

How The Brain Creates Mind
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Lecture – 18
Sleep–3

From consciousness and putting after putting forward all the various debates and confusions about consciousness which is still I feel. If there is a consciousness and what is it? But one thing we have more certain whether this consciousness or there is something called, something calls sleep, which is a definitive different state. At one point of time it was thought, that sleep is just about resting the restoring energy till Kytelman and other people found that just by recording the EEG, that it is a very very active state is a major shift in change. The sleep from being considered as a passive restorative metabolic state it is found to be active state that is one.

The second that sleep has components, sleep has stages which can be differentiated on the basis of EEG findings. So, there is a sleep which is a non-dreaming sleep called non rapid eye movement sleep and there is a part of sleep called rapid eye movement sleep. Third thing, which was link to it that if you awake for 16 hours you sleep for 8 hours, what are these? Are these two different states of consciousness in mind or are they connected? Do they have some combined functions? And the forth question was that if you are surviving in time and space and if why are we having this different state? Is there are rhythm in to it? Is there are oscillation?

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Biological rhythms

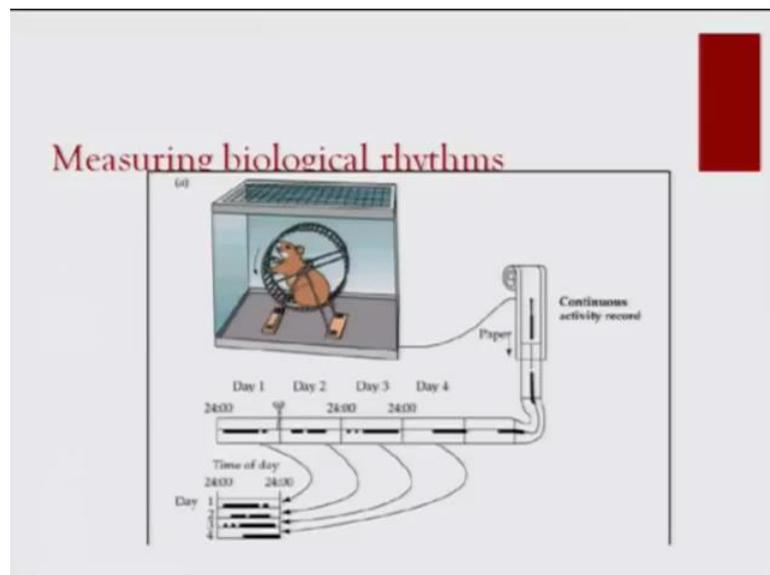
Types of rhythms

1. Ultradian (Basic Rest-Activity Cycle)
2. Circadian (sleep-wake cycles)
3. Infradian (menstrual cycle)
4. Circannual (annual breeding cycles)

***All rhythms allow us to anticipate change!**

And that really seems to with the fact. Our body has biological rhythms. It has Ultradian, which is basic rest activity, Circadian, sleep wake, Infradian, which is menstrual cycle and Circannual. But why have oscillation and rhythm, if we take this question to the brain oscillations.

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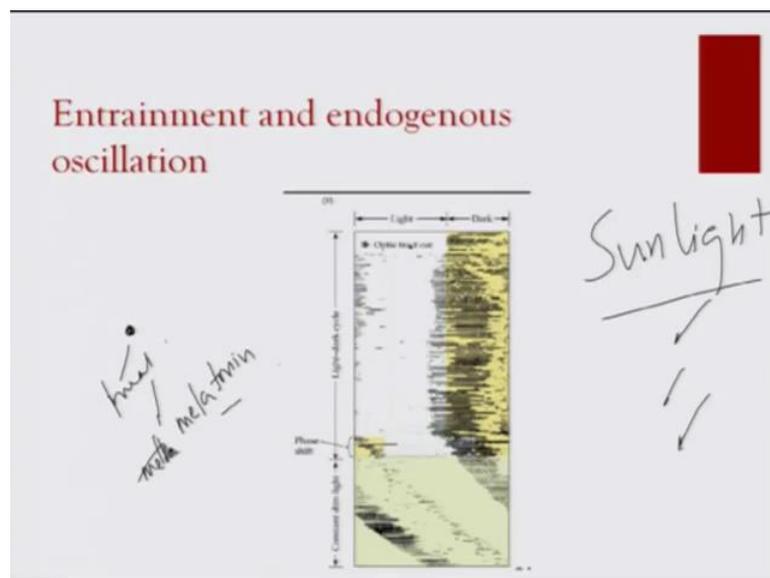


If you remember I told you that if the whole brain is firing in excretory pain and there is no any vision that how will you differentiate change? Oscillations help you differentiate change and that is base because of the basic purposes information gathering. So, change

is natural. So, this oscillation helps us anticipate change. So, this is the, this is how you measure biological rhythm, but there have been a experiments which have until that a person was put in a shielded case put down under the earth it was padded. So, that the peak traffic time does not disrupt and let him know that it is the peak traffic time. Light fluctuation of the peak voltage, peak consumer uses voltage for fluctuation where not there and he was left without the clock with the uniform light, everything else taken care of. So, this is the natural cycle of body in a brain the sleep (Refer Time: 03:40) cycle and all turned out to be around to 25 hours. So, 25 hours seems to be our biological rhythm, but because we have also greeted a contraction called clock.

When we talking about time you really do not know what time you are talking about are you talking about time which exists at their space time or this clock? This clock is a artificial contraction which is the mode of convenience actually in fact.

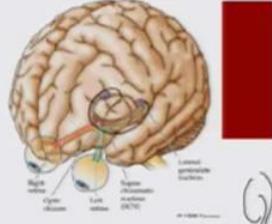
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So, and these oscillations are entrained with nature. What in nature? What is the biggest entrainer of oscillation? The biggest entrainer of oscillations is sunlight. Right from photosynthesis in plants to the carbonic structure forming to switching on a switching off in fact, this just above hypothermal there is something call pineal gland. This Pineal gland secret something called Melatonin and Melatonin as the sleep time goes nearer.

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**Suprachiasmatic nucleus
is master pacemaker**



1. Lesions of suprachiasmatic nucleus abolish free-running rhythms
2. Activity in suprachiasmatic nucleus correlates with circadian rhythms
3. Isolated suprachiasmatic nucleus continues to cycle
4. Transplanted suprachiasmatic nucleus imparts rhythm of the donor

Melatonin instigation increases, over in above hypothalamus this area you see this something calling is a pacemaker. We know this because of lesions of Suprachiasmatic nucleus abolish free running rhythms, activity correlates with Circadian rhythms, Circadian within 24 hours even if isolate this and keep recording it continues to cycle.

Once the cycles in the brain it causes in sleep wave, but in its own, it is (Refer Time: 05:41) and this is the most interesting fact. And if you take a Suprachiasmatic nucleus for one personal impart to the other person, the donor's cycle will super imposer over the recipient cycle. That means nature has already genetically created one pacemaker; that means, nature requires a master pacemaker, but why? Because lot of hormones like growth hormone like cortisone which as a stress hormone is temperature regulation or this movement oscillatory cycles within the sleep like in a state 3 and 4 growth hormone secant which is impotent for kids. This is just a, you can go through this set ledger, with this type of description in.

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Sleep in Hindu & Islamic Philosophy

- Vedas & Upanishadas consider sleep as part of consciousness:
 - *Jagrat* (or *Vaisvanara*)- awake.
 - *Svapna* (or *Tajjasa*)- dream.
 - *Sushupti* – dreamless sleep.
 - *Turiya* - spiritual state of consciousness.
- The Quran considers sleep as part of “state of self”:
 - Consciousness.
 - “*Wafat*” (death).
- *Wafat* is divided into:
 - sleep (temporary death).
 - death (real death).
- Quran refers to “dream” as *ru’ya* (vision), *hulm* (dream), *manam* (sleep) and *bushra* (tidings).

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What is sleep?

Behaviorally sleep is characterized by:

- Reduced motor activity.
- Decreased response to stimulation.
- Stereotyped posture.
- Relatively easy reversibility (this distinguishes it from coma, hibernation, torpor & estivation).

So, what is sleep? We talked about consciousness about; we do not know; what is consciousness. What is a sleep? But we do not know sleep either, that is the strange thing. In spite of all our knowledge if you really ask somebody what a sleep? Reduced motor activity, decreased response to stimulation, stereotyped posture, relatively easy reversibility, this distinguishes it from coma which is a part of will are hibernation lot of animal go torpor and estivation.

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Sleep investigations

- Modern sleep research is multidisciplinary.
- EEG has been the backbone of sleep research and sleep medicine since 1930s.
- Analysis of sleep should ensure that it is:
 - Compatible with existing scientific evidence.
 - Based on biological principles.
 - Applicable to clinical disorders.
 - Easily used by sleep clinicians, sleep scientists and technologists.

Handwritten notes: "Polysomnography" and "PSG" with arrows pointing to the list items.

These are various stages. So, modern sleep research is part clinical part research EEG is the backbone of all this and analysis should ensure that this comfortable with scientific evidence is based on biological principles, applicable easily used. Now this is the stuff which has gone in to make what you call PSG, the full form is Poly Somno Graphy. Why mentioning this, because sleep is still is not a part of pure clinical labs or (Refer Time: 07:58) scientific lab somewhere between because below overlap in the whole thing.

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Modern classification of sleep

- Though EEG has been the backbone of sleep analysis, it is used in combination with EMG and EOG.
- Polysomnographic recording includes electrocardiogram, respiratory effort, nasal/oral airflow, blood oxygen saturation, body position, limb movements, and video recording.
- Modern definition & classification
 - Nathaniel Kleitman (1939) Book "Sleep and Wakefulness".
 - Aserinsky & Kleitman (1953) REM sleep.
 - Rechtschaffen & Kales (1966) A Manual of Standardized Terminology, Techniques, and Scoring System for Sleep Stages of Human Subjects.
- American Academy of Sleep Medicine (AASM) modified the staging rules in 2007.

Handwritten notes: "PLMS" and checkmarks next to some items.

So, what is Polysomnographic? It has EEG, Electroencephalogram; it has the EMG, Electromyography; that means to measure the muscle activity. Electrooculogram to catch the eye movement, it also requires ECG respiratory effort, this is essentially if you get this set of data there are more than 50, 60 disorders associated with sleep. So, you require all this unless something called obstructive sleep apnea, where there is a problem in flow of oxygen. You required expiratory effort nasal oral flow blood oxygen saturation, for that there some people have what you call sudden body movements call periodic leg movements, which is called PLMS you required electro seared to check that, modern definition the Nathaniel Kleitman as I said that Aserinsky Rechtschaffen Kales.

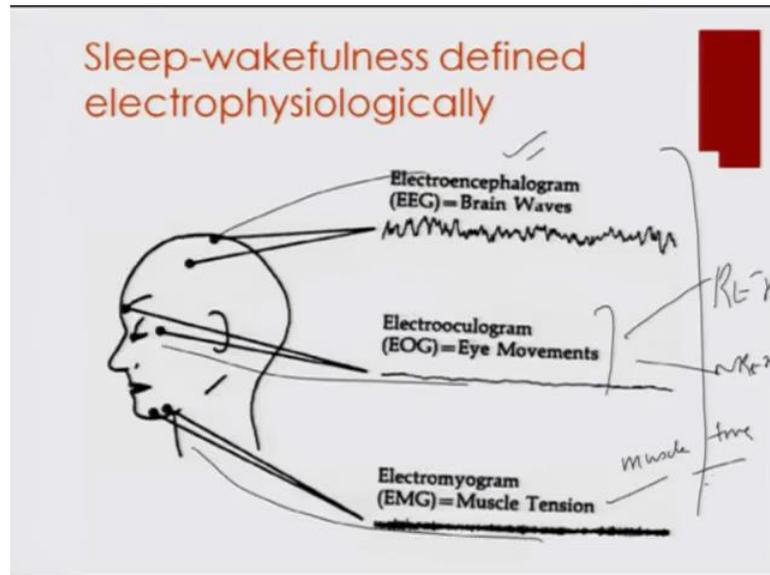
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Major issues in sleep analysis

- Our understanding of sleep and its neural mechanism is grossly inadequate.
- Modern sleep classification is based on the age old belief that sleep consists of REM sleep and Non-REM sleep.
- Classification of sleep into REM and Non-REM started with the assumption that REM sleep is sleep with dream, and Non-REM is dreamless sleep. *Rapid Eye movement*
- Use of computer has helped in fast analysis of large data. *Non-R*
- But computer analysis has not been able to take care all aspects of available information.
- There are major differences between manual (visual) scoring, and computer scoring.

So, what is all this about? It is about this, that there is a REM sleep and there is a non REM sleep. REM is Rapid Eye Movement and non REM is non Rapid Eye Movement. It was found that there are, while a person is sleeping there are phases of 20 minutes everyone 1 and half hours where the eye balls move very fast. Later on it was correlated the during this phase people dream. So, sleep was broadly divided into these two things and REM that is the base line. Initially paper recording was done and so all recording of EEG.

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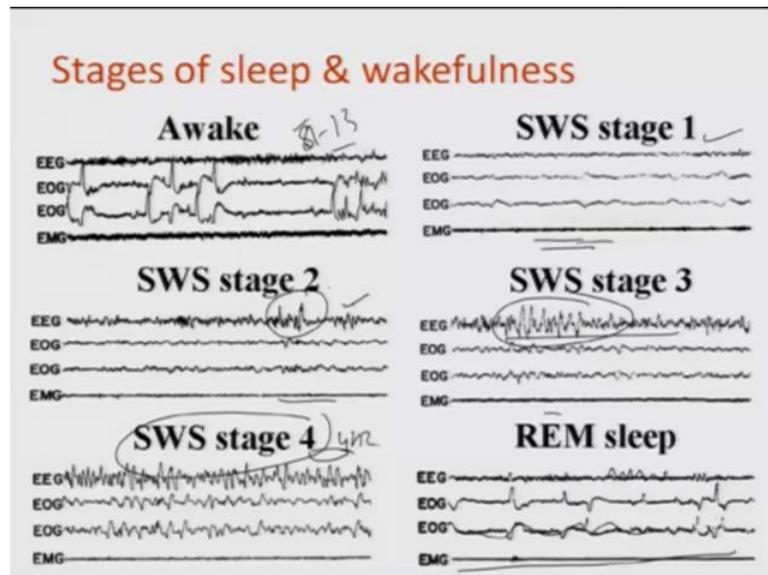


Like this. So, it is Electroencephalogram brain waves, Electrooculogram eye movements, Electromyogram. This is the basic Polysomnography. So, by EEG, what do you do? You check in the stages whether there is a variation in electrical activity throughout night. This you want to check to differentiate between the rapid eye movement and non rapid eye movement and this you check to the muscle tone why? Because the nature is smart, when you are dreaming your mind is shut off in the external reality. That is group of neurons called Locus Coeruleus, where (Refer Time: 11:16) is a system of mind, which gets attention that is shut off.

So, that you external stimulus does not enter because and why it has done is bases of one of the greater theories also. If you add tone on your dream the chances are you may hurt yourself. So, your whole body is paralyzed except for breathing muscles and your eye muscles. Why eye muscles? Because even if lot of animals when they sleep the half sleep actually because jungle is a dangers place. So, you are half sleeping your eye has scanning environment, even with your eyes close it is scanning for any predator. So, your predator comes as we are gone in to more secure living this a scanning business is a decrease, but rapid eye movement have been preserved, but the same time what we also doing you also seeing dreams within.

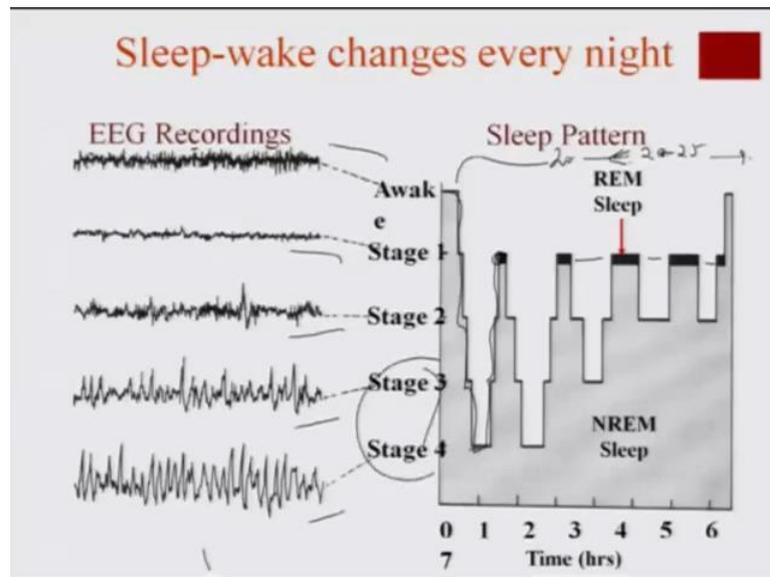
So, when you normally look you move. So, the whole cinema is going on inside the head; obviously, your eyes are not getting any stimulus from in when within, but when they getting.

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So, this was evolutionary mechanism. So, what happen in this stage? This is a type of stuff which you get awake EEG, first in the range of 8 to 13 energy alpha, slows down muscle tone is a still there to, the EEG further slows down with this sleep is spender appearing is stage 3 for governed to 4 to 7 hour hertz. Stage 4 further slowdown 4 hertz. This is the normal physiological state where a stage 4 appears otherwise it does not appear and then it changes to REM sleep where, EEG become faster, see your muscle tone muscle tone awake, decreased, decrease, decrease it almost flattens. Eye movements have becomes more rhythmic, you can make it out.

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Now, you can see this is the type of Hypnogram awake EEG stage 2. So, your brain will awake stage when it varies from 4 to 30 hertz also keep at changing its rhythm. So, in 8 hours sleep of a normal person what happens is the first 90 minutes you go down from awake to stage 1 to 2 to 3 to 4 right. First 90 minutes and then the first REM appears from this it goes to stage 3 to 2 REM sleep. As the night progresses, you can make it out here. The REM increases; that means, the first 90 minutes cycle 20 minutes of REM, then the REM decreases. There the REM sleep decreases, then REM may be increases to 30. So, when you are getting in to them, morning hours that is the maximum time of dreaming. So, if you have must you are wake up from dream.

This is the natural cycle which has happened 90 minutes, 20 minutes then stage 3, 4 and as night progresses what decreases is the stage 3 and 4 that decreases. More of the sleep remains in the stage 2.

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Polysomnography

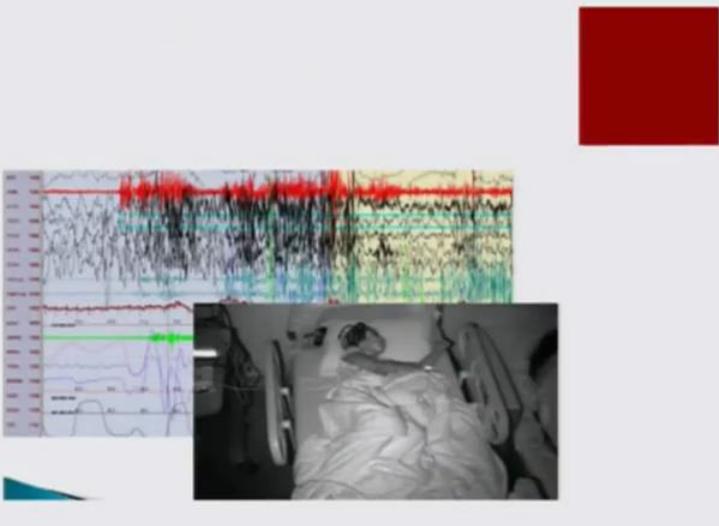
Apart from EEG, EOG and EMG, other variables include:

- Electrocardiogram (ECG) with two or three chest leads.
- Respiratory effort, by chest-wall and abdominal movements.
- Nasal and/or oral airflow via thermistor or pneumotachograph.
- Oxygen saturation via pulse oximetry.
- Body position via mercury switches or by direct observation.
- Limb movements (arms and legs) via EMG.



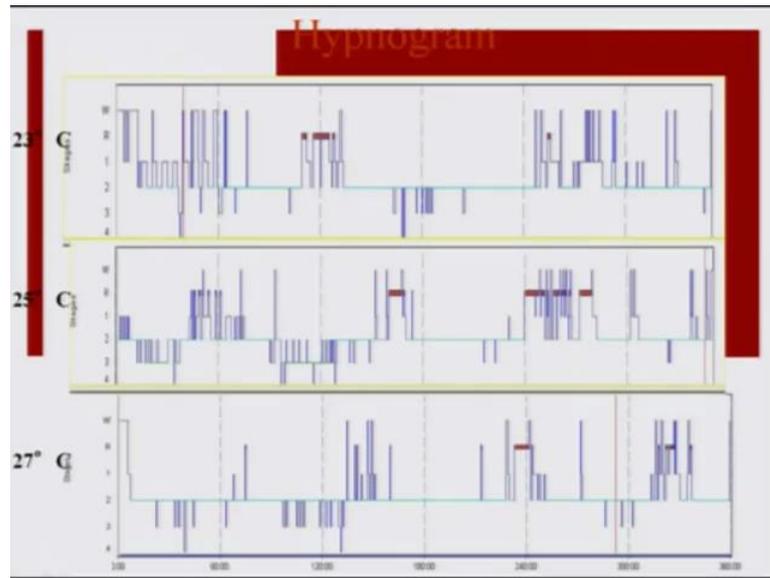
The composite image consists of three parts: a patient lying in bed with various sensors attached to their head and chest; a person standing and wearing a white chest strap sensor; and a close-up of a hand with a pulse oximeter sensor attached to the index finger.

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The image displays a polysomnography recording with multiple channels of data, including EEG, EOG, and EMG, overlaid on a photograph of a patient in bed. The recording shows various waveforms and signals, with a prominent red signal at the top. The photograph shows a patient lying in bed, covered with a white blanket, with sensors attached to their head and chest.

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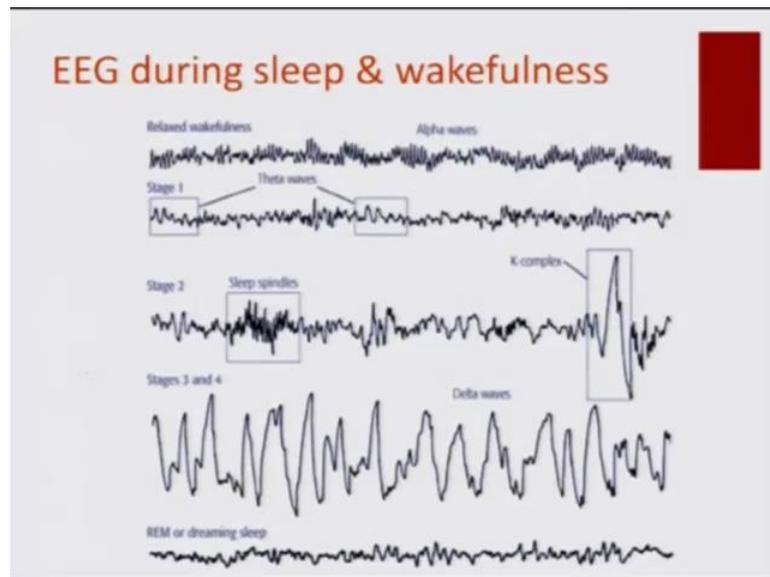
This is clinical do not bother about it. This is how the whole Polysomnograph appears.

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Electroencephalography

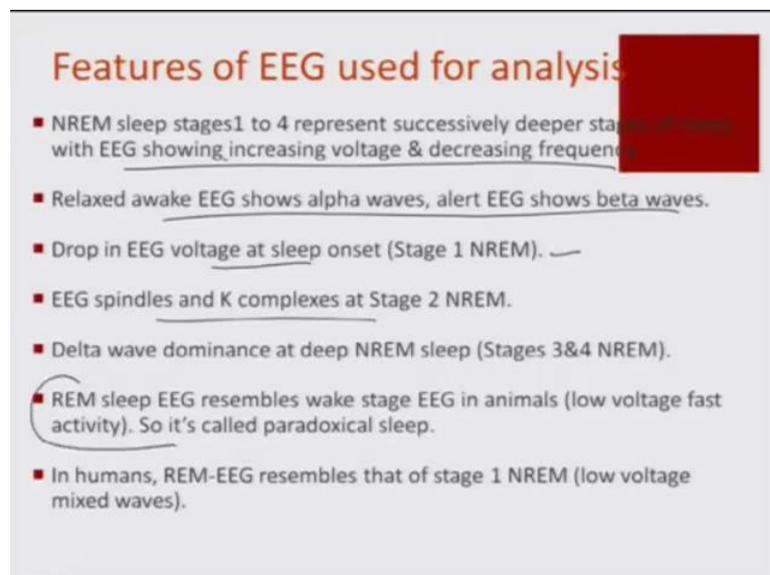
- Modern sleep research began with electrophysiological monitoring of sleep.
- The first person to record electric currents of the brain was Richard Caton in 1875.
- Hans Berger (1929) is generally credited with the discovery of the EEG. He showed that the EEG differs between sleep and waking.
- Aserinsky and Kleitman (1953) showed that sleep could be further differentiated into two distinct states, ie REM sleep and Non-REM sleep.
- EEG recorded from frontal, central and occipital regions using 6 electrodes in 10-20 system.

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So, Hans Berger, he is the man of discovery of EEG and he also showed the sleep and waking EEG differs. So, what is the purpose of all this? See this is again, you can see the EEG.

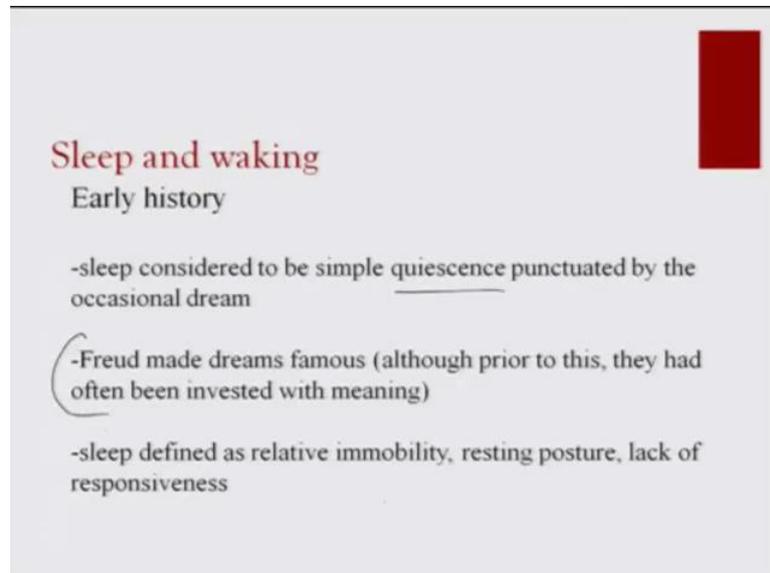
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NREM sleep is stage represent successively deeper stagers of EEG showing increasing voltage decreasing frequency. Relaxed awake EEG shows alpha waves also beta drop in EEG voltage at sleep onset spindles and k complex at these are oscillation which are

happening remember the oscillations. REM sleep EEG resembles wake stage EEG and REM, EEG resembles that of stage 1 REM.

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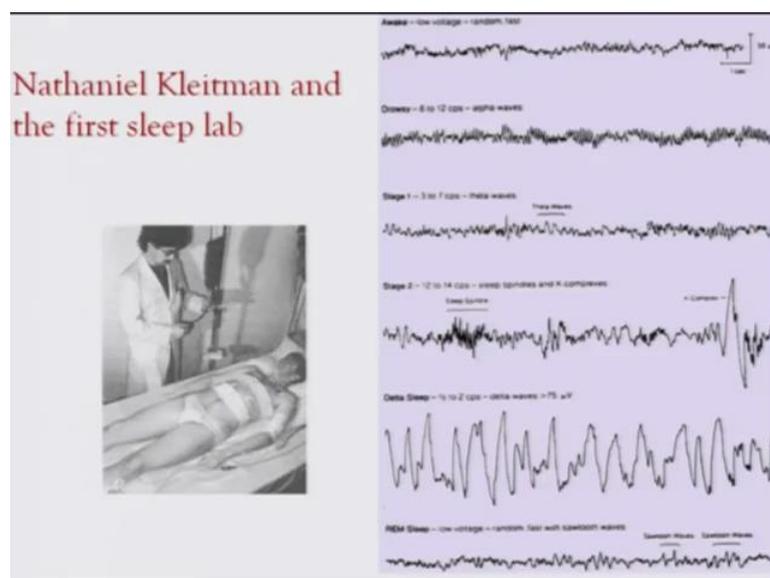


Sleep and waking
Early history

- sleep considered to be simple quiescence punctuated by the occasional dream
- Freud made dreams famous (although prior to this, they had often been invested with meaning)
- sleep defined as relative immobility, resting posture, lack of responsiveness

What is it actually? We forget the EEG part and the clinical part of it which I have covered in one of the (Refer Time: 16:19) in psychiatry in an over view. First it was thought to be simple quiescence period and a Freud gives all psychological theory of dream work.

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Nathaniel Kleitman and the first sleep lab



Awake - low voltage - random fast

Onset - 8 to 12 cps - alpha waves

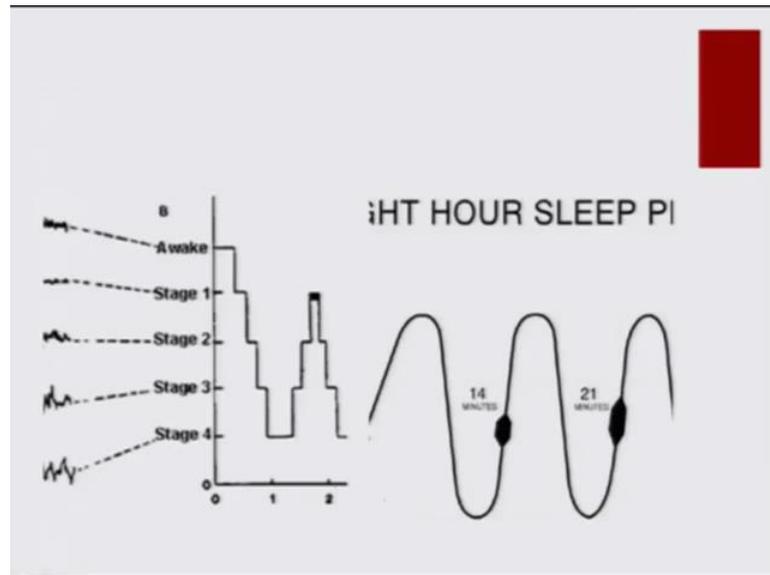
Stage 1 - 3 to 7 cps - theta waves

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

Delta Sleep - 1 to 2 cps - delta waves - 75 uV

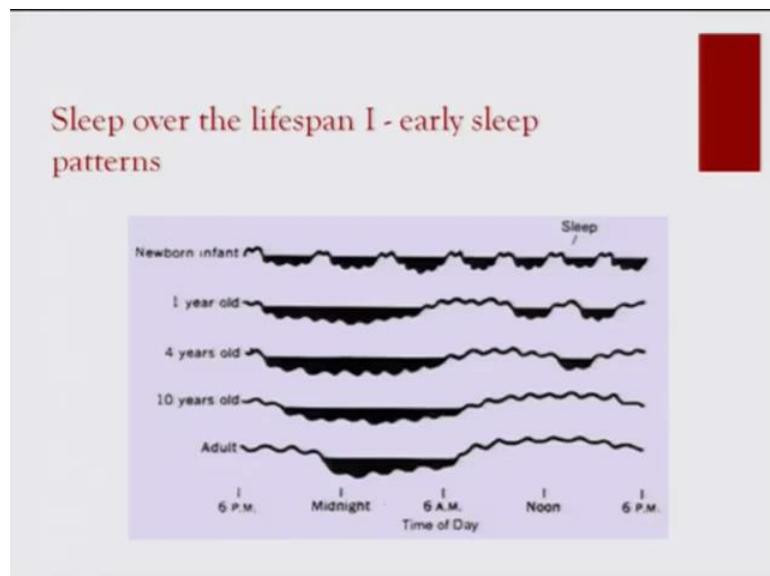
REM Sleep - low voltage - random fast with sawtooth waves

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This was the first sleep lab. This is a very very historical picture, he talked about architecture. So, it is not about your sleep only.

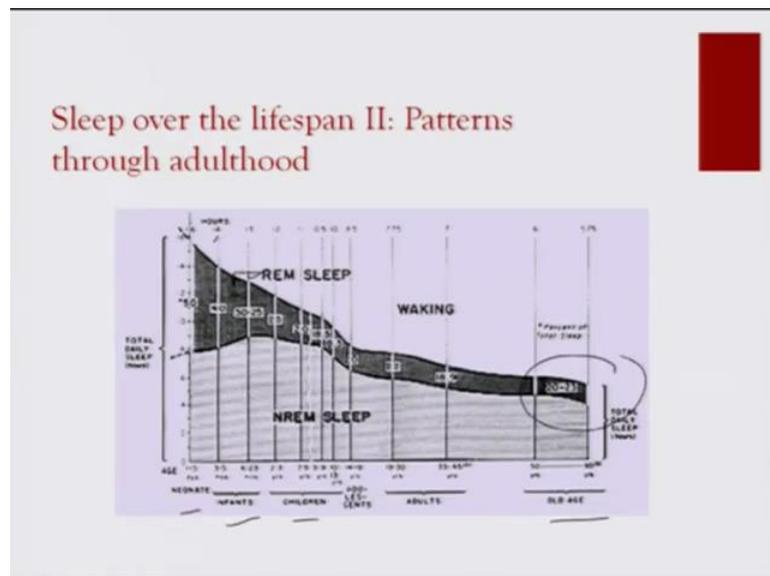
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If you remember we talked about in the first week about how the brain develops. Sleep is not something which comes after birth or whatever it is inherent with development. A new born infant sleeps more than 20 hours. Surprisingly we do 80 percent of the sleep is REM sleep that is the dream sleep. What is the new born dreaming, we do not know.

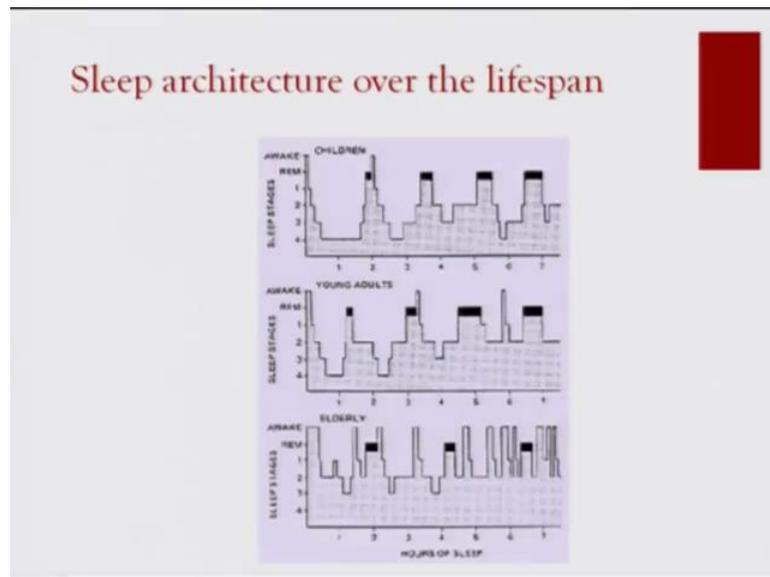
In the first year of life by the time that starts speaking they are forgetting everything. That is still one of the biggest research areas and has to really get the content of the dream of the first year. As the brain myelination happens as the brain network goes there, it all most by the 10 years of life, it all most becomes like an idle pattern. Where is a largely with first 3 years. So, this you see, this is if you take just take it as REM. So, much by the term it comes to 4 years, it is becoming like an idle pattern. Alpha waves normally become like mature people by the year of 10 years where, the myelination is complete.

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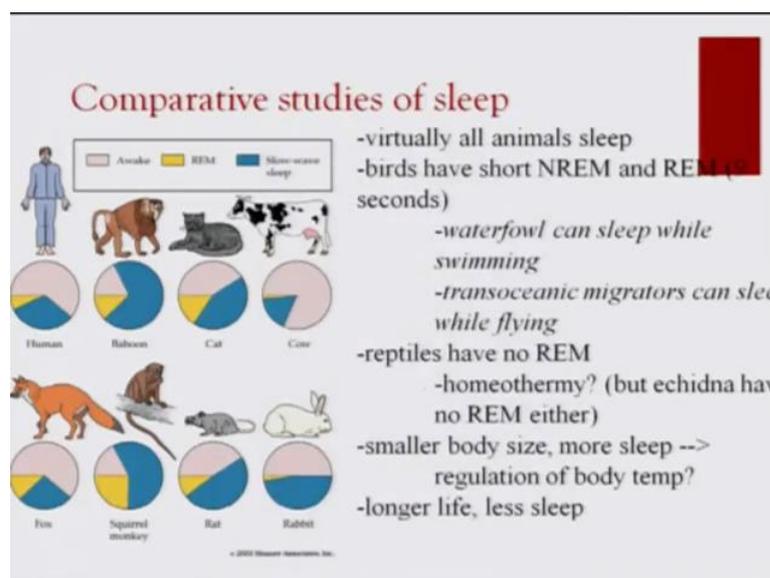


So this sleep is so inherent right from birth, otherwise you do not have in the first year of life. So, as you grow old of this sleep requirement also decreases. This is the through life span, total daily sleep decreases neonate this many hours, infant see this children as we become old age here struggle with sleep.

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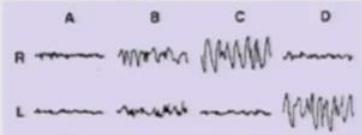
Or in the same thing, the interesting thing is as we said you we see sure lot of other nation this and that with animals, we also share this sleep business. All animals sleep and the interest is birds have short NREM and REM sleep waterfowl can sleep while swimming. Dolphin - when it sleeps 1 hour, the brain sleeps the other keeps awake. Reptiles have no REM, so is smaller body size each hemisphere takes turn sleeping.

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The amazing bottle-nosed dolphin



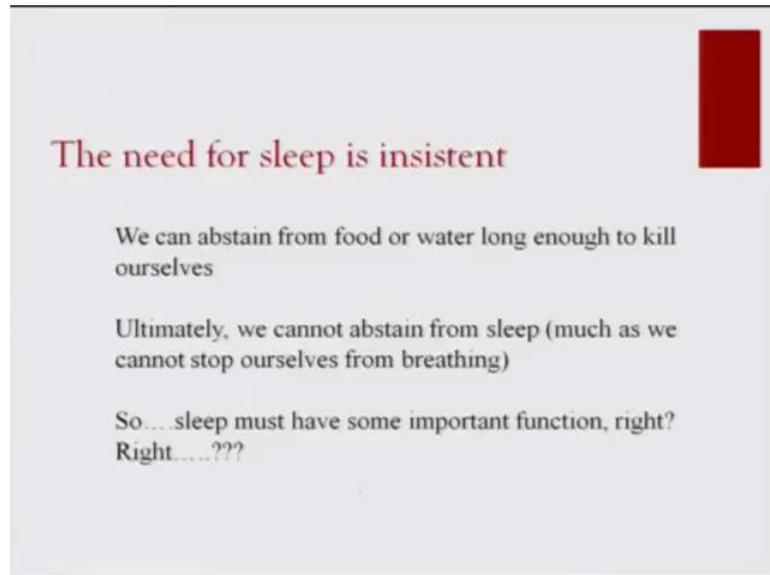
Each hemisphere takes turns sleeping



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The functions and neural bases of sleep

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The need for sleep is insistent

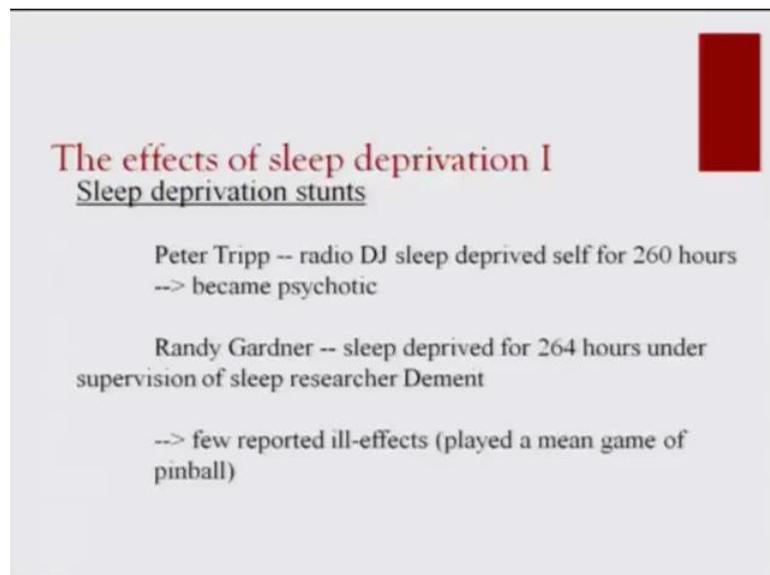
We can abstain from food or water long enough to kill ourselves

Ultimately, we cannot abstain from sleep (much as we cannot stop ourselves from breathing)

So... sleep must have some important function, right?
Right.....???

So, lot of people will ask, what why sleep required and how much? Anything less than 4 and anything more than 10 hours is pathological, that creates problem we can abstain from food long enough, but we cannot abstain from sleep your brain will crash. So, possible there must be important function.

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The effects of sleep deprivation I

Sleep deprivation stunts

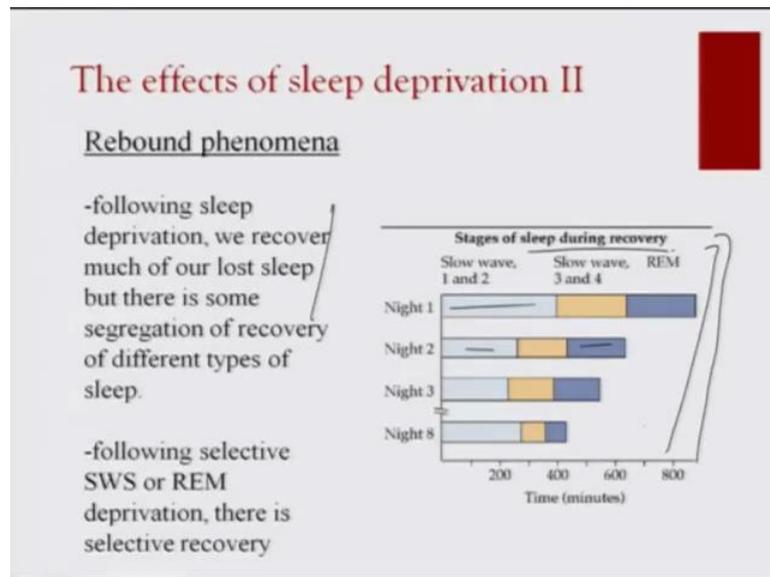
Peter Tripp -- radio DJ sleep deprived self for 260 hours
--> became psychotic

Randy Gardner -- sleep deprived for 264 hours under supervision of sleep researcher Dement

--> few reported ill-effects (played a mean game of pinball)

Radio DJ sleeps deprived for 260 hours became psychotic, lost touch with reality. 264 hours in the supervision of sleep researchers. Some of them report ill effects for few hours.

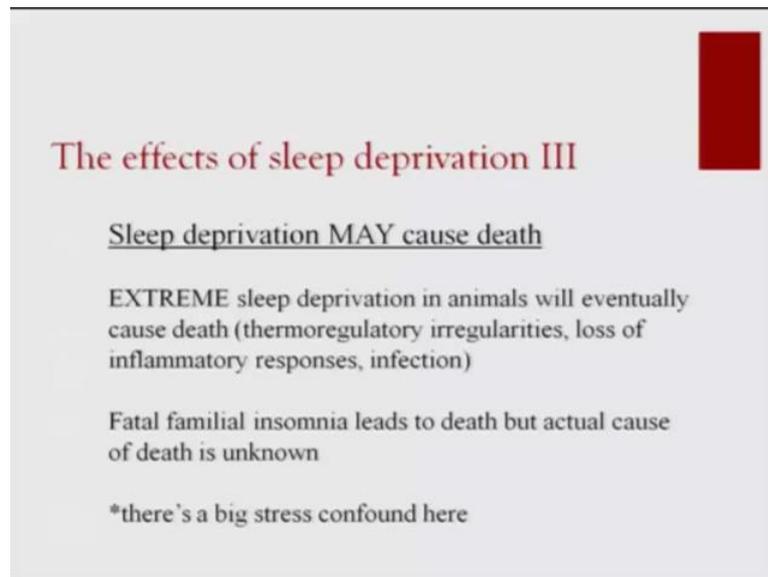
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With two sleep deprivation experiments, we deprive people are sleep, but we recover most of the last sleep, but it does not happen that you are slept you recover.

When you are recovering then, there is a lot of differentiation. Night 1 slow wave when night 2 REM sleep. So, what happens is that, there is a partial recovery of REM and NREM as you recover sleep. If you partially suppress then; obviously, that face will (Refer Time: 20:38). It happens with medication if you take some of the benzodiazepines and suppress dream sleep you get a deep sleep, but once you recover then the dream sleep remounts and you start seeing more dreams and all very vivid, instance dreams lot of people complaint, that the whole night have not slept and dreaming more and more.

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The effects of sleep deprivation III

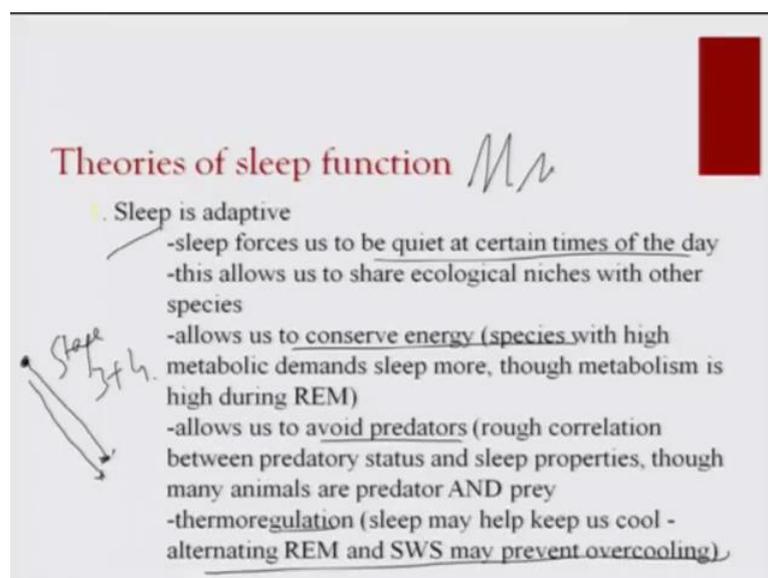
Sleep deprivation MAY cause death

EXTREME sleep deprivation in animals will eventually cause death (thermoregulatory irregularities, loss of inflammatory responses, infection)

Fatal familial insomnia leads to death but actual cause of death is unknown

*there's a big stress confound here

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Theories of sleep function *Mz*

1. Sleep is adaptive

- sleep forces us to be quiet at certain times of the day
- this allows us to share ecological niches with other species
- allows us to conserve energy (species with high metabolic demands sleep more, though metabolism is high during REM)
- allows us to avoid predators (rough correlation between predatory status and sleep properties, though many animals are predator AND prey)
- thermoregulation (sleep may help keep us cool - alternating REM and SWS may prevent overcooling)

Shape 3+4

So, extreme sleep deprivation will eventually cause death. There is illness called fatal familial insomnia which leads to death, but actual cause we do not know. So, what we call? Why sleep happening? Sleep may be adaptive it forces us to be quiet at certain times of the day. It allows us to conserve energy; it allows us to avoid predator's thermoregulation.

As you sleep the temperature falls, morning time the temperature are the lowest; that means, cottagers secretion is maximum year 1. Growth hormones are maximally secreted

in stage 3 and 4 that is very important for the growth. So, sleep may alternative REM are slow cycle may prevent over cooling where, REM may be sending the activity like this, slower sleep again cools down.

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Theories of sleep function

2. Sleep is restorative

- sleep helps us to get back something we lose during waking
- growth hormone is only secreted during sleep (though not in kids under 4, not in adults over 60 and not in all animals)
- correlational studies not THAT convincing
- small increase in SWS after ultramarathon
- no decreases in sleep in quadraplegics

But what is the REM doing? Like this growth hormone is only secreted during sleep though not in kids under 4 not in adult over 60.

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Theories of sleep function

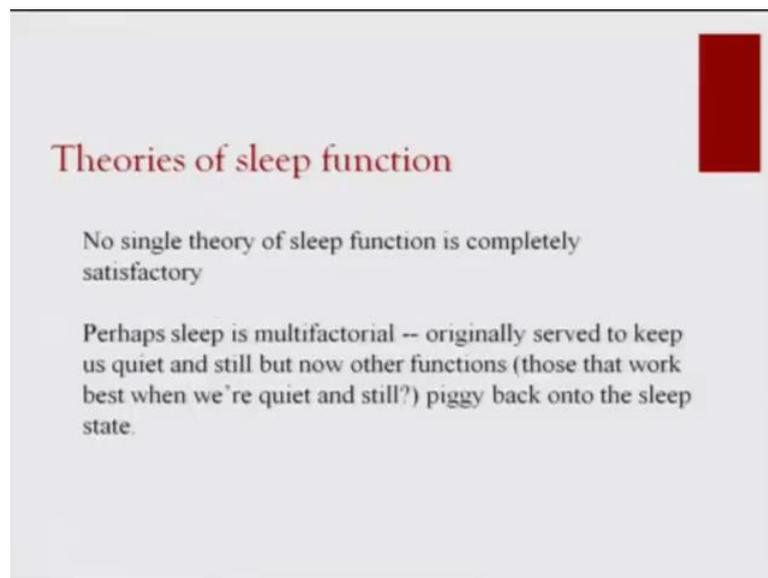
3. Sleep promotes learning

- there is NO good evidence that we can learn while asleep
- sleep deprivation can have small effects on ability to learn, but impossible to disentangle other effects of deprivation
- some studies show a slight increase in REM after difficult cognitive tasks
- some people sleep little or not at all and show no obvious deficits in ability to learn

So, what is REM doing? Thus sleep promote learning, there is no good evidence. Sleep deprivation can have small effects on ability to learn right, slight increase in REM after

difficult cognitive tasks. So, if you are using a brain too much lot of complicated activity your REM may go up actually. It happens with me at least you observe a sleep pattern when I am thinking allot I am reaming too much, but sleep is such a variable some people do not sleep at all. While I was giving the sleep research, I almost to in to sleep 4 hours in a day for 3 years nothing happen. I do not know whether that is cause the ill effect now, but that time may be I was younger at that time.

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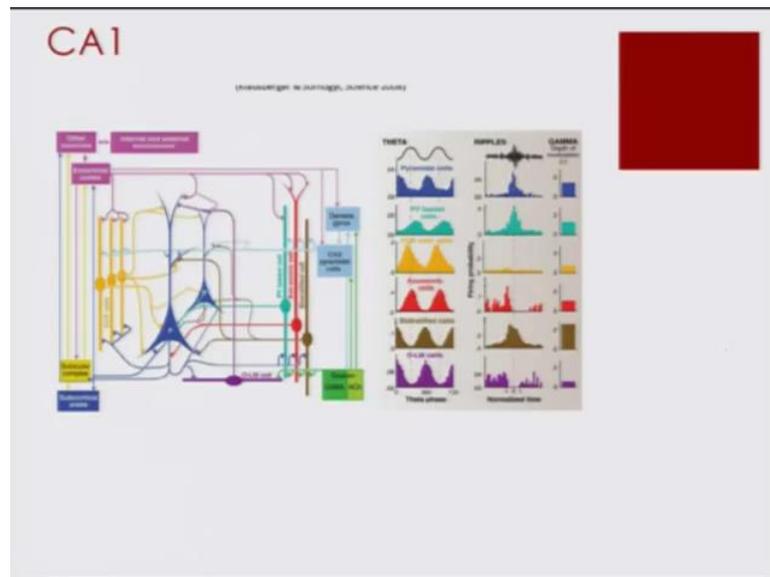
Theories of sleep function

No single theory of sleep function is completely satisfactory

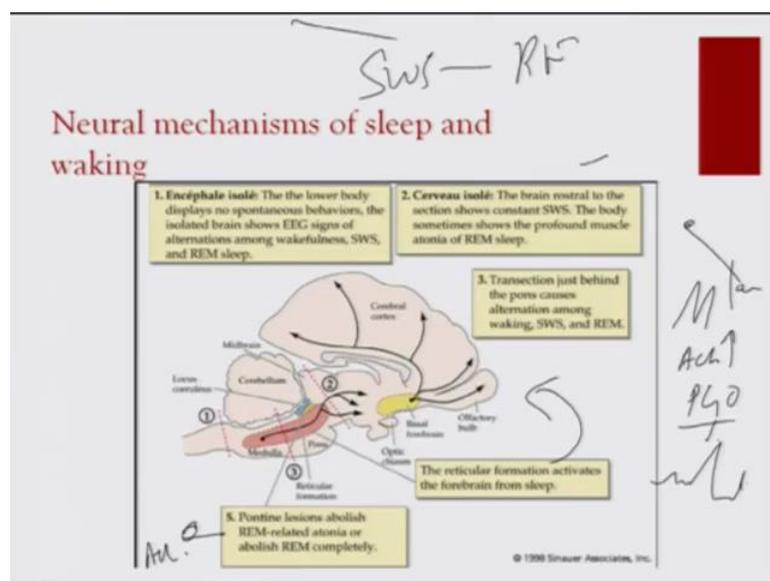
Perhaps sleep is multifactorial -- originally served to keep us quiet and still but now other functions (those that work best when we're quiet and still?) piggy back onto the sleep state.

So, no single theory of sleep like: no single theory of consciousness. So, we are still cropping in dark. Although other functions that cardiology another things they have piggy back onto sleep in search to find out.

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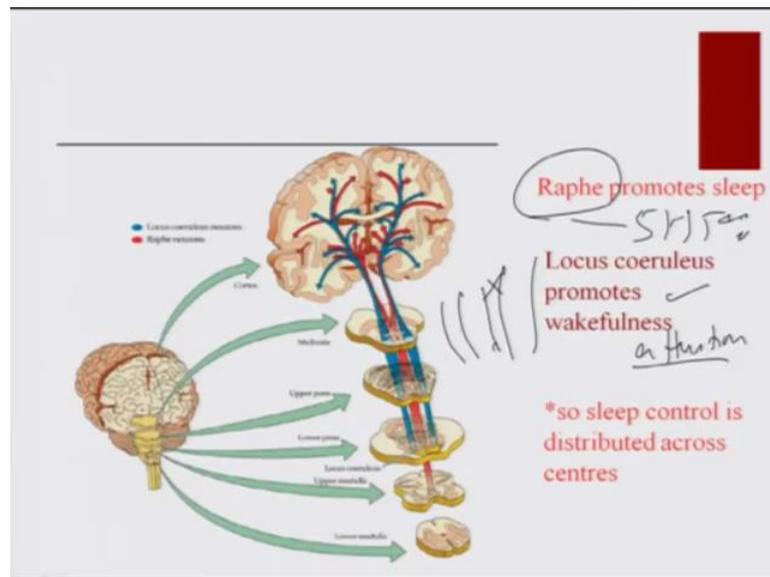


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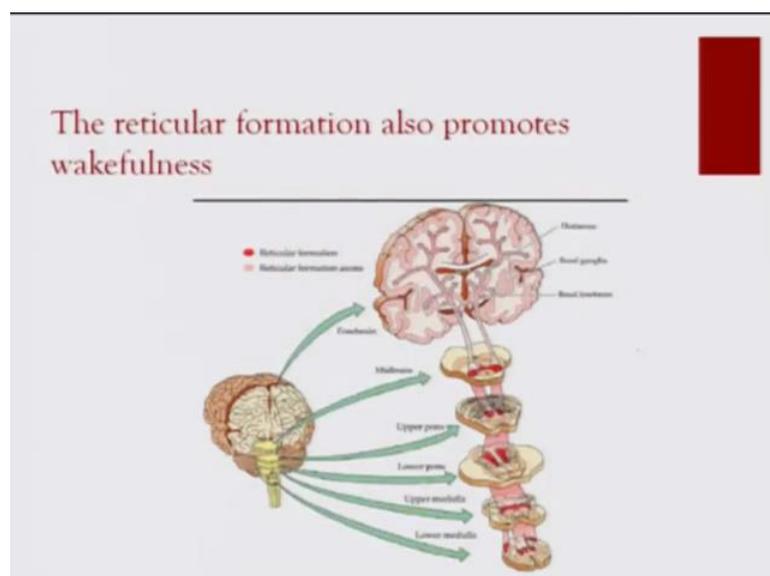
But they Communes theory, which is more popular is about learning. It is about this theory which (Refer Time: 23:27). So, this is how it happens, the semitone levels are high they start falling sleep triggers 90 minutes later certain areas is start secreting more stile cooling, in the form of Photogenitcal Oxibuto waves found in cats which sends spikes regards of the dream sleep right. Pontine lesions abolishes REM related this is the style Collin. The reticular formation activates the forebrain from sleep. Now this slower sleep to REM sleeps Serotonin Astailecolen.

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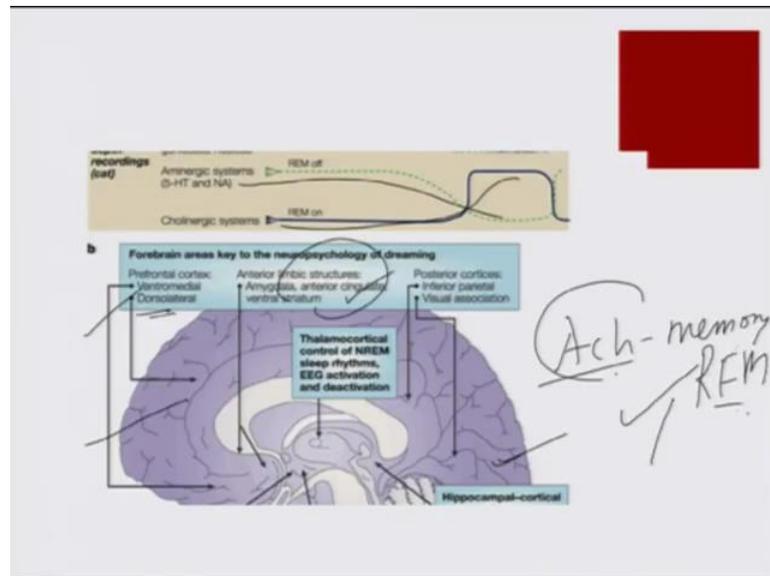
Raphe which is the serotonin thing, 5 h t; the lot of meditation which induce sleep actually block this - the receptors of this, why increases serotonin level activity level increases, it decreases serotonin level Locus Coeruleus level promotes wakefulness because as I said this is the chemical which regulates attention. REM sleep this shuts off because we do not want frequent things coming in from outside. Now because this shuts off and you do not want this is see how the brain looks at it first (Refer Time: 24:54).

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If you give meditation to activate this reticular formation to thalamus you will keep activated lot of this drugs of abuse which methylfolate and fitamins.

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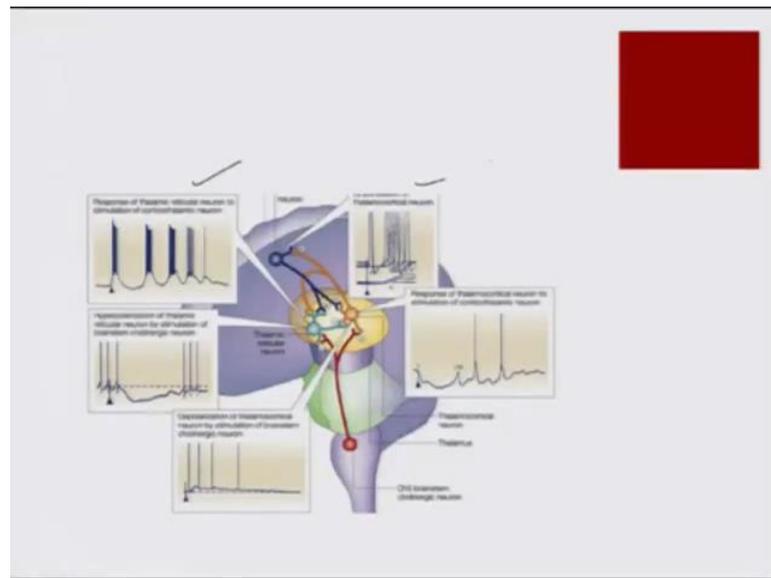
So, what is the theory behind all this? So, forebrain areas the pre frontal cortex, the one which decide and all gets activated while dreaming, emotional centers get activated while you because if you look at your dream you will find sometimes some dreams are very very emotionally and (Refer Time: 25:30) you are really get up (Refer Time: 25:32) and you actually feel and emotionally and, but you are not acting on it and dreams are so smart they will also in the lot of immediate need like in even a feel cold and you are sleeping them and if you dreaming something else, somewhere around the dreams are give suddenly feel.

This need as if some bodies putting a blanket on you actually nobody putting a blanket, your mind is telling you the need the blanket or if you want to you urinate suddenly you will some people, lot of people tell this suddenly feel like if you are urinating in the dreams. That is a whole racket of telling interpreting dream that; obviously, has no value people have correlated dreams and all.

So, what are activates in the dream the (Refer Time: 26:14) low because that actually senses the visual thing, the frontal lobe because that gives the meaning and the emotion brain which gives you the emotional content of it. So, like REM of 5 HT and as I told you REM of, REM on Cholinergic system, I acetylcholine, now if you remember as I

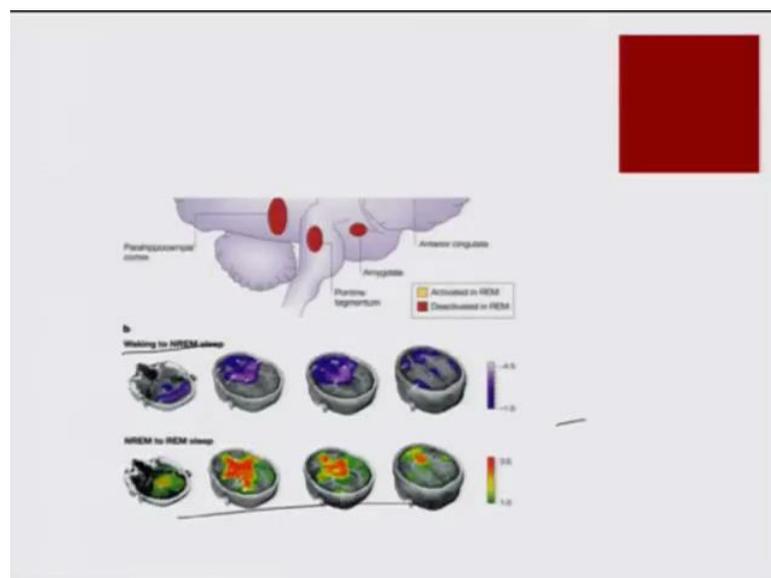
told you is very important for memory. Damage to area acetylcholine dementia, in dementia the area is actually get demesne are the areas where, acetylcholine neurons are maximal, acetylcholine goes up in REM and it. In fact, regards REM here comes in the clue is REM important for memory?

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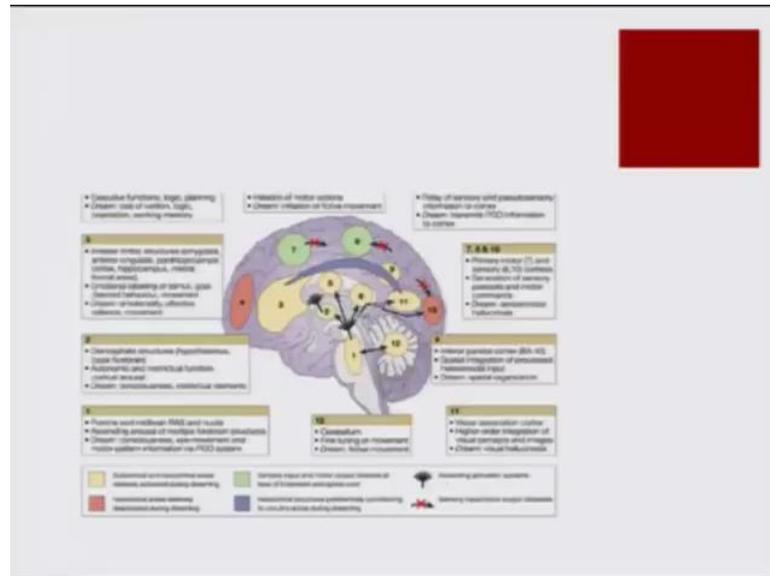
In fact, that is the theories which are the most popular again thalamic reticular nucleolus as I told you.

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This is a type of imaging which was if you go from waking from NREM sleep and NREM to REM sleep, this is the type of areas, but again we know this areas, some areas has to do something.

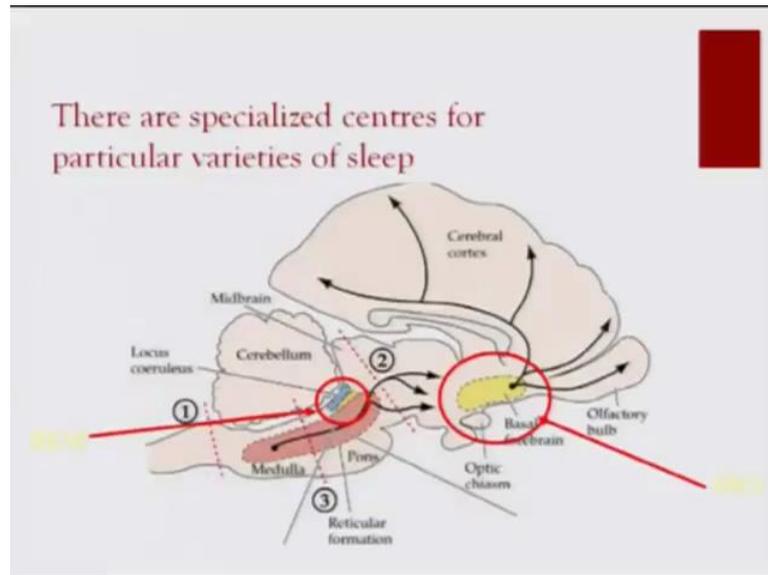
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So, theory which actually was brought out the (Refer Time: 27:34) and Christopher Coke I think (Refer Time: 27:39) was a person who discovered DNA. It shifted to neurophysiology; he says that REM sleep is about reverse learning.

Whatever has gone in to your head in the day time or may be days before has to be process otherwise mind will get in to overload. REM sleep serves the purpose of using whatever is important and consolidative it in that memory and rejecting the rest of the synaptic synapses. So, synaptic formation for learning happens in the REM sleep, that so that is the information processing thing. These are stuff which goes in to, like execute function logic forming in dream you see laws of variation logic orientation working memory, during emotionality effective silence dreams consciousness.

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So, this is a theory which has been brought out by Hopsin and that theory is called AIM. So, the AIM theory is says; which is the extension of the reverse learning. That, whatever in the simplest I mean certainly complicated whatever goes in to your head is already there in the day time, so the external import is stopped the whole neuro system is activated. The information is indicated the synapses are modulated, the memory is formed and rest of it, which not is rejected. In that process whatever is already been stored already there is activated in that causes dream is like almost hallucination happening there in the brain, in which the present information is integrated and that is why REM is important for learning and memory and it serves as a information processing.

So, this was briefly about sleep and I mean it requires a whole set of lectures on its own because there are EEG parameter as like this a imaging going on a interpret. So, our intention is not to talk about sleep. So, much, but sleep viz consciousness, they formulate two state of mind which are very essential and we do not know much about them, but brain probably knows much better and has as it is different state of electrical activity and synaptic formation during that time. So, I end at that and in the next lecture we will see where does it all stand in the currency scenario and where does the research take us.

Thank you.