NAME: NWAOKEZI DESIRE OGOCHUKWU

MATRIC No.: 17/MHS01/206

DEPARTMENT: MEDICINE AND SURGERY

COURSE: NEUROPHYSIOLOGY (PHS 305)

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ASSIGNMENT

1. Discuss the physiology of sleep.
2. Discuss the role of basal ganglia in coordinating movements.

ANSWER

A. **PHYSIOLOGY OF SLEEP.**

Sleep, this is a state of reversible unconsciousness in which the brain is less responsive to external stimuli. Sleep is distinguished from unconsciousness and anaesthesia by a characteristic cycle of sleep phases with specific EEG (electroencephalography) patterns and physiological changes.

Functions of sleep

The functions of sleep are still poorly understood. However, the observation that sleep (or, at least, an activity-inactivity cycle) is present in all species and has been preserved throughout evolution and that sleep deprivation leads to a drastic deterioration in cognitive function and eventually to mental and physical morbidity proves it's important. Sleep conserves energy by reducing core temperature slightly and lowering metabolic rate by 10% compared with quiet wakefulness.

Physiological changes that occur during sleep

During sleep, most of the body functions are reduced to basal level. Changes that occur in the body are;

- Plasma volume decreases by about 10% during sleep
- Rate and force of respiration is decreased
- Saliva secretion is decreased during sleep
- Formation of urine decreases and specific gravity of urine increases
- Sweat secretion increases
- Lacrimal secretion decreases during sleep
- Tone in all the muscles of the body except the ocular muscles decreases

Natural sleep is divided into two distinctive states;

- Non-Rapid Eye Movement (NREM) Sleep/ Quiescent Sleep; this is divided into stages 1, 2, 3, and 4, representing a continuum of relative depth.
- Rapid Eye Movement (REM) Sleep

1. **Rapid Eye Movement (REM) Sleep**

   This is the type of sleep that occurs at intervals during the night and is characterized by rapid eye movements, more dreaming and bodily movement and faster pulse and breathing. It is also called

Paradoxical Sleep. This sleep plays an important role in consolidation of memory.

2. **Non-Rapid Eye Movement (NREM) Sleep**

It is also called **Slow Wave Sleep.** This type of sleep occurs without the movement of the eyeballs. Dreams do not occur in type of sleep. There are four stages of NREM Sleep.

<u>Stages of sleep and EEG patterns</u>

1. **Stage 1**

This is usually a transition from wakefulness to a state of drowsiness. This stage lasts only 5-10mins, during this period, minor auditory stimuli will cause arousal. Alpha waves are diminished and abolished. EEG shows only low voltage fluctuations and infrequent delta waves.

2. **Stage 2**

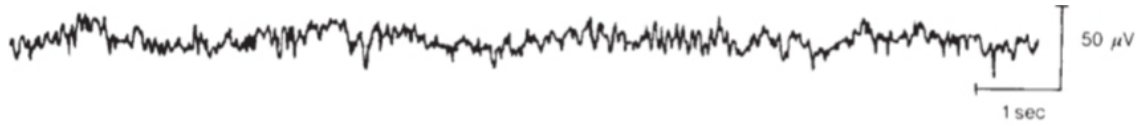
In this stage, bodily movements continue and EMG (electro-myogram) activity is low to moderate. This stage lasts for 10-20mins. It is characterized by short bursts of high frequency activity (12-15Hz – sleep spindles) and K-complexes (large amplitude biphasic waves).

3. **Stage 3 and 4**

Deep NREM sleep stages 3 and 4, sometimes combined as SLOW WAVE SLEEP (SWS), are characterized by high amplitude low frequency delta waves. EMG activity is low and eye movements are rare. Arousal through auditory stimuli from this stage of sleep is difficult and if awakened, the individual is often disorientated and slow to react. Return to sleep is easy and short arousals (<30secs) are rarely remembered.

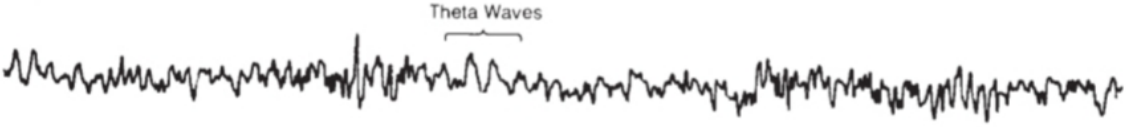
4. **REM Sleep**

   NREM sleep is usually followed by REM sleep. It is characterized by a fast mixed frequency low voltage EEG with saw tooth waves and rapid eye movement on the EOG (electro-oculogram). Natural wakening usually occurs from REM sleep. People woken up from REM sleep are much more likely to recall dream content than those awakened from NREM sleep. NREM dreams are usually vague and formless in contrast to REM dreams.

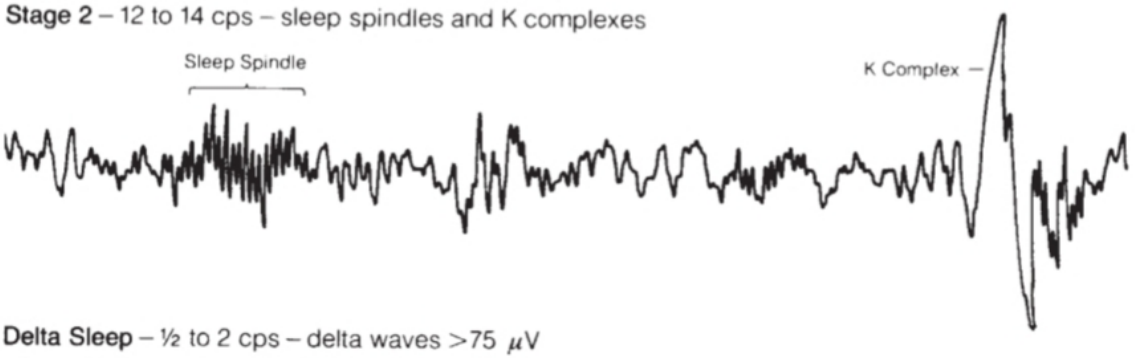


Drowsy – 8 to 12 cps – alpha waves

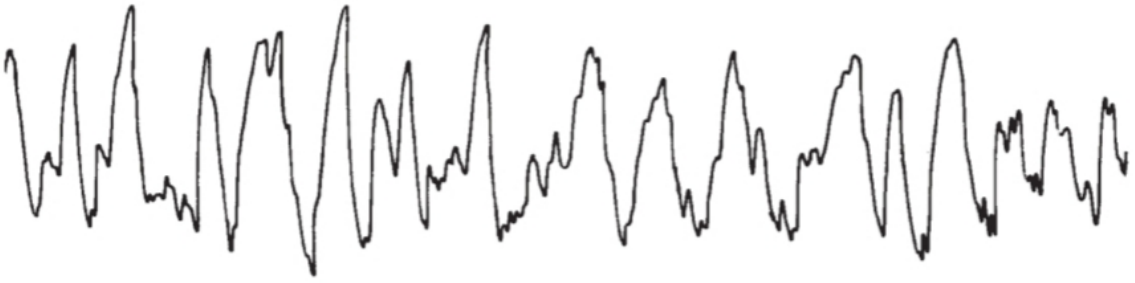
Stage 1 – 3 to 7 cps – theta waves



Stage 2 – 12 to 14 cps – sleep spindles and K complexes



Delta Sleep – ½ to 2 cps – delta waves >75 μV



REM Sleep – low voltage – random, fast with sawtooth waves

Mechanism of sleep

Sleep occurs due to the activity of the Sleep-Inducing Centers in the brain. Stimulation of these centers induces sleep while damage to the center cause insomnia (sleeplessness). Sleep centers are located in between the reticular formation of brainstem, diencephalon, and cerebral cortex. Two centers which induce sleep are found in the brainstem and they are;

- **Raphe Nucleus;** this is located in the lower pons and medulla. Serotonin, which is released by the nerve fibers arising from the nucleus, is responsible for activating the raphe nucleus and inducing Non-REM sleep.
- **Locus Ceruleus of Pons;** nor-adrenaline produced form the nerve fibers arising from the locus ceruleus induce REM sleep.

Applied physiology

1. **Insomnia**; this is simply the inability to sleep or abnormal wakefulness. It is usually caused by alcohol addiction, drug addiction, and psychiatric problems.

2. **Hypersomia**; this is excess sleep or the excess need to sleep. This occurs due to some endocrine disorders, brain tumors, encephalitis etc.

3. **Somnambulism;** this is getting up from bed and walking in the state of sleep. It is also called **Sleep Walking** or **Walking During Sleep**. It occurs during Non-REM sleep.

4. **Nocturnal Enuresis;** is the involuntary voiding of urine at bed. It is also called **Bedwetting**. It occurs due to the absence of voluntary control of micturition. It is a common and normal process in infants and children below 3 years. It is because of incomplete myelination of motor nerve fibers of the bladder. When myelination is complete, voluntary control of micturition develops and bedwetting stops. If nocturnal micturition occurs after 3 years of age it is considered abnormal. It occurs due to neurological disorders like lumbosacral vertebral defects. It can also occur due to psychological factors. Loss of voluntary control of micturition occurs even during the impairment of motor area of cerebral cortex.

B. **Basal Ganglia in coordinating movements**

Basal Ganglia are the scattered masses of gray matter submerged in subcortical substance of cerebral hemisphere. The basal ganglia form the part of the extrapyramidal system, which is concerned with motor activities.

The basal ganglia have various functions like;

- Control of muscle tone
- Control of motor activity
- Control of reflex muscular activity
- Control of automatic associated movements
- Role in arousal mechanism
- Role of neurotransmitters in the functions of basal ganglia

The function I will be writing on is the control of motor activity and it is divided into three, they are;

- **Regulation of Voluntary Movements**

  These movements are initiated by the cerebral cortex. But these movements are controlled by basal ganglia which are in close association with the cerebral cortex. When lesions occur on the basal ganglia, control mechanism is lost and movement becomes inaccurate and awkward. There is a nervous circuit between the basal ganglia and other parts of the brain involved in motor activities, which is why the basal ganglia control the motor activities. The nervous circuits come from three areas of the cerebral cortex and they are;

  *Premotor Area

*Primary Motor Area

*Supplementary Motor Area

Most of the nerve fibers from the cerebral cortex reach the caudate nucleus and from there, they go to the Putamen. While some of them go directly to the Putamen. The putamen sends fibers to globus pallidus. Fibers from here run towards the thalamus, subthalamic nucleus of Luys and substantia nigra. Subthalamic nucleus and substantia nigra are in turn, projected into thalamus. Now, the fibers from thalamus are projected back into primary motor area and other two motor areas, i.e. premotor area and supplementary motor area.

- **Regulation of Conscious Movements**

  This is known as Cognitive Control of Activity. The fibers located between the cerebral cortex and the caudate nucleus regulates conscious movements. For instance, when a stray dog barks at a man, immediately the person, understands the situation, turns away and starts running.

- **Regulation of Subconscious Movements**

  Cortical fibers reaching putamen are directly concerned with regulation of some subconscious movements, which take place during trained motor activities, i.e. skill ed activities such as writing the learnt alphabet, paper cutting, nail hammering, etc.