PSYCHOPHYSIOLOGY OF SLEEP AND DREAMS

Definition

- Sleep is a readily reversible suspension of sensorimotor interaction with the environment, usually associated with recumbence and immobility. It interrupts wakefulness periodically in vertebrate organisms

Normal Sleep Pattern

- The sleep stages, i.e. 4 stages of sleep, recur in a cyclical pattern during the night. An initial progression through stages 1 to 4 is followed by regular oscillation between REM and non-REM stages. REM phases are repeated at approximately 90 minute intervals, and add up to some 25% of total sleep time. Slow wave sleep is concentrated in the early part of the night, while REM sleep episodes become progressively longer with each sleep cycle

Types of Sleep

- Sleep
  - periodic, natural, reversible loss of consciousness
- Sleep Stages
  1. Stage 1 – 4
  2. Stage 4 is known as Deep Sleep and the stage where sleepwalking and sleeptalking occur. It's difficult to wake someone up from Stage 4 sleep.
- REM (Rapid Eye Movement) Sleep

Stage 1

Stage 1 is the beginning of the sleep cycle, and is a relatively light stage of sleep. Stage 1 can be considered a transition period between wakefulness and sleep. In Stage 1, the brain produces high amplitude **theta waves**, which are very slow brain waves. This period of sleep lasts only a brief time (around 5-10 minutes). If you awaken someone during might report that they weren't really asleep this stage, Phase one begins as soon as the sun sets, when the pineal gland starts to release melatonin, a hormone released in the absence of light and responsible for making us sleepy.

If you could look at the wave patterns being generated by the brain, you would see a change from the rapid beta waves of daytime to slower alpha waves. When the alpha waves disappear, replaced by theta waves.

Stage 2

Stage 2 is the second stage of sleep and lasts for approximately 20 minutes. The brain begins to produce bursts of rapid, rhythmic brain wave activity known as **sleep spindles**. Body temperature starts to decrease and heart rate begins to slow

Stage 3

Deep, slow brain waves known as **delta waves** begin to emerge during stage 3 sleep. Stage 3 is a transitional period between light sleep and a very deep sleep. After Phase two is over, the sleeper falls into a deeper sleep. During this stage, the sleeper falls deeper into phase three which lasts about 5 to 15 minutes

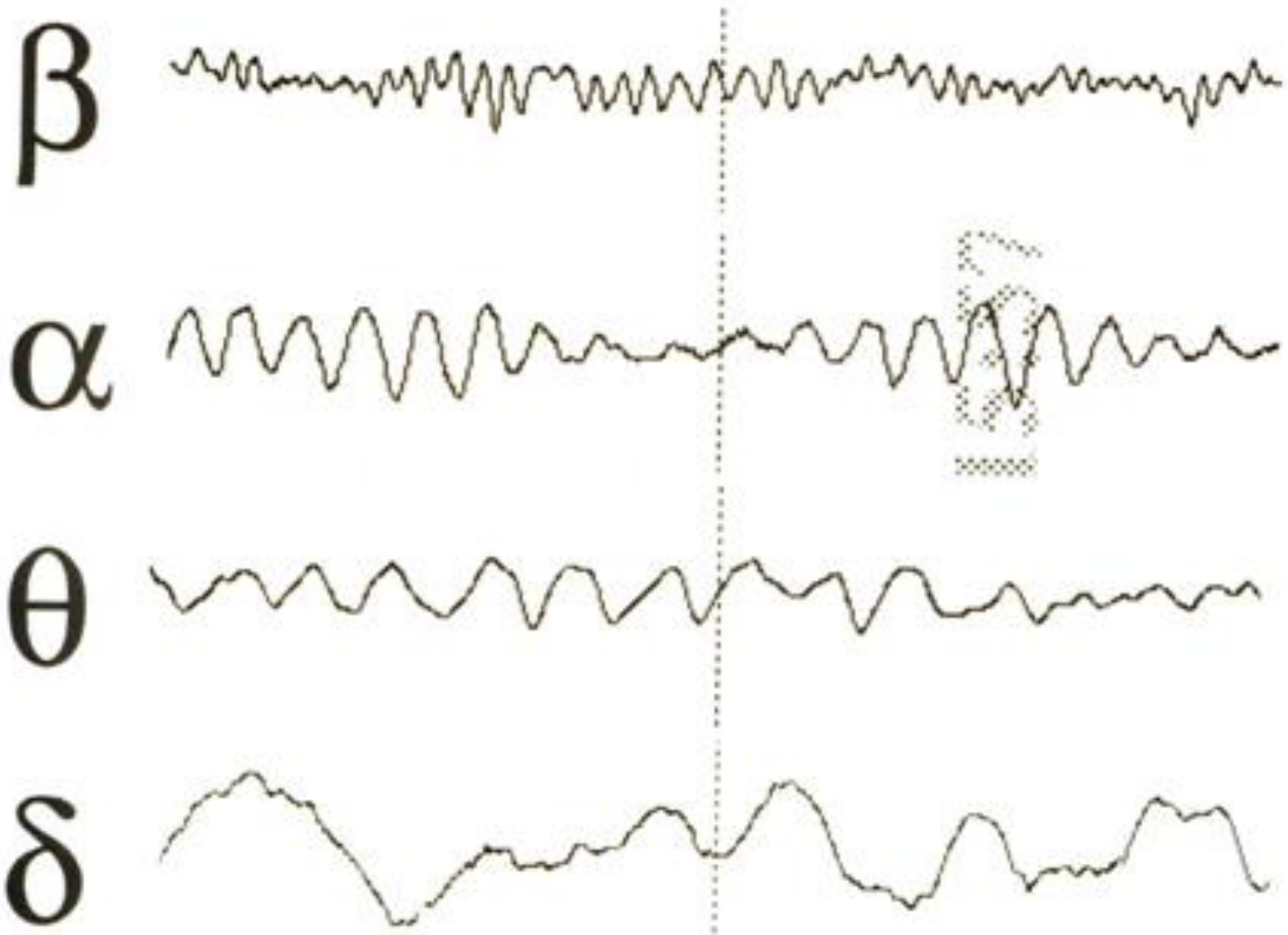
Stage 4

Stage 4 is sometimes referred to as **delta sleep** because of the slow brain waves known as **delta waves** that occur during this time. Stage 4 is a deep sleep that lasts for approximately 30 minutes. Bed-wetting and sleepwalking are most likely to occur at the end of stage 4 sleep ,at which the first dream occurs

stage 5

Most dreaming occurs during the fifth stage of sleep, known as rapid eye movement (REM) sleep. REM sleep is characterized by eye movement, increased respiration rate and increased brain activity. REM sleep is also referred to as paradoxical sleep because while the brain and other body systems become more active, muscles become more relaxed. Dreaming occurs because of increased brain activity, but voluntary muscles become paralyzed

On average, we enter the REM stage approximately 90 minutes after falling asleep. The first cycle of REM sleep might last only a short amount of time, but each cycle becomes longer. REM sleep can last up to an hour as sleep progresses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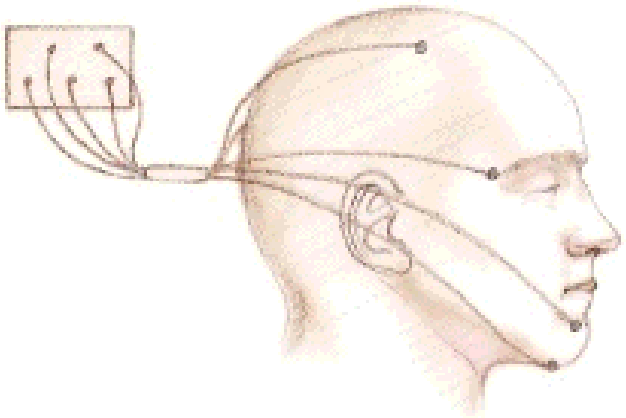
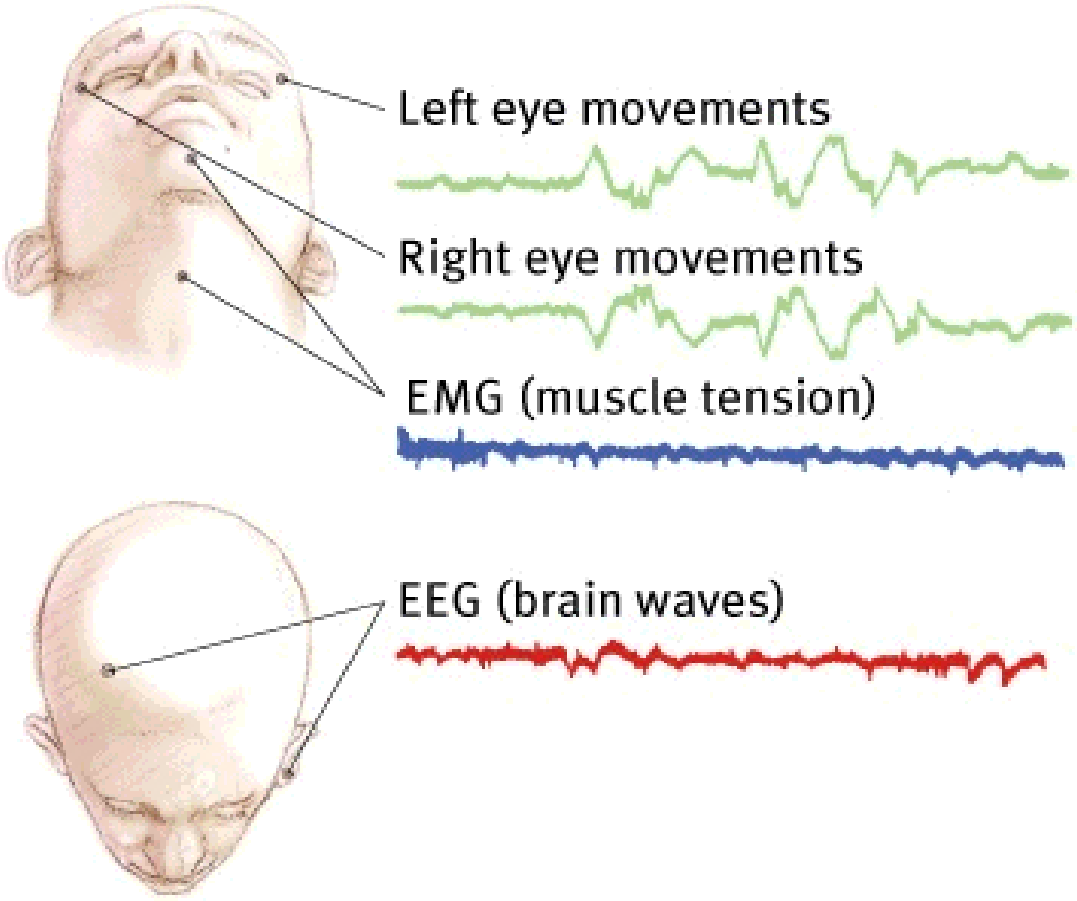
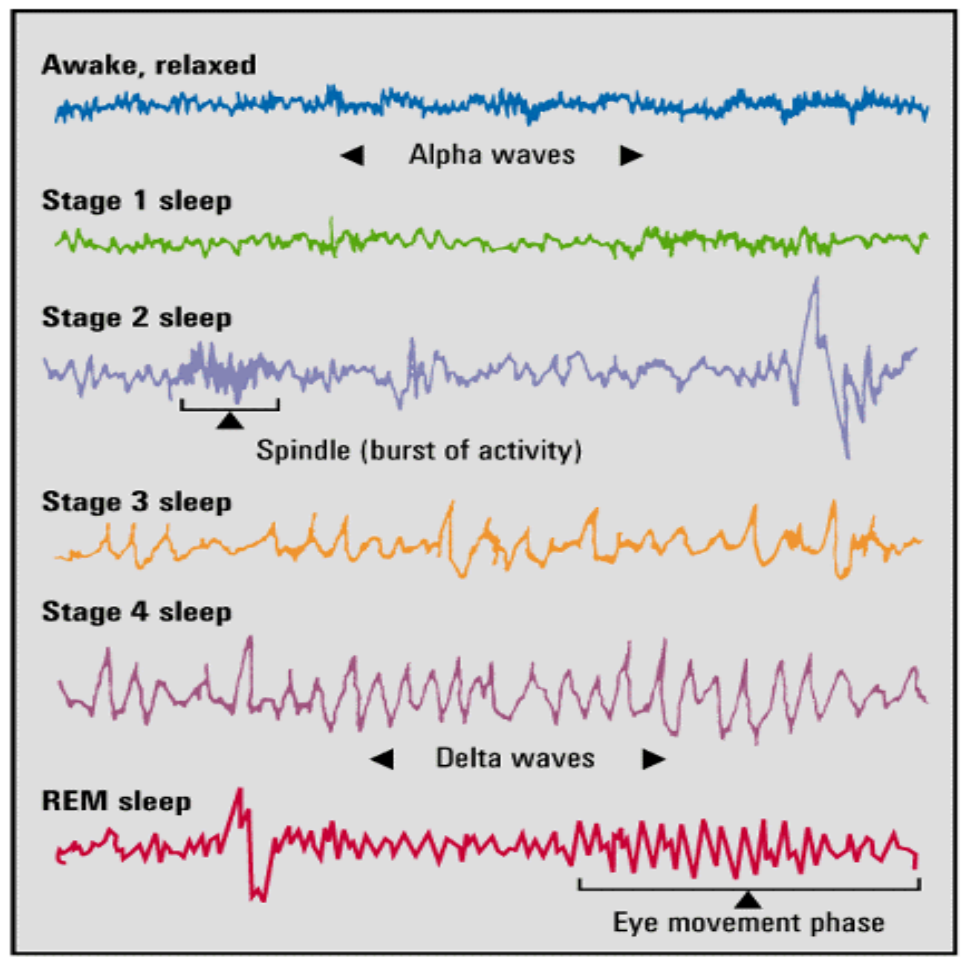
- Measuring sleep activity





Brain Waves and Sleep Stages

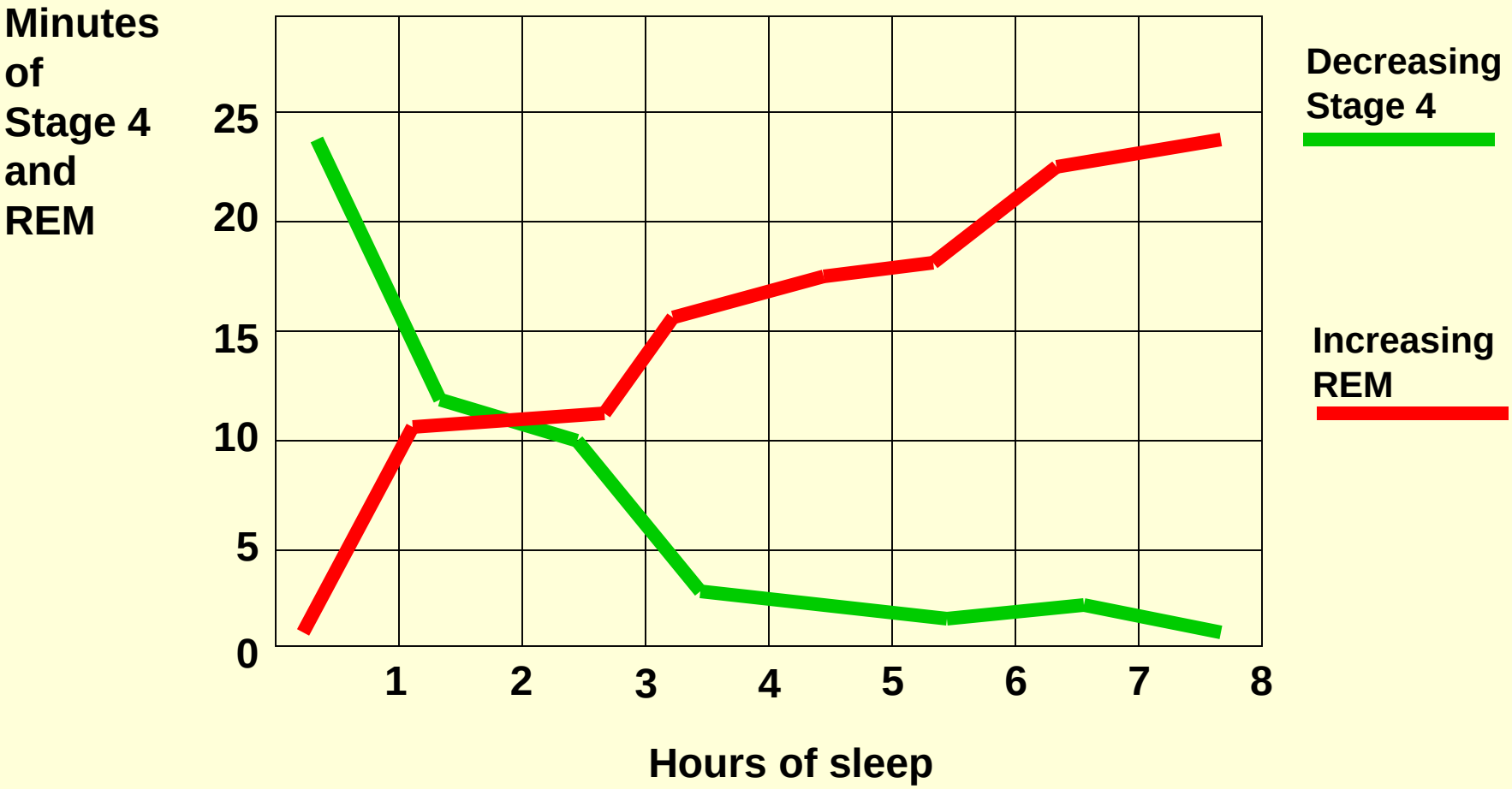


- Alpha Waves
  - slow waves of a relaxed, awake brain
- Delta Waves
  - large, slow waves of deep sleep
- Hallucinations
  - false sensory experiences

REM Sleep

- REM (Rapid Eye Movement) Sleep
  - vivid dreams/ bizarre imagery
  - Tonic immobility / active brain
  - “paradoxical sleep”
    - muscles are generally relaxed, but other body systems are active
  - Blind individuals experience this
  - Erections

Stages in a Typical Night's Sleep



I .NREM Sleep

A)Physiological characteristics

- **EEG activity (Figure, 7):** For all practical purposes, the electro-enecphalogram (EEG) defines the presence of NREM sleep in the human. It has been possible to describe four EEG stages according to the depth of sleep. Stage I EEG; consists of a mixture of low voltage irregular relatively fast (more than 14 c/sec.) waves. This stage corresponds to light sleep. Stage 4; consisting of high voltage slow wave activity (below 3 c/sec.) coincides with the maximum depth of sleep. The latter stage occurs mostly in the early hours of the night.

- **Oculomotor activity:** The eyeball activity during NREM sleep is characteristically slow and pendulous side to side movement. The appearance of these slow oscillations of the eyes is parallel to the abrupt transmission from wakefulness to sleep. Psychologically, it corresponds to the change of mental content from the conceptual mode of thinking to the perceptual mode, i.e., from ideas to images. This is called hypnagogic imagery.

- **Respiratory activity:** Respiration becomes relatively slow and regular.
- **Cardiovascular activity:** The heart rate is slowed down and the blood pressure gradually falls.
- **Other bodily activities:** fall of body temperature, increase of basal skin resistance, decrease of urinary output and parasympathetic over-activity occur during NREM sleep.

B) Psychological characteristics

- **Level of consciousness and attention :** The onset of sleep is associated with an abrupt and generally diminishing level of consciousness. The depth of sleep varies throughout the night sleep. Periods of deep sleep are interrupted by short intervals of light sleep. The pattern of variation of sleep depth is characteristically individual and more or less constant from night to night.

- Attention is diverted first from the external environment to preoccupation and uncontrolled imaginative thinking. The moment one enters sleep, the thoughts are transformed into images and attention to external environment is lost completely.

- **Sensory responsiveness :**Sleep is marked by abrupt change in sensory responsiveness. External stimuli lose their significance and cannot be perceived. However, selective response to some relevant and important stimuli may occur, e.g., the mother is immediately awakened by the cry of her infant, inspite of deep sleep and does not respond to other stimuli.

- **Problem solving and retention :**During sleep, there is continuous mental activity evidenced by occasional solution of a difficult problem after a restful night sleep and the better retention of recently learned material because of lack of interference.

- **Dreams :**At the onset of sleep, visual imagery and hypnagogic hallucinations take place. Dreams also occur in NREM sleep, but they are simple and have no significance. This is why dreams in NREM sleep are easily forgotten.

II-REM Sleep

This type of sleep is also called dreaming, paradoxical, fast.

A) Physiological characteristics

- **EEG activity :**Rapid eye movements take place within discrete intervals and are characterized by saw-toothed waves occurring on top of stage I EEG, characteristic of light sleep. In addition, spike discharges appear in the pons and visual system during REM sleep .

- **Oculo-motor activity :**Bilaterally synchronous fixation shifts of the eye, like the eye movements of optokinetic nystagmus, occur during this stage.

- **Cardiovascular activity :**The heart rate accelerates slightly, blood pressure rises, peripheral vasoconstriction and increase in the cerebral blood flow occurs .
- **Respiratory activity :**Respiration becomes more rapid and irregular, together with episodic shallow respiratory movements. There is also an increase in O2 consumption during REM sleep.

- **G.I.T activity :**Slight elevation of gastric acid secretion and dramatic rise in peptic ulcer patients, occur in REM sleep.
- **Genito-urinary activity :**Decrease in urinary output penile erection and emissions occur during REM sleep.

- **Skin changes :**Decrease of the skin resistance is recorded.
- **Muscular activity :**REM sleep is characterized by the presence of peripheral twitching movements of the limbs and facial muscles together with inhibition of the muscle tone between the twitches. Reflexes are also suppressed

B) Psychological Characteristics

- **Dreaming:** REM sleep is also called dreaming sleep, for it appears to be associated with dreaming activity.The pattern of rapid movements of the eye are also closely related to the visual imagery in a way suggesting that the dreamer is watching his dreams.

- Dream experiences during REM sleep appear to be more vivid, complex, associated with emotional experiences and variable, than those during NREM sleep and easily recalled. The dream content can be influenced by external stimuli, pre-sleep experience, certain chemical agents and hypnosis.

- In young adults, REM sleep, interrupts NREM sleep on the average of once every 90 minutes, lasts approximately 20 min. and accounts for 20 to 25% of the total sleeping time. In the cat, dreaming periods last about seven min. and NREM sleep 10-20 min. The periods devoted to dreaming sleep vary according to age. In the immediate neo-natal period in humans, REM sleep occupies 50% or more of the total sleeping time.

- Therefore, the infant, sleeping most of the day, experiences about 4-8 times as much dreaming sleep as the adult. An even greater percentage of REM sleep occurs in the premature infant. This suggests that the fetus spends all his time in dreaming sleep

Neurophysiology of sleep

I-NREM Sleep

A. Reduction of afferent impulses :
B. Reduction of the activity of the Ascending Reticular Formation:
C. Endogenous poisoning:
D. Neuro-anatomical mechanism (sleep center).

II-REM Sleep

A. **Neuro-anatomical mechanism:** REM sleep seems to depend on the integrity of a sleep center located in the pontine RF since lesions here abolish it totally.

A. **Biochemical mechanism:** REM is relatively constant from day to day in contrast to NREM sleep, which is variable in duration. Certain compounds increase REM sleep, such as tryptophan, 5 HTP (serotonin) and, LSD. Monoamine compounds and compounds that affect monoamine metabolism will selectively block REM sleep, e.g., Dexedrine, parnate and reserpine.

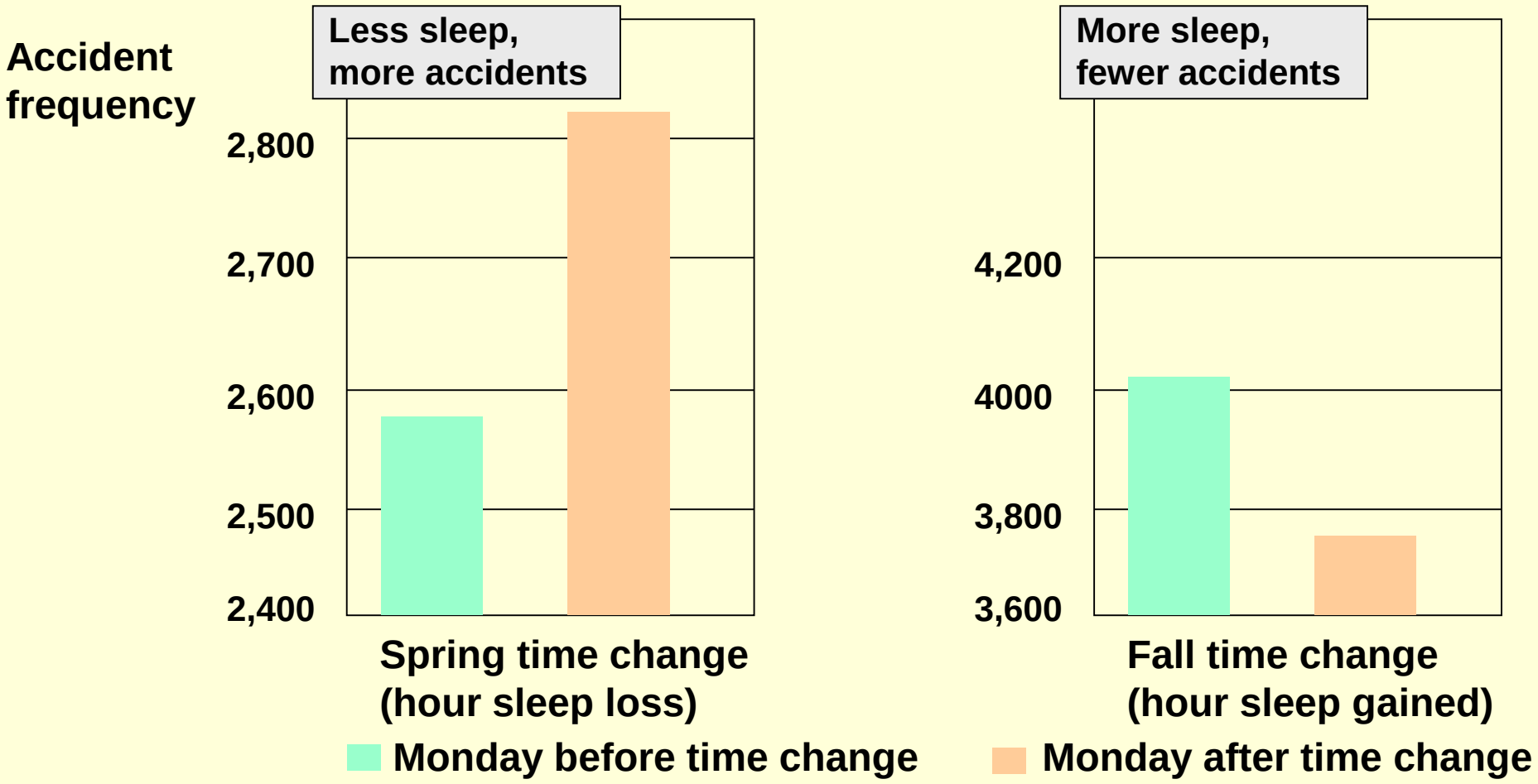
Effect of sleep deprivation

- The major effects of total sleep deprivation are an impairment of performance and the development of a tendency towards somnolence and drowsiness. No organic changes have been conclusively shown to be caused by sleep deprivation. It appears that the total amount of NREM sleep can be greatly decreased without harm to the organism. Prolonged selective REM sleep deprivation, however, results in neural hyperexcitability

Sleep Deprivation

- Effects of Sleep Loss
  - fatigue
  - impaired concentration
  - depressed immune system
  - greater vulnerability to accidents

Sleep Deprivation



Comparison between Psychophysiological Characteristics of NREM and REM Sleep (table, 2)

Function	NREM Sleep	REM Sleep
Oculomotor Activity	Pendular i.e. side to side	Bilateral i.e. Synchronized fix. Shifts
Electro encephalogram	Four stages	Saw-toothed on top of stage one
Autonomic Nervous System	**Increase activity of parasympathetic system**	Increase activity of sympathetic system
Cardiovascular System	Decrease pulse, blood pressure, oxygen concentration and vasodilatation	Increase pulse, blood pressure, oxygen concentration and vasoconstriction and cerebral blood flow.
Respiratory System	Slow regular with snoring	Rapid irregular with episodic slowing
Skin Resistance	Increase	Decrease
Genitourinary System	Decrease urine	Decrease urine output, penile erection and night emission
Muscular System	Decrease tone	Lost tone of all muscles except: ▪ Ocular muscle ▪ Sphincteric muscle ▪ Tympanic membrane muscle
Dreaming	Visual imagery	Sexual, aggressive vivid dreams
Sleep Deprivation	Decrease motor coordination	Decrease cognitive functions

During sleep, most of the body's systems are in an anabolic state, helping to restore the immune, nervous, skeletal, and muscular systems; these are vital processes that maintain mood, memory, and cognitive function, and play a large role in the function of the endocrine and immune systems. The internal circadian clock promotes sleep daily at night. Sleep is a highly conserved behavior across animal evolution.
Humans may suffer from various sleep disorders, including dyssomnias such as insomnia, hypersomnia, narcolepsy, and sleep apnea; parasomnias such as sleepwalking and REM behavior disorder; bruxism; and circadian rhythm sleep disorders. The advent of artificial light has substantially altered sleep timing in industrialized countries.