cannabinoid (CB1) receptors occur in high density in brain regions critically involved in memory functions and cannabinoids profoundly affect synaptic plasticity underlying learning and memory (Alger, 2005) disrupting long-term potentiating in the hippocampus (Chevaleyre,2006). Even a single exposure abolishes retrograde signalling (Mato, *et al*. 2004) and can induce lasting deficits in spatial learning and memory in mice 3-4 weeks and 4 months after exposure (Tselnicker, *et al*. 2007). Davies and his colleagues (2004) reported the high rates of substance use disorders among the general and clinical populations, and the abuse potential of many medications commonly used in the treatment of neurologic illnesses, the treating neurologist must deal with drug misuse and abuse in practice. Cannabis Neurologic effects of acute intoxication with cannabis include behavior changes, impaired memory, hyperphagia, in coordination, and possibly psychosis.

Visual immediate recall: Cannabis has substantial acute effects on human cognition and visuomotor skills (Huestegge, 2010). Adolescent cannabis users who were abstinent between 12 to 24 h demonstrated intact associative learning (Harvey, *et al*. 2007; Jager, *et al*. 2010). After longer periods of abstinence (28 days), adolescent cannabis users exhibited deficits on a story memory task (Medina, *et al*. 2007), but had intact visuospatial memory (Mahmood, *et al*. 2010; Medina, *et al*. 2007; Schweinsburg, *et al*. 2010). Abstinent adult cannabis users, report visuospatial memory deficits (Hermann, *et al*. 2007; McHale and Hunt, 2008), but others do not (Chang, *et al*. 2006; Gruber, *et al*. 2012). Recently abstinent adult cannabis users have demonstrated intact associative learning (Fisk and Montgomery, 2008) and semantic memory (Wadsworth, *et al*. 2006).

Degradation in performance of chronic cannabis users in all tasks involving visuomotor control, including spatial navigation (Warren, *et al*. 1981), scene perception, and reading. Children of cannabis users scored more poorly included parental ratings of behaviour problems, visual-perceptual tasks, language comprehension, and distractibility (Colleen, *et al*. 1991). Visuo-constructive ability requires attention, visuo-spatial perception, visuo-motor coordination, planning, and error correction abilities. This ability is a composite function which is mediated by bilateral parietal structures, predominantly by the right parietal structure. The prefrontal structures also mediate the planning and error correction required for visuo-constructive ability (Lezak, 1995).

Earlier findings suggest that age of onset may be a critical factor in the development and persistence of neurocognitive deficits and that the adolescent brain may be more vulnerable to the insult of even low-level cannabis use. Indeed, there is growing evidence for greater adverse cognitive outcomes when use is commenced during adolescence (e.g., prior to age 16 or 17 yrs) as opposed to young adulthood. Early-onset cannabis use confers the greatest risk of developing psychosis, either in its own right (Stefanis, *et al*. 2004), or as a gene by environment interaction (Caspi, *et al*. 2005).

Early onset cannabis users (before 17 yrs) were found to have smaller whole brain volumes, lower percent cortical grey matter, higher percent white matter and increased resting cerebral blood flow compared to later onset users (Wilson, *et al*. 2000). Individuals who begin to use cannabis when the brain is still developing may be most vulnerable to its deleterious effects. There is a growing recognition that substances affect the brain in different ways during adolescence versus adulthood, and insufficient research has investigated the unique effects of cannabis during this neuro developmentally vulnerable period, effect severity depend on onset time (Dragt, 2010).

The Verbal Learning Tests measure the cognitive functions of the Cannabis users on their ability to encode, consolidate, store and retrieve verbal episodic information and are highly sensitive to neurological impairment (Lezak, *et al*. 2004), though age, intelligence and educational experience also impact upon performance (Schmidt, 1996).Ranganathan and D'Souza (2006) found in their review that acute administration of cannabis impairs immediate and delayed free recall of information

Early onset cannabis use was shown to impair attentional processes measured by reaction time during visual scanning, visual search and short-term memory (Huestegge, *et al*. 2004; Huestegge, *et al*. 2002), and reduced attention ability (Kempel, *et al*. 2003). Early onset effects on brain volume grey and white matter and cerebral blood flow were reported above. That, the adolescent brain may be more vulnerable to the impairing effects of cannabis on memory (among other attentional and executive functions) is evident from the few studies that have now been conducted on adolescent samples of cannabis users.

Animal studies have also demonstrated greater adverse consequences when cannabinoids are administered to adolescent rats (O'shea, *et al*. 2004). Fletcher, *et al* (1996) found that only older long-term cannabis users differed from controls in list learning, while young users were unaffected.

Cannabis use may have a negative impact on some aspects of neurocognition, especially those mediated principally by frontal-limbic systems but a high degree of inconsistency related to the exact nature and chronicity or reversibility of these deficits (Crane, *et al.* 2013).In relation to verbal learning, neurocognitive deficits in adult cannabis users have variously been attributed to duration of cannabis use (Solowij & Michie, 2007), frequency of cannabis use (Pope, *et al*. 2001), cumulative dosage effects (Bolla, *et al*. 2002).

The evidence to date from both human and animal research suggests that they are not grossly impaired in the long term but that there are alterations in their function (Solowij and Greyner, 2001). Longitudinal study of young adults, trajectories of performance on measures of episodic memory in non-users, former users, and current users were different, such that non-users and former users immediate and delayed recall improved over a period of 8 years, while performance on these measures worsened over time in light and heavy current users (Tait, *et al*. 2011).

In recently abstinent adult cannabis users, some studies report impairments in inhibition and motor impulsivity (Battisti, *et al*. 2010; Clark, *et al*. 2009; Cunha, *et al*. 2010; Fontes, *et al*. 2011; Scholes and Martin-Iverson, 2010), with some evidence for a dose dependent relationship between amount of past 30 days use and performance (Cunha, *et al*. 2010; Piechatzek, *et al*. 2009)

Recognition performance was also significantly poorer in long-term users, and measures of recall and recognition correlated significantly and inversely with the years of cannabis use, after controlling for age and IQ (Solowij, *et al*. 2002), and long-term users also showed a smaller primacy effect. Messinis and friends (2006) found poorer performance by long-term users on most trials of the verbal tests, and on delayed recall and recognition.

Other evidence suggests that recall performance is negatively associated with amount of past year (Jager, *et al*. 2007) and lifetime cannabis use (Indlekofer, *et al*. 2009; Jager, *et al*. 2007; Murphy, *et al*. 2011; Solowij, *et al*. 2011), duration of cannabis use (Solowij, *et al*. 2011; Wadsworth, *et al*. 2006), frequency of cannabis use, and age of first cannabis use (Solowij, *et al*. 2011).

Schweinsburg and colleagues (Schweinsburg, *et al*, 2005) found cannabis users showed lower activation in inferior frontal and temporal regions and greater activation in prefrontal regions than non-user controls.

Previous work provided evidence that chronic cannabis use leads to long-term deficits of the oculomotor control system (Huestegge, *et al*. 2009), cannabis group exhibited increased sentence reading times associated with reduced text comprehension (Huestegge, *et al*. 2010) . Cognitive long-term impairments of chronic cannabis use demonstrated in earlier studies (Croft, *et al*. 2001; Solowij and Battisti, 2008).

Recognition performance was also significantly poorer in long-term users, and measures of recall and recognition correlated significantly and inversely with the years of cannabis use, after controlling for age and IQ (Solowij, *et al*. 2002), and long-term users also showed a smaller primacy effect. Messinis and friends (2006) found poorer performance by long-term users on most trials of the verbal tests, and on delayed recall and recognition.

However, duration of use is necessarily confounded with increasing age and increasing cumulative dose of exposure, Block and colleagues (2002), used positron emission tomography (PET) to examine memory-related regional cerebral blood flow in frequent users. Cannabis users required significantly more trials to achieve the learning criterion.

Pope and Yurgelun-Todd (1996) compared performance on the California verbal learning test (CVLT) of heavy and light users differed significantly, with poorer performance by heavy users in the number of words recalled on almost every trial, in the sum of all five trials, following the presentation of an interference list, following cueing and in delayed recall 40 minutes later. These results suggested reduced learning in heavy cannabis users, but the ability to retain newly learned information after a delay appeared to remain relatively intact.

Deficits in cannabis users have been demonstrated in all Verbal Learning Test (VLT) task measures and have variously been attributed to duration of cannabis use (Messinis, *et al*. 2006; Solowij, *et al*. 2002), frequency of cannabis use (Popej, *et al*. 2001; Pope, *et al*. 1996) or cumulative dosage effects (Bolla, *et al*. 2002).

Schwenk (1998) has argued that there is no clear causal relationship between cannabis use and job performance as long term users would perform reasonably well in routine tasks of everyday life, although they may be more distractible.

Ranganathan and D'Souza (2006) found in their review that acute administration of cannabis impairs immediate and delayed free recall of information. Cognitive long-term impairments of chronic cannabis use demonstratedin earlier studies (Croft, *et al*. 2001; Solowij and Battisti, 2008)

However, many other studies report no differences in performance between recently abstinent adult cannabis users and controls (Aharonovich, *et al*. 2008; Cane, *et al*. 2009; Chang, *et al*. 2006; Fernandez-Serrano, *et al*. 2010; Fontes, *et al*. 2011; Gonzalez, *et al*. 2012; Grant, *et al*. 2011; Gruber, *et al*. 2012; Hermann, *et al*. 2007; Hester, *et al*. 2009; Roberts and Garavan, 2010; Scholes and Martin- Iverson, 2010).

Manipur (where target population were drawn):

It is one of the eight North Eastern States of India where participation of the present research were drawn. It covers an area of 22,347 square kilometers. Its boundary is surrounded by Myanmar (Burma) in the east and south, and Nagaland state in the north, Assam (Cachar state) in the west and Mizoram state in the south-west. Manipur is a meeting point, epicenter, between South East Asia and the Indian sub-continent. The Manipur valley, in the middle of the state, is at a height of 790 meters above the sea level and is surrounded by nine hill ranges in circles creating a hill and trough geography. More than 60% of its inhabitants are Meiteis including Bamons and Pangans who settle mostly in the valley and the remaining are hill sub-tribes, namely, Tangkhul, Thadou, Zeliangrong (Zemi, Laingmai, Roungmei - Kabuis), Mao, Maram, Poumai, Paite, Hmar, Maring, Anal, Aimol, Angami, Chiru, Chothe, Gangte, Monsang, Moyon, Kom, Purum, Ralte, Sema, Simte, Salte, Vaiphei, Lamgang, Zhou, etc. Each group has their own language, tradition and culture. Meitei-lon (Meitei language or Manipuri) is the common language as all tribes can communicate one another. Imphal is the capital and a major trading centre. The present political system in the state includes nine districts with headquarters at Imphal, those nine districts are Imphal East, Imphal West, Thoubal, Bishenpur (Valley Districts), Ukhrul, Senapati, Tamenglong, Chandel and churachandpur (Hill Districts) bearing similar names for respective districts capital as well (Tensuba,1993).

Manipur grows cannabis plant (Indian hemp) abundantly, and illegally exports outside the state as a lucrative business. Local consumption during religious festivals and also for enjoyment in normal situation is very high, and has been an increasing trend especially among labourers. The paucity of research work in the field of cognitive deficits among the Marijuana users in Manipur draws the researcher’s curiosity and leads to formulate the present proposed study as a modest attempt in the context of Manipur situation.

The statement of the problem of the present study is presented in the next Chapter.

CHAPTER-II

STATEMENT OF THE PROBLEM

Statement of the problem

Earlier findings suggested that age of onset may be a critical factor in the development and persistence of neurocognitive deficits and that the adolescent brain may be more vulnerable to the insult of even low-level cannabis use. Indeed, there is growing evidence for greater adverse cognitive outcomes when use is commenced during adolescence (e.g., prior to age 16 or 17yrs) as opposed to young adulthood. Early-onset cannabis use confers the greatest risk of developing psychosis, either in its own right (Stefanis, *et al*. 2004), or as a gene by environment interaction (Caspi, *et al*. 2005). Thus, individuals who begin to use cannabis when the brain is still developing may be most vulnerable to its deleterious effects. There is a growing recognition that substances affect the brain in different ways during adolescence versus adulthood, and insufficient research has investigated the unique effects of cannabis during this neuro developmentally vulnerable period. Animal studies have also demonstrated greater adverse consequences when cannabinoids are administered to adolescent rats (O'shea, *et al*. 2004).

Marijuana is commonly regarded as an innocuous drug and the prevalence of lifetime and regular use has increased in the most developed countries. However, accumulative evidence highlights the risk of dependence and other adverse effects, particularly among Marijuana users. To evaluate the adverse effects of Marijuana users as an appreciable proportion of cannabis users reports short-lived, adverse effects, psychological and behavioural disorders including psychotic and that regular abusers are at risk of dependence. People with major mental illnesses such as schizophrenia are especially vulnerable with taking of Marijuana as provokes relapse, and aggravate existing symptoms. Health workers need to recognize and respond to the adverse effects of Marijuana on human.

Decades of research have examined the effects of cannabis on cognitive functions. Recent advances in this field provide us better understanding of how cannabis use influences neurocognition both acutely and non-acutely (Crane, *et al.* 2013). Evidences supported that different areas of cognitive function were adversely affected by cannabis use under various conditions.

The main psychoactive compound in cannabis (THC) may have important implications for various neurobehavioral processes, including mood and anxiety regulation (Crippa, *et al*. 2011, 2009), learning, memory, motivation, motor control, reward processing, and executive functions (Crean, *et al*. 2011), in executive functions, intoxicated individuals performed more poorly in the domain of episodic memory, especially recall of newly acquired information (Ferraro, 1980).

Jacobsen (2007) did further study on cannabis users (aged 13-18 yrs) and found that poorer performance in verbal reasoning was apparent in cannabis users at the start of the working week and correlated with frequency of cannabis use. Cannabis users also showed slower response organization and lower alertness than non-users generally, and slower psychomotor speed, reflecting a lack of improvement in speed. The findings of this study suggest that impaired performance in cannabis users may only manifest under certain conditions, for example when tired or under a heavy cognitive load, the results are informative with regard to hangover effects and impacts on real world work performance.

Poorer performance among both short and long-term cannabis users on measures of verbal memory, language functions, and processing speed compared to controls after 24 h of abstinence (Messinis, *et al*. 2006), Bolla and colleagues (2002) examined a sample of heavy cannabis users and found higher frequency of cannabis-use correlated with poorer performance across most neuropsychological measures, such as tests of memory, executive functions, inhibitory control, and psychomotor speed.

Heavy cannabis users have deficits on measures of information processing speed, compared to 22 controls while abstinent, but not while acutely intoxicated (Kelleher, *et al*. 2004).

Mental speed is a composite measure, which requires rapid processing of information. In any given modality, even at low levels of stimulus complexity, information processing speed requires coordination of different areas of the brain. The measures of speed are useful to document the efficiency of motor processes and the rate of information processing. Marijuana users display significantly slowed information-processing speeds (longer ITs) compared to controls. Paradoxically, this deficit appears to be normalized whilst users are in the acute state (Kelleher, 2004).

Some studies has documented impairments in attention and concentration following administration of small and large doses of THC in cannabis users and non-users compared to placebo administration (Anderson, *et al*. 2010; Ramaekers, *et al*. 2009, 2011; Theunissen, *et al*. 2011), amount of THC smoked and degree of impairment

(Hunault, *et al*. 2009). However, some studies found no differences in performance on measures of auditory selective attention and concentration in regular cannabis users a (O'Leary, *et al*. 2007) on a measure of sustained attention in occasional cannabis users (Sugarman, *et al*. 2011).

Review of studies suggested that results were somewhat equivocal on several measures of attention and executive functions, but a clear pattern of disruption in memory was present among intoxicated individuals (Ferraro, 1980) as divided attention is closely related to the central executive function of working memory. Discrimination of shape, color and speed of a visual stimulus under conditions of divided attention activated the anterior cingulated and the dorsolateral prefrontal cortex (Corbetta, Miezin, Dobmeyer, Shulman & Petersen, 1991).

Peter Fried and colleagues (2002) studied the marijuana use among seventy 17- to 20 year-olds whose intelligence quotient (IQ) had been determined at the age of 9-12 years and compared the difference in IQ scores of current heavy users (at least 5 joints per week), current light users (less than 5 joints per week), former users (who had not smoked regularly for at least 3 months) and non-users (who never smoked more than once per week and no smoking in the past two weeks). Results showed that Current marijuana use had a negative effect on global IQ score only in subjects who smoked 5 or more joints per week. A negative effect was not observed among subjects who had previously been heavy users but were no longer using the substance and concluded that marijuana does not have a long-term negative impact on global intelligence.

Most studies have sought to match cannabis users and controls on IQ or else have used IQ as a covariate to determine cannabis-related memory-specific effects by accounting for confounding that may be due to differing cognitive reserves. Memory deficits that are shown to be dose-related, cognitive impairments have been found to be greater in cannabis users of lower IQ than in higher IQ users in several studies (Pope, *et al*. 1996). Pope and colleagues (2001) highlighted above with regard to IQ differences: it is possible that neurocognitive deficits in cannabis users with lower IQ may also be less amenable to recovery following prolonged abstinence. Deficits have been shown to increase as a function of frequency, duration, dose and age of onset of cannabis use, but the precise parameters of cannabis use that result in memory deficits remain to determine.

Ranganathan and D’Souza (2006) reviewed the extant literature on acute effects of marijuana (or THC) on neuropsychological functioning and reported that the most consistent deficits are found on measures of immediate and delayed of wordlists, prose, and nonverbal stimuli but no differences in recall for information learned prior to intoxication. THC administration impairs specific aspects of learning and memory of decision-making and risk taking (Busemeyer and Stout, 2002).

Psychoactive compound in cannabis have important implications for various neurobehavioral processes, including learning, memory, motivation, motor control, reward processing, and executive functions (Crean, *et al*. 2011). THC has been found to impair healthy young adults’ performance on a reasoning task (Morrison, *et al*. 2009) and significantly increased total errors in regular cannabis users on a task of abstract reasoning (Weinstein, *et al*. 2008). In contrast, most evidence suggests that acute intoxication does not negatively impact decision-making or risk-taking in occasional, regular, or heavy cannabis users (Ramaekers, *et al*. 2011), slow decision-making (Vadhan, *et al*. 2007), THC may actually reduce risk taking behaviors in healthy young adults (Rogers, *et al*. 2007).

THC administration adversely affects inhibition, impulsivity, and working memory, but not verbal fluency, and findings are mixed for decision making, risk-taking, and aspects of attention (Crean, *et al*. 2011).

THC impaired episodic memory, including immediate (D’Souza, *et al*. 2008; Dumont, *et al*. 2011; Morrison, *et al*. 2009) and delayed recall (D’Souza, *et al*. 2008); procedural memory (Dumont, *et al*. 2011); and associative learning and memory (Ballard, *et al*. 2012), inhibition, motor impulsivity, and psychomotor control (Moeller, *et al*. 2001). Morgan and colleagues (2010) found cannabis users demonstrated poorer performance on immediate and delayed episodic memory (but not verbal and category fluency), immediate and delayed episodic memory, and source memory, compared to users with higher cumulative CBD exposure when both groups were intoxicated.

Evidence indicates there may be a dose dependent relationship between amount of intravenousTHC and impairments in total free and delayed verbal recall, but not delayed cued or recognition recall (D’Souza, *et al*. 2008). They also compared non-using controls and frequent cannabis users result showed frequent users showed blunted THC-related impairments in verbal episodic memory, suggesting potential tolerance effects of cannabis negative influence on memory.

In contrast to earlier finding, other finding said no effect from THC on visuospatial memory (Anderson, *et al*. 2010), associative memory (Bossong, *et al*. 2012), or verbal episodic memory (Sugarman, *et al*. 2011). Hart and colleagues (2010) also found that THC administration did not affect overall performance on a task of verbal episodic memory in regular cannabis users.

Pope and colleagues (2001) examined groups of former heavy cannabis users (n=45), current heavy cannabis users (n=63), and non using controls (n=72) that completed thorough neuropsychological assessments at days 0, 1, 7, and 28 of supervised abstinence. Only current heavy users performed more poorly than controls (on measures of verbal memory); however, these differences were only observed on days 0, 1, and 7, with no significant differences detected by day 28.

Some studies find THC to impair psychomotor performance (D'Souza, *et al*. 2008; Hunault, *et al*. 2009; Ramaekers, *et al*. 2009), but several others do not (Dumont, *et al*. 2011; O'Leary, *et al*. 2007; Ramaekers, *et al*. 2011). Ramaekers and colleagues (2009) found THC administration impaired psychomotor control in occasional cannabis users, but not in heavy cannabis users, suggesting a potential tolerance effect. Hunault and colleagues (2009) found THC to significantly decrease response time and increase errors in a dose-dependent manner in heavy cannabis users on a motor control task.

Planning using the Tower of London test (Morris, Ahmed, Syed and Toone, 1993) activates a wide network consisting of the dorsal prefrontal cortex, premotor and parietal cortex and the cerebellum. The dorsolateral prefrontal cortex is associated with the components of generating, selecting and / or remembering mental moves (Rowe, Owern, Johnsrude and Passingham, 2001).

Set shifting ability is assessed using the Wisconsin Card Sorting Test (WCST). Frontal lobe lesions impair set shifting ability (Heaton, 1993). Lesions of the dorsolateral prefrontal cortex impair set shifting ability and increases preservative responses (Milner, 1963). Frontal lobe lesions have been associated with increased number of errors. Increased preservative responding was reported in patients with lesions in the right frontal cortex. Left frontal lesions have been associated with poor performance on most of the scores. Medial frontal lesions have been associated with poorer concept formation ability (Drewe, 1974). Bilateral dorsolateral prefrontal and superior medial lesions significantly impair the performance on the WCST (Struss, 2001)

THC has shown negative influence on inhibitory control by increasing reaction time and decreased accuracy of responses in occasional and heavy cannabis users (Ramaekers, *et al*. 2009; Theunissen, *et al*. 2011), but after THC administration of 3 hours did effect on inhibition or motor impulsivity in heavy cannabis users on the same task in another study (Ramaekers, *et al*. 2011).

Heavy cannabis use may produce deficits on measures of decision-making and inhibitory control that persist for longer as a chronic brain disease that involves compulsive use of a substance in the face of negative consequences (Leshner, 1997).

Drug users perform more poorly than control participants on measures of impulsive decision-making (Gonzalez, *et al*. 2007), motor inhibition (Fillmore and Rush, 2002), rate of discounting delayed rewards (Bechara, *et al*. 2001). The psychoactive effects of marijuana are experienced almost immediately after smoking, peak levels of intoxication are reported to occur in about 30 min, and effects diminish in approximately 4 hours (Grotenhermen, 2003). After oral consumption, subjective "highs" have a later onset and longer duration—peak effects are felt by 90 minutes and abate in up to 6 hours (Grotenhermen, 2003), increased rCBF is most often seen in frontal, limbic, paralimbic, and cerebellar regions.

Block and friends (2002) found that recently abstinent, frequent users of cannabis showed decreased metabolism in prefrontal cortical regions, increased metabolism in cerebellum, and a different lateralization pattern of hippocampal metabolism relative to controls during one of several conditions of a list-learning task.

Fried and friends (Fried, *et al*. 2005) examined the neuropsychological performance of a large cohort (n=74 and n=113) of longitudinally followed individuals at ages 9–12 years old and again at 17–20 years of age. At follow-up, all subjects were classified into subgroups according to severity of current and previous cannabis use: (1) current regular heavy cannabis smokers (>5 joints/ week); (2) current regular light smokers (<5 joints/week); 3) former regular smokers (no regular use for at least 3 months and no more than two joints in the last two months); and (4) a control group who reported not using cannabis regularly. Only current heavy cannabis users demonstrated a statistically significant decrease in IQ scores, immediate and delayed memory, and information-processing speed. Deficits in neuropsychological functioning (when present) are most likely to been seen only among current heavy users.

Lyons and colleagues (2004) conducted study on twin pairs, who were genetically identical, rose in the same home and did not differ on history of alcohol, other drug use, or indices of achievement (e.g., employment, educational attainment, school grades, and academic difficulties). On average, those with history of cannabis use first began regular use of cannabis at about 21 years of age (range =19–43) for an average duration of about 6 years (range 1–22 years). No participants reported using cannabis at least one year prior to testing, with last regular use occurring about 27 years prior on average. Of over 50 different indices of neuropsychological performance examined, statistically significant differences of very small magnitude were only observed on one measure of visuo constructional abilities (Block Design). Abstinent cannabis users experience poorer neuropsychological performance than noncannabis-using controls. Furthermore, the totality of evidence suggests that any deficits observed are most likely to be seen only among heavy, frequent users of cannabis, not withstanding acute cannabis intoxication.

90 % of the brain's total volume has developed by approximately age 6 (Giedd, 2004), global cortical development follows an inverted U-shaped trajectory, peaking around 12 to 14 years of age then decreasing in volume and thickness over adolescence (Giedd, *et al*. 1999; Gogtay, *et al*. 2004).Thus, it is possible that use of cannabis during this time period may be disruptive to normal neuro maturation (Bava and Tapert, 2010). Rats exposed to synthetic cannabinoids or THC during adolescence experience impaired working memory at adulthood (O'Shea, *et al*. 2004, 2006; Rubino, *et al*. 2009), younger brains that the same amount of THC exposure led to decreased working memory performance in adolescent rats while had no effect in adult rats (Quinn, *et al*. 2008), impairments in working memory (Realini, *et al*. 2009). Rats exposed to chronic doses of THC during adolescence, evidenced deficits in learning during adulthood (Harte and Dow-Edwards, 2010). Those who initiate use before 15 to 17 years of age demonstrate more pronounced deficits in visual attention (Ehrenreich, *et al*.1999), verbal fluency (Gruber, *et al*. 2012; Pope, *et al*.2001), inhibition (Fontes, *et al*. 2011; Gruber, *et al*. 2012; Pope, *et al*. 2001), and other aspects of executive functioning (Fontes, *et al*. 2011) as compared to those who initiate use later on. Poorer performance on measures of inhibition (Battisti, *et al*. 2010; Gruber, *et al*. 2012) and impulsivity (Solowij, *et al*. 2012)

have also been associated with earlier age of onset. Moreover, Gruber and colleagues (2012) reported that early-onset users made more errors and showed greater disruptions in brain activation patterns than late-onset users during an inhibition task.On the other hand, others have reported no differences between early and late-onset cannabis users (and healthy controls) on measures of working memory and attention (Ehrenreich, *et al*. 1999; Gruber, *et al*. 2012; Pope, *et al*. 2001), as well as on a task of visuospatial memory (Gruber, *et al*. 2012).

Many recent studies have also examined specific variables that may contribute to some of the incongruity findings pertaining to the cognitive function of cannabis use. Here we suggest that level of addiction and onset of use factors are important to consider when examining cognitive effects of cannabis use. For example, different onset of use during may be associated with disruption of cognitive function and result in neurocognitive deficits.

Together, data reviewed indicates that cannabis use have a negative impact on neurocognition. However, there is a high degree of inconsistency related to the effect of cannabis use on cognitive functions with different levels of addiction and time of use; their reversibility of these deficits. The present study was designed to depict the differential effects of the level of addiction (high, low and non users) and onset of use (early and late onset of use) factors on different areas cognitive functions.

Manipur is located in the northeast region of India and has become a market place for heroin and other drugs processed in and transported from the Golden Triangle. People in Manipur have used **marijuana**, opium, and alcohol for centuries (Sarker, *et al*. 1996). Extensive drug use has been observed in Manipur for over thirty years (Singh, 2001). If it so, the Marijuana has been extensively used in Manipur, in both accepted way and non accepted ways, but the alarming situation hardly draws attention of researchers. Cannabis users, as well as the average person on the street, may not have the necessary insight, knowledge or vocabulary to describe their perception on cognitive problems to any degree of precision. It was the aim of this proposed research as a researcher, and the scientific community to enable us to better define the nature of cognitive abilities among cannabis users.

Objectives

It will examine the effect of marijuana on general health and cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) by way of incorporating between group classification of five variables '***Level of disorder***' ('Abuse' and 'Dependence' of marijuana:(DSM-IV TR, APA, 2000), and the time of '***Onset***' ('Early onset': before 18 years and 'Late onset'; after 18 years)of Marijuana and a control group (non user) on the sub-scale/sub-factor measures of cognitive abilities (dependent measures) among the samples.

It will examine the effects of 'Level of disorder', 'Onset' differences on measures of the dependent variables.

It will examine the cultural specific problems of the selected population regarding the Marijuana user on cognitive deficiencies.

In the light of the earlier studies, it is expected that the behavioral measures would find replicability in the project population the 'Manipuri'. The participants of marijuana user would manifest different cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory).The proposed research study would be an exploratory in nature since no academic research has been done on the selected psychological measures in the targeted population, the 'Manipuri'.

The hypotheses as aimed to be incorporated to achieve the objectives are hereby described.

Hypotheses

The following hypotheses are set forth for the study of Cognitive deficiency among Marijuana users in Manipur for the proposed research study:

(1) Significant difference would be observed in relation to 'Level of disorder' of marijuana on cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) among the subjects.

(2) 'Onset' of marijuana use would be manifested differently on cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) among the subjects.

(3) Dependency and early onset are expected to show more cognitive deficiencies as compared to abuse with late onset.

(4) Specific cluster of cognitive deficiencies are expected with regards to the main cell of the design.

The methods and procedure that were aimed to be incorporated to achieve the objectives of the study are outlined in the next chapter on ‘Chapter – III: Methods and procedure’

CHAPTER-III

METHODOLOGY

Methodology

Sample:

A total of 200 samples, 40 early and 40 late onset abuse,40 early and 40 late onset dependence who were marijuana user and 40 control (non user),users were screened out by employing DSM-IVTR criteria (DSM-IV TR, APA, 2000) for '***level of disorder***'***('***Abuse' and 'Dependence' of marijuana), and the '***Onset***' ('early onset': before 18 years and 'late onset': after 18 years***)*** of marijuana use was screened out through the Structured Interview questionnaire. Only literate subjects of marijuana users were chosen and applied the NIMHANS Neuropsychology Battery (2004) to assess their cognitive abilities and General Health Questionnaire (GHQ-12) Goldberg and Williams, 1988) to assess their mental health condition of the subjects. The age range was 18 to 40 years for the whole samples, only male samples were selected because female marijuana users are hardly seen in the selected population. All the 160 of (marijuana users) selected samples were registered patients in the Psychiatry Department and Department of Clinical psychology of Regional institute of Medical Sciences, Imphal-West; and Jawaharlal Nehru Institute of Medical Sciences, Imphal- East; and NGOs operating in Manipur State. The samples for the study were selected based on their past history in regards to marijuana use, of which only those who had a history of substance use (cannabis) for at least 2 years were selected. The identified marijuana users were partitioned into four groups depending upon the'level of disorder', and 'onset' of marijuana use among the marijuana users in the target population of Manipur. One more group comprises of same number samples that were not involved with marijuana, were selected for comparison with the other four groups of marijuana users on cognitive abilities. A number of background information of the subject like age, educational qualification, marital status, socio- economic status, profession and average monthly income was carefully listed with the help of Demographic Profile for the groups to fulfill the objectives of the present study.

Design:

The study incorporated between group classifications of five variables '***level of disorder'*** ("abuse' and 'dependence' of Marijuana), '***Onset'*** ('early onset': before 10-18 years and ‘Late onset’: after 18 - 30 years of marijuana user), and non user group (control group); to capture the developing age (Hurlock, 1976). Age group for Youth is differently used by different organisation that United Nation defined youth as “people between 15 and 24 years of age” (UNO, 2002), 10-24 years for World Health Organization (WHO, 2014). However, each region might have specific definition of youth according to their convenient. Under each cell of the five-cells of the main design (2 levels of disorder, 2 onsets and a control group), an equal proportion of Manipuri males, 40 in each were included for psychological evaluation in the study.

The present study entitled “Cognitive Deficiency among Marijuana Users in Manipur: A Psychological Study” was designed to investigate the difference between the two ‘Level of disorder (“abuse’ and ‘dependence’ of Marijuana), two ‘Onset’ (‘early onset’ and ‘late onset’ of Marijuana user) in comparison with a control group on their general health and cognitive abilities (cognitive abilities: Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory). Extraneous variables like educational qualification, socio- economic status and profession were carefully listed under Demographic profile that was employed for screening of the samples to meet the objectives of the study.

To meet the objectives of the research scheme, as envisioned in the foregoing research, correlation design between five groups consisting of early onset abuse, late onset abuse, early onset dependence, late onset dependence of Marijuana users and non-users (controlled) group, was proposed. In essence, the overall considerations of the experimental design may be diagrammatically presented as follows:

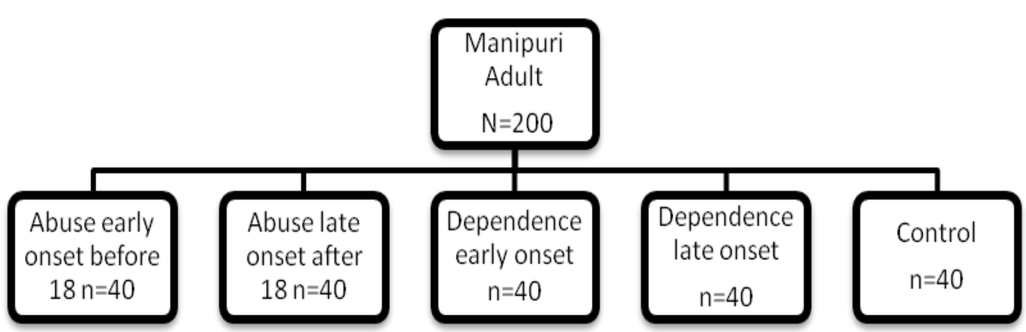


Figure- I: Between group Design for the studied groups.

Psychological tools used:

To meet the objectives of the present study, the researcher had employed the following psychological tools which are mentioned below:

1. General Health Questionnaire (GHQ-12: David Goldberg and Paul Williams 1988): Since Goldberg introduced the General Health Questionnaire (GHQ), it has been translated into 38 different languages, testament to the validity and reliability of the questionnaire (Goldberg DP, *et al*. 1978).It is a screening device for identifying minor psychiatric disorder. Reliability coefficients have ranged from 0.78 to 0.95 in various studies. The GHQ-12 contained three factor structures, namely psychological distress, social and emotional dysfunction and cognitive disorder. The GHQ-12 is a useful instrument to be used for assessing the overall psychological well-being. GHQ had been recommended as a reliable screening instrument for psychological distress in all clinical groups. The highest possible score is 12. It has 4 point scoring system that ranges from much less than usual, same as usual, more than usual and much more than usual. The possible method for scoring the questionnaire: GHQ scoring (0-0-1-1). This method is advocated by the test author. The normal range score is less than 2 or exact 2. This scale may be employed for screening the Physical health condition and minor psychiatric disorder to validate the psychiatric/mental disorders of the samples. Higher scores shows higher problem in physical and mental health.

2. Alexander Pass Along Test (Alexander 1932): This test was developed by Alexander for measurement of the intelligence. The (1958) revision of this scale included the Koh's Block Design and Cube Construction, and called the test as Diagnostic performance tests. Alexander Pass Along test consists of nine sub-tests. It was used to screen the intelligent levels of the subject as it is applicable to both.

3. NIMHANS Neuropsychology Battery (Rao, Subbakrishna and Gopukumar, 2004): Neuropsychological assessment is a clinical examination of both working brain and dysfunctional brain.The objective of neuropsychological assessment is to chart the deficits and adequacies in the behaviour of patients. It is explained by underlying cognitive, emotional, and volitional deficits as well as changes in the personality of the patient. The outcome of a neuropsychological assessment is a profile of the patient's deficits and adequacies.

Behaviour is an outcome of the interaction of the brain with the environment. A composite of multiple psychological processes shape behaviour. The chief domains of the psychological processes are cognition, emotion, and volition. The objective of neuropsychological assessment is to identify the disturbed psychological domain /process /component, which could be giving rise to the behavioural disruption. The first goal is to identify the disrupted psychological components in an individual patient and arrive at a profile of adequacies and deficits of psychological functions. The second goal is to identify the brain structures/ functional networks, which are dysfunctional or damaged using the neuropsychological profile that has previously been derived. Finally this information is used to lateralize and localize the brain lesion.Neuropsychological tests are aids in the neuro psychological examination. The level of difficulty is not high, as the goal of the testing is to identify a deficit in functioning and not to test the limits of the top end of performance. These are the test that should have adequate reliability and validity, the scoring should be objective, and the test should have adequate normative data.

Ideometric approach and psychometric approach are the two methods that are used in the identification of deficits in neuropsychological tests. Ideometric approach is suitable for a clinical examination requiring in-depth examination of the individual patients. On the other hand, the psychometric approach takes a "here" and "now" view. It interprets objective scores with reference to normative data, without taking into account previous history or current functioning in other areas. While the first is used in a clinical examination that takes into account the background of the patient, the second is used in an examination of abilities and aptitudes of the patient irrespective of his or her background. Performance on neuropsychological tests is influenced by socio-demographic variables such as age, education, and the test-taking attitude of the population. These tests cannot be used in our country without being modified. For instance, some words used in a test may have to be changed, as they may not carry meaning to our population.

The NIMHANS Battery consist 19 tests in all, but to measure the above neuropsychological domains and its function, from the General Neuropsychology Battery Tests only the tests constructed for Literate will be administered in accordance with the design of the proposed study. The selected tests are: ***General Neuropsychology Battery Tests For (Literate Subjects):(1) Finger Tapping Test(for motor speed), (2) Digit Symbol Substitution Test (mental speed), (3) Digit Vigilance Test (sustain attention), (4) Animal Names Test (category fluency), (5) N Back Test (Verbal) for working memory (6) Tower of London Test for planning, (7) Wisconsin Card Sorting Test (WCST) for set shifting ability., (8) Stroop Test for response inhibition, (9) Token Test for verbal comprehension, (10) Auditory Verbal Learning Test (AVLT) for verbal immediate recall (11) Complex Figure Test (CFT) for visual immediate recall.***

NIMHANS Battery description:

(I) Motor speed (Finger Tapping Test; Spreen & Strauss, 1998): It measures the speed with which the index finger of each hand can tap. It consists of a tapping key mounted on a box. The box consists of a platform 10 cms wide and 25 cms long. On one end of the platform an electronic counter is mounted. This counter is connected to a tapping key on the other end of the platform. The key is placed in an elevated position on the platform.

The subject is given a total of 5 trials lasting 10 seconds each. Three such consecutive trails are followed by a brief rest pause of 30 seconds. After the pause 2 more trails are given for the same hand. A similar procedure is followed for the other hand. The subject is instructed to tap the key as fast as they can without moving either body or shoulder.

(II) Mental speed (Digit Symbol Substitution Test; Wechsler, 1981): Is a test of visual motor coordination, motor persistence, sustained attention and response speed. The test consists of a sheet in which numbers 1-9 are randomly arranged in 4 rows of 25 squares each. The subject substitutes each number with a symbol using a number-symbol key given on the top of the page. The first ten squares are for practice. The test sheet is placed in front of the subject. The principle of substituting symbols for digits is explained. Practice is given for the first ten squares after which the test commences.

(III) Sustained attention (Digit Vigilance Test; Lezak, 1995): It consists of numbers 1-9 randomly ordered and placed in rows on a page. There are 30 digits per row and 50 rows on the sheet. The subject has to focus on the target digits i.e. 6 and 9 amongst other distracter digits. Inability to sustain and focus attention leads to both increased time to complete the test as well as errors.The subject is asked to scan the sheet and cancel the target numbers 6 and 9 (by drawing a / mark on them). The subject is asked to cancel the digits as fast as possible without missing the targets or canceling wrong numbers.

(IV) Category fluency (Animal Names Test; Lezak, 1995): It is the content of the words, rather than the phonetic similarity of the words, that is regulated. The subject generates words, which belong to a particular semantic category, names of animals for one minute.The subject is asked to generate the names of as many animals as possible in one minute. They are asked to exclude the names of fish, birds and snakes. The number of names generated forms the scorers.

(V) Verbal Working Memory (Verbal N Back Test; Smith & JonideS, 1999): The 1 back and 2 back versions of the N back test were used. The 1 back version requires verbal storage and rehearsal, while the 2 back version requires, in addition to the above, manipulation of information. Thirty randomly ordered consonants common to multiple Indian languages are presented auditory at the rate of one per second. Nine of the 30 consonants are repeated. In the 1 back test the subject responds whenever a consonant is repeated consecutively. In the 2 back test the subject responds whenever a consonant is repeated after an intervening consonant.

(VI) Planning (Tower of London Test; Shallice, 1982): The test evaluates the subject's ability to plan and anticipate the results of their actions to achieve a predetermined goal. The test consists of two identical wooden boards. Each board measured 38 cms long and 13 cms wide. Each board is fitted with 3 round pegs of different sizes. The first peg is 18 cms in height, the second is 11 cms in height and the third is 7 cms in height. There are three wooden balls, painted red, green and blue respectively. Each ball has a bore in the middle. The tallest peg can hold 3 balls. The second tallest can hold two balls, while the shortest can hold one ball.The test has a total of 12 problems. The first 2 problems can be solved with 2 moves. The next 4 problems can be solved with 3 moves. The next 4 problems can be solved with 4 moves and the last 4 problems with 5 moves. Every time the subject picks up a ball it is define as a move. It is emphasized that the subject should plan before lifting the ball. The subject is presented with a goal state of the arrangement of the 3 balls on one of the boards, which is placed near the examiner. The arrangement of the balls in the other board is the initial state. This board is placed near the subject. The subject has to arrive at the goal state in the board placed on his side.

(VII) Set Shifting Ability (Wisconsin Card Sorting Test; Milner, 1963): This test examines concept formation, abstract reasoning and the ability to shift cognitive strategies in response to changing environments. The test has a pack of 128 cards consists of two sets of 64 cards each. Each card is a square of dimensions 8 cms by 8 cms. Stimuli of various forms are printed on the cards. The stimuli vary in terms of three attribute: colour, form and number. The stimuli are geometrical figures of different forms (triangle, star, cross, circle), in different colours (red, green, yellow, blue) and in different number (one, two, three, four), which are presented on each card. There are 4 stimulus cards. Out of those four stimulus cards, the first card consists of 1 red triangle, the second consists of 2 green stars, the third consists of 3 yellow crosses and the fourth consists of 4 blue circles.

The four stimulus cards are placed in front of the subject. The stimulus card with 1 red triangle is placed on the left side of the subject. Next to is the card with 2 green stars, followed by the card with 3 yellow crosses and finally, on the extreme right, is the card with blue circles. The deck of the cards is arranged according to the sequence of presentation in the test manual and is placed to the left of the subject. The subject is instructed to study the cards and match each successive card from the pack to one of the four stimulus cards. The subject is told only whether each response is right or wrong and is never told the correct sorting principle. The subject has to guess the concept based on the examiner's feedback and continue with the test. Each time the subject places a card, if it is according to the principle of sorting in operation at the time, the examiner puts a number on the scoring form starting from 1. The numbers are put in serial order for consecutive correct responses. After the subject places 10 consecutive cards correctly, the tester changes the concept without the subject's knowledge. The subject's capacity to form a mental set is measured by how quickly subject attains the concept and retains it for 10 consecutive trails. The subject's capacity to perceive a change in the concept when the next sorting principle is introduced is a measured of the set shifting ability. The test is terminated after the subject attains all the 6 concepts or after all the 128 cards have been used. The first principle of matching is by colour, followed by form, and finally by number. Then the same sequence is repeated again.

(VIII) Response Inhibition (StroopTest; Aalexander Benson & Stuss, 1989): Response inhibition measures the ease with which a perceptual set can be shifted both to conjoin changing demands and by suppressing a habitual response in favour of an unusual one. The colour names "Blue", "Green", "Red", and "Yellow" are printed in capital letters on a paper. The colour of the print occasionally corresponds with the colours designated by the word. The words are printed in 16 rows and 11 columns. The subject is asked to read the stimuli column- wise as fast as possible. The time taken to read all the 11 columns is noted down. Next, the subject is asked to name the colour in which the word is printed. This time also the subject proceeds column wise. The time taken to name all the colours is noted down.

(IX) Verbal Comprehension (Token Test; DE RenzI & Vignolo, 1962): Is a test measure of verbal comprehension. It involves tokens differing in colour, size and shape. The test involves the capacity to follow spoken commands of varying complexity. Squares and circles of two sizes in 5 colours, called as tokens, are placed in front of the subject. The task of the subject is to follow the spoken instruction of the examiner. There are 6 levels of instructions, which increase gradually in difficulty as the test progresses. The order of placing tokens is fixed. If the level involves only large tokens, the circles are placed in a first row nearest to the tester, while the squares are placed in second row beneath it. If the level involves both the large and the small tokens, the large circles are placed in the first row, the large squares in the second row, and the small circles in the third row and the small squares in the last row. The positions of the tokens are the same across all the level. In each level instruction is given once for each item. If the subject does not understand it or does not follow the command correctly, the instruction is repeated. After two such repetitions the trial is considered a failure and the next trail is commenced.

(X) Verbal immediate recall (Rey's Auditory Verbal Learning Test; Schmidt, 1996): Adapted for different cultures by WHO (Maj, *et al.1994*) was adapted to suit conditions in India. It consists of words designating familiar objects like vehicles, tools, animals and body parts. There are two lists A and B, with 15 different words in each list. The words were translated into the four Indian languages of Kannada, Tamil, Telugu and Hindi. Words in List A are presented at the rate of one word per second during 5 successive trials. The words are presented in the same order in every trial. In each trail, after the presentation the subject is asked to recall the words but not cues are given. After the completion of all the five trials of List A, words in List B are presented once and an immediate recall is taken for the same. This is followed by the immediate recall of words from List A. After a delay of 20 minutes, words from List A are again recalled to form the delayed recall score. Following delayed recall, recognition of the words in List A is tested. The words in List A are randomly mixed with 15 new words. The words are called out one at a time and the subject indicates whether each word belonged to List A or not. Hits and errors are recorded.

(XI) Visual immediate recall (Complex Figure Test; Mayers & Meyers, 1995): This ability is the capacity to translate a visually perceived form into a three dimensional object or a two dimensional figure. The test consists of a complex design which is abstract in nature and cannot be named easily. It has an overall structure and multiple subcomponents within it. An 8.5 inch by 11 inch card containing the complex figure is placed in front of the subject. A paper of same size of the complex figure card is placed in front of the subject. The subject has to copy the figure on the paper. The subject is not allowed to use rulers to draw lines, but rather has to draw it freehand. An eraser may be used. The subject is asked to recall the figure twice: the first time is an immediate recall three minutes after the copying is completed, and the second time is delayed recall 30 minutes later.

4. Diagnostic Criteria for Cannabis Abuser and Dependence: (DSM IV TR; American Psychiatrist Association, 2005). The DSM IV TR contained the diagnostic criteria for Cannabis Abuse and Dependence, and with the help of those criteria the Manipuri Marijuana user can be classified into Abuse and Dependence of marijuana to serve as samples in the present study.

5. Demographic Profiles: The background information of the participants such as age, birth order, educational qualifications, employment status of the parents, the family structure (nuclear and joint), size of the family, amount of consumption in a day, onset of first intake, how he starts, and all other necessary information to be included looking the objective of the study, and to obtain true representative samples as per designed of the present study, and so on which will supplement and also cross validation of the information.

Procedure:

The selected psychological measure of the General Health Questionnaire (GHQ-12: David Goldberg and Paul Williams 1988 was originally in English, which was translated into Manipuri language as the participants mostly speak in Manipuri and then back to English language to confirm the reliability of the translated scale. The original and translated psychological tests were compared by three language experts who were both well verse with English and Manipuri, they accepted as not losing the originality. Through pilot study the translated scales were confirmed to be reliable at (.81) for the study. Even though the reliability of the translated scales was previously proved reliable in the same population, it was administered again to confirm the reliability.

Firstly, the researcher obtained the necessary consents, rapport and careful instructions were given to the subjects for completing the psychological measurements. The demographic sheets were distributed to each subject with assured confidentiality. Then the researcher asked the subjects to fill up the demographic profile then only administered the psychological measurements to those participants. Each testing session lasted for approximately two hour.

The subjects were ensured regarding the confidentiality of their response patterns and requested to respond unanimously. After successful completion of all psychological measurements, scoring were done separately for two 'Level of disorder ("abuse' and dependence' of Marijuana), two 'Onset' ('early onset' and 'Late onset' of Marijuana user) in comparison with a control group, and were subjected to close examination for inferential conclusions of the findings.

The participants were tested in individual session in the presence of the researcher. After completion of the test, the researcher carefully checked the response sheets and rejected those data that are incomplete and those that highly differed from other participants. Finally, after screening the responses of large participants, 200 participants were selected for analysis.

Statistical Analysis:

Keeping in view of the problems of the study, the methodological refinements were done in a step-wise manner. Firstly, the preliminary psychometric analysis of the GHQ 12 on the sampled equated and/or matched on the demographic variables included the statistical analysis of psychometric adequacy including: item-total coefficient of correlation, Cronbach alpha and split-half reliability coefficient and inter-scale relationships as the psychological reliability and validity of their proven psychometric adequacy cannot be assumed to carry their psychometric properties when transported and applied in any other cultural setting.

The analysis of the preliminary psychometric analysis subscribes to the admonition of researchers in culture specific and cross-cultural studies: that scale constructed and validated for measurement of theoretical construct in a given population when taken to another cultural milieu may not be treated as reliable and valid unless specific checks are made (Witkin, *et al*. 1975); and that cultural researches employing the derived-etic approach assume that each group that occupies an ecological niche is equivalent to that of the other and the study is free of systematic bias (Pootinga, 1989).

Secondly, correlation design between five groups consisting early onset abuse, late onset abuse, early onset dependence, late onset dependence of Marijuana users and non user (controlled) groups, was proposed with appropriate Post-hoc mean comparison to highlight the independent and interaction effects of the independent variables on the dependent measures.

The Data were collected through experiment, on this count it was not applicable to parametric statistics. Therefore, appropriate Statistical Analysis of data were employed which included Spearman correlation, and post hoc comparision for non parametric, the Steel Dwass Test on these points.

Nonparametric tests are useful for testing whether group means or medians are located the same across groups. However, the usual analysis of variance assumption of normality is not made. Non parametric tests use functions of the response ranks, called rank scores (Hajek, 1969).

The Spearman correlation coefficient is defined as the Pearson correlation coefficient between the ranked variables (Myers, *et al*. 2003).Spearman's correlation coefficient, (ρ, also signified by r_s) measures the strength of association between two ranked variables. It assesses how well the relationship between two variables can be described using a monotonic function. If there are no repeated data values, a perfect Spearman correlation of +1 or −1 occurs when each of the variables is a perfect monotone function of the other.Spearman's coefficient, like any correlation calculation, is appropriate for both continuous and discrete variables, including ordinal variables (Ann Lehman, 2005).

Steel-Dwass test is the nonparametric version of the All Pairs. It is Post hoc multiple comparisons for non parametric data set. As nonparametric tests based on pairwise ranks, Steel (1960) and Dwass (1960) discussed simultaneous tests for the null hypotheses of all-pairwise *{H (ii_)} {1≤i<i_≤k}*. Steel (1959) discussed simultaneous tests for the null hypotheses of control vs. treatments *{H (1i)} {2≤i≤k}*.

Thirdly, Kruskal Wallis of Non parametric analyses was employed for the prediction of the psychological symptoms from the other behavioural measures for clarity and precision.

In statistics, the Kruskal–Wallis one-way analysis of variance by ranks (named after William Kruskal and W. Allen Wallis) is a non-parametric method for testing whether samples originate from the same distribution. It is used for comparing more than two samples that are independent, or not related. The parametric equivalent of the Kruskal-Wallis test is the one-way analysis of variance (ANOVA). When the Kruskal-Wallis test leads to significant results, then at least one of the samples is different from the other samples. The test does not identify where the differences occur or how many differences actually occur. It is an extension of the Mann–Whitney U test to 3 or more groups. The Mann-Whitney would help analyse the specific sample pairs for significant differences.

Since it is a non-parametric method, the Kruskal–Wallis test does not assume a normal distribution of the residuals, unlike the analogous one-way analysis of variance. However, the test does assume an identically shaped and scaled distribution for each group, except for any difference in medians. Kruskal–Wallis is also used when the examined groups are of unequal size (Dancey, *et al*. 2011).

The responses of the subjects were computerized and analysed employing statistical software by following the objectives set forth for this study. The overall analysis of results are presented and discussed in the chapter to follow, Chapter – IV.

CHAPTER-IV

RESULTS AND DISCUSSION

The present study entitled "Cognitive Deficiency among Marijuana Users in Manipur: A Psychological Study" was designed to investigate the difference between the two 'Level of disorder' ('abuse' and 'dependence' of Marijuana), two 'Onset' ('early onset' and 'late onset' of Marijuana user) in comparison with a control group (non user) on their general health and cognitive abilities (cognitive abilities - Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory).

Psychological tools used:

To meet the objectives of the present study, the researcher had employed the following psychological tools,

1) General Health Questionnaire (GHQ-12: David Goldberg and Paul Williams, 1988) was employed for screening the Physical health condition and minor psychiatric disorder to validate the psychiatric/mental disorders of the samples. Higher scores show higher problem in physical and mental health.

2) Alexander Passalong Test (Alexander, 1932) was used to screen the intelligent levels of the subject.

3) NIMHANS Neuropsychology Battery (Rao, Subbakrishna and Gopukumar, 2004) employed to assess the deficits and adequacies in the behaviour of patients. It originally consists of 19 tests, but the sub test specially constructed for Literate subject will be administered in accordance with the design of the proposed study.

The selected sub test of the General Neuropsychology Battery Tests For (Literate Subjects) are:(1) Finger Tapping Test(for motor speed), (2) Digit Symbol Substitution Test (mental speed), (3) Digit Vigilance Test (sustain attention), (4) Animal Names Test (category fluency), (5) N Back Test (Verbal) for working memory, (6) Tower of London Test for planning, (7) Wisconsin Card Sorting Test (WCST)for set shifting ability, (8) Stroop Test for response inhibition, (9) Token Test for verbal comprehension, (10) Auditory Verbal Learning Test for verbal immediate recall, (11) Complex Figure Test (CFT) for visual immediate recall.

4) Diagnostic Criteria for Cannabis Abuse and Dependence**:** (DSM IV TR; American Psychiatrist Association, 2005). The DSM IV TR contained the diagnostic criteria for

Cannabis Abuse and Dependence, and with the help of those criteria the Manipur Marijuana user can be classified into Abuse and Dependence of marijuana to serve as samples in the present study.

Psychometric Properties of the Behavioural Measures

Psychometric analysis of the behavioural measure included the analysis of (i) item-total coefficient of correlation (as an index of internal consistency and item validity) was ascertained for the scales/subscales of the behavioural measures with the criterion of items showing item-total coefficient of correlation ≥.10 for the whole sample to be retained for further analysis, (ii) Reliability coefficients (Cronbach alphas & Split-half)of the specific subscales, (iii) inter-scale relationships (in the instances where there were two or more sub-scales/ sub-factors). Following the broad format of analysis, the psychometric properties of the General Health Questionnaire (GHQ-12: David Goldberg & Paul Williams, 1988), the preliminary psychometric analysis over the level of analysis for each of the specific items and scale determined with the objectives to ensure further statistical analysis, and the results are presented in Table - 1. Results (Tables - 1) show internal consistency and item validity for the whole samples of GHQ.

The preliminary analysis of the psychometric properties of the behavioural measures were computed in view of the fact that scale constructed and validated for measurement of theoretical construct in a given population when taken to another cultural milieu may not be treated as reliable and valid unless specific checks are made (Eysenck & Eysenck, 1985; Witkin, 1975). So, the reliability coefficient (Cronbach Alpha and Spearman Brown coefficient) of the GHQ was .56 of alpha reliability and .57 for Spearman Brown coefficients.

Table – 1: Descriptive statistics for the GHQ 12 behavioural measures internal consistency and item validity for the whole samples.

Variables	Variable	Cronbach Alpha (∝)	Spearman-Brown Coefficient (Split- half)
GHQ	12	.56	.57

Table – 2: Mean and Standard Deviation on Behavioural measures for the whole samples.

Level of disorder	Onset	Statistics	General Health	Intelligence	Motor Speed	Mental Speed	Sustained Attention	Category Fluency	Working Memory	Planning	Set Shifting Ability	Response Inhibition	Comprehension	Verbal Immediate Recall	Visual Immediate Recall
Abuse (n=80)	Early (n=40)	M	0.28	29.33	88.10	2.69	6.28	11.00	13.98	9.40	4.43	1.20	35.58	12.60	24.75
		SD	0.45	2.68	4.19	65.16	110.57	2.45	1.21	1.77	1.62	46.06	0.50	1.45	3.42
	Late (n=40)	M	0.08	29.20	88.30	2.11	4.85	14.05	14.90	10.43	4.65	1.11	35.90	13.45	28.28
		SD	0.27	2.11	2.55	56.46	83.81	2.15	0.96	1.60	1.75	28.24	0.30	1.15	3.36
Dependence (n=80)	Early (n=40)	M	0.60	28.43	87.73	2.88	6.47	9.73	13.25	8.48	2.33	1.56	35.45	11.25	17.00
		SD	0.55	3.03	5.72	77.95	141.80	2.71	1.21	1.69	1.51	52.73	0.60	2.16	3.17
	Late (n=40)	M	0.30	29.05	90.18	2.52	5.81	11.43	13.40	9.60	4.10	1.13	35.60	12.30	23.95
		SD	0.46	2.85	6.06	71.43	101.13	2.64	1.61	1.53	1.75	42.60	0.50	1.92	3.44
Control (N=40)		M	0.05	31.00	91.75	1.59	4.56	15.13	15.60	10.30	5.83	1.09	35.95	14.38	28.70
		SD	0.22	2.16	8.25	27.94	75.83	1.52	0.63	1.29	0.50	25.80	0.22	0.87	2.86
Total User (n=160)	Early onset (n=80)	M	0.44	28.88	87.91	2.97	6.38	10.36	13.61	8.94	3.38	1.38	35.51	11.93	20.88
	Late onset (n=80)	M	0.19	29.13	89.24	2.32	5.33	12.74	14.15	10.01	4.38	1.12	35.75	12.88	26.11
	Abuse (n=80)	M	0.18	29.26	88.20	2.40	5.56	12.53	14.44	9.91	4.54	1.16	35.74	13.03	26.51
	Dependence (n=80)	M	0.45	28.74	88.95	2.70	6.14	10.58	13.33	9.04	3.21	1.34	35.53	11.78	20.48

Table-2: Results on GHQ reveals that Dependence Early Onset group scores (M=.60) as the highest, higher than comparision group on general health which indicate dependence with early onset were more disturbed concerning their general health compared with other groups whereas Control group scores (M=.05) lowest among the comparision groups that showed they were more sound in Physical and mental health condition. Early onset (M=.44) scores higher than Late onset (M=.19) depicted that early onset had higher effect on general health. Dependence group showed higher means scores than Abuse group. These findings are in conformity with the earlier findings that regular marijuana use and frequency of such use was related to anxiety, depressive symptoms and perceived health among young adult tobacco smokers; that predicted anxiety symptoms and perceived general health, whereas frequency of marijuana use predicted only anxiety symptoms (Marcel O. Bonn-Miller, *et al*. 2005).

Intelligence Test results showed (Table-2) that highest scores were among the Control group (M =31), late onset higher than early onset (M = 29.13; 28.88), Abusers higher than Dependants (M = 29.26; 28.74), which indicate early onset and dependency on marijuana had more deterioration in their intellectual functioning. Control group was more superior in terms of intellectual functioning in comparision with rest of the groups.Wilson and his colleagues also found that the excessive daily doses of cannabis, over a prolonged period of time, result in structural brain changes; age of onset of cannabis use is a critical factor with potentially greater deleterious effects to the brain as it commences during significant periods of neurodevelopment, such as adolescence. Early onset cannabis users (before age 17) were found to have smaller whole brain volumes, lower percent cortical grey matter, higher percent white matter and increased resting cerebral blood flow compared to later onset users (Wilson, *et al*. 2000).

Motor Speed results showed (Table-2) the highest scores on Control group (M =91.75), late onset higher than early onset (M = 89.24; 87.91), Dependants higher than abusers (M = 88.95; 88.20), which indicate early onset , abusers and dependency had greater effect on motor speed among samples as it slow down processing of information in the brain. Hunault and colleagues (2009) also found THC to significantly decrease response time and increase errors in a dose-dependent manner in heavy cannabis users on a motor control task.

Mental Speed results showed (Table-2) that the highest scores were reflected on early onset dependence group (M =2.88), early onset higher than late onset (M = 2.97; 2.32), Dependants higher than Abusers (M = 2.70; 2.40), which indicate early onset and dependence had lower mental speed among samples they took longer time duration in completing the given mental task. Earlier studies also found marijuana users display significantly slowed information-processing speeds (longer ITs) compared to controls. Paradoxically, this deficit appears to be normalized whilst users are in the acute state (Kelleher, 2004).

Sustained Attention results showed (Table-2) that the highest scores were among early onset dependence group (M =6.47), early onset higher than late onset (M = 6.38; 5.33), Dependants higher than Abusers (M =6.14; 5.56), which indicate early onset and dependence took more time on completing the given task. They had lower sustained attention among samples. Regular cannabis users differed significantly from non-regular users on test of sustained attention with working memory component errors (Harvey, *et al*. 2007). Cannabis users had difficulties on focused attention on complex tasks (Lundqvist, 2005).

C**ategory Fluency** results showed (Table-2) that highest scores in control group (M =15.13), late onset higher than early onset (M = 12.74; 10.36), Abusers higher than Dependants (M = 12.53; 10.58), which indicate early onset and dependency had high effects on categorical fluency among samples as early onset and dependence had difficulty in generating words of same semantic category.The results are in accordance with the finding of Pope, *et al*. (2002) who examined verbal fluency differences between two groups based on age of onset (early and late) that early onset cannabis users (who began smoking before 17 years of age) demonstrated significant impairments in verbal fluency compared with controls. This suggested that age of onset, and possibly years of use, mediates the impact of the long-term effects of cannabis on verbal fluency.

Working Memory (one and two back hit) which indicate dependence with early onset had difficulty in both verbal storage and rehearsal and manipulation of information in comparison with other groups. Control group were more capable of verbal storage, rehearsal and manipulation of ongoing information from rest of the groups.Results revealed (Table-2) that highest scores among control group (M =15.60), late onset higher than early onset (M = 14.15; 13.61), Abusers higher than Dependants (M = 14.44; 13.33), which indicate early onset and dependency had high effects on Working memory among samples supporting the earlier finding that cannabis neurologic effects of acute intoxication with cannabis include behavior changes, impaired memory, hyperphagia, in coordination, and possibly psychosis; that chronic neurologic problems associated with long- term use include *memory impairment* in patients whose heavy use started before age 17 years.(Robert D. Davies, *et al*. 2004).

P**lanning** results showed (Table-2) that highest scores in late onset abuse group (M =10.43), late onset higher than early onset (M = 10.01; 8, 94), Abusers higher than Dependants (M = 9.91; 9.04), which indicate early onset and dependence had high effects on planning ability among samples. It indicates that dependency and early onset had difficulty on planning and anticipating achieving a predetermined goal in comparison with other groups whereas late onset abuse performed slightly better than control group. They were good in indentifying and organizing of the steps and elements needed to carry out an intention or achieve a goal from rest of the groups (Lezak, 1995).

Set Shifting Ability (Number of categories completed) which indicates dependence with early onset had difficulty in concept formation, abstract reasoning and ability to shift cognitive strategies in comparison with other groups. Results showed (Table-2) that highest scores in control group (M =5.83), late onset higher than early onset (M = 4.38; 3.38), Abusers higher than Dependants (M = 4.54; 3.21), which indicate early onset and dependency had high effects on set shifting ability among samples. It conform with the earlier finding that a range of cognitive functions, encompassing attention, memory, executive and inhibitory processes are impaired during both the acute intoxication period and following long term use of cannabis (Castle, *et al*. 2011).

R**esponse Inhibition** results showed (Table-2) that highest scores in early dependence group (M =1.56), early onset higher than late onset (M = 1.38; 1.12), Dependants higher than Abusers (M = 1.34; 1.16), which indicate early onset and dependency hampered response inhibition ability among samples. They have high response inhibition in comparison with other groups. (Stroop Effect) It indicates dependence with early onset had difficulty in shifting perceptual set to conjoin changing demands and by suppressing a habitual response in favour of an unusual one. Control group was more ease in changing demands according to situation from rest of the groups. Cannabis induces loss of internal control and cognitive impairment, decreased mental flexibility, increased perseveration, and reduced learning, to shift and/or sustain attention (Karen, *et al*. 2005). Some studies reported among recently abstinent adolescent cannabis users, regular and non-regular users showed no difference in inhibition or psychomotor control (Harvey, *et al*. 2007). After 28 days of abstinence, adolescent cannabis users demonstrated intact inhibition and motor impulsivity (Tapert, *et al*. 2007).

V**erbal Comprehensions** results depicted (Table-2) that highest scores in control group (M =35.95), late onset higher than early onset (M = 35.75; 35.51), Abusers higher than Dependants (M = 35.74; 35.53), which indicate early onset and dependency impede verbal comprehension ability among samples. Children of cannabis users scored more poorly included parental ratings of behaviour problems, visual-perceptual tasks, language comprehension, and distractibility (Colleen, *et al*. 1991).

V**erbal Immediate Recall** results illustrated (Table-2) that highest scores in control group (M =14.38), late onset higher than early onset (M = 12.88; 11.93), Abusers higher than Dependants (M = 13.03; 11.78), which point out early onset and dependency slow down verbal learning among samples. Dependency and early onset had difficulty in learning and remembering verbal material. Control group can recalled more words comparing with rest of the groups. Results was in conformity with the other findings that Cannabinoid (CB1) receptors occur in high density in brain regions critically involved in memory functions and cannabinoids profoundly affect synaptic plasticity underlying learning and memory (Alger, 2005) disrupting long-term potentiation in the hippocampus (Chevaleyre, 2006).

Visual Immediate Recall results depicted (Table-2) that highest scores in control group (M =28.70), late onset higher than early onset (M = 26.11; 20.88), Abusers higher than Dependants (M = 26.51; 20.48), which indicate early onset and dependency had negative impact on visual delayed recall among samples. The findings has confirmatory findings, that early onset and dependence had difficulty on visual memory (Ranganathan and D'Souza, 2006) found in their review that acute administration of cannabis impairs immediate and delayed free recall of information. Even a single exposure abolishes retrograde signalling (Mato, *et al*. 2004) and can induce lasting deficits in spatial learning and memory in mice 3-4 weeks and 4 months after exposure (Tselnicker, *et al*. 2007).

Figure- 2: Mean of early and late onset on all dependent variables.

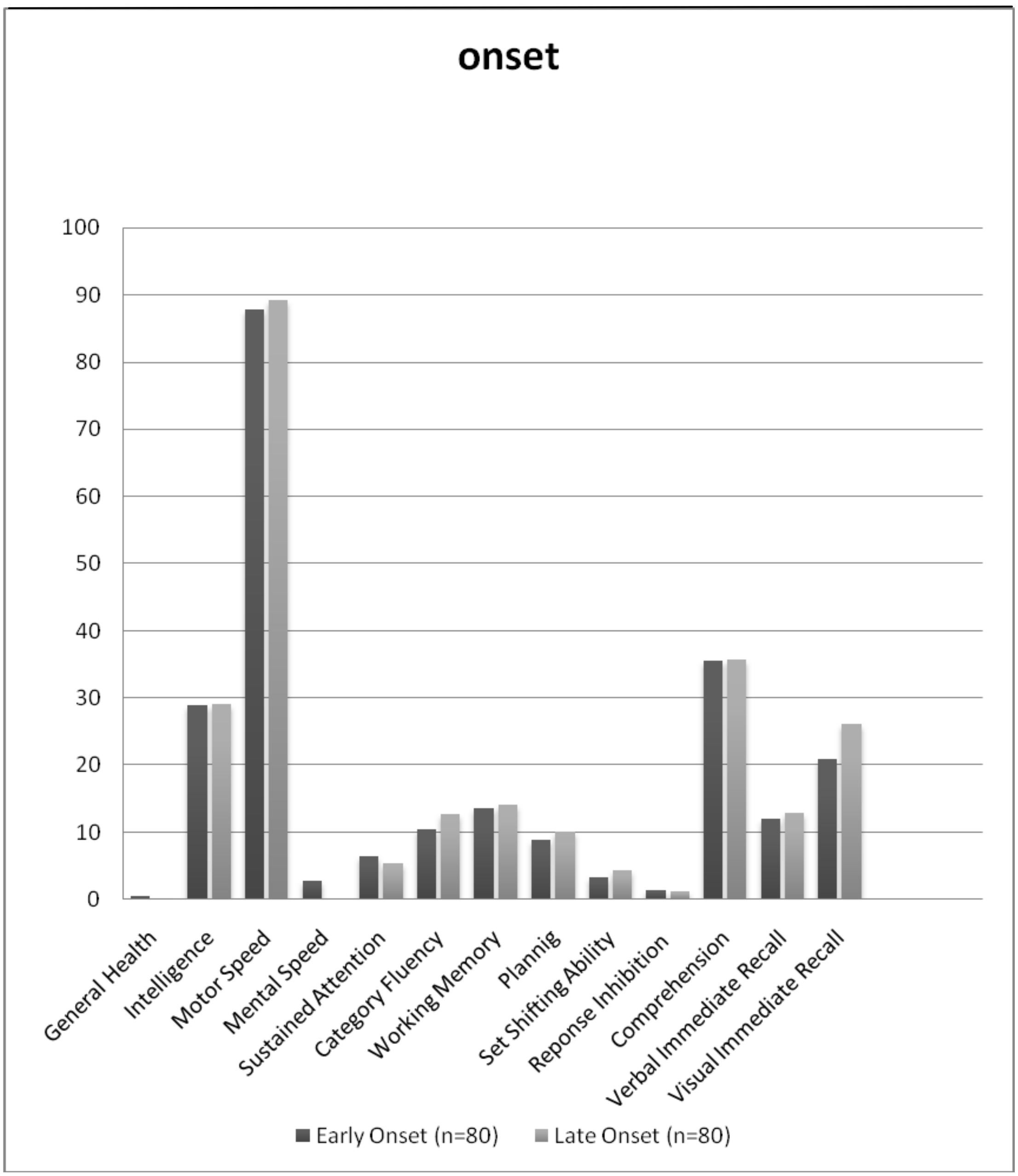
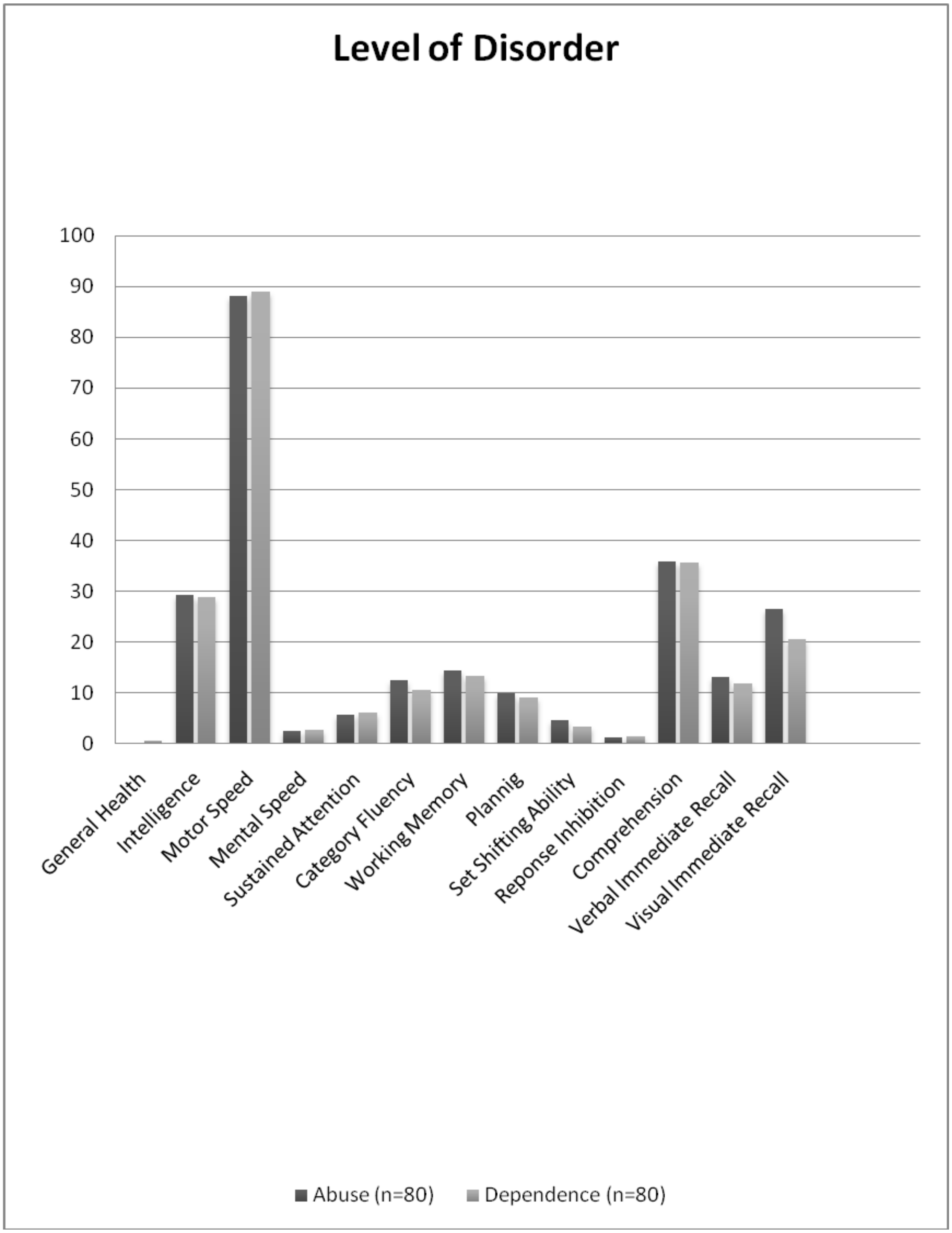


Figure- 3: Mean of level of disorder on all dependent variables.



Bivariate Relationships between the Behavioural Measures

The bivariate relationship between the scales of the behavioural measures were computed (Table - 3) and it indicated the difference between the two ‘Level of disorder (‘abuse’ and dependence’ of Marijuana), two ‘Onset’ (‘early onset’ and ‘late onset’ of Marijuana user) in comparison with a control group (non user) on their general health and cognitive abilities (cognitive abilities - Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory).

The results on Table -3 revealed that there were significant relationships amongst the scales/subscales of the behavioural measures. As shown on the table, bivariate correlation (Spearman’s correlation) between dependent variables for the whole samples was computed by employing Statistical Packages for Social Sciences to depict significant positive and negative significant relationship between dependent variables. Though the correlation does not explain the cause and effect between variables but gives hint for possible reasons of further analysis.

Table-3: Correlation matrix of the behavioural measures (Spearman Correlation) for the whole samples.

Dependent variables statistics	General Health	Intelligence	Motor Speed	Mental Speed	Sustained Attention	Category Fluency	Working Memory	Planning	Set Shifting Ability	Response Inhibition	Comprehension	Verbal Immediate Recall	Visual Immediate Recall
General Health	1	-0.10	-0.06	0.26**	0.30**	-0.32**	-0.23**	-0.18**	-0.28**	0.18*	-0.30**	-0.32**	-0.38**
Intelligence		1	0.04	-0.29**	-0.22**	0.24**	0.28**	0.21**	0.17*	-0.17*	0.14	0.27**	0.28**
Motor Speed			1	-0.01	-0.03	0.13	0.12	0.03	0.10	0.05	0.18**	0.09	0.10
Mental Speed				1	0.69**	-0.44**	-0.54**	-0.25**	-0.46**	0.32**	-0.35**	-0.58**	-0.54**
Sustained Attention					1	-0.53**	-0.46**	-0.25**	-0.36**	0.31**	-0.37**	-0.46**	-0.52**
Category Fluency						1	0.45**	0.30**	0.42**	-0.31**	0.40**	0.55**	0.56**
Working Memory							1	0.29**	0.33**	-0.25**	0.36**	0.52**	0.54**
Planning								1	0.27**	-0.19**	0.16*	0.24**	0.35**
Set Shifting Ability									1	-0.28**	0.20**	0.43**	0..55**
Response Inhibition										1	-0.11	-0.27**	-0.37**
Comprehension											1	0.39**	0.28**
Verbal Immediate Recall												1	0.58**
Visual Immediate Recall													1

** Correlation is Significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Results of the relationship between the selected dependent variables for the whole samples are presented below:

General Health showed positive significant relationship with mental speed (r= 0.26**), sustained attention (r= 0.30**) and response inhibition (r= 0.18*)whereas negative significant relationship with category fluency (r= -0.32**), working memory (r= -0.23**), planning (r= -0.18**), set shifting ability (r= -0.28**), comprehension (r= -0.30**), verbal immediate recall (r= -0.32**) and visual immediate recall (r= -0.38**). Majority of studies have suggested a significant cognitive decline in cannabis abusers compared to non-abusers and healthy controls (Solowij, 1988).

Intelligence had positive significant relationship with category fluency (r= 0.24**), working memory (r= 0.28 **), planning (r= 0.21**), set shifting ability (r= 0.17*), verbal immediate recall (r=0.27**) and visual immediate recall (r= 0.28**). Whereas negative significant relationship with mental speed (r= -0.29*), sustained attention (r= -0.22**) and response inhibition (r= -0.17**). Pope and colleagues (2001) highlighted IQ differences: is possible that neurocognitive deficits in cannabis users with lower IQ may also be less amenable to recovery following prolonged abstinence. Deficits have been shown to increase as a function of frequency, duration, dose and age of onset of cannabis use, but the precise parameters of cannabis use that result in memory deficits remain to determine.This is also in line with our findings of structural brain alterations in excessively heavy users (albeit in much older users) and earlier starter showing greater cognitive impairment in lower IQ users (Solowij and Michie, 2007).

Motor Speed showed positive significant relationship with comprehension (r= 0.18**). Ramaekers and colleagues (2009) also found THC administration impaired psychomotor control in occasional cannabis users, but not in heavy cannabis users, suggesting a potential tolerance effect.

Mental Speed had positive significant relationship with sustained attention (r= 0.69**) and response inhibition (r= 0.32**) whereas negative significant relationship with category fluency (r= -0.44**), working memory (r= -0.54**), planning (r= -0.25**), set shifting ability (r= -0.46**), comprehension (r= -0.35**), verbal immediate recall (r= -0.58**) and visual immediate recall (r= -0.54**). Hunault and colleagues (2009) also found THC to significantly decrease response time and increase errors in a dose-dependent manner in heavy cannabis users on a motor control task.

Sustained Attention had positive significant relationship with response inhibition (r= 0.31**) whereas negative significant relationship with category fluency (r= -0.53**), working memory (r= -0.46**), planning (r= -0.25**), set shifting ability (r= -0.36**), comprehension (r= -0.37**), verbal immediate recall (r= -0.46**) and visual immediate recall (r= -0.52**). Harvey and colleagues (2007) investigated attention functions in adolescent cannabis users, and found that regular cannabis users differed significantly from non-regular users on sustained attention with working memory component errors

Category Fluency had positive significant relationship with working memory (r= 0.45**), planning (r= 0.30**), set shifting ability (r= 0.42**), comprehension (r= 0.40**), verbal immediate recall (r= 0.55**) and visual immediate recall (r= 0.56**). Whereas negative significant relationship with response inhibition (r= -0.31**). Cannabis exhibits a spontaneous flexibility that requires a ready flow of ideas and answers, often in response to a single constituent (Eslinger and Grattan, 1993).

Working Memory had positive significant relationship with planning (r= 0.29**), set shifting ability (r= 0.33**), comprehension (r= 0.36**), verbal immediate recall (r= 0.52**) and visual immediate recall (r= 0.54**) whereas negative significant relationship with response inhibition (r= -0.25**). Performance deficits found in chronic cannabis users are more likely to be elicited in complex tasks (Solowij, 1998) or tasks with a greater memory load (Jager, 2006).

Planning had positive significant relationships with set shifting ability (r= 0.27**), comprehension (r= 0.16*), verbal immediate recall (r= 0.24**) and visual immediate recall (r= 0.35**) whereas negative significant relationship with response inhibition (r= -0.19**). Rebecca and colleagues (2011) found Cannabis use has been shown to impair cognitive functions such as the ability to plan, organize, solve problems, make decisions, remember, and control emotions and behavior. A mental representation of the task, including the relevant stimulus information encoded into memory and the desired future goal state (Pennington and Ozonoff, 1996).

Set Shifting Ability had positive significant relationships with comprehension (r= 0.20**), verbal immediate recall (r= 0.43**) and visual immediate recall (r= 0.55**) whereas negative significant relationship with response inhibition (r= -0.28**). Heavy users displayed significantly greater impairment than light users on attentional/executive functions, as evidenced particularly by greater perseverations on card sorting and reduced learning of word lists (pope, 1996).

Response Inhibition had negative significant relationship with verbal immediate recall (r= -0.27**) and visual immediate recall (r= -0.37**). In recently abstinent adult cannabis users showed impairments in inhibition and motor impulsivity (Battisti, *et al*. 2010).

Comprehension had positive significant relationships with verbal immediate recall (r= 0.39**) and visual immediate recall (r= 0.28**). Children of cannabis users scored more poorly including parental ratings of behaviour problems, visual-perceptual tasks, language comprehension, and distractibility (Colleen, *et al*. 1991).

Verbal Immediate Recall had positive significant relationships with visual immediate recall (r= 0.58**). Ranganathan and D'Souza (2006) reported that the most consistent deficits are found on measures of immediate and delayed of wordlists, prose, and nonverbal stimuli but no differences in recall for information learned prior to intoxication.

The Post hoc multiple comparision of non parametric statistics (equivalent to Scheffe Test of parametric statistic) Steel Dwass Test is a popular form of simultaneous nonparametric inference in the one-way layout for all pair wise comparison (Dwass, 1960, Hollander and Wolf, 1999; Steel, 1960). It requires the calculation of the ranks for each combination of treatments.

GHQ: The data on general health which was collected by using GHQ 12 does not fulfill parametric statistic assumption and required nonparametric statistic of Post Hoc multiple comparision of Steel Dwass Test, results are presented in Table –4.1.

Table- 4.1: Post-Hoc multiple comparisons of Steel Dwass Test on General Health Questionnaire for all five groups.

General Health Questionnaire			Abuse Early Onset	Abuse Late Onset	Dependence Early Onset	Dependence Late Onset	Control
Total Score	**Abuse**	**Early Onset**	X	2.34	-2.75*	-0.25	3.55**
		Late Onset		X	-4.75**	-2.56	1.75
	Dependence	**Early Onset**			X	2.52	5.63**
		Late Onset				X	3.73**
	Control						X

Results (Table -4.1) revealed early onset abuse had negative significant (sig.) difference with early onset dependence (-2.75: < .05 level), and positive sig. difference with control group (3.55 :< .01 level). Late onset abuse showed negative sig. difference with early onset dependence (- 4.75: < .01 level), early onset dependence had positive sig. with control group (5.63: < .01 level) and late onset dependence also had positive sig. difference with control group (3.73: < .01 level).Neuropsychological deficits and differences in brain functioning are most consistently observed only among frequent, heavy users, who are those most likely addicted to cannabis. The dire impact of drug addiction on a person's life and everyday functioning suggests that the large number of individuals addicted to cannabis experience substantial negative effects from its use (Raul Gonzalez , 2007).

Intelligence: The data on intelligence which was collected by using Alexander Pass Along Test required nonparametric statistic of Post Hoc mutiple comparision of Steel Dwass test, the results are presented in Table -4.2.

Table- 4.2: Post-Hoc multiple comparisons of Steel Dwass Test on intelligence (Alexander Pass Along Test) for five comparision groups.

Alexander Pass Along Test			Abuse Early Onset	Abuse Late Onset	Dependence Early Onset	Dependence Late Onset	Control
Raw Scores	**Abuse**	**Early Onset**	X	-0.46	1.54	0.27	-3.63**
		Late Onset		X	1.89	0.59	-3.22*
	Dependence	**Early Onset**			X	-1.29	-4.35**
		Late Onset				X	-3.27**
	Control						X

Steel Dwass Test results (Table -4.2) revealed early onset abuse had negative significant (sig.) difference with control group (-3.63: P<.01 level). Late onset abuse showed negative sig. difference with control group (- 3.22: P< .05 level), early onset dependence had negative sig. with control group (-4.35: P<.01 level) and late onset dependence also had negative sig. difference with control group (-3.27: P<.01 level). It may be that only excessive daily doses of cannabis, over a prolonged period of time, will result in structural brain changes (Wilson, *et al*. 2000). Earlier starter showing greater cognitive impairment in lower IQ users (Solowij and Michie, 2007)

Motor Speed: The data on motor speed which was collected by using Finger Tapping Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table –4.3.

Table- 4.3: Post Hoc multiple comparision of Steel Dwass Test on motor speed (Finger Tapping Test) for all groups.

Finger Tapping Test			Abuse		Dependence		Control
			Early Onset	Late Onset	Early Onset	Late Onset	
Right &Left hand	Abuse	Early Onset	X	-1.10	0.94	-1.62	-2.43
		Late Onset		X	1.69	-1.26	-2.20
	Dependence	Early Onset			X	-1.83	-2.62
		Late Onset				X	-1.13
	Control						X

Steel Dwass Test (Table- 4.3) on Motor speed (Finger Tapping Test) for all groups do not depict any significant effects on all comparision among the groups. Ramaekers and colleagues (2009) also found that THC administration impaired ***psychomotor control*** in occasional cannabis users, but not in heavy cannabis users, suggesting a potential tolerance effect; that that younger brains that the same amount of THC exposure led to decreased working memory performance in adolescent rats while had no effect in adult rats (Quinn, *et al*. 2008).

Mental Speed: The data on mental speed which was collected by using Digit Symbol Substitution Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, result are presented in Table –4.4.

Table- 4.4: Post Hoc multiple comparision of Steel Dwass Test on mental speed (Digit Symbol Substitution Test) between comparision groups.

Digit Symbol Substitution Test			Abuse		Dependence		Control
			Early Onset	Late Onset	Early Onset	Late Onset	
Total Time	Abuse	Early Onset	X	3.96**	-1.06	1.28	6.92**
		Late Onset		X	-4.52**	-2.76*	4.74**
	Dependence	Early Onset			X	2.16	7.00**
		Late Onset				X	6.38**
	Control						X

Results displayed in Table – 4.4 revealed early onset abuse had positive significant (sig.) difference with late abuse and control group (3.96: P< .01 level; 6.92: P< .01 level). Late onset abuse showed negative sig. difference with early and late onset dependence (-4.52: P<.01 level; -2.76: P<. 05 level) and positive sig. difference with control group (4.74: P<.01 level). Early onset dependence had positive sig. difference with control group (7.00: P<.01 level) and late onset dependence also had positive sig. difference with control group (6.38: P<.01 level). Rebecca and colleagues (2011) found Cannabis use has been shown to impair cognitive functions on a number of levels—from basic motor coordination to more complex executive function tasks, such as the ability to plan, organize, solve problems, make decisions, remember, and control emotions and behavior. These deficits differ in severity depending on the quantity, recency, age of onset and duration of marijuana use.

Sustained Attention: The data on sustained attention which was collected by using Digit Vigilance Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table – 4.5.

Table- 4.5: Post Hoc multiple comparision of Steel Dwass Test on sustained attention (Digit Vigilance Test) for all comparision groups.

Digit Vigilance Test			Abuse		Dependence		Control
			Early Onset	Late Onset	Early Onset	Late Onset	
Total Time	Abuse	Early Onset	X	5.36**	-0.22	1.91	6.09**
		Late Onset		X	-5.38**	-4.12**	1.19
	Dependence	Early Onset			X	1.93	6.10**
		Late Onset				X	5.13**
	Control						X

Steel Dwass Test results (Table -4.5) revealed early onset abuse had positive significant (sig.) difference with late onset abuse and control group (5.36: P< .01 level; 6.09: P< .01 levels). Late onset abuse had negative sig. difference with early and late onset dependence (-5.38 :< .01 level; -4.12: P<.01 level). Early onset dependence had positive sig. difference with control group (6.10; P<.01 level) and late onset dependence also had positive sig. difference with control group (5.13: P<.01 level).Marijuana users showed difficulty in information processing and focusing attention on relevant stimuli during selective attention (Solowij, 1995). Harvey and colleagues (2007) investigated attention functions in adolescent cannabis users, and found that regular cannabis users differed significantly from non-regular users on sustained attention with working memory component errors.

Category Fluency: The data on category fluency which was collected by using Animal Name Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table -4.6.

Table- 4.6: Post Hoc multiple comparision of Steel Dwass Test on category fluency (Animal Names Test) for all groups.

Animal Names Test			Abuse		Dependence		Control
			Early Onset	Late Onset	Early Onset	Late Onset	
Total New Words	Abuse	Early Onset	X	-5.02**	1.95	-0.78	-6.43**
		Late Onset		X	6.11**	4.14**	-2.09
	Dependence	Early Onset			X	-2.45	-7.25**
		Late Onset				X	-5.62**
	Control						X

Steel Dwass Test results (Table -4.6) revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-5.02: P<.01 level; -6.43: P<.01 level). Late onset abuse showed positive sig. difference with early and late onset dependence (6.11: P<.01 level; 4.14: P<.01 level). Early onset dependence had negative sig. difference with control group (-7.25: P<.01 level) and late onset dependence also had negative sig. difference with control group (-5.62: P<.01 level).The results got support of the earlier finding that the marijuana taking impairs cognitive functions including verbal *fluency ability and ability to plan (*Morrison, *et al*. 2009) as the content of marijuana deficits executive functioning, attention, and learning and memory (Schweinsburg, *et al*. 2008). Former research finding already confirmed that those who initiate use before 15 to 17 years of age demonstrate more pronounced deficits verbal fluency (Gruber, *et al*. 2012; Pope, *et al*. 2003)**.**

Working Memory: The data on working memory was collected by using Verbal N Black Test of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table -4.7.

Table- 4.7: Post Hoc multiple comparision of Steel Dwass Test on working memory (Verbal N Back Test) for all comparision groups.

Verbal N Back Test			Abuse		Dependence		Control
			Early Onset	Late Onset	Early Onset	Late Onset	
One and two back hit	Abuse	Early Onset	X	-3.40**	2.59	1.41	-5.79**
		Late Onset		X	5.58**	4.46**	-3.72**
	Dependence	Early Onset			X	-0.97	- 6.89**
		Late Onset				X	-6.44**
	Control						X

Steel Dwass Test results (Table –4.7) revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-3.40: P<. 01 level; -5.79: P<. 01 level). Late onset abuse had positive sig. difference with early and late onset dependence (5.58: P< .01 level; 4.46: .01 level) and negative sig. difference with control group (-3.72: P< .01 level). Early onset dependence had negative significant difference with control group (-6.89: P< .01 level) and late onset dependence also had negative sig. difference with control group (-6.44: P< .01 level). (Fletcher and Honey, 2006) also cite evidence for difficulties in manipulating the contents of working memory, failure to use semantic processing and organisation to optimise episodic memory encoding, and impaired retrieval performance. Animal studies substantiated that rats exposed to synthetic cannabinoids or THC during adolescence experience impaired working memory at adulthood (O'Shea, *et al*. 2004, 2006; Rubino, *et al*. 2009), younger brains that the same amount of THC exposure led to decreased working memory performance in adolescent rats while had no effect in adult rats (Quinn, *et al*. 2008).

Planning: The data on planning was collected by using Tower of London of NIMHANS Battery which required nonparametric statistic and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table -.4.8

Table- 4.8: Post Hoc multiple comparision of Steel Dwass Test on planning (Tower of London) for all comparision groups.

Tower of London			Abuse		Dependence		Control
			Early Onset	Late Onset	Early Onset	Late Onset	
Total no of problems solved with minimum moves	Abuse	Early Onset	X	-2.68	2.47	-0.53	-2.21
		Late Onset		X	4.62**	2.33	0.83
	Dependence	Early Onset			X	-2.99*	-4.62**
		Late Onset				X	-1.63
	Control						X

Steel Dwass Test (Table-4.8) results revealed late onset abuse had positive sig. difference with early onset dependence (4.62: P< .01 level) and early onset dependence had negative sig. difference with late onset dependence and control group (-2.99: P<. 05 level; -4.62: P< .01 level) .The results got support of the earlier finding that the marijuana taking impairs cognitive functions including verbal fluency ability and ability to plan (Morrison, *et al*. 2009). Former research findings depicted that those who initiate use before 15 to 17 years of age demonstrate more pronounced deficits in executive functioning (Fontes, *et al*. 2011) as compared to those who initiate use later on.

Set Shifting Ability: The data on set shifting ability was collected by using Wisconsin Card Sorting of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table -4.9.

Table- 4.9: Post Hoc multiple comparision of Steel Dwass Test on set shifting ability (Wisconsin Card Sorting Test) for all comparision groups.

Wisconsin Card Sorting Test			Abuse		Dependence		Control
			Early Onset	Late Onset	Early Onset	Late Onset	
No of Categories completed	Abuse	Early Onset	X	-0.82	4.91**	0.84	-4.53**
		Late Onset		X	5.22**	1.49	-3.53**
	Dependence	Early Onset			X	-4.00**	-7.92**
		Late Onset				X	-4.85**
	Control						X

Steel Dwass Test (Table -4.9) results revealed early onset abuse had positive significant (sig.) difference with early onset dependence (4.91: P< .01 level), and negative sig. difference with control group (-4.53: P< .01 level). Late onset abuse showed positive sig. difference with early onset dependence (5.22 :< .01 level) and negative sig. difference with control group (-3.53: P< .01 level). Early onset dependence had negative sig. difference with late onset dependence and control group (-4.00: P< .01 level; -7.92: P< .01 level). Late onset dependence also had negative sig. difference with control group (-4.85: P< .01 level) on set shifting abilities. Former study had confirmed that rats exposed to chronic doses of THC during adolescence evidenced deficits in learning during adulthood (Harte and Dow-Edwards, 2010). Heavy user are more prone to preservative error, a test of set shifting at least one day abstinence impaired set shifting (Austin, *et al*. 1992).

Response Inhibition: The data on response inhibition was collected by using Stroop Test of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table -4.10.

Table- 4.10: Post Hoc multiple comparision of Steel Dwass Test on response inhibition (Stroop Test) for all comparision groups.

Stroop Test			Abuse		Dependence		Control
			Early Onset	Late Onset	Early Onset	Late Onset	
Stroop Effect	Abuse	Early Onset	X	0.56	-3.28**	0.31	0.77
		Late Onset		X	-4.53**	-0.38	0.17
	Dependence	Early Onset			X	3.71**	4.78**
		Late Onset				X	0.50
	Control						X

Steel Dwass Test (Table- 4.10) results revealed early onset abuse had negative significant (sig.) difference with early onset dependence (-3.28: P<.01 level). Late onset abuse had negative sig. difference with early onset dependence (-4.53: P<.01 level). Early onset dependence had positive sig. difference with late onset dependence and control group (3.71: P<. 01 level; 4.78: P<.01 level) on response inhibition. Bolla and colleagues (2002) also confirmed that heavy cannabis users had poorer performance across most neuropsychological measures, including tests of memory, executive functions, inhibitory control, and psychomotor speed than light and non users. Some studies substantiated that early-onset users made more errors and showed greater disruptions in brain activation patterns than late-onset users during an inhibition task (Gruber, *et al*. 2012).

Verbal Comprehension: The data on verbal comprehension was collected by using Token Test of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table – 4.11

Table- 4.11: Post Hoc multiple comparision of Steel Dwass Test on verbal comprehension (Token Test) for all comparision groups.

Token Test			Abuse		Dependence		Control
			Early Onset	Late Onset	Early Onset	Late Onset	
Total Score	Abuse	Early Onset	X	-3.28**	0.85	-0.23	-3.92**
		Late Onset		X	3.91**	3.08*	-0.84
	Dependence	Early Onset			X	-1.06	-4.48**
		Late Onset				X	-3.72**
	Control						X

Steel Dwas Test (Table -4.11) results revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-3.28: P<.01 level; -3.92: P<.01 level). Late onset abuse had positive sig. difference with early and late onset dependence (3.91: <.01 level; 3.08: P<.05 level). Early onset dependence had negative sig. difference with control group (-4.48: P<.01 level). Late onset dependence also had negative sig. difference with control group (-3.72: P<. 01 level) on verbal comprehension. Cannabis user group exhibited increased sentence reading times associated with reduced text comprehension (Huestegge, *et al*. 2010). Children of cannabis users were usually poor in language comprehension, and distractibility (Colleen, *et al*. 1991).

Verbal immediate recall: The data on verbal immediate recall was collected by using Auditory Verbal Learning Test of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table -4.12

Table- 4.12: Post Hoc multiple comparision of Steel Dwass Test on verbal immediate recall **(**Auditory Verbal Learning Test) for all comparision groups.

Auditory Verbal Learning Test			**Abuse**		**Dependence**		**Control**
			Early Onset	**Late Onset**	**Early Onset**	**Late Onset**	
Immediate Recall	**Abuse**	**Early Onset**	X	-3.18*	3.18*	0.33	-5.64**
		Late Onset		X	5.72**	3.22*	-4.35**
	Dependence	**Early Onset**			X	-2.52	-7.09**
		Late Onset				X	-5.61**
	Control						X

Steel Dwass Test (Table- 4.12) results revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-3.18: P< .05 level; -5.64: P< .01 level), positive significant difference with early onset dependence (3.18: P< .05 level). Late onset abuse had positive sig. difference with early and late onset dependence (5.72: P< .01 level; 3.22: P<.05 level) and negative significant difference with control group (-4.35: < .01 level). Early onset dependence had negative sig. difference with control group (-7.09: P< .01 level). Late onset dependence also had negative sig. difference with control group (-5.61: P< .01 level) on immediate recall.(Egerton, *et al*. 2006) and (Solowij & Michie, 2007) and clearly demonstrate deficits in short-term and working memory and reversal-learning after acute and chronic administration of cannabinoids to rodents and monkeys, implicating hippocampal and prefrontal cortical dysfunction.Verbal learning and memory have been, perhaps, the most consistently impaired cognitive among cannabis users. In acute studies, poorer performance has been observed in immediate and delayed recall of words (D'Souza, 2004), greater intrusion errors (Ilan, 2004) and, at high doses, no learning what so ever occurring over trials (Curran, 2002). Impairment on word list learning tasks has been consistently demonstrated in recent neuropsychological studies of heavy or long-term cannabis users in the unintoxicated state. The Verbal Learning Tests measure the cognitive functions of the Cannabis users on their ability to encode, consolidate, store and retrieve verbal episodic information and are highly sensitive to neurological impairment (Lesek, *et al*. 2004), though age, intelligence and educational experience also impact upon performance (Schmidt, 1996). Frequency of cannabis use (Pope, *et al*. 2001; Pope, *et al*, 1996) or cumulative dosage effects (Bolla, *et al*. 2002). Generally, long-term heavy cannabis users learn fewer words on each trial and overall, recall fewer words and forget more words following interference or a delay than short term or light cannabis users or non-user controls. Recognition performance may also be poor, albeit less consistently, while intrusion errors may be present but are not routinely monitored or reported in studies.

Visual Immediate Recall: The data on visual immediate racall was collected by using Complex Figure Test of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test, results are presented in Table –4.13

Table- 4.13: Post Hoc multiple comparision of Steel Dwass Test on visual immediate recall for all comparision groups.

Complex Figure Test			Abuse		Dependence		Control
			Early Onset	**Late Onset**	**Early Onset**	**Late Onset**	
Immediate Recall	**Abuse**	**Early Onset**	X	-4.21**	7.35**	1.10	-4.82**
		Late Onset		X	7.68**	4.82**	-0.12
	Dependence	**Early Onset**			X	-7.15**	-7.72**
		Late Onset				X	-5.43**
	Control						X

Steel Dwass Test (Table- 4.13**)** results revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-4.21: P< .01 level; -4.82:P<. .01 level), positive significant difference with early onset dependence (7.35: P< .01 level). Late onset abuse had positive sig. difference with early and late onset dependence (7.68: P< .01 level; 4.82: P< .01 level). Early onset dependence had negative sig. difference with late onset dependence and control group (-7.15: P< .01 level; -7.72: P< .01 level). Late onset dependence also had negative sig. difference with control group (-5.43: P< .01 level) on immediate recall.The finding conforms the earlier finding that abstinent adult cannabis users report more on visuospatial memory deficits (Hermann, *et al*. 2007), children of cannabis users scored more poorly on visual-perceptual tasks, (Colleen, *et al*. 1991). Rats exposed to chronic doses of THC during adolescence evidenced deficits in learning during adulthood (Harte and Dow-Edwards, 2010).

Since functional impairment is likely to precede major structural alterations in the brain, or to manifest concomitant to more minor neural alterations. Thus, it can be a good reason to suspect long-term effects of cannabis use on memory function (Chan, *et al*. 1998).Pope and colleagues (2001) in heavy cannabis users, performance on delayed recall was significantly worse in heavy users, and excessively heavy use in young adults of lower IQ may result in persistent impairment of memory (and other cognitive functions) that may require a much longer period of abstinence to recover.

Prediction of the selected variables: The Kruskal–Wallis one-way analysis of variance by ranks (named after William Kruskal and W. Allen Wallis) of non-parametric method for testing whether samples originate from the same distribution which is equivalent to parametric statistics of one-way analysis of variance (ANOVA). When the Kruskal-Wallis test leads to significant results, then at least one of the samples is different from the other samples. The test does not identify where the differences occur or how many differences actually occur. It is an extension of the Mann–Whitney U test to 3 or more groups. Nonparametric tests use functions of the response ranks, called rank scores (Hajek, 1969). The results of Kruskal Wallis of the dependent variables were presented below:

General Health Questionnaire: The data on GHQ does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table -5.1.

Table-5.1: Kruskal Wallis Test on General Health Questionnaire for whole groups.

General Health Questionnaire	Kruskal- Wallis Test		
	Chi-Square	df	Asymp. Sig.
Total Score	43.78	4	0.00

Kruskal Wallis Test (Table-5.1) depicted that there was overall significant effect of GHQ across the groups (X^2 =43.78, df= 4, $P < 0.00$) at .01 level.

Intelligence: The data on intelligence was collected by using Alexander Pass Along Test does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table –5.2.

Table -5.2: Kruskal Wallis Test on Intelligence (Alexander Pass along Test) for all groups.

Alexander Pass Along Test	**Kruskal Wallis Test**		
	Chi-Square	**df**	**Asymp. Sig.**
Raw Scores	24.17	4	0.00

Results on Kruskal Wallis presented in Table -5.2 which revealed that overall significant effect across the groups (X^2 =24.17, df=4, P < 0.00) at .01 levels on Intelligence abilities as cognitive impairments have been found to be greater in cannabis users of lower IQ than in higher IQ users in several studies (Pope, *et al*. 1996), also suggests that perhaps higher IQ individuals are better able to compensate for cannabis related cognitive impairment (Bolla and colleagues, 2002).

Motor Speed: The data on motor speed was collected by using Finger Tapping Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table-5. 3.

Table -5.3: Kruskal Wallis Test on Motor Speed (Finger Tapping Test) for all groups.

Finger Tapping Test	**Kruskal Wallis Test**		
	Chi-Square	**df**	**Asymp. Sig.**
Right & Left hand	12.16	4	0.02

Results on Kruskal Wallis presented in Table -5.2 revealed that overall significant effects in the groups (X^2 =12.16, df=4, P < 0.02) at .05 levels on Motor Speed as THC to impair inhibition, motor impulsivity, and psychomotor control (Moeller, *et al*. 2001). The combined THC and CBD, but not THC alone, impaired psychomotor control in cannabis users (Roser, *et al*. 2009).

Mental Speed: The data on mental speed was collected by using Digit Symbol Substitution Test of NIMHANS Battery and it does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table -5.4.

Table- 5.4: Kruskal Wallis Test on Mental Speed (Digit Symbol Substitution Test) for all groups.

Digit Symbol Substitution Test	Kruskal Wallis Test		
	Chi-Square	**df**	**Asymp. Sig.**
Total Time	83.95	4	0.00

Results on Kruskal Wallis presented in Table -5.4 revealed an overall significant effect across the groups (X^2 =83.95, df=4, P < 0.00) at .01 levels on mental speed.The finding conformed to the earlier study that heavy cannabis users have deficits on measures of ***information processing speed***, compared to 22 controls while abstinent, but not while acutely intoxicated (Kelleher, *et al*. 2004).

Sustained Attention: The data on sustained attention was collected by using Digit Vigilance Test of NIMHANS Battery, The data does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table – 5.5.

Table- 5.5: Kruskal Wallis Test on Sustained Attention (Digit Vigilance Test) for all groups.

Digit Vigilance Test	Kruskal Wallis Test		
	Chi-Square	**df**	**Asymp. Sig.**
Total Time	73.92	4	0.00

Results on Kruskal Wallis presented in Table -5.5 revealed an overall significant effect across the groups(X^2 =73.92, df=4, P < 0.00) at .01 levels on Sustained attention. Some studies also document impairments in ***attention*** and concentration following administration of small and large doses of THC in cannabis users and non-users compared to placebo administration (Anderson, *et al*. 2010; Ramaekers, *et al*. 2009, 2011; Theunissen, *et al*. 2011).Sustained attention and transient information management are significantly impaired during the drug-induced psychosis state, while selective attention is less affected (Willmore, *et al*. 2008).

Category Fluency: The data on category fluency was collected by using Animal Name Test of NIMHANS Battery. The data does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis presented are in Table -5.6.

Table- 5.6: Kruskal Wallis Test on Category Fluency (Animal Names Test) for all groups.

Animal Names Test	**Kruskal Wallis Test**		
	Chi-Square	**df**	**Asymp. Sig.**
Total New Words	87.89	4	0.00

Results on Kruskal Wallis presented in Table -5.6 revealed an overall significant effect across the groups (X^2 =87.89, df=4, $P < 0.00$) at .01 levels on category fluency. Martin and colleagues (2011) supported the hypothesis that individuals who are using stimulants occasionally exhibit subtle executive dysfunctions when required to generate verbal sets under time pressure.

Working Memory: The data on working memory which was collected by using Verbal N Back Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table -5.7.

Table- 5.7: Kruskal Wallis Test on Working Memory (Verbal N Back Test) for all groups.

Verbal N Back Test	**Kruskal Wallis Test**		
	Chi-Square	**df**	**Asymp. Sig.**
One and two back hit	80.99	4	0.01

Kruskal Wallis Test (Table -5.7) depicted that working memory had an overall significant effect across the groups (X^2 =80.99, df=4, $P < 0.01$) at .01 level. Earlier study also found that THC administration adversely affects on working memory (Crean, *et al*. 2011).

Planning: The data on planning which was collected by using Tower of London Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table -5.8.

Table-5.8**:** Kruskal Wallis Test on Planning (Tower of London Test) for all groups.

Tower of London	**Kruskal Wallis Test**		
	Chi-Square	**df**	**Asymp. Sig.**
Total no of problems solved with minimum moves	31.64	4	0.00

Kruskal Wallis Test depicted that there was an overall significant effect across the groups (X^2 =31.64, df=4, $P < 0.00$) at .01 level on planning. It is found that very heavy users of MJ have persistent decision-making deficits and alterations in brain activity (Karen, *et al*. 2005). Specifically, the Heavy MJ users may focus on only the immediate reinforcing aspects of a situation (i.e., getting high) while ignoring the negative consequences. Thus, faulty decision-making could make an individual more prone to addictive behavior and more resistant to treatment.

Set Shifting Ability: The data on set shifting ability which was collected by using Wisconsin Card Sorting of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table -5.9.

Table- 5.9: Kruskal Wallis Test on Set Shifting Ability (Wisconsin Card Sorting Test) for all groups.

Wisconsin Card Sorting Test	**Kruskal Wallis Test**		
	Chi-Square	**df**	**Asymp. Sig.**
No of Categories Completed	73.80	4	0.00

Kruskal Wallis Test (Table – 5.9) depicted that there was an overall significant effect across the groups (X^2 =73.80, df = 4, $P < 0.00$) at .01 level on set shifting ability.Findings conform earlier finding that Cannabis during this time period may be disruptive to normal neuro maturation (Bava and Tapert, 2010). Lyons and colleagues (2004) found that neuropsychological performance deficits among heavy, frequent users of cannabis, not withstanding acute cannabis intoxication.

Response Inhibition: The data on response inhibition which was collected by using Stroop Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table -5.10.

Table- 5.10: Kruskal Wallis Test on Response Inhibition (Stroop Test) for all groups.

Stroop Test	Kruskal Wallis Test		
	Chi-Square	df	Asymp. Sig.
Stroop Effect	27.78	4	0.00

Kruskal Wallis Test (Table – 5.10) depicted that there was an overall significant effect across the groups (X^2 =27.78, df=4, P < 0.00) at .01 level on response inhibition.THC administration adversely affects inhibition (Crean, *et al*. 2011).

Verbal Comprehension: The data on verbal comprehension which was collected by using Token Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table -5.11.

Table- 5.11: Kruskal Wallis Test on Verbal Comprehension (Token test) for all groups.

Token Test	Kruskal Wallis Test		
	Chi-Square	df	Asymp. Sig.
Total score	32.56	4	0.00

Kruskal Wallis Test on verbal comprehension revealed **(**Table – 5.11) there was an overall significant effect across the groups (X^2 =32.56, df=4, P < 0.00) at .01 level on verbal comprehension. Previous work provided evidence that chronic cannabis use leads to long-term deficits of the oculomotor control system (Huestegge, *et al*. 2009). Cannabis users have also been reported to demonstrate deficits in text comprehension (Huestegge, *et al*. 2010).

Verbal Immediate Recall: The data on verbal immediate recall was collected by using Auditory Verbal Learning Test of NIMHANS Battery. It does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table -5.12.

Table- 5.12: Kruskal Wallis Test on Verbal Immediate Recall **(**Auditory Verbal Learning Test) for all groups.

Auditory Verbal Learning Test	**Kruskal Wallis Test**		
	Chi-Square	**df**	**Asymp. Sig.**
Immediate Recall	78.23	4	0.00

Kruskal Wallis Test on verbal immediate recall revealed that **(**Table – 5.12) there was an overall significant effect across the groups (X^2 =78.23, df=4, $P < 0.00$) at .01 level learning and memory. Morgan and colleagues (2010) cannabis users demonstrated poorer performance on immediate and delayed episodic memory (but not verbal and category fluency), immediate and delayed episodic memory, and source memory.

Visual Immediate Recall: The data on visual immediate recall was collected by using Complex Figure Test of NIMHANS Battery. It does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis. Results on Kruskal Wallis are presented in Table -5.13

Table- 5.13: Kruskal Wallis Test on Visual Immediate Recall (Complex Figure Test) for all groups.

Complex Figure Test	**Kruskal Wallis Test**		
	Chi-Square	**df**	**Asymp. Sig.**
Immediate Recall	121.62	4	0.00

Kruskal Wallis Test on visual immediate recall (Table – 5.13) there was an overall significant effect across the groups(X^2 =121.62, df=4, $P < 0.00$; at .01 level on learning and memory as earlier research also confirmed that Cannabis has substantial acute effects on human cognition and visuomotor skills (Huestegge, 2011).

Since functional impairment is likely to precede major structural alterations in the brain, or to manifest concomitant to more minor neural alterations. Thus, it can be a good reason to suspect long-term effects of cannabis use on memory function (Chan, *et al*. 1998). Pope and colleagues (2001) in heavy cannabis users, performance on delayed recall was significantly worse in heavy users, and excessively heavy use in young adults of lower IQ may result in persistent impairment of memory (and other cognitive functions) that may require a much longer period of abstinence to recover.

The result findings of this study are summarised in the followings, in relation to the theoretical expectation set forth for the study.

Overall findings met the objectives of the study, Cannabis used adversely affected the general health and the neurocognitive domains such as(1) intelligence, (2) motor speed, (3) mental speed, (4) sustain attention, (5) category fluency, (6) working memory, (7) planning, (8) set shifting ability, (9) response inhibition, (10) verbal comprehension, (11) verbal immediate recall, (12) visual immediate recall by cannabis use under various conditions (Crane, *et al*. 2013) as the present study also highlighted mean significant differences between groups, significant correlation between dependent variables, and also among the selected comparision groups on dependents variables.

The study examines the five comparision groups (two levels of disorder', two levels of 'Onset' with control group non users of marijuana) on measures of the dependent variables. Such as the general health and the neurocognitive domains such as (1) intelligence, (2) motor speed, (3) mental speed, (4) sustain attention, (5) category fluency, (6) working memory, (7) planning, (8) set shifting ability, (9) response inhibition, (10) verbal comprehension, (11) verbal immediate recall, (12) visual immediate recall, and found significant differences between them.

The demographic profiles clearly explained some of the cultural specific problems of the selected population regarding the Marijuana User on cognitive deficiencies which got support of earlier studies as expected ; and the finding would replicable in the project population the 'Manipuri'. It was found that maximum numbers of users were school dropout or undermatricute. They have minimum education or qualification. Low socio economic status and large family size have a role in using the substance.

The following hypotheses were set forth for the study of Cognitive deficiency among Marijuana users in Manipur for the proposed research study:
The results provided empirical bases of the hypotheses set forth for the study that:

(1) Significant differences are observed in relation to 'Level of disorder' of marijuana use on GHQ and cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) among the comparision groups.
(2) 'Onset' of marijuana use has manifested differently on GHQ and cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) among the comparision groups.
(3) Dependency and early onset have more cognitive deficiencies as compared to abuse with late onset.
(4) Early onset of marijuana used and dependence have showed specific cluster of cognitive deficiencies as expected with regards to the main cell of the design.

On the whole the findings of the study provided the component empirical bases that are sufficient enough in conformity with the theoretical expectations as set forth for the conduction of the study.

CHAPTER-V

SUMMARY AND CONCLUSIONS

The present study was designed to illustrate effects of Marijuana on “Cognitive Deficiency among Marijuana Users in Manipur.The study incorporated between group classifications of five independent variables ‘***level of disorder’*** (“abuse’ and ‘dependence’ of Marijuana), and ‘***Onset’*** (‘early onset’: before 18 years and ‘late onset’: after 18 years of marijuana user) and a ***control group*** (non user). The present study investigated the difference between the two ‘Level of disorder (“abuse’ and dependence’ of Marijuana), two ‘Onset’ (‘early onset’ and ‘Late onset’ of Marijuana user) in comparison with a control group on their general health and cognitive abilities (cognitive abilities: Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory).

The objectives of the study were (i) to examine the effects of ‘Level of disorder’, ‘Onset’ differences on measures of the dependent variables., (ii) to examine the cultural specific problems of the selected population – Manipuri with regards to Marijuana User effect on cognitive deficiencies , (iii) with a an expectation that the behavioral measures would find replicability in the project population the ‘Manipuri’ and (iv) the participants of marijuana user would manifest different cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) in comparision with non users.

The following hypotheses were set forth for the study of Cognitive deficiency among Marijuana users in Manipur for the proposed research study: (i) Significant difference would be observed in relation to ‘Level of disorder’ of marijuana on cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) among the subjects; (ii) ‘Onset’ of marijuana use would be manifested differently on cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) among the subjects.; (iii) Dependency and early onset are expected to show more cognitive deficiencies as compared to abuse with late onset; and (iv) Specific cluster of cognitive deficiencies are expected with regards to the main cell of the design.

To meet the objective of the study, a total of 200 samples, 40 early and 40 late onset abuse, 40 early and 40 late onset dependence who are marijuana user and 40 control,users were screened out through purposive sampling procedure by employing DSM-IVTR criteria (DSM-IV TR, APA, 2000) for 'level of disorder'*('Abuse' and 'Dependence' of marijuana*), and the 'Onset' *('early onset': before 18 years and 'late onset': after 18 years)* of marijuana use was cross checked with the help of the Structured Interview questionnaire prepared by the researcher. General health (mental and psychiatric) condition of the subjects was work out by employing the General Health Questionnaire (GHQ-12: Goldberg and Williams, 1988) to screen out the eligibility of the subject for application of the selected Psychological tools. Alexander Pass Along Test (Alexander 1932) was used to screen the intelligent levels of the subject. The NIMHANS Neuropsychology Battery (2004) for literate was applied to assess the cognitive abilities. The age range was18 to 40 years for the whole samples, only male samples were selected because female marijuana users are hardly seen in the selected population. All the 160 of (marijuana users) samples were selected from Psychiatry Department and Department of Clinical psychology of Regional Institute of Medical Sciences, Imphal-West; and Jawaharlal Nehru Institute of Medical Sciences, Imphal- East; and also NGOs which were operating in Manipur State. The Marijuana user samples of the proposed study were comprised only of *dominant Marijuana user*; who had a history of substance use (cannabis) for at least 2 years and a control group. The control group (non user of marijuana) was collected from the same population having same demographic background for comparision with the user groups to depict deviation on selected dependent variables.

The geographical location of Manipur has become a market place for heroin and other drugs processed in and transported from the Golden Triangle. Above all the traditional lifestyle and culture of the people in both accepted way and non accepted ways are some of the cultural specific problems of the selected population regarding the Marijuana Use or consumption.

Psychological tools used:

To meet the objectives of the present study, the researcher had employed the following psychological tools which are mentioned below:

1) General Health Questionnaire (GHQ-12: David Goldberg and Paul Williams, 1988) was employed for screening the Physical health condition and minor psychiatric

disorder to validate the psychiatric/mental disorders of the samples. Higher scores shows higher problem in physical and mental health.

2) Alexander Passalong Test (Alexander, 1932) was used to screen the intelligent levels of the subject.

3) NIMHANS Neuropsychology Battery (Rao, Subbakrishna and Gopukumar, 2004) employed to assess the deficits and adequacies in the behaviour of patients. It originally consists of 19 tests, but the sub test specially constructed for Literate subject will be administered in accordance with the design of the proposed study; in interpretation only the selected sub set were selected, to save time, above all it was thought that would gratify the required inferences on variables.

The selected sub test of the General Neuropsychology Battery Tests for (Literate Subjects) are:(1) Finger Tapping Test (for motor speed), (2) Digit Symbol Substitution Test (mental speed), (3) Digit Vigilance Test (sustain attention), (4) Animal Names Test (category fluency), (5) N Back Test (Verbal) for working memory, (6) Tower of London Test for planning, (7) Wisconsin Card Sorting Test (WCST)for set shifting ability, (8) Stroop Test for response inhibition, (9) Token Test for verbal comprehension, (10) Auditory Verbal Learning Test for verbal immediate recall, (11) Complex Figure Test (CFT) for immediate visual information .

4) Diagnostic Criteria for Cannabis Abuse and Dependence**:** (DSM IV TR; American Psychiatrist Association, 2005). The DSM IV TR contained the diagnostic criteria for Cannabis Abuse and Dependence, and with the help of those criteria the Manipuri Marijuana user can be classified into Abuse and Dependence of marijuana to serve as samples in the present study.

Psychometric Properties of the Behavioural Measures

Psychometric analysis of the behavioural measure included the analysis of (i) item-total coefficient of correlation (as an index of internal consistency and item validity) was ascertained for the scales/subscales of the behavioural measures with the criterion of items showing item-total coefficient of correlation $\geq .10$ for the whole sample to be retained for further analysis, (ii) Reliability coefficients (Cronbach alphas & Split-half) of the specific subscales, (iii) inter-scale relationships (in the instances where there were two or more sub-scales/ sub-factors). Following the broad format of analysis, the psychometric properties of the General Health Questionnaire (GHQ-12: David Goldberg & Paul Williams, 1988), the preliminary psychometric analysis over the level of analysis for each of the specific items and scale determined with the objectives to ensure further statistical analysis, and the results are presented in Table - 1. Results (Tables - 1) show internal consistency and item validity for the whole samples of GHQ.

The preliminary analysis of the psychometric properties of the behavioural measures were computed in view of the fact that scale constructed and validated for measurement of theoretical construct in a given population when taken to another cultural milieu may not be treated as reliable and valid unless specific checks are made (Eysenck & Eysenck, 1985; Witkin & Berry, 1975). So, the reliability coefficient (Cronbach Alpha and Spearman Brown coefficient) of the GHQ was .56 of alpha reliability and .57 for Spearman Brown coefficients.

Descriptive statistic for Mean and SD on GHQ revealed that Dependence Early Onset group scores (M=.60) as the highest, higher than comparision group on general health which indicated dependence with early onset were more disturbed concerning their general health compared with other groups whereas Control group scores (M=.05) lowest among the comparision groups that showed they were more sound in Physical and mental health condition. Early onset (M=.44) scores higher than Late onset (M=.19) depicted that early onset had higher effect on general health. Dependence group showed higher means scores than Abuse group. These findings are in conformity with the earlier findings that regular marijuana use and frequency of such use are related to anxiety, depressive symptoms and perceived health among young adult tobacco smokers; that predicted anxiety symptoms and perceived general health, whereas frequency of marijuana use predicted only anxiety symptoms (Marcel O. Bonn-Miller, *et al*. 2005).

Intelligence Test results showed that highest scores were among the Control group (M =31), late onset higher than early onset (M = 29.13; 28.88), Abusers higher than Dependants (M = 29.26; 28.74), which indicate early onset and dependency on marijuana had more deterioration in their intellectual functioning. Control group was more superior in terms of intellectual functioning in comparision with the rest of the groups. Wilson and his colleagues also found that the excessive daily doses of cannabis, over a prolonged period of time, result in structural brain changes; age of onset of cannabis use is a critical factor with potentially greater deleterious effects to the brain as it commences during significant periods of neurodevelopment, such as adolescence. Early onset cannabis users (before age 17) were found to have smaller whole brain volumes, lower percent cortical grey matter, higher percent white matter and increased resting cerebral blood flow compared to later onset users (Wilson, *et al*. 2000).

Motor Process Speed results showed the highest scores on Control group (M =91.75), late onset higher than early onset (M = 89.24; 87.91), Dependants higher than abusers (M = 88.95; 88.20), which indicate early onset , abusers and dependency had greater effect on motor speed among samples as it slow down processing of information in the brain. Hunault and colleagues (2009) also found THC to significantly decrease response time and increase errors in a dose-dependent manner in heavy cannabis users on a motor control task.

Mental Speed results showed that the highest scores were reflected on early onset dependence group (M =2.88), early onset higher than late onset (M = 2.97; 2.32), Dependants higher than Abusers (M = 2.70; 2.40), which indicate early onset and dependence had lower mental speed among samples they took longer time duration in completing the given mental task. Earlier studies also found marijuana users display significantly slowed information-processing speeds (longer ITs) compared to controls. Paradoxically, this deficit appears to be normalized whilst users are in the acute state (Kelleher, 2004).

Sustained Attention results showed that the highest scores were among early onset dependence group (M =6.47), early onset higher than late onset (M = 6.38; 5.33), Dependants higher than Abusers (M =6.14; 5.56), which indicate early onset and dependence took more time on completing the given task. They had lower sustained attention among samples. Regular cannabis users differed significantly from non-regular users on test of sustained attention with working memory component errors (Harvey, *et al*. 2007). Cannabis users had difficulties on focused attention on complex tasks (Lundqvist, 2005).

C**ategory Fluency** results showed that highest scores in control group (M =15.13), late onset higher than early onset (M = 12.74; 10.36), Abusers higher than Dependants (M = 12.53; 10.58), which indicate early onset and dependency had high effects on categorical fluency among samples as early onset and dependence had difficulty in generating words of same semantic category. The results are in accordance with the finding of Pope, *et al*. (2002) who examined verbal fluency differences between two groups based on age of onset (early and late) that early onset cannabis users (who began smoking before 17 years of age) demonstrated significant impairments in verbal fluency compared with controls. This suggested that age of onset, and possibly years of use, mediates the impact of the long-term effects of cannabis on verbal fluency.

Working Memory (One and two back hit) which indicate dependence with early onset had difficulty in both verbal storage and rehearsal and manipulation of information in comparison with other groups. Control group were more capable of verbal storage, rehearsal and manipulation of ongoing information from rest of the groups. Results revealed that highest scores among control group (M =15.60), late onset higher than early onset (M = 14.15; 13.61), Abusers higher than Dependants (M = 14.44; 13.33), which indicate early onset and dependency had high effects on Working memory among samples supporting the earlier finding that cannabis neurologic effects of acute intoxication with cannabis include behavior changes, impaired memory, hyperphagia, in coordination, and possibly psychosis; that chronic neurologic problems associated with long- term use include *memory impairment* in patients whose heavy use started before age 17 years.(Robert D. Davies, *et al*. 2004).

P**lanning** results showed highest scores in late onset abuse group (M =10.43), late onset higher than early onset (M = 10.01; 8, 94), Abusers higher than Dependants (M = 9.91; 9.04), which indicate early onset and dependence had high effects on planning ability among samples. It indicates that dependency and early onset had difficulty on planning and anticipating achieving a predetermined goal in comparison with other groups whereas late onset abuse performed slightly better than control group. They were good in indentifying and organizing of the steps and elements needed to carry out an intention or achieve a goal from rest of the groups (Lezak, 1995).

Set Shifting Ability (Number of categories completed) which indicates dependence with early onset had difficulty in concept formation, abstract reasoning and ability to shift cognitive strategies in comparison with other groups. Results showed that highest scores in control group (M =5.83), late onset higher than early onset (M = 4.38; 3.38), Abusers higher than Dependants (M = 4.54; 3.21), which indicate early onset and dependency had high effects on set shifting ability among samples. It conform with the earlier finding that a range of cognitive functions, encompassing attention, memory, executive and inhibitory processes are impaired during both the acute intoxication period and following long term use of cannabis (Castle, *et al*. 2011).

R**esponse Inhibition** results showed highest scores in early dependence group (M =1.56), early onset higher than late onset (M = 1.38; 1.12), Dependants higher than Abusers (M = 1.34; 1.16), which indicate early onset and dependency hampered response inhibition ability among samples. They have high response inhibition in comparison with other groups. (Stroop Effect) It indicates dependence with early onset had difficulty in shifting perceptual set to conjoin changing demands and by suppressing a habitual response in favour of an unusual one. Control group was more ease in changing demands according to situation from rest of the groups. Cannabis induces loss of internal control and cognitive impairment, decreased mental flexibility, increased perseveration, and reduced learning, to shift and/or sustain attention (Karen, *et al*. 2005). Some studies reported among recently abstinent adolescent cannabis users, regular and non-regular users showed no difference in inhibition or psychomotor control (Harvey, *et al*. 2007). After 28 days of abstinence, adolescent cannabis users demonstrated intact inhibition and motor impulsivity (Tapert, *et al*. 2007).

V**erbal Comprehensions** results depicted highest scores in control group (M =35.95), late onset higher than early onset (M = 35.75; 35.51), Abusers higher than Dependants (M = 35.74; 35.53), which indicate early onset and dependency impede verbal comprehension ability among samples. Children of cannabis users scored more poorly included parental ratings of behaviour problems, visual-perceptual tasks, language comprehension, and distractibility (Colleen, *et al*. 1991).

Verbal Immediate Recall results illustrated highest scores in control group (M =14.38), late onset higher than early onset (M = 12.88; 11.93), Abusers higher than Dependants

(M = 13.03; 11.78), which point out early onset and dependency slow down verbal learning among samples. Dependency and early onset had difficulty in learning and remembering verbal material. Control group can recalled more words comparing with rest of the groups. Results are in conformity with the other findings that Cannabinoid (CB1) receptors occur in high density in brain regions critically involved in memory functions and cannabinoids profoundly affect synaptic plasticity underlying learning and memory (Alger, 2005) disrupting long-term potentiation in the hippocampus (Chevaleyre, 2006).

Visual Immediate Recall results depicted highest scores in control group (M =28.70), late onset higher than early onset (M = 26.11; 20.88), Abusers higher than Dependants (M = 26.51; 20.48), which indicate early onset and dependency had negative impact on visual delayed recall among samples. The findings has confirmatory findings, that early onset and dependence had difficulty on visual memory (Ranganathan and D'Souza, 2006) found in their review that acute administration of cannabis impairs immediate and delayed free recall of information. Even a single exposure abolishes retrograde signalling (Mato, *et al*. 2004) and can induce lasting deficits in spatial learning and memory in mice 3-4 weeks and 4 months after exposure (Tselnicker, *et al*. 2007).

Bivariate Relationships between the Behavioural Measures

The bivariate relationship between the scales of the behavioural measures were computed and it indicated the difference between the two 'Level of disorder ('abuse' and dependence' of Marijuana), two 'Onset' ('early onset' and 'late onset' of Marijuana user) in comparison with a control group (non user) on their general health and cognitive abilities (cognitive abilities - Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory).

The results reveal that there are significant relationships amongst the scales/subscales of the behavioural measures. Bivariate correlation (Spearman's correlation) between dependent variables for the whole samples was computed by employing Statistical Packages for Social Sciences to depict significant positive and negative significant relationships between dependent variables. Though the correlation does not explain the cause and effect between variables, it however gives hint for possible reasons for further analysis.

Results of the relationship between the selected dependent variables for the whole samples are presented below:

General Health showed positive significant relationship with mental speed (r= 0.26**), sustained attention (r= 0.30**) and response inhibition (r= 0.18*)whereas negative significant relationship with category fluency (r= -0.32**), working memory (r= -0.23**), planning (r= -0.18**), set shifting ability (r= -0.28**), comprehension (r= -0.30**), verbal immediate recall (r= -0.32**) and visual immediate recall (r= -0.38**). Majority of studies have suggested a significant cognitive decline in cannabis abusers as compared to non-abusers and healthy controls (Solowij, 1988).

Intelligence had positive significant relationship with category fluency (r= 0.24**), working memory (r= 0.28 **), planning (r= 0.21**), set shifting ability (r= 0.17*), verbal immediate recall (r=0.27**) and visual immediate recall (r= 0.28**). Whereas negative significant relationship with mental speed (r= -0.29*), sustained attention (r= -0.22**) and response inhibition (r= -0.17**). Pope and colleagues (2001) highlighted IQ differences: is possible that neurocognitive deficits in cannabis users with lower IQ may also be less amenable to recovery following prolonged abstinence. Deficits have been shown to increase as a function of frequency, duration, dose and age of onset of cannabis use, but the precise parameters of cannabis use that result in memory deficits remain to determine.This is also in line with our findings of structural brain alterations in excessively heavy users (albeit in much older users) and earlier starter showing greater cognitive impairment in lower IQ users (Solowij & Michie, 2007).

Motor Speed showed positive significant relationship with comprehension (r= 0.18**). Ramaekers and colleagues (2009) also found THC administration impaired psychomotor control in occasional cannabis users, but not in heavy cannabis users, suggesting a potential tolerance effect.

Mental Speed had positive significant relationship with sustained attention (r= 0.69**) and response inhibition (r= 0.32**) whereas negative significant relationship with category fluency (r= -0.44**), working memory (r= -0.54**), planning (r= -0.25**), set shifting ability (r= -0.46**), comprehension (r= -0.35**), verbal immediate recall (r= -0.58**) and visual immediate recall (r= -0.54**). Hunault and colleagues (2009) also found THC to significantly decrease response time and increase errors in a dose-dependent manner in heavy cannabis users on a motor control task.

Sustained Attention had positive significant relationship with response inhibition (r= 0.31**) whereas negative significant relationship with category fluency (r= -0.53**), working memory (r= -0.46**), planning (r= -0.25**), set shifting ability (r= -0.36**), comprehension (r= -0.37**), verbal immediate recall (r= -0.46**) and visual immediate recall (r= -0.52**). Harvey and colleagues (2007) investigated attention functions in adolescent cannabis users, and found that regular cannabis users differed significantly from non-regular users on sustained attention with working memory component errors

Category Fluency had positive significant relationships with working memory (r= 0.45**), planning (r= 0.30**), set shifting ability (r= 0.42**), comprehension (r= 0.40**), verbal immediate recall (r= 0.55**) and visual immediate recall (r= 0.56**). Whereas negative significant relationship with response inhibition (r= -0.31**). Cannabis exhibits a spontaneous flexibility that requires a ready flow of ideas and answers, often in response to a single constituent (Eslinger and Grattan, 1993).

Working Memory had positive significant relationships with planning (r= 0.29**), set shifting ability (r= 0.33**), comprehension (r= 0.36**), verbal immediate recall (r= 0.52**) and visual immediate recall (r= 0.54**) whereas negative significant relationship with response inhibition (r= -0.25**). Performance deficits found in chronic cannabis users are more likely to be elicited in complex tasks (Solowij, 1998) or tasks with a greater memory load (Jager, 2006).

Planning had positive significant relationship with set shifting ability (r= 0.27**), comprehension (r= 0.16*), verbal immediate recall (r= 0.24**) and visual immediate recall (r= 0.35**) whereas negative significant relationship with response inhibition (r= -0.19**). Rebecca and colleagues (2011) found Cannabis use has been shown to impair cognitive functions such as the ability to plan, organize, solve problems, make decisions, remember, and control emotions and behavior. A mental representation of the task, including the relevant stimulus information encoded into memory and the desired future goal state (Pennington and Ozonoff, 1996).

Set Shifting Ability had positive significant relationship with comprehension (r= 0.20**), verbal immediate recall (r= 0.43**) and visual immediate recall (r= 0.55**) whereas negative significant relationship with response inhibition (r= -0.28**). Heavy users displayed significantly greater impairment than light users on attentional/executive functions, as evidenced particularly by greater perseverations on card sorting and reduced learning of word lists (pope, 1996).

Response Inhibition had negative significant relationship with verbal immediate recall (r= -0.27**) and visual immediate recall (r= -0.37**). In recently abstinent adult cannabis users showed impairments in inhibition and motor impulsivity (Battisti, *et al*. 2010).

Comprehension had positive significant relationship with verbal immediate recall (r= 0.39**) and visual immediate recall (r= 0.28**). Children of cannabis users scored more poorly including parental ratings of behaviour problems, visual-perceptual tasks, language comprehension, and distractibility (Colleen, *et al*. 1991).

Verbal Immediate Recall had positive significant relationship with visual immediate recall (r= 0.58**). Ranganathan and D'Souza (2006) reported that the most consistent deficits are found on measures of immediate and delayed of wordlists, prose, and nonverbal stimuli but no differences in recall for information learned prior to intoxication.

The Post hoc multiple comparision of non parametric statistics (equivalent to Scheffe test of parametric statistic) Steel Dwass Test is a popular form of simultaneous nonparametric inference in the one-way layout for all pair wise comaprision (Dwass, 1960; Hollander and Wolf, 1999; Steel, 1960). It requires the calculation of the ranks for each combination of treatments.

GHQ: The data on general health which was collected by using GHQ 12 does not fulfill parametric statistic assumption and required nonparametric statistic of Post Hoc multiple comparision of Steel Dwass Test.

Results revealed early onset abuse had negative significant (sig.) difference with early onset dependence (-2.75: P< .05 level), and positive sig. difference with control group (3.55: P< .01 level). Late onset abuse showed negative sig. difference with early onset dependence (- 4.75: P< .01 level), early onset dependence had positive sig. with control group (5.63: P < .01 level) and late onset dependence also had positive sig. difference with control group (3.73: P < .01 level).Neuropsychological deficits and differences in brain functioning are most consistently observed only among frequent, heavy users, who are those most likely addicted to cannabis. The dire impact of drug addiction on a person's life and everyday functioning suggests that the large number of individuals addicted to cannabis experience substantial negative effects from its use (Raul Gonzalez, 2007).

Intelligence: The data on intelligence was collected by using Alexander Pass Along Test that required nonparametric statistic of Post Hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed early onset abuse had negative significant (sig.) difference with control group (-3.63: P<.01 level). Late onset abuse showed negative sig. difference with control group (- 3.22: P<.05 level), early onset dependence had negative sig. with control group (-4.35: P<.01 level) and late onset dependence also had negative sig. difference with control group (-3.27: P<.01 level). It may be that only excessive daily doses of cannabis, over a prolonged period of time, will result in structural brain changes (Wilson, *et al*. 2000). Earlier starter showing greater cognitive impairment in lower IQ users (Solowij & Michie, 2007)

Motor Speed: The data on motor speed was collected by using Finger Tapping Test of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test on motor speed (Finger Tapping Test) for all groups does not depict any significant effect on all comparision among the groups. Ramaekers and colleagues (2009) also found that THC administration impaired ***psychomotor control*** in occasional cannabis users, but not in heavy cannabis users, suggesting a potential tolerance effect; that younger brains which had the same amount of THC exposure led to decreased working memory performance in adolescent rats while it had no effect in adult rats (Quinn, *et al*. 2008).

Mental Speed: The data on mental speed which was collected by using Digit Symbol Substitution Test of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Results revealed early onset abuse had positive significant (sig.) difference with late abuse and control group (3.96: P< .01 level; 6.92: P< .01 level). Late onset abuse showed negative sig. difference with early and late onset dependence (-4.52: P<.01 level; -2.76: P<. 05 level) and positive sig. difference with control group (4.74: P<.01 level). Early onset dependence had positive sig. difference with control group (7.00: P<.01 level) and late onset dependence also had positive sig. difference with control group (6.38: P<.01 level). Rebecca and colleagues (2011) found Cannabis use has been shown to impair cognitive functions on a number of levels—from basic motor coordination to more complex executive function tasks, such as the ability to plan, organize, solve problems, make decisions, remember, and control emotions and behavior. These deficits differ in severity depending on the quantity, recency, age of onset and duration of marijuana use.

Sustained Attention: The data on sustained attention which was collected by using Digit Vigilance Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed early onset abuse had positive significant (sig.) difference with late onset abuse and control group (5.36: P<.01 level; 6.09: P<.01 levels). Late onset abuse had negative sig. difference with early and late onset dependence (-5.38: .01 level; -4.12: P<.01 level). Early onset dependence had positive sig. difference with control group (6.10; P<.01 level) and late onset dependence also had positive sig. difference with control group (5.13: P<.01 level).Marijuana users showed difficulty in information processing and focusing attention on relevant stimuli during selective attention (Solowij, 1995). Harvey and colleagues (2007) investigated attention functions in adolescent cannabis users, and found that regular cannabis users differed significantly from non-regular users on sustained attention with working memory component errors.

Category Fluency: The data on category fluency which was collected by using Animal Name Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-5.02: P<.01 level; -6.43: P<.01 level). Late onset abuse showed positive sig. difference with early and late onset dependence (6.11: P<.01 level; 4.14: P<.01 level). Early onset dependence had negative sig. difference with control group (-7.25: P<.01 level) and late onset dependence also had negative sig. difference with control group (-5.62: P<.01 level).The results got support of the earlier finding that the marijuana taking impairs cognitive functions including verbal *fluency ability and ability to plan (*Morrison, *et al*. 2009) as the content of marijuana deficits executive functioning, attention, and learning and memory (Schweinsburg, *et al*. 2008). Former research finding already confirmed that those who initiate use before 15 to 17 years of age demonstrate more pronounced deficits verbal fluency (Gruber, et al. 2012; Pope, *et al*. 2003**)**.

Working Memory: The data on working memory which was collected by using Verbal N Black Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-3.40: P<. 01 level; -5.79: P<. 01 level). Late onset abuse had positive sig. difference with early and late onset dependence (5.58: P< .01 level; 4.46: P< .01 level) and negative sig. difference with control group (-3.72: P< .01 level). Early onset dependence had negative significant difference with control group (-6.89: P< .01 level) and late onset dependence also had negative sig. difference with control group (-6.44: P< .01 level). (Fletcher and Honey, 2006) also cite evidence for difficulties in manipulating the contents of working memory, failure to use semantic processing and organisation to optimise episodic memory encoding, and impaired retrieval performance. Animal studies substantiated that rats exposed to synthetic cannabinoids or THC during adolescence experience impaired working memory at adulthood (O'Shea, *et al*. 2004, 2006; Rubino, *et al*. 2009), younger brains which had the same amount of THC exposure led to decreased working memory performance in adolescent rats while it had no effect in adult rats (Quinn, *et al*. 2008).

Planning: The data on planning which was collected by using Tower of London of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed late onset abuse had positive sig. difference with early onset dependence (4.62: P< .01 level) and early onset dependence had negative sig. difference with late onset dependence and control group (-2.99: P<. 05 level; -4.62: P< .01 level) .The results got support of the earlier finding that the marijuana taking impairs cognitive functions including verbal fluency ability and ability to plan *(*Morrison, *et al*. 2009). Former research findings depicted that those who initiate use before 15 to 17 years of age demonstrate more pronounced deficits in executive functioning (Fontes, *et al*. 2011) as compared to those who initiate use later on.

Set Shifting Ability: The data on set shifting ability which was collected by using Wisconsin Card Sorting of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed early onset abuse had positive significant (sig.) difference with early onset dependence (4.91: P< .01 level), and negative sig. difference with control group (-4.53: P< .01 level). Late onset abuse showed positive sig. difference with early onset dependence (5.22: P< .01 level) and negative sig. difference with control group (-3.53: P< .01 level). Early onset dependence had negative sig. difference with late onset dependence and control group (-4.00: P< .01 level; -7.92: P< .01 level). Late onset dependence also had negative sig. difference with control group (-4.85: P< .01 level) on set shifting abilities. Former study had confirmed that rats exposed to chronic doses of THC during adolescence evidenced deficits in learning during adulthood

(Harte and Dow-Edwards, 2010). Heavy user are more prone to preservative error, a test of set shifting at least one day abstinence impaired set shifting (Austin, *et al*. 1992)**.**

Response Inhibition: The data on response inhibition which was collected by using Stroop Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed early onset abuse had negative significant (sig.) difference with early onset dependence (-3.28: P<.01 level). Late onset abuse had negative sig. difference with early onset dependence (-4.53: P<.01 level). Early onset dependence had positive sig. difference with late onset dependence and control group (3.71: P<. 01 level; 4.78: P<.01 level) on response inhibition. Bolla and colleagues (2002) also confirmed that heavy cannabis users had poorer performance across most neuropsychological measures, including tests of memory, executive functions, inhibitory control, and psychomotor speed than light and non users. Some studies substantiated that early-onset users made more errors and showed greater disruptions in brain activation patterns than late-onset users during an inhibition task (Gruber, *et al*. 2012).

Verbal Comprehension: The data on verbal comprehension which was collected by using Token Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-3.28: P<.01 level; -3.92: P<.01 level). Late onset abuse had positive sig. difference with early and late onset dependence (3.91: P <.01 level; 3.08: P<.05 level). Early onset dependence had negative sig. difference with control group (-4.48: P<.01 level). Late onset dependence also had negative sig. difference with control group (-3.72: P<. 01 level) on verbal comprehension. Cannabis user group exhibited increased sentence reading times associated with reduced text comprehension (Huestegge, *et al*. 2010). Children of cannabis users were usually poor in language comprehension, and distractibility (Colleen, *et al*. 1991).

Verbal Immediate Recall: The data on verbal immediate recall which was collected by using Auditory Verbal Learning Test of NIMHANS Battery required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-3.18: P< .05 level; -5.64: P<.01 level), positive significant difference with early onset dependence (3.18: P<.05 level). Late onset abuse had positive sig. difference with early and late onset dependence (5.72: P< .01 level; 3.22: P< .05 level) and negative significant difference with control group (-4.35: P< .01 level). Early onset dependence had negative sig. difference with control group (-7.09: P< .01 level). Late onset dependence also had negative sig. difference with control group (-5.61: P< .01 level) on immediate recall. (Egerton, *et al*. 2006) and (Solowij & Michie, 2007) and clearly demonstrate deficits in short-term and working memory and reversal-learning after acute and chronic administration of cannabinoids to rodents and monkeys, implicating hippocampal and prefrontal cortical dysfunction.Verbal learning and memory have been, perhaps, the most consistently impaired cognitive among cannabis users. In acute studies, poorer performance has been observed in immediate and delayed recall of words (D'Souza, 2004), greater intrusion errors (Ilan, 2004) and, at high doses, no learning what so ever occurring over trials (Curran, 2002). Impairment on word list learning tasks has been consistently demonstrated in recent neuropsychological studies of heavy or long-term cannabis users in the unintoxicated state. The Verbal Learning Tests measure the cognitive functions of the Cannabis users on their ability to encode, consolidate, store and retrieve verbal episodic information and are highly sensitive to neurological impairment (Lesek, *et al*. 2004), though age, intelligence and educational experience also impact upon performance (Schmidt, 1996). Frequency of cannabis use (Pope, *et al*. 2001; Pope, *et al*. 1996) or cumulative dosage effects (Bolla, *et al*. 2002). Generally, long-term heavy cannabis users learn fewer words on each trial and overall, recall fewer words and forget more words following interference or a delay than short term or light cannabis users or non-user controls. Recognition performance may also be poor, albeit less consistently, while intrusion errors may be present but are not routinely monitored or reported in studies.

Visual Immediate Recall: The data on visual immediate recall which was collected by using Complex Figure Test of NIMHANS Battery which required nonparametric statistic, and analysed by using nonparametric statistics post hoc multiple comparision of Steel Dwass Test.

Steel Dwass Test results revealed early onset abuse had negative significant (sig.) difference with late onset abuse and control group (-4.21: P< .01 level; -4.82: P< .01 level), positive significant difference with early onset dependence (7.35: P< .01 level). Late onset abuse had positive sig. difference with early and late onset dependence (7.68: P< .01 level; 4.82: P< .01 level). Early onset dependence had negative sig. difference with late onset dependence and control group (-7.15: P< .01 level; -7.72: P< .01 level). Late onset dependence also had negative sig. difference with control group (-5.43: P< .01 level) on immediate recall.The finding conforms the earlier finding that abstinent adult cannabis users report more on visuospatial memory deficits (Hermann, *et al*. 2007), children of cannabis users scored more poorly on visual-perceptual tasks, (Colleen, *et al*. 1991). Rats exposed to chronic doses of THC during adolescence evidenced deficits in learning during adulthood (Harte and Dow-Edwards, 2010).

Since functional impairment is likely to precede major structural alterations in the brain, or to manifest concomitant to more minor neural alterations. Thus, it can be a good reason to suspect long-term effects of cannabis use on memory function (Chan, *et al*, 1998). Pope and colleagues (2001) in heavy cannabis users, performance on delayed recall was significantly worse in heavy users, and excessively heavy use in young adults of lower IQ may result in persistent impairment of memory (and other cognitive functions) that may require a much longer period of abstinence to recover.

Prediction of the selected variables: The Kruskal–Wallis one-way analysis of variance by ranks (named after William Kruskal and W. Allen Wallis) of non-parametric method for testing whether samples originate from the same distribution which is equivalent to parametric statistics of one-way analysis of variance (ANOVA). When the Kruskal-Wallis test leads to significant results, then at least one of the samples is different from the other samples. The test does not identify where the differences occur or how many differences actually occur. It is an extension of the Mann–Whitney U test to 3 or more groups. Nonparametric tests use functions of the response ranks, called rank scores (Hajek, 1969). The results of Kruskal Wallis of the dependent variables are presented below:

General Health Questionnaire: The data on GHQ does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Kruskal Wallis Test depicted that there was overall significant effect of GHQ across the groups (X^2 =43.78, df=4, P < 0.00) at .01 level.

Intelligence: The data on intelligence was collected by using Alexander Pass Along Test does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Results on Kruskal Wallis revealed that overall significant effect across the groups (X^2 =24.17, df=4, P < 0.00) at .01 levels on intelligence abilities as cognitive impairments have been found to be greater in cannabis users of lower IQ than in higher IQ users in several studies (Pope, *et al*. 1996), also suggests that perhaps higher IQ individuals are better able to compensate for cannabis related cognitive impairment (Bolla and colleagues, 2002).

Motor Speed: The data on motor speed which was collected by using Finger Tapping Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Results on Kruskal Wallis revealed overall significant effects in the groups (X^2 =12.16, df=4, P < 0.02) at .05 levels on motor speed as THC to impair inhibition, motor impulsivity, and psychomotor control (Moeller, *et al*. 2001).

Mental Speed: The data on mental speed which was collected by using Digit Symbol Substitution Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Results on Kruskal Wallis revealed an overall significant effect across the groups (X^2 =83.95, df=4, P < 0.00) at .01 levels on mental speed.The finding conformed to the earlier study that heavy cannabis users have deficits on measures of ***information processing speed***, compared to 22 controls while abstinent, but not while acutely intoxicated (Kelleher, *et al*. 2004).

Sustained Attention: The data on sustained attention which was collected by using Digit Vigilance Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Results on Kruskal Wallis revealed an overall significant effect across the groups(X^2 =73.92, df=4, P < 0.00) at .01 levels on Sustained attention. Some studies also document impairments in ***attention*** and concentration following administration of small and large doses of THC in cannabis users and non-users compared to placebo administration (Anderson, *et al*. 2010; Ramaekers, *et al*. 2009, 2011; Theunissen, *et al*. 2011).Sustained attention and transient information management are significantly impaired during the drug-induced psychosis state, while selective attention is less affected (Willmore, *et al*. 2008),

Category Fluency: The data on category fluency which was collected by using Animal name Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Results on Kruskal Wallis revealed an overall significant effect across the groups (X^2 =87.89, df=4, P < 0.00) at .01 levels on Category Fluency. The combined THC and CBD, but not THC alone, impaired psychomotor control in cannabis users (Roser, *et al*. 2009).

Working Memory: The data on working memory which was collected by using Verbal N Back Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Kruskal Wallis Test depicted working memory has an overall significant effect across the groups (X^2 =80.99, df=4, P < 0.01) at .01 level. Earlier study also found that THC administration adversely affects on working memory (Crean, *et al*. 2011).

Planning: The data on planning which was collected by using Tower of London Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Kruskal Wallis Test depicted that there was an overall significant effect across the groups (X^2 =31.64, df= 4, P < 0.00) at .01 level on planning. Lyons and colleagues (2004) found that neuropsychological performance deficits among heavy, frequent users of cannabis, not withstanding acute cannabis intoxication.

Set Shifting Ability: The data on set shifting ability which was collected by using Wisconsin Card Sorting Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Kruskal Wallis Test depicted that there was an overall significant effect across the groups (X^2 =73.80, df = 4, P < 0.00) at .01 level on set shifting ability. Findings conform earlier findings that Cannabis during this time period may be disruptive to normal neuro maturation (Bava and Tapert, 2010). Regular heavy marijuana use compromises the ability to learn and remember information primarily by impairing the ability to focus, sustain, and shift attention (Robert, 1996).

Response Inhibition: The data on response inhibition which was collected by using Stroop Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Kruskal Wallis Test depicted that there was an overall significant effect across the groups (X^2 =27.78, df= 4, P < 0.00) at .01 level on response inhibition.THC administration adversely affects inhibition (Crean, *et al*. 2011).

Verbal Comprehension: The data verbal comprehension which was collected by using Token Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Kruskal Wallis on verbal comprehension revealed that there was an overall significant effect across the groups (X^2 =32.56, df=4, P < 0.00) at .01 level on verbal comprehension. Previous work provided evidence that chronic cannabis use leads to long-term deficits of the oculomotor control system (Huestegge, *et al*. 2009). Cannabis users have also been reported to demonstrate deficits in text comprehension (Huestegge, *et al*. 2010).

Verbal Immediate Recall: The data on verbal immediate recall which was collected by using Auditory Verbal Learning Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Kruskal Wallis on verbal immediate recall revealed there was overall significant effect across the groups (X^2 =78.23, df=4, P < 0.00) at .01 level learning and memory. Morgan and colleagues (2010) cannabis users demonstrated poorer performance on immediate and delayed episodic memory (but not verbal and category fluency), immediate and delayed episodic memory, and source memory.

Visual Immediate Recall: The data on visual immediate recall which was collected by using Complex Figure Test of NIMHANS Battery does not meet the parametric statistic assumptions, and analysed by using nonparametric statistics of Kruskal Wallis.

Kruskal Wallis on visual immediate recall revealed there was overall significant effect across the groups(X^2 =121.62, df=4, P < 0.00; at .01 level on learning and memory as earlier research also confirmed that Cannabis has substantial acute effects on human cognition and visuomotor skills (Huestegge, 2010).

Since functional impairment is likely to precede major structural alterations in the brain, or to manifest concomitant to more minor neural alterations. Thus, it can be a good reason to suspect long-term effects of cannabis use on memory function (Chan, *et al*. 1998).Pope and colleagues (2001) in heavy cannabis users, performance on delayed recall was significantly worse in heavy users, and excessively heavy use in young adults of lower IQ may result in persistent impairment of memory (and other cognitive functions) that may require a much longer period of abstinence to recover.

The result findings of this study are summarised in the followings, in relation to the theoretical expectation set forth for the study.

Overall findings met the objectives of the study that cannabis used adversely affected the general health and the neurocognitive domains such as(1) intelligence, (2) motor speed, (3) mental speed, (4) sustain attention, (5) category fluency, (6) working memory, (7) planning, (8) set shifting ability, (9) response inhibition, (10) verbal comprehension, (11) verbal immediate recall, (12) visual immediate recall by cannabis use under various conditions (Crane, *et al*. 2013) as the present study also highlighted mean significant differences between groups, significant correlation between dependent variables, and also among the selected comparision groups on dependents variables.

The study examines the five comparision groups ('two levels of disorder', two levels of 'Onset' with control group non users of marijuana) on measures of the dependent variables. Such as the general health and the neurocognitive domains such as (1) intelligence, (2) motor speed, (3) mental speed, (4) sustain attention, (5) category fluency, (6) working memory, (7) planning, (8) set shifting ability, (9) response inhibition, (10) verbal comprehension, (11) verbal immediate recall, (12) visual immediate recall, and found significant differences between them.

The results from demographic profiles clearly explained some of the cultural specific problems of the selected population regarding the Marijuana User on cognitive deficiencies which got support of earlier studies as expected ; and the finding would replicable in the project population the 'Manipuri'. It was found that maximum numbers of users were school dropout or undermatricute. They have minimum education or qualification. Low socio economic status and large family size have a role in using the substance.

The following hypotheses were set forth for the study of Cognitive deficiency among Marijuana users in Manipur for the proposed research study:

The results provided empirical bases of the hypotheses set forth for the study that:

(2) Significant differences are observed in relation to 'Level of disorder' of marijuana use on GHQ and cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) among the comparision groups.

(2) 'Onset' of marijuana use has manifested differently on GHQ and cognitive abilities (Intelligence, Speed, Attention, Executive Functions, Comprehension, Learning and Memory) among the comparision groups.

(3) Dependency and early onset have more cognitive deficiencies as compared to abuse with late onset.

(4) Early onset of marijuana used and dependence have showed specific cluster of cognitive deficiencies as expected with regards to the main cell of the design.

On the whole the findings of the study provided the component empirical bases that are sufficient enough in conformity with the theoretical expectations set forth to carry out the study.

Limitations and suggestions:

Although, it was designed to be the systematic and authentic research, being the first endeavour, the present study was not free from limitations. Due to time limitation the NIMHANS Battery comprises of many sub set such as trial, error, time taken, immediate recall, and delayed recall and so on. The present study could initiate only the selected variables. It was felt that with complete and more psychological scale(s) tapping wider behavioural gamut by employing larger sample size was ideal to replicate in support of the findings; and also for making generalization in formulating prevention and intervention strategies to help the cannabis users in the selected population under study. The present study could cover only a small part of marijuana users in the selected population; the wider population remains meager and undecided that required further studies on this area. The present study is not sufficient to make generalization on the selected population, which requires further study to cover all range of age, with bigger sample and more psychological tools for methodological concern of internal and external validity.

Suggestions for further research: Studies could examine whether cognitive abilities change over time in more details. The cognitive impairment in cannabis users were in the literature but few studies have conducted longitudinal research to better understand how and when the impairment develops over time.Another interesting area of research to investigate is whether the association between cognitive abilities and cannabis use are different across different ages and culture. Future research could also explore whether the presence of external stressors influences the association between cognitive abilities and cannabis use.

However, the present study was a small step in the long ladder towards authentic academic research work on substance abused especially in the selected population; it would give a resourceful insight into the multi-complex nature of Cannabis user's behavioural; components with the differing levels of disorder and time of onset of marijuana use. The findings advocate urgent attention of the future researchers to provide more empirical bases to the policy makers and bureaucrats for framing government policy and implementation of the policy.

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APPENDIX -1

Demographic Profiles

Demographic Profiles **Code No: ___________**

1. Name: _________________________________ Contact No: _______________
2. Address: ________________________
3. Age: ________
4. Educational Qualification: ____________________
5. No of Sibling: One/Two/More than Two
6. Marital Status: Single/Married
7. Family Type Nuclear/Joint Family.
8. Family Size: Below 5/5-10/Above 10.
9. Status in the Sibling: Elder/Middle/Younger
10. House Type Traditional House/Assam Type/RCC
13. Communication Availability Village Linked/Jeep/Bus
14. Crime committed before Yes/No
15. Having Government job Yes/No
16. Parents having Government job Yes/No
17. Economic Sufficiency Self Sufficient/Not Sufficient
18. Source of Support Mother Alone/Father Alone/Parents
19. Recreation Facility available in the Village Hockey Playground/Football/No
20. Received abandonment from family: Yes/No
21. When did you started taking Marijuana ____________________________
22. Since you have started, for how long you have been doing? _______________________
23. No of previous attempt(s) at quitting which lasted for at least one month? ____________
24. Family history in first- degree relatives; Cannabis use: Yes/ No
25. History of head injury Yes/ No
25. Other substance use Yes/ No
26. Any invitation from friend or other Yes/No
27. Any permission from family: Yes/No
28. Amount of Marijuana consumption in a day/ week/ year _________________________
29. Give your experience on any of the following during in the 12 months preceding the survey:
    - Recurrent marijuana use resulting in failure to fulfill major role obligations;
    - Recurrent marijuana use in physically hazardous situations;
    - Recurrent marijuana-related legal problems; and
    - Continued use despite recurrent or persistent social or interpersonal problems caused or exacerbated by marijuana use.
30. Give your experience on any of the following during in the past-year:
    - Need for increased amounts of marijuana to achieve desired effect;
    - Use of marijuana in larger amounts or over longer periods than intended;
    - Persistent desire or unsuccessful efforts to cut down marijuana use;
    - A great deal of time spent obtaining, using, or recovering from the effects of Marijuana;
    - Giving up important social, occupational, or recreational activities in favor of using Marijuana; and
    - Continued use despite persistent or recurrent physical or psychological problems caused or exacerbated by use.

Thanking you for your kind help!!!

APPENDIX – II

General Health Questionnaire (GHQ -12)

We would like to know how your health has been in general, over the past few weeks, please answer the following questions by circling the number that best applies to you.

Have you recently…………………

		much less than usual	same as usual	more than usual	much more than usual
1.	Been able to concentrate on whatever you are doing?	☐	☐	☐	☐
2.	Lost much sleep over worry?	☐	☐	☐	☐
3.	Felt that you were playing a useful part in things?	☐	☐	☐	☐
4.	Felt capable of making decisions about things?	☐	☐	☐	☐
5.	Felt constantly under strain?	☐	☐	☐	☐
6.	Felt that you couldn't overcome your difficulties?	☐	☐	☐	☐
7.	Been able to enjoy your normal day-to-day activities?	☐	☐	☐	☐
8.	Been able to face up to your problems?	☐	☐	☐	☐
9.	Been feeling unhappy and depressed?	☐	☐	☐	☐
10.	Been losing self-confidence in yourself?	☐	☐	☐	☐
11.	Been thinking of yourself as a worthless person?	☐	☐	☐	☐
12.	Been feeling reasonably happy, all things considered?	☐	☐	☐	☐

Shadharan hakchang ge phibam ge matang hangba wahang ge paring

Makha ge si munna pabiyu:

Adom ge houkhiba mamang ge chayon kharasi ge manungda (nahakki) hakchang nungaikhidaba ana-ayek leikhiba amasung nahakki shadharan oina hakchang ge phibam karam toukhibage haibadu eikhoi khangning e. Hangjariba wahangsing da adom ge phibam ga khwaidage chunana/manana thokpa matangdu chumnata makhada lei e ama chingbira ga (underline tourga) paokhum pibiyu, aduga wahang pumnamak (paokhum pibiyu) khumbiyu. Kaobiroidabadi, eikhoi na khangjaninglib si adom ge houjik houjik mak leiriba/oiriba amasung kuidriba mamang ge matamda oikhiba nungaitaba/anaba ma ong singduge matangdani, kuikhra bage mamang da oikhiba/toukhiba adu nte, masi ning singbi gadabni.

Adomge wahang pumnamak ki paokhumbinaba hotnabiba yamna kanei. Maru oiba thabakni, eikhoibu sahajok/mateng pibiba ge damak adombu thagatchari.

1. Adom ge toubiriba thabak khuding makta pukning thingjin na, choithoktana touba ngambibra?

    a) Hannadage henna fajana touba ngamkhi.
    b) Hannage hannagum adum tou e.
    c) Hannadage khara hanthaba ma ongda lei.
    d) Mamang ngei dage chang yamna hanthei.

2. Thawai waba dage tumba yadaba yamna toubibra ?

    a) Sung tou toude.
    b) Hannage chang dage thoina henjinde.
    c) Hannage chang dage kharadum thoina henjinli.
    d) Hannage dage chang yam henjinli.

3. Thabak pumnamakta adomna maru oiba thoudang ama loubiribni haina pukningda khanbage ma ong toubibra?

    a) Mamang ngei dage khara henna khanbagum tou e.
    b) Hanna ge hanna douna adum lei/oi.
    c) Hanna dage khara kanaba watle haina khanli.
    d) Chang ka henna kanaba thoudang loudre khanli.

4. Hiram/thabak pumnamakta warep/rai louba ngambage shakti leire haina pukningda ningbibra?

    a) Mamang ngei dage khara henna ngamle khanli.
    b) Hanna ge hanna douna adum oi/tou e.
    c) Hanna dage khara hanthana tou e.
    d) Shakti ge chang yamna watna leikhre.

5. Matam chupada awaba, arumba kokthong ama puduna leiba, wakhal wai chin dunata leibagum faobibra?

   a) Sukfao faode/karimata khande.
   b) Hanna oiba chang dage thoina henjinde.
   c) Hanna touba dage thoina khara henna leibagum tou e.
   d) Hanna touba dage yam chang henjinna tou e.

6. Esa ge aruba thabak/shameisya kaya mayoknaduna thengnaduna lak sinba ngamdre haina pukningda khanba leibibra?

   a) Suk lei leikhide.
   b) Hanna ge khanba ge chang dage thoina henjinde.
   c) Hanna khanba dage thoina khara henjina khanbagum tou e.
   d) Hanna touba dage chang yam henjinna khanli.

7. Nongmage toufam/nomfam thokpa thabak-enkhang kaidana adum chathabibra?

   a) Hanna touba dage khara henna nungaina chatthei.
   b) Hanna ge hannagum adum tou e.
   c) Mamang ngei dage chang khara hanthei.
   d) Hanna touramba chang dage yamna henna hanthei.

8. Adom ge shameisya sing mairong yana fajana thengna biba ngambra?

   a) Hanna dage khara henna ningthina thengnaba ngammi.
   b) Hanna ge hannagum adum oi.
   c) Hanna dage chang khara hanthana ngammi.
   d) Yam sathina ngamdre.

9. Thawai nungaitaba amasung monda hanthaba (depressed) thengnabiba faokhibra?

   a) Suk lei leikhide.
   b) Hanna ge oiba chang dage thoina henjinde.
   c) Hanna dage chang khara henjin bagum tou e.
   d) Hanna touba dage chang yam henjinna tou e.

10. Esha etomta tabu thajaba poktaba toubibra?

   a) Suk tou toukhide.
   b) Hanna ge oiba chang dage karisu hende.
   c) Hanna leiramba chang dage khara hanjinli.
   d) Hanna oiramba chang dage yam wang e.

11. Kanadraba mamal yaodraba mini haina esha etomta khanjabra?

    a) Suk khan khande.
    b) Hanna khanbge chang dage karisu henna khande.
    c) Hanna khanba chang dage khara henjinna khanli.
    d) Hanna khanba chang dage yamnamak henjinnli.

12. Maikei/hiram khudingmak loina yenglubada ma ong chana nungaibage wakhal faobibra?

    a) Hanna dage khara henna fajana fao e.
    b) Hanna ge hanna gum adum tou e.
    c) Hanna oiramba chang dage khara hanthei.
    d) Hanna oiramba chang dage yamna henna hanthei.

APPENDIX-III

NIMHANS Neuropsychology Battery (Record Sheet)

Name: - **<u>AVLT</u>** **Date: -**

Sl No	**LIST-A**	Trial 1	Trial 2	Trial 3	Trail 4	Trail 5	**LIST B**		IR-A	DR-A	Recognition
1	Arm						Shoes				**<u>Hits</u>**
2	Cat						Monkey				Mirror **Hammer**
3	Axe						Bowl				**Knife** Candle
4	Bed						Cow				Motorcycle **Axe**
5	Plane						Finger				**Clock** **Chair**
6	Ear						Dress				**Plane** Turtle
7	Dog						Spider				Leg **Dog**
8	Hammer						Cup				Table **Cat**
9	Chair						Bee				Lips Tree
10	Car						Foot				**Arm** Nose
11	Eye						Hat				Sun Truck
12	Horse						Butterfly				**Eye** Fish
13	Knife						Kettle				**Ear** **Horse**
14	Clock						Mouse				**Bike** Stool
15	Bike						Hand				Bus **Bed** **Car**

TOTAL SCORES

Trial-1	Trial-2	Trial-3	Trial-4	Trial-5	LIST B	IR-A	DR	RECOGNITION	
								HITS	
								OMMISSION	
								COMMISSION	

N BACK TEST (Verbal Working Memory)

1 BACK

1	GA	
2	JA	
3	**JA**	
4	CHA	
5	HA	
6	**HA**	
7	SHA	
8	RA	
9	NA	
10	MA	
11	**MA**	
12	KA	
13	PA	
14	**PA**	
15	LA	
16	VA	
17	TA	
18	**TA**	
19	LA	
20	PA	
21	VA	
22	**VA**	
23	DA	
24	**DA**	
25	CHA	
26	SHA	
27	**SHA**	
28	GA	
29	YA	
30	**YA**	

2 BACK

1	NA	
2	GA	
3	**NA**	
4	MA	
5	LA	
6	JA	
7	**LA**	
8	MA	
9	KA	
10	LA	
11	**KA**	
12	JA	
13	YA	
14	MA	
15	**YA**	
16	DHA	
17	BHA	
18	**DHA**	
19	VA	
20	SHA	
21	**VA**	
22	GA	
23	**VA**	
24	**GA**	
25	DA	
26	NA	
27	**DA**	
28	CHA	
29	RA	
30	MA	

	H	O	C	ERROR (O + C)
1 BACK				
2 BACK				

WISCONSIN CARD SORTING TEST (WCST) C F N / C F N

1 C F N O	33 C F N O	1 C F N O	33 C F N O
2 C F N O	34 C F N O	2 C F N O	34 C F N O
3 C F N O	35 C F N O	3 C F N O	35 C F N O
4 C F N O	36 C F N O	4 C F N O	36 C F N O
5 C F N O	37 C F N O	5 C F N O	37 C F N O
6 C F N O	38 C F N O	6 C F N O	38 C F N O
7 C F N O	39 C F N O	7 C F N O	39 C F N O
8 C F N O	40 C F N O	8 C F N O	40 C F N O
9 C F N O	41 C F N O	9 C F N O	41 C F N O
10 C F N O	42 C F N O	10 C F N O	42 C F N O
11 C F N O	43 C F N O	11 C F N O	43 C F N O
12 C F N O	44 C F N O	12 C F N O	44 C F N O
13 C F N O	45 C F N O	13 C F N O	45 C F N O
14 C F N O	46 C F N O	14 C F N O	46 C F N O
15 C F N O	47 C F N O	15 C F N O	47 C F N O
16 C F N O	48 C F N O	16 C F N O	48 C F N O
17 C F N O	49 C F N O	17 C F N O	49 C F N O
18 C F N O	50 C F N O	18 C F N O	50 C F N O
19 C F N O	51 C F N O	19 C F N O	51 C F N O
20 C F N O	52 C F N O	20 C F N O	52 C F N O
21 C F N O	53 C F N O	21 C F N O	53 C F N O
22 C F N O	54 C F N O	22 C F N O	54 C F N O
23 C F N O	55 C F N O	23 C F N O	55 C F N O
24 C F N O	56 C F N O	24 C F N O	56 C F N O
25 C F N O	57 C F N O	25 C F N O	57 C F N O
26 C F N O	58 C F N O	26 C F N O	58 C F N O
27 C F N O	59 C F N O	27 C F N O	59 C F N O
28 C F N O	60 C F N O	28 C F N O	60 C F N O
29 C F N O	61 C F N O	29 C F N O	61 C F N O
30 C F N O	62 C F N O	30 C F N O	62 C F N O
31 C F N O	63 C F N O	31 C F N O	63 C F N O
32 C F N O	64 C F N O	32 C F N O	64 C F N O

Digit Symbol Substitution Test

Name: - Sex: - Age: - Date:-

1	2	3	4	5	6	7	8	9
—	⊥	⊐	L	U	O	^	X	=

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

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

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

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

NIMHANS Neuropsychological Assessment Record sheet

Name: - Sex: - Age: - Date:-

Digit Vigilance Test

Time taken	Misses	Commissions

Colour Trials

Trials	Time taken	Errors	
A			
B			

Digit Symbol Substitution

Time taken	Errors

Finger Tapping Test

	Right	Left
1		
2		
3		
4		
5		
Avg		

Animal Names Test

Scores	

Animal Names:-

Triads Test

	Number	Word
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
Err		

Token Test

I		**II**		**IV**		**IV**	
a		a		a		a	
b		b		b		b	
c		c		c		c	
d		d		d		d	
e						e	
f		III		V		f	
g		a		a		g	
		b		b		h	
		c		c		i	
		d		d		j	
						k	
						l	
		Total				m	

Stroop Test

	Half time	Full time	Errors
Word			
Color			

Complex Figure Test

	Score
Copy	
IR	
CR	

Tower of London Test

Trials	ST	ET	Moves	
II. a				
II. b				
		MT	MM	NMM
III. a				
III. b				
III. c				
III. d				
		MT	MM	NMM
IV. a				
IV. b				
IV. c				
IV. d				
		MT	MM	NMM
V. a				
V. b				
V. c				
V. d				
		MT	MM	NMM
TNMM				

Digit Vigilance Test

Name: - Total time: - Errors: - O C Date:-

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

Appendix- IV

ALEXANDER PASS ALONG PERFORMANCE TEST OF INTELLIGENCE
(SCORING SHEET)

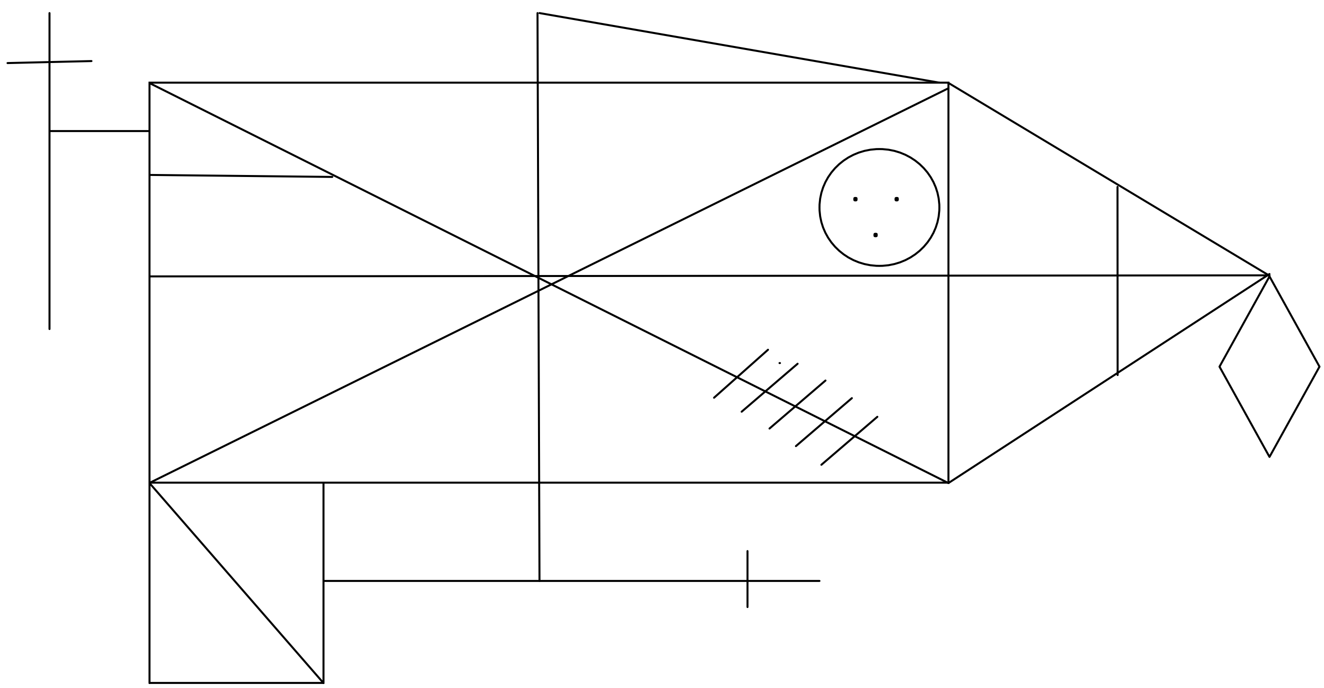
Name: - Sex: - Age: - Date:-

Design. No.	Allotted time (Seconds)	Actual time taken by testee to solve the problem	Score awarded	Remarks
1	120 (2 min)	Seconds :		
2	120 (2)	Seconds :		
3	180 (3)	Seconds :-		
4	180 (3)	Seconds :		
5	180 (3)	Seconds :		
6	180 (3)	Seconds :		
7	180 (3)	Seconds :		
8	240 (4)	Seconds :		
9	300 (5)	Seconds :		
Total Score Obtained :				
CA in Yrs. : MA in Yrs. :				
IQ = MA/CA X 100 =		Category:-…………………………………………		

Signature

APPENDIX –V

Complex Figure Test of NIMHANS Neuropsychology Battery



Token Test of NIMHANS Neuropsychology Battery **APPENDIX-VI**

A. Present only large tokens		
1	Touch a circle	
2	Touch a square	
3	Touch a yellow token	
4	Touch a red token	
5	Touch a green token	
6	Touch a blue token	
7	Touch a white token	
B. Present only large tokens		
8	Touch the yellow square	
9	Touch the blue circle	
10	Touch the green circle	
11	Touch the white square	
C. Present all tokens		
12	Touch the small yellow circle	
13	Touch the large white square	
14	Touch the large blue square	
15	Touch the small green circle	
D. Present large tokens only		
16	Touch the red circle and yellow square	
17	Touch the blue square and white square	
18	Touch the green square and blue circle	
19	Touch the white circle and blue circle	
E. Present all tokens		
20	Touch the large white square and large red circle	
21	Touch the small yellow circle and large green square	
22	Touch the large blue square and large red square	
23	Touch the small white square and large red square	
F. Present large tokens only		
24	Put the red circle on the green square	
25	Touch the blue circle with the red square	
26	Touch the blue circle and the red square	
27	Pick up the blue circle or the red square	
28	Put the green square away from the yellow square	
29	If there is a black circle, pick up the red square	
30	Put the green square beside the red circle	
31	Touch the squares slowly and the circles quickly	
32	Put the red circle between the yellow square and green square	
33	Except for the green one, touch all the circles	
34	Pick up the red circle- no! the white square	
35	Instead of the white square, take the yellow circle	
36	Together with the yellow circle, take the blue circle	

TOKEN TEST ARRANGEMENT OF TOKENS IN FRONT OF SUBJECT

ROW 1					
LARGE CIRCLES IN ORDER	RED	BLUE	YELLOW	WHITE	GREEN
ROW 2					
LARGE SQUARES IN ORDER	BLUE	RED	WHITE	GREEN	YELLOW
ROW 3					
SMALL CIRCLES IN ORDER	WHITE	BLUE	YELLOW	RED	GREEN
ROW 4					
SMALL SQUARES IN ORDER	YELLOW	GREEN	RED	BLUE	WHITE

APPENDIX- VII

Tower of London of NIMHANS Nueropsychology Battery

II MOVES

a)	Green	Red	Blue

b)		Red	
	*	Blue	Green

III MOVES

a)	Blue		
	Green	Red	*

b)	Red	Blue	Green

c)		Green	
	*	Red	Blue

d)		Green	
	Red	Blue	*

IV MOVES

a)	Green		
	Red	Blue	*

b)	Blue	Green	
		Red	*

c)		Blue	
	*	Red	Green

d)	Blue		
	Red	*	Green

V MOVES

a)	Green		
	Blue		
	Red	*	*

b)	Blue		
	Red	Green	*

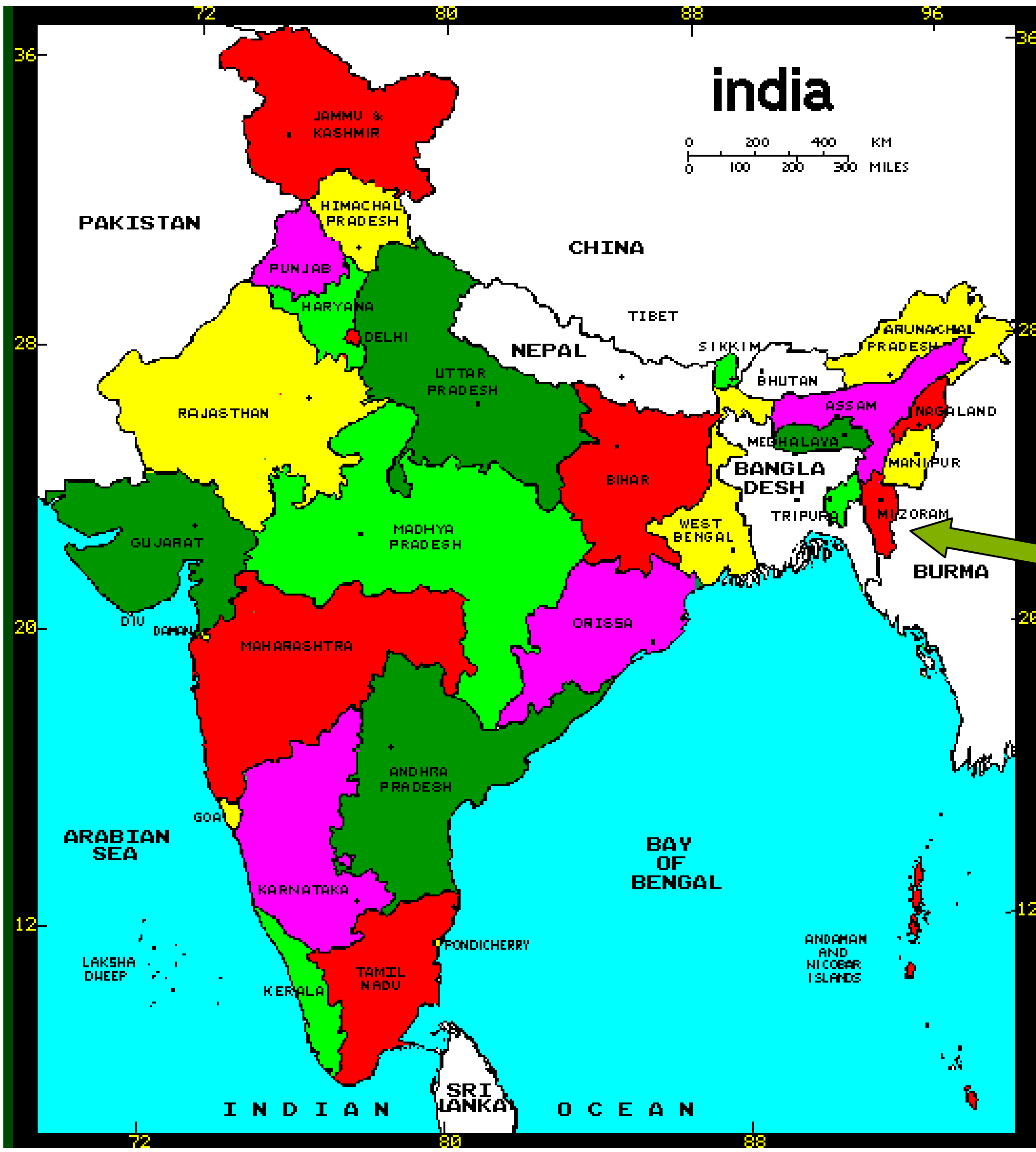
c)	Blue	Red	Green

d)	Blue		
	Green		
	Red	*	*

APPENDIX-VIII

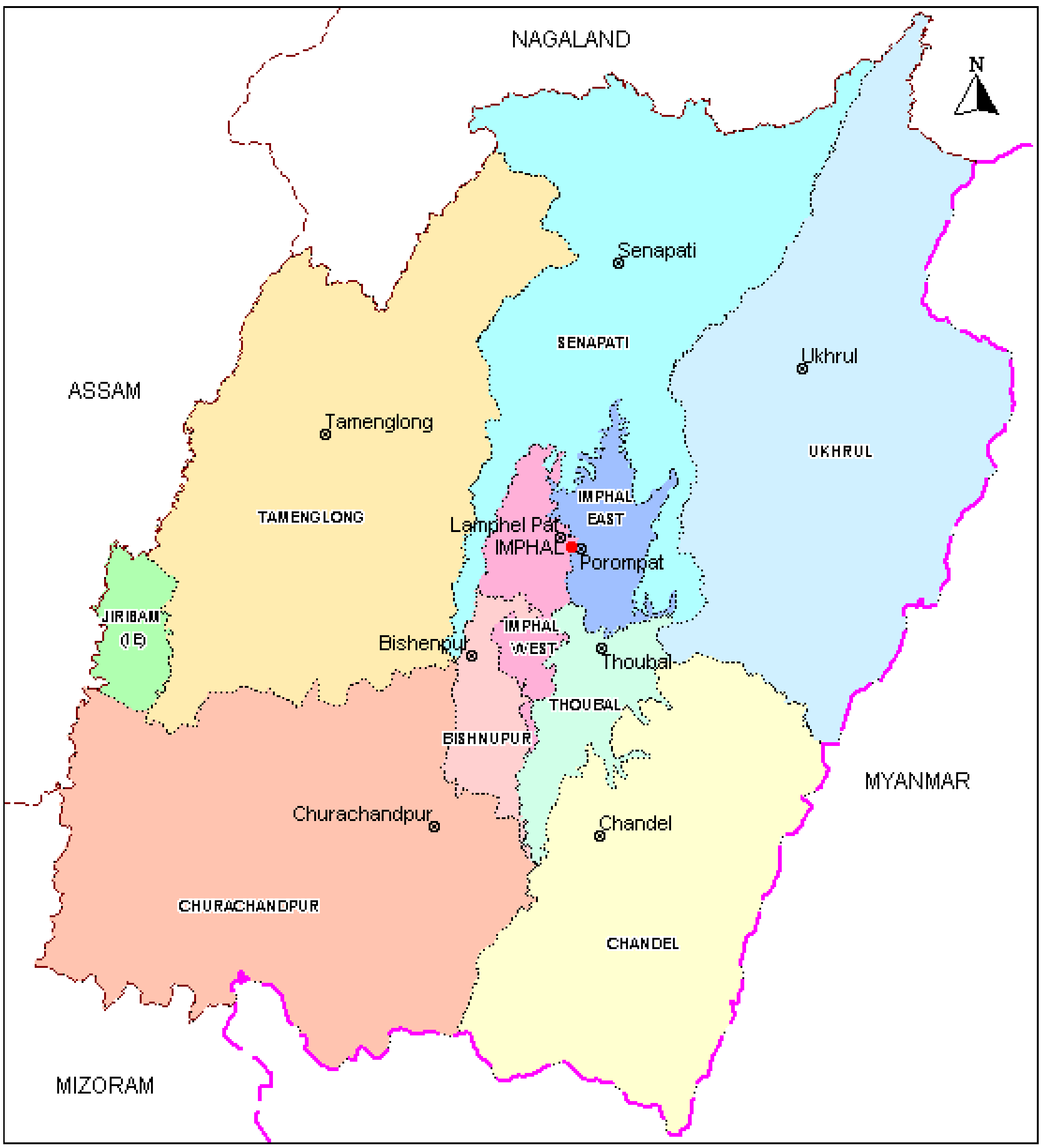
MAP OF INDIA

(Showing the location of Mizoram State)



APPENDIX-IX

MAP OF MANIPUR



DEPARTMENT OF PSYCHOLOGY
MIZORAM UNIVERSITY
MIZORAM: AIZAWL
Tanhril, Aizawl – 796001, Mizoram

PARTICULARS OF THE CANDIDATE

Name of the Candidate	:	Mr. Laishram Devraj
Degree	:	Doctor of Philosophy
Department	:	Psychology
Title of Dissertation	:	"Cognitive Deficiency among Marijuana Users in Manipur: A Psychological Study"
Date of Admission	:	22.07.2010
Approval of Research Proposal		
1. BPGS	:	18.10.2010
2. School Board	:	20.10.2010
Registration No. & Date	:	MZU/Ph. D/349, 20.10.2010
3. Academic Council	:	15.12.2010
Extension (If any)	:	Nil

(ZOKAITLUANGI)
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Department of Psychology