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Vorstand: Prof. Dr. E. Pöppel

**EPISODIC MEMORY IN PATIENTS WITH DISORDERS OF CONSCIOUSNESS  
AND HEALTHY CONTROLS.**

**A study from Nairobi / Kenya**

Dissertation

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Winfred Kitavi

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Berichtserstatter: Prof. Dr. E. Pöppel

Mitberichtserstatter: Priv. Doz. Dr. Michael Riedel

Mitbetreuung durch den  
promovierten Mitarbeiter: Dr. Karin Meißner

Dekan: Prof. Dr. med. Dr. h.c. M. Reiser, FACR, FRCR

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**Episodic memory in patients with disorders of consciousness  
and healthy controls  
A study from Nairobi / Kenia**

Dissertation

W. Kitavi

Department of medical psychology, University of Munich, Germany

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Disturbances of consciousness are often accompanied by impairment of memory. In the clinical context, the most frequently assessed memory system following states of altered consciousness is semantic memory. This study focused on episodic memory and aimed to investigate the effects of brain lesions leading to disorders of consciousness on episodic memory and to gather further evidence supporting theories of episodic memory in a different geographical setting.

The study was conducted at the neurology unit of Nairobi University hospital and in certain residential areas in Nairobi, and it had in total 70 participants (35 patients and 35 healthy controls). Episodic memory was assessed by interviews using a standardized list of questions. Episodic questions referred to personally experienced events and required the subjects to mentally visualize the events before reporting them.

The tasks were designed to test the episodic memories of the recent and remote past. In all cases a free recall approach was applied, and there was no time limit for the production and description of events. During the interviews, attention was paid to the number of pictures retrieved in each task, the spontaneity in response, details with which the events were described, and the content of the events.

The performance of the patients and controls was determined by the total number of pictures retrieved. The Mann-Whitney U-test showed that control subjects produced a significantly larger number of pictures compared to the patients ( $U=387.500$ ,  $P=0.008$ ), suggesting the deficits in episodic memory in the patients. Tests were also carried out to compare the performance of subjects in different age groups. Contrary to previous assumptions, episodic memory could not be proved to decline with age. Additionally, emotions were found to play a key role in the retrieval of episodic memories. Events that had been encoded with greater

emotional contents were more clearly recalled even if they lay far back in time, whereas non-emotional events were found to fade with time.

These results indicate the necessity to introduce standardized tests to evaluate the episodic memory, which could advance our understanding of potential mechanisms of cognitive functions in the brain.

# **Untersuchung des episodischen Gedächtnisses bei Patienten mit Bewusstseinstörungen und gesunden Probanden**

## **Eine Studie aus Nairobi / Kenia**

Dissertation

W. Kitavi

Institut für medizinische Psychologie, Ludwig-Maximilians-Universität München

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Störungen des Bewusstseins werden oft von Beeinträchtigungen des Gedächtnisses begleitet. Das menschliche Gedächtnis unterscheidet zwei Formen des Expliziten Gedächtnisses, das Semantische und das Episodische. Im klinischen Alltag wird nach Gehirnläsionen mit Störungen des Bewusstseins oft nur das semantische Gedächtnis untersucht.

In der vorliegenden Arbeit wurde das episodische Gedächtnis untersucht, um mögliche Auswirkungen von Gehirnläsionen mit folgenden Störungen des Bewusstseins auf diese Form des Gedächtnisses zu bestimmen. Die Studie wurde in der Klinik für Neurologie am Universitätsklinikum von Nairobi und in Wohngegenden von Nairobi durchgeführt und hatte insgesamt 70 Teilnehmer (35 Patienten und 35 gesunde Probanden). Das episodische Gedächtnis wurde anhand eines standardisierten Fragebogens untersucht. Die Fragen bezogen sich auf persönlich erlebte Ereignisse der Vergangenheit. Das Abrufen von Bildern erfolgte ohne Denkanstöße und es gab keine Einschränkung im Bezug auf Assoziationen.

Der Leistungsvergleich zwischen Patienten und gesunden Probanden wurde anhand der Anzahl der abgerufenen Bilder getroffen. Es konnte gezeigt werden, dass die gesunden Probanden im Vergleich zu den Patienten deutlich mehr Bilder aus ihrem episodischen Gedächtnis abrufen konnten. Dies weist auf Defizite der Gedächtnisleistung in der Gruppe der Patienten hin.

Im Vergleich von Studienteilnehmern verschiedener Altersgruppen zeigte sich, entgegen den Erwartungen, dass das Abrufen autobiographischer Ereignisse nicht mit dem Alter nachlässt. Zudem konnte gezeigt werden, dass Emotionen eine Schlüsselrolle beim Abrufen von episodischen Ereignissen spielten. An Ereignisse, die mit größerem emotionalen Inhalt gespeichert worden waren, wurde eindeutig erinnert, selbst wenn sie weit zurück lagen. Nicht emotionale Ereignisse dagegen verblassten mit der Zeit.

Diese Ergebnisse unterstreichen die Notwendigkeit, standardisierte Tests einzuführen, um das episodische Gedächtnis zu untersuchen. Ein solcher Schritt könnte unser Verständnis von Informationsverarbeitung und kognitiven Funktionen im Gehirn verbessern.

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## 1. INTRODUCTION

Disturbances of consciousness and memory impairment often occur together. Cortical and sub-cortical structures that subservise memory are likewise necessary for the formation of consciousness. Thus, injury to any of these brain structures may lead to a change in the level of awareness and may be accompanied by impairment of memory. Memory is classified into multiple systems each containing different information. Subsequently, amnesia (memory loss) can occur for a single system or for a combination of systems.

The nature of memory that was evaluated in this study is called episodic memory. It is a memory system that allows individuals to mentally travel to their past and to retrieve events that occurred at a particular time and place. Recently, there has been use of experiments for research in this field. This notwithstanding, I opted to use the technique of introspection in this study as it allows the subjects more freedom to report their associations and because it could deliver unanticipated results. Introspection involves asking the concerned about their past experiences and requires the particular person to look within themselves and report their experiences, emotions and sensations presenting the observer with a picture.

This study of episodic memory focused on subjects who had suffered disturbances of consciousness, paying no attention to aetiology, lesion size or location. The study aimed at accumulating evidence in support of the concept of episodic memory in a different geographical setting, and further to establish if episodic memory was affected following disorders of consciousness. Despite our present knowledge on memory systems, tests are rarely carried out to assess episodic memory following brain lesions or diminished level of consciousness but are routinely carried out to establish semantic memory. This is probably due to the fact that semantic memory is easier to assess as it contains facts about the world that can be memorized and then tested by asking the subject to recall information previously given to him. Episodic memory on the other hand, contains information about the past that is personal, and which cannot be learned by heart.

According to theory, episodic memory evolved out of semantic memory. Tulving (2002) states: "Episodic memory is a recently evolved, late-developing, and early deteriorating past-oriented memory system, more vulnerable than other memory systems to neuronal dysfunction, and probably unique to humans". Concisely, I engaged to find out the features that define this memory system and make it distinguishable from other memory

systems. Accordingly, I had to find answers to questions that have been posed in relation to episodic memory - to what extent could people remember events happening in their lives in the recent and remote past, - what do they remember, - at what age do humans develop a functioning episodic memory and - does episodic memory degenerate with time and age.

This research is important as it could reinforce the findings of initial studies on episodic memory and therefore further our understanding of brain mechanisms. Additionally, the study may also provide some information on the anthropological universals of episodic memory, if the results are compared with those obtained in other geographical settings. Pertaining to consciousness and its disturbances, the study may give some answers as to how brain lesions leading to states of altered consciousness may affect episodic memory since it has been shown in previous studies that episodic memory is very vulnerable to focal and diffuse brain damage.

## **2. Memory**

Memory is a function of the brain that entails acquisition, retention and retrieval of information. Stored contents can be accessed through free recall, cued recall or recognition.

### **2.1 Classifications of memory**

Human memory constitutes many separable systems. Two types of memory, short-term and long-term, are distinguished based on capacity and duration of storage. Short-term memory defines the memory that has a duration of about half a minute and whose capacity is limited to about 10 items. Long-term memory which can be subdivided into recent memory (lasting minutes to months) and remote memory (lasting months to years) contains - needless to say - a much larger storage capacity.

Advances in the investigation of memory have led to additional classifications of memory on the part of psychologists. Two major forms are distinguished based on the type of information to be remembered: Implicit and explicit memory.

Implicit (nondeclarative) memory is a form of memory that is involved in the acquisition and retention of a skill or procedure such as riding a bicycle, getting dressed or playing a sport. The retrieval of this information occurs unintentionally, and does not require conscious experience.

Explicit (declarative) memory contains recent and remote information and is further divisible into episodic and semantic memory. The former refers to personally experienced events which must be consciously retrieved to be remembered. The latter contains our knowledge about the world which must be acquired by study. Personal semantics refers to facts about oneself such as our place of birth, where, where we lived, who our friends were and so on and is a component of semantic memory (Cermak & O'Connor, 1983; Kopelman et al., 1989).

## 2.2 Episodic memory

### Literature review

The concept of episodic memory was first proposed some 30 years ago (Tulving 1972), and has since undergone various revisions. It is a unique memory system that enables us to remember specific events in our lives. It contains information about personal events, when and where they occurred, and is also referred to as autobiographical memory. Owing to this personal component, episodic memory gives us a sense of identity (episodic amnesia means a loss of identity). The ability to recreate past events occurs only in a state of conscious awareness of our experiences.

Tulving also uses the phrase “mental time travel” to refer to the ability to relive past events. He proposes that mental time travel depends upon three components: 1.a sense of subjective time; 2.autonoetic awareness and 3.a‘self’ that is capable of travelling in subjective time. Autonoesis is a characteristic of episodic memory which describes conscious awareness while remembering occurrences of the past.

Remembering an event that occurred in one’s life a year ago, requires one to mentally travel back in subjective time and to recreate the event. This ability to imagine things that occurred in the past is in Tulving’s view unique to human beings. The development of a fully functioning episodic memory occurs at about the age of 4 years (Perner & Ruffman 1995, Nelson 1993). In the foregoing time, young children acquire their knowledge and skills in the absence of autonoesis and without sense of self in subjective time.

A mental journey to the past is mostly intentional but may sometimes occur automatically. Certainly, many a reader has experienced spontaneous recollections that were triggered by familiar sensations e.g. a picture of a beach could spark off memories of our past vacations. Further, the retention of autobiographical events occurs automatically and without effort. For instance, we usually remember travelling to a different place even without intending to encode this information in our memory. The fact that the retention of episodes occurs involuntarily proves that this memory system benefits humans; - it is crucial in the acquisition of survival skills and defines not only the past life but also the present and the future.

Autobiographical memories are usually embedded in a rich context, whereas the context is lost in semantic memory. (One may remember a lot of facts learned in school, but not the context in which the facts were acquired).

Neural substrates associated with episodic memory include the hippocampus, medial temporal lobe regions, retrosplenial cortex, precuneus, posterior cingulate gyrus and prefrontal cortex. (For reviews, see Graham et al. 1999, Tranel et al. 1997, Martin & Chao 2001; Thompson–Schill, 2003). Neural correlates of episodic memory have largely been identified using functional neuroimaging.

### Previous research

#### Toronto

The most famous case study on episodic memory is that of K.C. which took place at the University of Toronto over a number of years. At 30 years of age, K.C. suffered a head injury with severe brain lesions and subsequent amnesia following a motorcycle accident. Although he recovered and regained full mental faculties, there was a persisting asymmetry of his explicit memory; semantic information acquired before the injury remained intact, whereas episodic information was impaired. Even years after the head injury, K.C. has continued to deny the recollection of any personal events from his birth till the time of investigation no matter how often this information has been given to him. This striking case and other (even though less severe) similar cases were a pointer to the existence of episodic memory as a separate entity of memory.

#### Innsbruck

In 2002, a group of students in the Department of Psychology at Innsbruck University began studies on episodic memory under the supervision of Prof. Pöppel. The students carried out studies of episodic memory on different samples for their diploma thesis. The studies were designed to test for recent and remote episodic memories of subjects and to evaluate the characteristics of episodic memory. Introspection was used in all groups.

The comparison of different groups (men and women of different age groups, catholic nuns, monks, patients suffering major depression ) led to similar conclusions. Regarding the number of pictures, the students concluded that at any one particular time, only a certain number of pictures (a few hundred) can be derived from episodic memory, and

that this limit cannot be exceeded. The mean average of pictures of the day before ranged from 3.21 to 21.6 pictures.

Other features of episodic memory:

A significant amount of the pictures recalled involved humans and their relationships. Emotions were found to play a major role in the encoding and retrieval of episodic memories. Besides, the subject's state of emotion at the time of the interview had no impact on the emotionality of pictures produced during the interview.

The students also found that emotional pictures were clearer and contained more detail than non-emotional pictures. During introspection, pictures of the recent past were described as dynamic, whereas pictures of the remote past were described as static. In a study across a population of young male adults, subjects who were extraverted produced a larger amount of pictures than their introverted counterparts.

In some cases pictures of the remote past were black and white, whereas pictures of the recent past were all colored. The subjects with depressive disorder produced a significantly smaller amount of pictures compared to all other subjects. All episodes relived were fixed in time and space.

Criticisms of episodic memory:

The existence of episodic memory as a separate entity of memory has yet to become generally accepted. A lot of controversy arose when Tulving first suggested that episodic and semantic memory were two "functionally different memory systems" (Tulving 1983). The hypothesis was rejected for lack of enough evidence and there ensued severe criticism against him for wanting to disintegrate memory. Critics view episodic memory as part of semantic memory and advocate the status quo of unitary memory.

Numerous studies in this field have led to increasing evidence that the two memory systems (semantic and episodic memory) can be separated functionally and biologically. The idea of episodic memory is here to stay. One could either reject it for lack of substantial evidence or embrace it and join forces with others in the search for more evidence.

### **3. Consciousness**

#### **3.1 Human consciousness and its impairment**

My interest in the subject of consciousness began when I was undergoing my first practical training in general medicine during which I encountered patients who had sustained head injuries and subsequently lost consciousness for a while. On awakening and during assessment of their mental status (including memory evaluation), most patients display a satisfactory performance. The majority of the standardized tests have, however, been designed to assess only semantic memory. Aware of this fact, I wanted to check for disturbances in recollection of personal experiences since this memory system is known to be quite sensitive to damage. Episodic memory is particularly important following such incidences because its loss usually means a loss of one's identity.

At this stage, it is important to give an overview of the subject of consciousness, its anatomical and functional correlates and further its maintenance and impairment. It is also necessary to distinguish sleep from unconsciousness because the two states have superficial similarities but are actually quite different.

A comprehensive review of this concept is beyond the scope of this study. Readers are referred to my sources in which the complexity of brain mechanisms underlying consciousness and its disorders are elaborated.

##### **3.1.1 Definition and classification:**

What is consciousness? Plum and Posner (1969) defined consciousness as; "the state of awareness of self and the environment". In general, two physiological components of consciousness are distinguished: arousal and awareness.

**Awareness** can be classified into self-awareness and environmental awareness. A normal state of awareness is that whereby a person is aware of and able to respond to internal needs e.g. hunger or the urge to empty one's bladder and to external stimuli e.g. noise, touch, painful stimulation danger etc.

**Arousal** basically defines the level of wakefulness/ alertness and can range from alert wakefulness to deep coma. We all experience transitions in the levels of wakefulness throughout the day; for example early in the morning when the alarm clock rings a lot of

people experience some form of ‘normal drowsiness’, whereby they are slow to respond to external stimuli but can actually still respond adequately. A few hours later, cerebral neuronal activity reaches its maximum and at this stage we are known to be most alert i.e. we experience the state of alert wakefulness our reaction time reduces and we are quicker to respond to external stimuli. Cerebral activity and therefore level of wakefulness varies through out the day reaching its high most a few hours after arousal and its low point a few hours after we fall asleep (stages 3 and 4 of non-REM sleep also known as deep sleep stage).

Briefly, consciousness in the medical context means awareness of the ongoings within and without oneself and having the capacity to respond adequately to external and internal stimuli. Sleep is a normal variation of consciousness and it shall be discussed in more detail in a later chapter.

### **Meditation:**

Meditation has been practiced in religious context for many centuries and basically means ‘awareness’, i.e. awareness of a process, object or anything in the absence of all thoughts and distractions. Meditation is usually practiced in order to achieve a “higher” state of consciousness, attention and a more relaxed and peaceful state of mind.

### **3.1.2 Anatomical representation:**

In my review of available sources, I came across different proposals for the structural localization of consciousness. It seems to be generally accepted that multiple neuronal structures rather than a single neural structure are essential for the maintenance of consciousness. Brain areas that have been identified include cerebral cortex, ascending reticulo-activating system (ARAS) of the brainstem, thalamic nuclei and non-thalamic sub-cortical systems. The state of wakefulness is believed to depend on a continuous inflow of ascending impulses from the ARAS that maintains the central tone of the forebrain.

Equally essential for the maintenance of consciousness is an equilibrium in the neurotransmission. Noradrenergic, dopaminergic, serotonergic and cholinergic neurotransmitters are involved in the modulation of the level of consciousness.

Damage of the aforementioned brain structures, metabolic derangement of the system, as well as an imbalance in the neurotransmission are capable of causing disturbances of consciousness or reducing the content or level of awareness.

### **3.1.3 Manifestation and aetiology of impaired consciousness**

Disturbances of consciousness are characterized by inadequate responsiveness and diminished level of arousal or unarousability. Disorders of consciousness may be attended by a variety of focal neurological signs, seizures, impairment of cognitive function, abnormal psychomotor behaviour or behavioural alterations.

Various etiological factors affecting the integrity of the arousal system singly or in combination lead to states of impaired consciousness. A list of this factors can be viewed in table 1-I

Table 1-I outline of causes of coma / impaired consciousness

#### A. metabolic

- Hypoglycaemia
- Diabetic mellitus
- Renal failure
- Hepatic failure
- Hypothermia
- Hypothyroidism
- Cardiorespiratory failure
- Hypoxic encephalopathy

#### B. drug overdose (including alcohol)

#### C. Structural

Diffuse

- Meningitis
- Encephalitis

- Other infections (e.g. cerebral malaria)
- Subarachnoid haemorrhage
- Epilepsy
- Head injury
- Hypertensive encephalopathy

Focal

Supratentorial lesions

- Cerebral lesions
- Cerebral haemorrhage
- Cerebral infarctions with oedema
- Subdural haematoma
- Extradural haematoma
- Tumour
- Cerebral abscess
- Pituitary apoplexy

Subtentorial lesions

- Cerebellar haemorrhage
- Pontine haemorrhage
- Brainstem infarction
- Tumour
- Cerebellar abscess
- Secondary effects of transtentorial herniation of brain due to cerebral mass lesions

### **3.1.4 Diagnosis of impaired consciousness**

The clinical approach of patients with altered consciousness which is characterized by one or a combination of the following; - abnormal response to external stimuli, diminished level of arousability, disorientation, disturbance of higher level function and cognitive function - differs from that of conscious patients and usually requires a structured assessment. In order to define the degree of altered consciousness, the Glasgow Coma Scale is commonly used. It is also an important instrument in the

assessment of clinical progress or detection of deterioration. Additionally, it is crucial to take a good history (usually from witnesses), examine the patient and observe the patient's behaviour.

The Glasgow Coma or Responsiveness Scale describes three categories of performance: - eye opening to command, verbal response and motor response. The best score is 15 and the worst is 3, which represents no response in all of the 3 categories. In the Kenyan setting, a high score does not necessarily mean better chances of survival or recovery.

<i>Eye opening</i>		<i>Best verbal response</i>		<i>Best motor response</i>	
spontaneous	4	orientated	5	Obeys commands	6
To sound	3	confused	4	Localizes pain	5
To pain	2	inappropriate	3	Normal withdrawal	4
never	1	incomprehensible	2	Flexion(abnormal)	3
		none	1	Abnormal extension	2
				none	1

The Glasgow Coma Scale (GCS)

### 3.1.5 Grading of impaired consciousness

I Drowsiness is a disorder that simulates light sleep from which the patient can easily be aroused by touch or noise and can maintain alertness for some time.

II Stupor defines a state in which the patient can be awakened only by vigorous stimuli and effort to avoid discomfort or aggravating stimulation is displayed.

III Coma is defined as unarousability and unresponsiveness. Patients make no attempt to avoid painful stimuli.

Delirium, also referred to as an 'acute confusional state' in general medicine, is clinically not easy to distinguish from the other states of impaired consciousness partly because they are produced by many of the same medical conditions. Delirium more often than not progresses into stupor or coma.

### **3.1.6 Wakefulness, sleep and unconsciousness**

Features of impaired consciousness have been discussed above. The following is a basic outline of the features of sleep and which also highlights the characteristics that distinguish sleep from diminished consciousness. Although a state of altered consciousness, sleep has been proved to have restorative functions and is thus essential for survival of humans. It is a periodical interruption of waking consciousness and is broadly classified into REM-sleep and non-REM sleep. Sleep follows a particular pattern depending on age. Three quarters of the adult population shows a 24-hour sleep-wake cycle, with predominance of daytime wakefulness and night time sleep.

Mechanisms that are thought to underlie normal wakefulness and therefore also play a role in the regulation the sleep- wake -cycle include:

-Normal neurotransmission

-Integrity of brain structures that subserve consciousness

-Normal cerebral blood flow (oxygen supply to the brain)

The neural structure that controls the circadian rhythm is thought to reside in the ventral anterior region of the hypothalamus –the suprachiasmatic nuclei.

A person in their sleep (motionless, inactive) may appear to be unconscious on the first instance. His ability to respond to external stimuli from this state (sleep), however, remains preserved whereas it is lacking in the unconscious state. To distinguish between the states of wakefulness, sleep and unconsciousness, methods such as measurement of cerebral blood flow and EEG-pattern can be applied. Cerebral blood flow and EEG pattern ( indication of cerebral neuronal activity) have been found to correlate with levels of consciousness. As a general rule, fast beta frequency (13-30 Hz) is associated with the alert waking state. During the relaxed waking state, the EEG displays alpha-waves of 9-11 Hz and a low voltage fast activity pattern. Cerebral blood flow is high in the waking state and has been found to remain stable during non-REM sleep and to increase during REM-sleep.

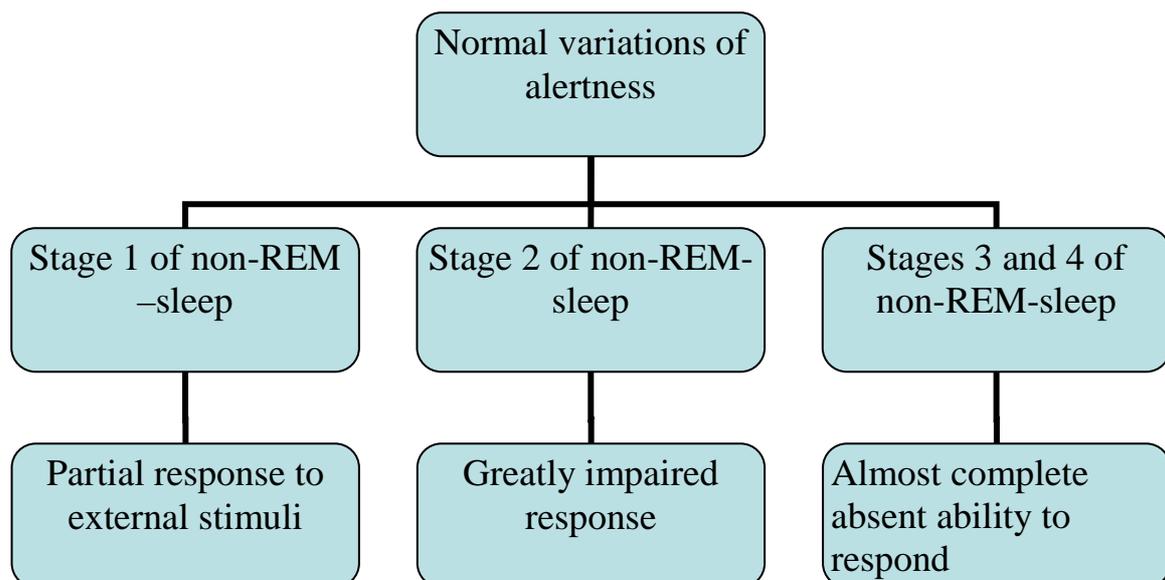
EEG patterns during sleep also vary continually depending on sleep stage. During REM-sleep, the EEG shows a low voltage, fast activity pattern that is similar but not identical

to that of the waking state. The unconscious state, however, is characterized by reduced neuronal activity. During states of impaired consciousness, cerebral blood flow is reduced and the EEG displays a low voltage slow activity pattern.

Sleep and unconsciousness also differ in their arousal threshold. The threshold for arousal is higher in states of impaired consciousness than in sleep. (Vigorous stimuli are necessary to arouse stuporous patients, whereas a sleeping person can be easily awakened). Notably, the threshold for arousal during sleep also varies depending on sleep stage. It is highest in stages 3 and 4 of non-REM-sleep (deep sleep stages), during which the EEG displays a slow activity pattern. At this stage we are said to be desynchronized from the environment. Response to external stimuli would take much longer and even response to inner needs may not occur automatically. This is said to be the stage in sleep when bed-wetting occurs.

Conclusively, sleep is a highly active state during which neuronal activity matches that of the waking state. In contrast, cerebral function is low in states of impaired consciousness. The ability to respond to stimuli remains preserved, though with a lengthened reaction time. Thus, sleep can easily be distinguished from the unconscious state.

The following illustrates some normal variations of alertness based on response latency to various external stimuli.



## **4. Methods and study**

### **4.1 Geographical location**

This study was conducted at the neurology unit of Kenyatta national hospital (University of Nairobi), little sisters of the poor old people's home (Nairobi) and other residential areas in Nairobi. Kenyatta national hospital is the oldest hospital in Kenya. It is a national referral, teaching and research hospital of the University of Nairobi. As the name suggests, it is the sort of place where people from all parts of the country and from all walks of life are unified. Being a public institution, Kenyatta offers health services at affordable prices and sometimes costs are even subsidized for the neediest. So it was easy to find Kenyans of all age groups, representing different ethnic groups, and who had different social and educational background.

The neurology department has a capacity of about 42 beds and is divided into a male and female ward. Sometimes, however, patients who have no neurological disease are also treated in this unit. Apparently, people who go to Kenyatta are used to having students in the wards, asking questions and examining them, so it was not a surprise to many when I asked them if they could participate in the study. I was turned down only few times and most of the time people gave their consent to take part in the study.

### **4.2 Definition of study subjects**

Adult patients who were admitted with acute confusional state (delirium) or with diminished level of consciousness (drowsiness or stupor) and who post morbidly fulfil the criteria outlined below:

- Normal level of consciousness
- Well oriented in time; space and person
- language comprehension and expression is normal
- Ability to concentrate and maintain focused attention are normal
- Thought processes are clear
- Verbal response and response to commands is normal

Symptoms had to be acute and occurring for the first time.

N= 35 Participants, ranging between 19 and 77 years of age (14 male, 21 female).

Medical conditions observed on my subjects are:

Meningitis

Encephalitis

Malaria

Enteric fever

Metabolic derangements, e.g. hyperosmolarity, hypoglycaemia

Stroke

Head injury

Cerebral venous sinus thrombosis

Cerebral abscess

As part of the medical team at the department of neurology I was involved in the medical care of possible study participants from the time of admission to recovery. This entailed finding historical information about the onset of their illness, past medical history, clinical examination, daily observation and medical follow-up until subjects fully regained consciousness and mental faculties. Sufficiently recovered subjects were interviewed within a few days of recovery. In average, subjects were interviewed 10-15 days from the time of admission. Mortality rates are high in patients who are unarousable for more than three weeks.

### **4.3 Definition of Control subjects**

I identify the controls this way: - Individuals above 19 years of age, not diseased and who have no medical history of disordered of consciousness. These individuals were selected from different residential areas in Nairobi and include some relative and friends. Most of the elderly live at the little sisters of the poor old people's home - commonly known as nyumba ya wazee (Swahili for old people's home) - in Nairobi. The congregation of the little sisters of the poor are a non-profit-organisation who run homes for the elderly poor all over the world. The home in Nairobi is situated in Ruaraka, a residential area at the outskirts of the city.

N= 35 Participants, ranging 23 and 103 years of age (18 male, 17 female).

#### 4.4 Demographic data

The sample size comprised 70 native Kenyans. 35 subjects who had suffered disorders of consciousness and 35 healthy controls. The study participants belong to different ethnic groups and are aged between 19 and 103 years. More female than males participated in the study (38 female, and 32 males). Twenty study participants are aged 35 and below. The age bracket 36 to 60 years has the most study participants, i.e. 32 in total.

The least number of participants (18 altogether), is of the age bracket 61 and above. Most study participants in this age group reside in little sisters of the poor old people's home in Nairobi. Initially, I lacked control subjects in this age bracket. For a person who is familiar with the settlement pattern in Kenya, the fact that a lot of people aged 70 and above do not live in the city does not come as a surprise: They usually leave the city after retirement to settle in the districts. Going to the districts in search of them would have meant over-stretching my time budget. I was lucky because the administration of the old people's home, granted me access to the institution thus facilitating my project in many ways.

	<b>N</b>	<b>subjects</b>	<b>controls</b>
<b>Sample size</b>	70	35	35
<b>female</b>	38	21	17
<b>male</b>	32	14	18

**Table 1: study participants**

#### 4.5 Method of Data collection

A pilot study was conducted in the same geographical location in August of 2004. The purpose of the initial study was not just to test the design but also the practicability of the technique used to study episodic memory. The pilot study had a total of 23 participants and laid a foundation for the current study. In the conducted preliminary research, it turned out that the only reliable way to obtain information about autobiographical events in an individual's life is by asking the concerned himself. For this purpose, the subjects

were presented with a task-sheet containing a list of questions. The tasks in the preliminary study are similar to those presented in the current study.

Initially, subjects received the list of questions a day or two before the set date of interview. Although subjects proved to be well prepared, spontaneity could not be observed during the interview. In the current study, a visit was paid to the subjects a day before the interview and they were instructed in order to mentally prepare them for the interview. As opposed to the approach in the pilot study, subjects are not presented with the list of questions a day before the interview.

My approach to the subjects is quite similar to that applied by physicians on a daily basis. It involves interviewing (tasks) as well as taking medical history, observation, listening and probing when necessary. The subjects are a key source of information and it is therefore essential to rely on their answers. The information obtained verbal or non-verbal sums up to a significant amount of data.

In this study, tasks are designed to determine personal episodes that are encoded in our memory and which have to be visualised on retrieval. Subjects were instructed to recall an event in their recent or remote past, mentally visualize it (picturize) and recount the same while paying attention to vividness, detail and color. Additionally, tasks were designed to test for accompanying emotions, location information, content and other accompanying sensations. There was no time limit for the interview nor use of cues to aid recollection. All memories are based on free recall. Subjects were asked to relate as many pictures as they could come up with.

While the subjects related their recollections, I recorded the information given in a form. In the entire duration of the interview, subjects were observed and checked for hesitancy, fluency or difficulty in recalling pictures. They were occasionally interrupted and asked to fill out missing information, specifically, emotions and personal significance. In most cases, contextual information was delivered spontaneously. In spite of misgivings at the beginning that the subjects might be tempted to conceal information, a majority of subjects revealed a lot of personal information, spontaneously.

#### 4.5.1 List of questions

All study subjects were asked each of the following questions. After they reproduced and described a picture, subjects were then asked to fill in information related to the picture (details, colour, emotion) if this had not already been conveyed. Since my intention was especially to test the spontaneity with which the pictures were generated, I moved on to the next question if subjects indicated they had difficulty, e.g. if the subject said they could not recall any pictures or following a long pause.

What is present in your memory as a picture?

- Yesterday
- Last week
- Last month
- Last year
- Early adult life
- Childhood

Could you describe everything about the picture?

Is the picture clear? Detailed?

Does the picture have colour or not?

Feelings to the picture? Accompanying emotions?

What time of the day are the events taking place? Morning? Evening? Afternoon?

Do you remember the exact place?

Do you recall sound? Smell? Taste? i.e. accompanying sensations

Do you have a memory of early childhood?

What is the earliest age of which you can retrieve a picture?

#### **4.5.2 Tasks in summary**

Task: To recall pictures of recent life and events which occurred in various age periods of life.

Task 1 To recall pictures of previous day

Task 2 To recall picture of previous week

Task 3 To recall picture of month before

Task 4 To recall picture of year before

Task5 To recall picture of puberty /early adult life (14 -  $\leq 25$  years of age)

Task6 To recall pictures of childhood ( $\leq 13$  years of age)

Task7 To recall pictures of early childhood ( $\leq 8$  years of age)

Task8 Earliest age of which a picture can be retrieved

At first, early childhood was defined as the age period below 5 years of age, it was later redefined to represent the age bracket below 8 years due to difficulty to recall on the side of subjects.

### **4.5.3 Introspection as method of data collection/ limitations of introspection**

Introspection is a self –examination process which involves intentional observation and reporting of one’s inner thoughts, emotions and sensations. It is a well known fact, that in scientific research one should use techniques that adhere to certain rules like objectivity, reliability and validity:

**Objectivity** refers to the fact that similar results of measurement are obtained independent of the individual person who conducts or proposes a measuring process.

**Reliability** refers to repetition of results over repeated tests of the same subject under identical conditions.

**Validity** refers to the degree to which a test measures what it was supposed to measure.

These criteria can only be fulfilled if measuring tools are available. Introspection does not adhere to all of these rules and scientists have therefore failed to acknowledge introspection as a valid method of investigation. It is argued that the information gathered is subjective and immeasurable. Other reasons as to why this method is objected to, is the fear that vital information is withheld or regarded as not important by the concerned. Invariably, the opinion as to what is relevant or not may vary between the interviewer and interviewee depending on the issue at hand.

Whereas critics may be right, it is important to be aware of the benefits of this technique. Introspection is applied successfully by medical doctors on a day-to-day basis. In practice, a patient communicates his subjective state of well-being to a doctor who can in turn use other methods such as laboratory tests and imaging (x-ray and other) to objectify this information. Introspection is the only way to get access to first hand information and learn about circumstances surrounding any illness. It is indeed essential to rely on this information. In the analysis and treatment of psychiatric disorders for instance, doctors and therapists rely almost entirely on information obtained through interview and observation of the patient. Seldom, laboratory tests, x-rays or other methods of investigation are applied. Similarly, in the study of episodic memory, there is no other way to determine an individual’s autobiographical memory except by asking the concerned about their experiences. The interviewee may not relate all that is going on in his mind, nevertheless, the interviewer is presented with a picture. One should bear in

mind that even a medical consultation demands a lot of personal and subjective information and other tests no matter how objective, cannot replace this important step which forms the base of the diagnostic pyramid.

The applicability of this method in the study of episodic memory has been reinforced by results. Previous studies on episodic memory have produced similar results over and over again. For instance the number of images retrieved from episodic memory shows a normal distribution. Furthermore, there is consistency on the information that is accessible in episodic memory even if subjects are interviewed in different places. The qualities that define episodic memory (emotion, sensation, personal significance) are similar in people of different culture or race.

Based on such observations, one can conclude that the structure of the results verifies the usefulness of introspection as a technique. This information may eventually contribute to the development of other methods which may provide numerical data and / or lead to refinement of already existing ones (e.g. use of experimental paradigms). Introspection as a subjective and objective technique are complementary. It is essential not to discard introspection.

## **5. Results**

### **5.1 Case descriptions**

The following is a summary of data collection in a 77 year old male participant. The subject was admitted to the neurological unit with clouded consciousness, right sided hemiplegia and aphasia. The medical history was reported to be of sudden onset. The subject, a diabetic with no previous history of disordered consciousness was diagnosed to be suffering from a stroke. Needless to say, medical history of patients suffering disorders of consciousness is initially collected / obtained from witnesses.

I visited the subject 10 days after admission to conduct the interview. The subject had fully regained consciousness and was well oriented in time, space and person. His ability to concentrate and maintain focused attention was adequate. On task 1, the subject describes two pictures, which are seen as clear; colored and detailed. The subject can clearly recall what, where and when the events are taking place. As observed in most cases, the pictures of the recent past are not emotionally linked.

Subsequently, the subject is asked to relive events of the past week, month and year. The performance on these tasks (2, 3 and 4) was average. All recalled events are non-emotional. The performance in task 5 indicates that the subject intensely experienced his early adult life. All 6 pictures are emotionally linked and of personal significance. Three are associated with positive, three with negative emotions. They are related in great detail. Colour and clarity are emphasised. All the while, the subject sees the picture in front of him.

Upon asking the subject to travel even further back, to his childhood and early childhood times, the subject produces 6 pictures without hesitation. The most striking picture occurs at the age of 3. The subject re-experiences cutting his finger with a knife while attempting to cut a cassava. A lot of pain is associated with this event, and his visibly deformed middle finger is shown. This is also the subject's earliest memory. The subject also recalls his first and very frightening experience with the colonial government at the age of 5, his arrest by a white man and the overnight retention in a school. The early childhood pictures are mostly linked to emotion. Four pictures of early childhood are produced. The subject recalled a total of 17 autobiographical memories out of free recall.

This subject showed difficulty in recalling pictures of the recent past. This performance is similar to that observed in the majority of subjects. It is difficult to remember pictures of an ordinary day. A lot of subjects used the phrase “just the routine” when asked to recall pictures of the recent past. It should be kept in mind that there was no use of cues to aid recollection, therefore the actual performance remains uninvestigated. This study mainly dwells on spontaneously recalled episodic memories.

In comparison, I shall describe data collection in 2 female participants who serve as controls (both not diseased and with no history of disordered consciousness). The first one, a 23 year old who resides in Nairobi is a student of media and communication at the university of East Africa. Likewise, the subject is asked to reflect on her past, relive events and relate them. The performance of the subject on task 1 is above average. She produces a total of 5 pictures without hesitation. All pictures are described as clear and colored. three pictures are emotional, two are not associated with emotion (neutral). Without probing I moved on to task 2 and asked the subject to recall something memorable that occurred the week before. The subject described four pictures, which were seen as neither detailed nor colored. The picture appears in front of the subject. All other occurrences are referred as “routine” and not mentioned.

The performance on task 3 regarding the previous month was much better although it lies further back in the time axis. More pictures were spontaneously recalled. This is probably due to the personal significance of events taking place. Events recalled include, end of year exam-period, first employment opportunity and a visit to relatives abroad. All events were attached to emotions and were re-experienced in front of the subject.

The subject recalled 2 pictures of early childhood and 1 picture at 15 years of age. The earliest picture retrieved is at 5 years of age and is described as a very disturbing event (emotionally linked). The subject recalled a total of 25 episodes.

The second is 62 years old, self-employed lady who also resides in Nairobi. The evaluation of episodic memory was carried out in her home. The subject recalled 5 pictures of the previous day, 2 of which were classified emotional and 3 non- emotional (neutral). The 2 emotional pictures concerned re-union with a brother and visit to an old friend, the two events took place in different places and at different times of the day. The meeting with the brother was linked to negative emotions (sad), because the brother was ill. The visit to the old friend is described as a joyful event.

Only one picture of the previous week could be retrieved – emotional - birth of a grandchild. The incidents of the previous month that were described were both non-emotional, and were related in less detail. The subject did not see them clearly and they were not colored. On the next task, the subject generated two events that occurred in the previous year. In the first picture, the subject does not appear within the picture, but describes the event as very memorable/shocking (television news coverage of a minister's death). These kinds of events whereby the subject does not appear within the context of a picture, but extracts the picture from his episodic memory have been termed external events. The second event recalled evokes fear in the subject and is of personal significance to the subject (a near displacement from her home which is now private property).

All three pictures on task 5 were neutral. The subject's overall performance was good. Remote episodic memories appear to be better preserved than recent ones. A total of five pictures of childhood and early childhood period were recalled and related in great detail. Three pictures were associated with positive emotions (joy) and 1 with negative emotion (fear). The other two were not connected to emotion (neutral). The earliest event memorable to the subject occurred at the age of five. Unlike most of the study participants, this subject's earliest episodic memory is not connected to emotion.

One particularly unusual case is a 42 year old male participant who was admitted to the neurological unit with disordered consciousness of insidious onset. The subject was initially diagnosed to be suffering from cerebral malaria. As in all other study subjects, I was involved in the subject's clinical progress from admission to recovery. The subject appeared to be fully recovered and had clear thought processing on the set date of interview.

Despite probing, the subject produced only 1 picture in each of the tasks 1, 2, 3 and 4. The subject described the events being re-experienced as vivid and sees all pictures in front of him. Once while describing an event, the subject interrupted his thought process to relate a different picture based on a dream that occurred during daytime sleep. The dream contained imaginary items. The subject proceeded to relate 2 pictures of early adult life which were described as emotionally related and of personal significance. (High school sport competition and first employment). Both are linked to positive emotions. The picture described of early childhood occurs at the age of 8. It is described

as not clear and appears on the right hand side. Overall, the subject recalled 9 events (dream excluded).

All individuals were given as much time as they required to generate and describe a picture. The performance of control subject number 19 is remarkable. The 52 year old male subject is a lecturer at a training centre for bankers. All 16 pictures on task 1 were described in detail. Without pondering too long, the subject produced 8 pictures of the previous week. The subject described the week before as 'eventful' this could also be the reason why the subject described so many pictures of the week before. He recalled clearly his car breaking down on his way to a lecture in a town outside of Nairobi and all the events that followed before he could be towed away. All other pictures described his late arrival in the town, his stay, the lectures and his journey back home. The picture described of the month before was not clear and described routine day to day activities. The subject had difficulty retrieving other pictures of the previous month.

On the fourth task, the subjects reconstructed two events linked to negative emotions. One involved witnessing a road accident – emotion shock and the second picture involved the death of a nephew - “going to identify the body. It was the first time I had ever been to a mortuary” - the subject then described the scenario at the mortuary. The next picture that occurred when the subject was 15 years of age involved animals. The subject was herding animals when a bull attacked him - fear. All other pictures described of the early childhood and childhood periods were also outstanding pictures that the subject did not have to think long to generate. Two of these pictures were emotional (negative) losing an aunt and his father's illness.

The subject also recalls queuing for relief food at 5 years of age during a drought period (hunger) and 'people scabbling for food' this picture was not linked to any emotion. In total, the subject recalled 33 pictures. Five were connected to negative emotions and none to positive emotion. All other pictures were neutral. The earliest age of which the subject could produce a picture was at 3. The subject's overall performance was above average.

How can this be accounted for? My attempt to explain this observation led me to the following conclusion; the subject being a lecturer, is used extracting pictures from his memory to teach or bring across a point. The experience in activating his episodic memory probably enabled the subject to respond to all questions with ease. It should not be mistaken for retrieval of semantic information. People who have the responsibility of

teaching do not only pass on semantic information but also refer to past experiences to impart knowledge.

The following case summary describes data collection in a 58 year old male subject who was admitted to the neurology unit with a stroke. On admission the subject had clouded consciousness, left sided hemiparesis and facial nerve palsy. The subject comes from a rural area in western Kenya. During his entire stay at the hospital the subject was in a depressed mood which he attributed to the hard time he was experiencing before he fell ill. The subject's performance on recent task events was better than that of remote tasks. He related three pictures of the day before, one of which was linked to positive emotion (although he cried while retelling this). The subject's recollections concern visit from family and friends and doctors doing ward round. This is one thing that patients seemed to look forward to. Doctor's ward rounds were commonly mentioned by subjects as one of the previous day pictures.

Pictures of the week before concerned activities during his hospitalisation (e.g. physiotherapy). The subject recalled three pictures of the month before describing two events that occurred at work and one on his farm. All five pictures that were described of the year before were emotional (negative) and all defined his emotional ordeal that began with suspicion of embezzling from the electricity department in his rural area of which he was chairman, arrest by the police, trial in a court of law, his release from jail, and a job transfer that ensued due to the foregoing. The subject proceeded to describe one picture of puberty and one of childhood. The earliest age of which he could remember a picture was at 11 years. The picture was emotional and concerned domestic violence. The subject produced a total of 15 pictures. None of those pictures was linked to positive emotions.

## 5.2 Data representation

The following tables show the data that have been collected. Each row corresponds to a different individual and each column corresponds to a different variable

Description of the variables ( also as applied in statistical description):

Sub=subject number

Age= age in years

Sex= sex (m=male) , (f=female)

Task 1= how many events of the day before were recalled

Task 2= how many events of the week before were recalled

Task 3= how many events of the month before were recalled

Task 4= how many events the year before were recalled

Task 5= how many events of puberty were recalled

Task 6= how many events of childhood were recalled

Task 7= how many events of early childhood were recalled

Task 8= earliest age of which a picture was retrieved

Total= total number of pictures retrieved

Neutral= how many of the events recalled were neutral memories (non-emotional)

Positive= how many of the events are linked to positive emotions

Negative=how many of the events are linked to negative emotions

External= were there external events recalled? (0= No) (1=yes)

Difficulty=did they have difficulty in recollection

(0=no difficulty, 1=only recent, 2=only remote, 3=recent and remote)

Detail=level of detail? (0=low, 1= moderate, 2=highly detailed)

Age 2=classification of age groups (1=above 50yrs) (2=below 50yrs)

Recent= total number of pictures of the recent past (task1+task2+task3)

Remote= total number of pictures of the remote past (task 4 - task 7)

Group definition: group 1=study subjects group 2=control subjects

1=female 2=male

Table 2: displays data collected from study subjects (n=35)

Table 3: displays data collected from control subjects (n=35)

0 indicates missing values. Missing values reflect difficulty in recalling events.

Subject no.	Age(years)	sex	Number of events recalled							earliest
			Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	
1	19	m	2	2	2	0	0	2	2	6
2	20	m	2	1	2	1	0	1	1	8
3	20	f	3	1	1	1	0	1	0	13
4	25	f	4	2	1	1	0	1	1	8
5	25	m	2	2	2	2	3	2	0	10
6	26	f	2	1	1	1	1	1	0	10
7	26	f	7	1	2	1	0	1	2	5
8	28	f	4	1	3	2	0	3	3	6
9	25	m	2	0	1	1	2	0	1	8
10	30	f	2	1	1	1	1	1	0	13
11	35	f	4	1	2	1	1	1	2	5
12	39	f	6	3	1	1	1	2	0	9
13	42	m	1	1	1	1	2	2	1	8
14	42	m	2	2	1	1	0	1	0	12
15	48	m	3	1	1	1	2	1	1	7
16	48	m	7	5	1	1	0	0	2	7
17	51	f	4	5	4	3	1	3	1	8
18	52	f	7	4	2	0	1	1	0	9
19	52	m	1	1	1	1	0	2	1	8
20	54	m	4	4	2	1	3	1	2	8
21	54	f	2	1	1	2	6	2	2	7
22	55	f	5	2	2	1	3	3	5	5
23	55	f	4	3	2	0	1	1	1	12
24	56	f	6	1	5	2	2	1	1	7
25	58	m	3	2	3	5	1	1	0	11
26	59	f	3	1	1	1	1	1	0	13
27	62	m	8	1	1	1	0	3	0	9
28	64	f	4	1	1	4	4	3	2	6
29	65	f	3	1	1	0	3	2	2	7
30	65	f	3	1	1	2	2	1	2	7
31	69	f	6	4	1	1	2	2	1	8
32	71	f	2	1	0	0	4	1	2	6
33	72	f	5	1	2	1	2	1	1	7
34	76	m	2	1	0	1	4	1	1	8
35	77	m	2	1	1	1	6	2	4	3

Table 2: data collected from study subjects

Subject no.	Age(years)	sex	Number of events recalled							earliest
			Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	
1	23	f	5	4	8	5	1	0	2	5
2	24	f	10	3	0	1	1	0	2	4
3	25	m	4	1	1	1	1	2	3	3
4	28	f	3	1	2	1	1	1	2	6
5	29	f	7	1	3	1	2	1	4	5
6	29	m	4	1	1	1	3	1	2	5
7	30	m	7	1	2	1	1	1	0	10
8	33	f	8	1	1	1	2	3	1	3
9	42	f	1	1	1	1	2	2	3	4
10	44	m	9	2	1	1	1	2	1	4
11	45	f	14	7	1	3	2	2	2	5
12	46	m	4	2	1	1	2	0	2	8
13	47	f	4	3	0	3	1	4	4	5
14	48	f	8	1	1	1	3	2	1	8
15	47	m	5	1	1	1	0	2	1	7
16	50	f	4	1	2	1	0	1	0	12
17	50	f	8	1	1	1	2	2	2	7
18	50	m	7	5	1	3	0	3	3	4
19	52	m	16	8	1	2	1	2	3	3
20	54	m	5	7	1	4	4	2	1	5
21	53	m	6	1	1	1	1	4	1	5
22	55	f	7	2	2	1	2	2	2	6
23	59	f	2	1	1	1	2	2	2	7
24	59	f	4	2	2	0	1	3	0	9
25	60	m	6	3	1	1	1	3	1	7
26	62	f	5	1	2	2	3	2	4	5
27	63	m	3	4	1	1	4	4	2	8
28	64	m	3	2	2	3	0	0	2	5
29	65	f	3	2	2	3	5	2	1	8
30	70	f	3	3	1	2	5	2	2	7
31	72	m	2	2	0	1	2	3	3	7
32	80	m	1	1	1	1	3	1	0	11
33	82	m	2	2	1	1	2	1	2	6
34	103	m	2	1	1	0	2	3	1	5
35	25	m	6	1	1	1	1	1	2	3

Table 3: data collected from controls

### 5.3 Statistical description

The statistical analysis was performed using SPSS version 15.0. Since the distribution of most variables in question is not normal, non-parametric tests were used for statistical testing.

#### Performance on task 1 to task 7

##### Method

The Friedman-test was employed to compare the difference in performance on task 1 to task 7

##### Results

There was a significant difference in the performance of various tasks. The highest amount of pictures was derived on task 1.

Chi-quadrat-	115.777
df	6
P-value	0.000

The following bar chart displays the average number of pictures retrieved on each task. The largest amount of pictures produced, is of the day before. When considering the analysis, one should keep in mind that the count is based on free recall. These pictures are easy to access as they do not lie far back in time. In simple words, one could say that they are “fresh memories”. Most pictures of the day before are neutral i.e. not linked to any emotion.

The performance on previous week pictures drops by half. Compared to the performance on task 1, this is an indication that episodic memories fade with time if they are not striking. Most pictures of the previous day and week among study subjects concern their hospitalization. Pictures frequently recalled involved visit by relatives, distribution of medication, recollection of doctors and nurses doing ward rounds. Among control subjects, pictures of the previous day and week mostly involve doing house chores. Study subjects as well as control subjects had difficulty in recalling pictures of the

previous year or month if nothing out of the ordinary happened. This observation is signified by the drop in the performance on these tasks.

Notable was the increase in the number of pictures recalled in time periods that lie in the distant past (early childhood, childhood and puberty). This is probably due to the fact that these pictures are related to emotion and are therefore prominently represented in episodic memory thus the ease with which they are retrieved.

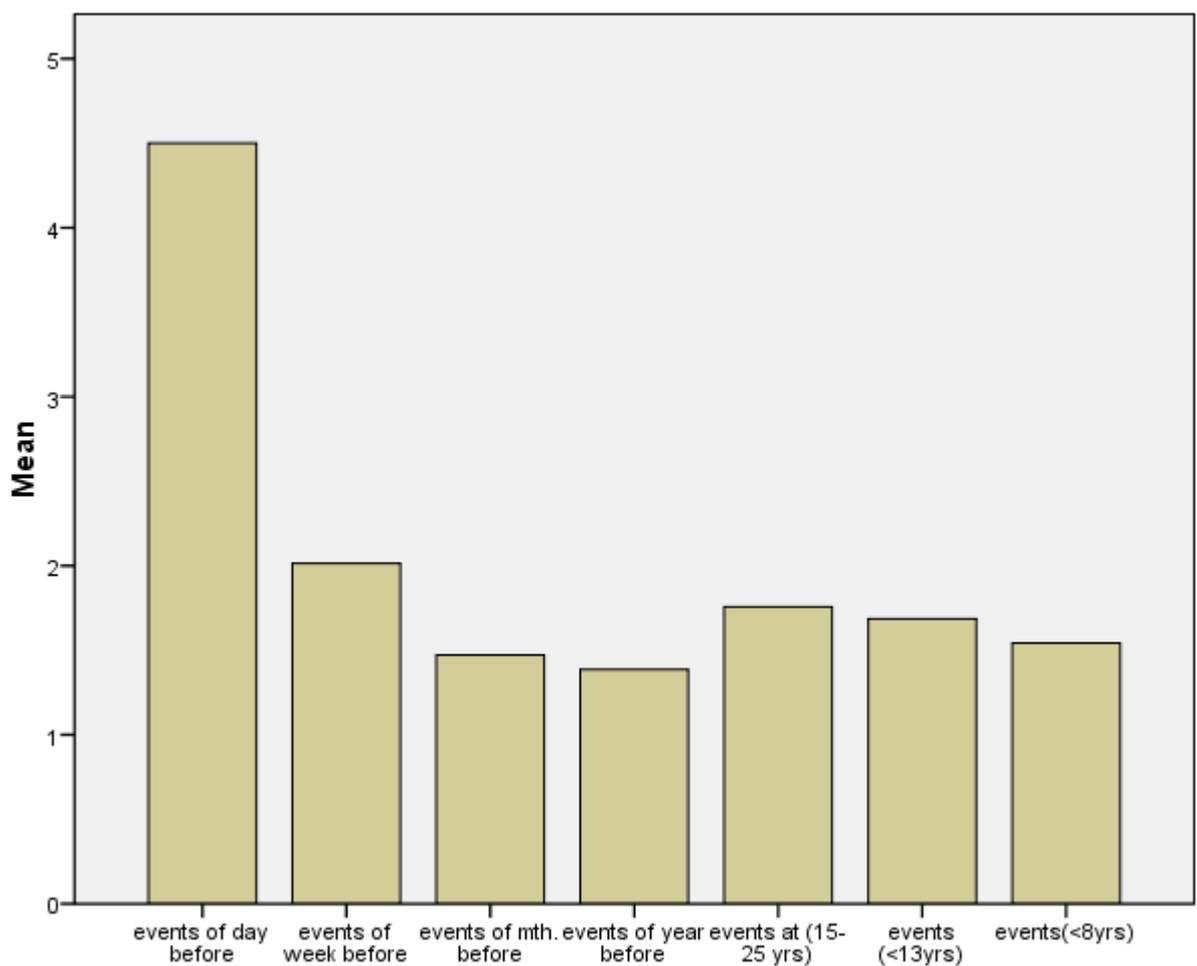


Chart 1: Performance on task 1 to task 7

### Total number of pictures

The Mann-Whitney U-test was used to compare overall performance between subjects and controls based on the total number of pictures.

The control subjects produced a significantly larger amount of pictures compared to the subjects ( $U=387.500$ ,  $P=0.008$ ).

The following bar chart displays the performance of subjects and controls. When viewing this results it should be taken into consideration that the subject were disadvantaged especially regarding their recent past since they had spend some time at the hospital.

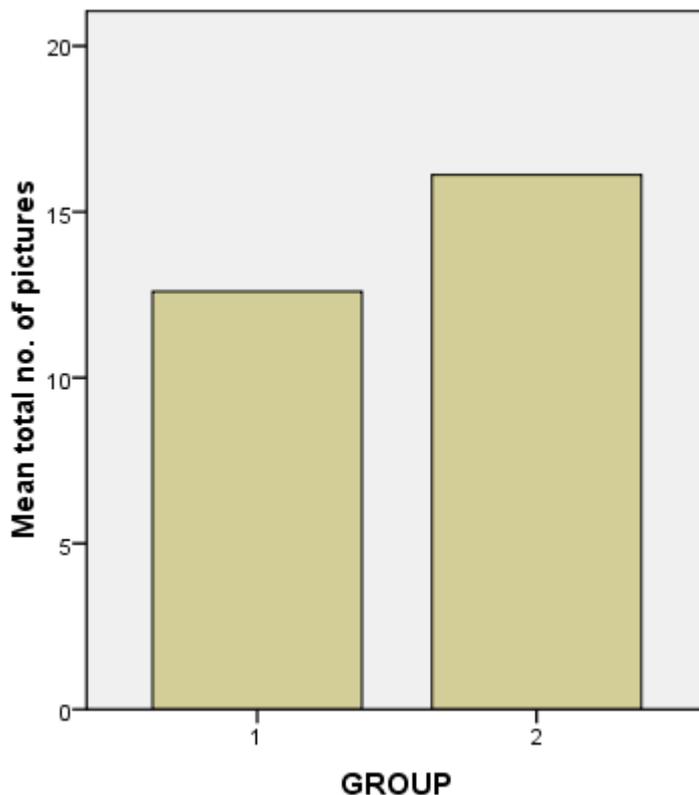


Chart 2: overall performance of subjects and controls (group1 represents study subjects and group 2 represents controls subjects)

### Comparison of performance by sex based on total number of pictures

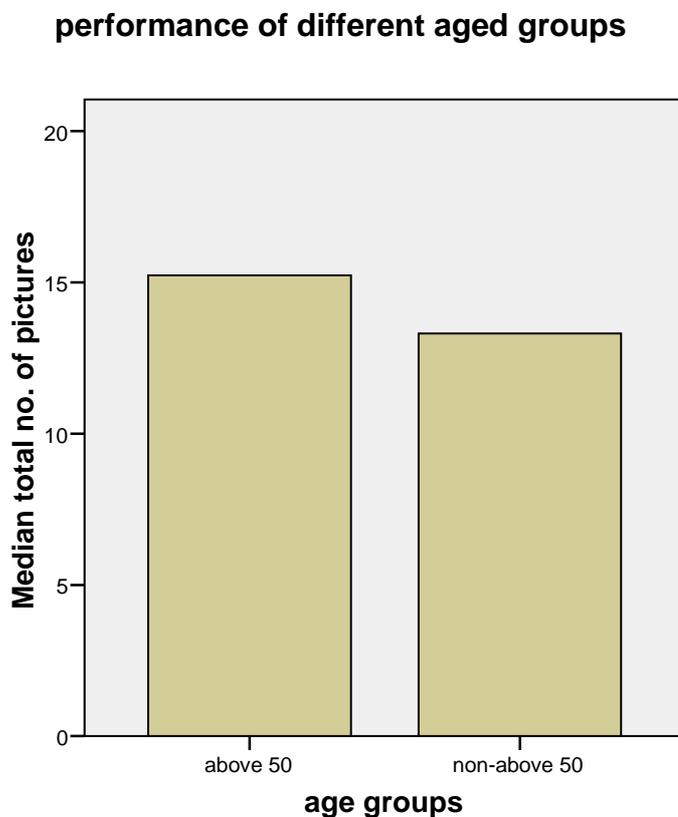
There is little reason to believe that sex would influence the performance in episodic memory tests. There was no significant difference between the performance of men and women based on total number of pictures ( $U=481.500$ ,  $P=0.135$ ).

As observer, I did not notice any difference in the count of pictures during interviews. The male were as keen as their female counterparts to engage in the mental journey, provided as much detail and also displayed associated emotion.

### **Comparison of performance between different age groups**

Classification 1=above 50 years of age 2=below 50 years of age.

The performance of the subjects aged 50 and above is significantly different from that of subjects aged 50 and below. This statistic was derived using the Mann –Whitney U test ( $U=380.500$ ,  $P=0.006$ ). Assumptions that there is a decline in episodic memory performance with age could not be confirmed. In contrast, the subjects aged 50 and above did better than those aged below 50 years. It should, however, be kept in mind that there are more study participants in group 1 (38 in total) than in group 2 (32 in total). The chart below illustrates the results.



## Recent and remote events

Performance on recent and remote events by age.

It cannot be determined whether or not there is a difference in performance between the subjects of the two age groups on recent and remote events. These results were obtained using the Mann-Whitney -U-Test.

Recent events ( $U=600.000$ ,  $P=0.924$ ).

### Descriptive statistics

	age groups	N	Mean rank	Rank sum
Total recent events	above 50	38	35.71	1357.00
Total recent events	non-above 50	32	35.25	1128.00
	Total	70		

### performance on recent events

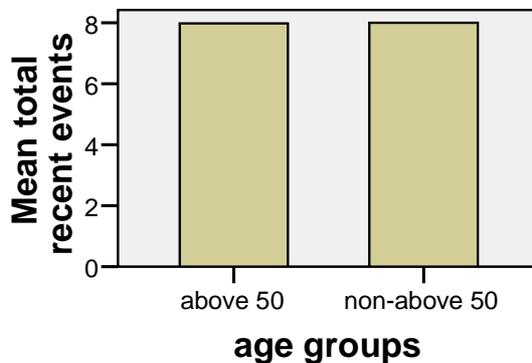


Chart 5:

The results on remote events are quite similar to those acquired on recent events. A lot of elderly subjects performed better on events in the distant past than on recent event tasks. The overall performance was as good as that seen in the subjects aged 50 and below. Most of the distant past events were related to hardship (poverty, hunger, distress) and were remembered vividly.

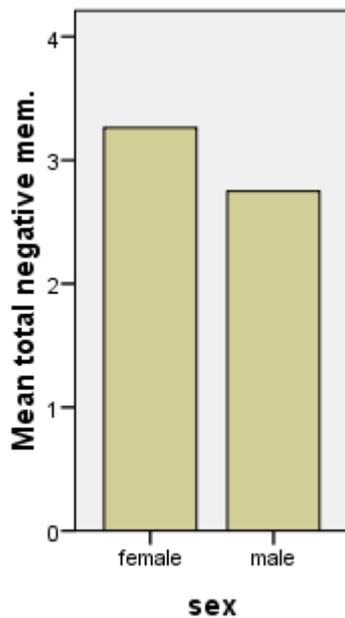
## Episodic Memory and emotion

Comparison of emotion by sex

The Mann-Whitney test was used to compare emotionality of men and women with regard to episodic memories. There is no clear evidence to show that there is a difference between men and women with reference to the quality of emotion linked to episodic memories.

### Negative emotion:

Mann-Whitney-U-Test	519.500
<i>P</i> -value	0.287

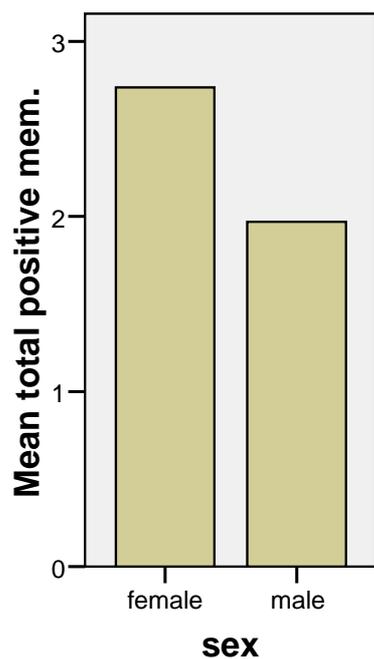


### Situations pertaining to negative emotions

Death of relatives, friends or famous people
Physical pain (illness, injury)
Domestic violence, conflict
Life threatening experiences (nearly drowning, involvement in road accidents)
Poverty, drought, hunger
abandonment
circumcision
Harassment by the colonial government
Detention by the police / colonial government
First day of school

### Positive emotions

Mann-Whitney-U-Test	470.500
<i>P</i> -value	0.097



## Situations connected with positive emotions

Acknowledgement of personal achievements
Public holidays
vacation
birth
Visit or reunion with friends/family members
wedding
Gaining employment
travelling

Emotion is undeniably a characteristic of episodic memory. Certain emotions may reconnect us with our past experiences. Conversely, emotions may be triggered by recall. On one occasion, a subject broke down in tears while relating an incident. Another subject expressed his gratitude for the opportunity to re-experience childhood events since they were linked to positive emotions. Commonly mentioned emotional qualities are joy, sadness, fear, surprise and anger. Joy and sadness predominate.

## 5.4 Qualities of episodic memory

### Emotion

In some cases, emotions were not only mentioned in connection with personal events. Emotions linked to external events (events whereby the subject is not within the picture) can cause us to remember these events clearly. In 5 cases, external events were mentioned. This involved some striking pictures in the television news. These pictures concern the death of well known public figures (a minister and a church leader). It is noteworthy that all five subjects who recalled the demise of these particularly influential leaders had different social and educational backgrounds, and were interviewed in different places.

### Personal significance

Episodic memory contains pictures which not only make us aware of, but also define our individuality. Each person possesses different goals and desires. A lot of pictures related to personal achievements and appreciation of one's efforts were described. These reflect the subject's desires and goals e.g. graduation from university, setting up new business, business prosperity, increase in farm production. A good harvest in the year before was remembered by a farmer. These pictures were also attached to positive emotions.

### Sensation

Sensation occurs when our sensory organs are stimulated. Humans have external and internal organs of sense which enable us to experience our environment and to respond to our inner needs. The traditional classification of human senses into five senses is outdated. Other classifications include sensations such as nociception (sense of pain), equilibrioception (sense of balance) or thermoception (sense of heat). Internal organs and viscera also send sensory information to our nervous system, an example is sensation of hunger.

Visual perception is a central issue in this study and in episodic retrieval in general. Other accompanying sensations that were commonly re-experienced in connection with episodic memories include sound perception (ringing of phones, street noise, and music), hunger, pain tactition and smell. Pain was frequently recalled by both subjects and

controls when referring to a time when they fell ill, following accidents (even minor accidents) and in connection with physical violence. In 9 cases, subjects recalled events which led to acquisition of body scars. Hunger was most commonly mentioned by the elderly, with exception of a 23 year old street boy who retrieved pictures associated with hunger. Another subject associated a picture occurring in a hospital very strongly with smell. 'Whenever I think of that day I spent in hospital, I smell hospital disinfectants'.

## **6. Summary of results**

From the perspective as observer, the study of episodic memory involved the application of skills as used on a daily basis in medical practice. I encountered a variety of people, bankers, lawyers, retired ministers, street boys, and housewives to mention but a few. The one thing they all had in common was the ability to engage in a mental journey that began in the present and ended in the first years of human life. The time that elapsed between the beginning of an interview to the end of an interview proved to be a richly benefiting experience to the interviewer. Through observation of facial expression (sometimes happy, sad, indifferent or hard to discern), I experienced emotional ups and downs with the subjects as they recalled.

In the course of the study, I acquired a lot of historical information and knowledge about cultural practices in the traditional Kenyan society thanks to my interviewees above age 50. Especially older subjects gave very detailed representation of experienced environments and circumstances making this a memorable and enriching experience. There was a lot of similarity in items recalled by interviewees of the older generation even though interviewed in different locations. Commonly described practices are for example circumcision, marital coaching, arrangement of shelter in a traditional African homestead and distribution of duties among family members. All these subjects began their lives in the rural areas, at a time when traditional practices were strictly adhered to, sometimes living there until early adulthood, before relocating to the city of Nairobi. Pictures also portray that people were living in extended families in the traditional African setting. Another similarity is the mention of pictures associated with the colonial period / colonial government.

Subjects of the younger generation, especially those raised in urban areas had little or no exposure to this kind of environment. The items recalled differed by context from those recalled by subjects in the older generation. These findings reflect the gap between the generations in the Kenyan society. On one hand, the young affluent post-colonial generation, on the other hand, a traditional older generation that underwent times of hardship and profoundly experienced their early years of life.

Across the interviewed population there were a lot of similarities in the content of episodes described.

52.3% of the subjects recalled events whereby they travelled to a different city or town, (to visit, on vacation or in search of employment). Interestingly, this is the most frequently recalled event by subjects as well as controls. This indicates that change from “normal” environment to which one is accustomed tend to leave an impression on most people.

40.6% of the subjects remember events involving death of relatives, friends or public figures.

A lot subjects aged 50 years and above remember their first day of school, this appears to be the case because they were compelled to do so by the colonial government. No subject below the age of 50 mentioned their first day of school as a memorable event.

On the other hand, subjects aged 35 and below tend to easily remember personally meaningful events e.g. exam- related periods, graduation from high school or university, first day of employment or setting up a business (personal significance as a quality of episodic memory).

Outstanding events are retrieved with more ease and spontaneity than everyday events. They were vividly remembered and mostly linked to emotion. Events of the recent past (previous day and previous week) were mostly non-emotional and vaguely remembered. Subjects often referred to everyday events as ‘just routine’.

Events causing emotional stress are also easily remembered. Numerous pictures regarding illness of oneself, friends and relatives were recalled. This was more often the case in subjects than in controls.

Other striking or event related pictures produced by both subjects and controls include wedding days, road accidents in which the subjects are involved or witnessed, birth, being burglarized or robbed, holidays (new years eve, Christmas holidays, Easter holidays, independence day ).

The pictures recalled mainly involved humans and their relationships. The few cases whereby animals were mentioned involved domestic animals (cows, goats, sheep and dogs). Subjects remembered events that occurred for example while herding animals.

## **7. Discussion:**

This study was aimed at accumulating evidence in support of the concept of episodic memory in a different geographical setting, and further to establish if episodic memory was affected following disorders of consciousness. This was accomplished through interviews whereby participants (35 patients, and 35 healthy controls) were instructed to generate pictures of events in the recent and distant past. Attention was paid to the contextual information and to the spontaneity with which personal events were related.

It should be noted that there was no use of cues to prompt remembering. Therefore, subjects may have a lot more memorable episodes than the data collected displays. It has already been mentioned that this study focused on the spontaneity with which pictures were retrieved. It was basically designed to test how many pictures are easily accessible i.e. “are on the surface”. Subjects definitely have more pictures stored in their episodic memory than displayed in this study. In fact, previous studies on episodic memory suggest that episodic memory contains a large number of pictures and that the number available at a particular time depends on / is influenced by the present emotional state or present circumstances and experiences. This is consistent with findings in my study. A lot of study subjects recalled pictures of the past regarding illness of family members or friends reflecting their current emotional situation.

So did I find answers to the questions I sought to answer in the course of this project? Yes and No. A lot of questions will still remain unanswered but I made observations that support a lot of theories that have already been put forward. This was a different kind of memory testing for the observer as well as for the subjects. Whenever I informed the subjects that I would conduct a study on memory, a lot of them warned me that they had poor memories and were later quite delighted to engage in this kind of memory testing whereby they just had to tell the stories of their life. After the first two tasks, subjects usually seemed quite at ease.

All individuals interviewed in the course of this study displayed the ability to access and retrieve events stored in this memory system even if they had never engaged in this kind of memory testing before. It would be correct to assume that the subject’s performance would improve exponentially if they were interviewed on a second or even third occasion. The reader is referred to the case description of the 52 year old bank lecturer

that was described before. All people who have received some formal education know that we are actually trained on how to encode, access and retrieve facts from our semantic memory and we require training and repetition to get good at it. Even a child learning the Alphabet Chart needs some training before they can get it right. There was no training required in order to learn how to access episodic memory.

As regards the extent to which people remember events happening in their recent life I deduce that emotion and personal significance increase the potency of episodic memories and thus the ease with which they are remembered. Non-emotional everyday events are transient and fade with time - although the performance on tasks of the previous day was good in most cases, it dropped by half on previous week tasks in cases where nothing out of the ordinary happened - this is the reason why subjects summed the answer on task 2 and 3 up to 'just the routine' implying difficulty in recollection. By contrast, highly unusual events were easily recalled even if they lay farther back in time e.g. early childhood. This is more so the case if the pictures of the remote past are linked to emotion or have personal significance. This implies that the extent to which people remember events happening in their recent and remote past depends on emotion and personal significance.

Study subjects showed a slightly poorer performance compared to controls. It has been proved in recent studies that episodic memory is very susceptible to damage due to its complexity. However, it should be kept in mind that controls were exposed to a larger environment with constantly changing circumstances whereas subjects were restricted to the same environment (bed or ward room) in which something out of the ordinary is less likely to happen which could explain why they have less pictures of the recent past -some had been hospitalized for 2 to 3 weeks by the time they were interviewed. These results should be viewed cautiously. Additionally, some psycho-mental slowing a few weeks to months post morbid is known to occur, e.g. after cerebral malaria and could also account for the results.

As observed, there was no evidence of decline in episodic memory functioning with age. The performance did not differ significantly in the young and the old. Among the elderly, remote events appear to be better preserved than recent ones. This is an indication that this age period of life was profoundly experienced.

My findings signify the link between episodic memory and emotions. In general, emotional episodic memories contain more details than neutral (non-emotional) episodic memories. Associations, for example emotions and can trigger a re-experience of events.

This study also showed that episodic memories are attached to sensations. Some personal experiences recalled were related to auditory, olfactory, and sensory stimuli.

Memory for striking events is better preserved than memory for everyday events.

My findings conform to the findings of Perner & Ruffmann (1995) and Nelson (1993) that the development of a fully functioning episodic memory occurs at the about the age of 4 years. 95.7% of my subjects recall events which took place when they are above 4 years of age or above.

In conclusion, emotions and sensations play a major role in the encoding and retrieval of episodic information and the extent to which people remember events also depends on these features. Episodic memory is a late-developing memory system whose function could not be proved to decline with age. Moreover, significant deficits of episodic memory following disorders of consciousness could not be detected by the method applied and it would be necessary to employ more standardized methods in future. The method used, however, delivered a lot of contextual information, enabled free associations and was evidently the best method in this case as I was also trying to find information about anthropological universals of episodic memory.

There was no significant difference in the results obtained in this study of episodic memory compared to results obtained in Innsbruck. The context is likely to differ but the basic features of episodic memory that were represented are universal. The most striking differences between cultures was the varying contextual information between members of different ethnic groups in Kenya. The two ethnic groups that were strongly represented in the plus 50 generation are the Kikuyu and the Kamba. The participants of the older generation who belong to the Kikuyu tribe (Kenya's most populous ethnic group) described a lot of pictures concerning the fight for independence and colonial government. Historically, the Kikuyu played a key role in the fight for the independence of Kenya from the British colonial government. Their contributions in this fight were recalled vividly and indeed their domination in politics has continued to date. Subjects of the Kamba gave information about hunger periods. The climate of the geographical area

occupied by the Kamba is semi-arid and every few years the area is hit by drought. These drought periods are known to cause great distress for them since they heavily rely on agriculture for their livelihood. This kind of information that I was familiar with only from text books came across in the form of pictures during the interviews. Members of the other ethnic groups gave little information that could be attributed to their tribes.

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## 9. Appendix

### 9.1 statistical tables

This appendix contains tables with descriptive statistics. The results have been discussed in the text.

**Descriptive statistics**

	N	Mean	Standard Deviation	Minimum	Maximum
events of day before	70	4.50	2.827	1	16
events of mth. before	70	1.47	1.164	0	8
events of week before	70	2.01	1.620	0	8
events of year before	70	1.39	1.067	0	5
events at (15-25 yrs)	70	1.76	1.479	0	6
events(<13yrs)	70	1.69	.986	0	4
events(<8yrs)	70	1.54	1.163	0	5

Table 1: Overall Performance on recent and remote tasks

	Group	N	Mean rank	Rank sum
Total no. of pictures	1	35	29.07	1017.50
	2	35	41.93	1467.50
	total	70		

Table 2: Comparison total number of pictures between subjects and controls. Group represents the study subjects and group 2 represents control subjects.

	sex	N	Mean rank	Rank sum
Total no. of pictures	female	38	38.83	1475.50
	male	32	31.55	1009.50
	total	70		

Table 3: Comparison of overall performance by sex

# LEBENS LAUF

## Persönliche Daten

Name: Winfred Kitavi  
Geburtsdatum: 27.05.1977  
Geburtsort: Nairobi, Kenia  
Staatsangehörigkeit: Kenianisch

## Schul- und Hochschulausbildung

1984 – 1991      Grundschule (Primary school) in Nairobi, Kenia  
1992 – 1995      Gymnasium (High school) in Nairobi, Kenia  
11/1995          Schulabschluss: Abitur  
  
09/1998-09/1999      Deutschkurs an der Universität München  
  
09/1999-09/2000      Studienkolleg München (Vorbereitung für ausländische Studienbewerber auf ein Fachstudium in Deutschland)  
  
10/2000          Aufnahme des Studiums der Humanmedizin an der Ludwig-Maximilians-Universität München.  
  
03/2003          Ärztliche Vorprüfung  
  
2004              Beginn der Dissertation  
  
06/2007          Abschluss des Studiums nach neuer ÄAppO

## Ärztliche Tätigkeit

Seit 09/2007      Assistenzärztin in der Weiterbildung zur Fachärztin für Hals-Nasen-Ohrenheilkunde