Sleep

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No longer think of sleep as an isolated block of time at the end of the day.

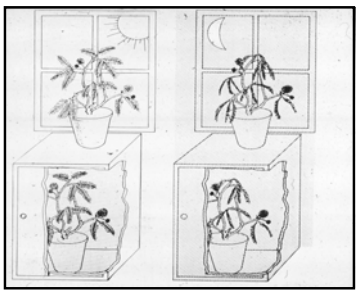
Sleep is not just the absence of wakefulness,

It is an active physiologic process.

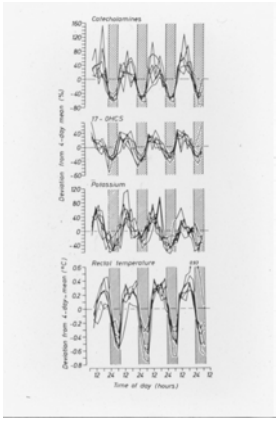
SLEEP IS PART OF A 24 HOUR CYCLE OF SLEEPING AND WAKING BEHAVIOR.

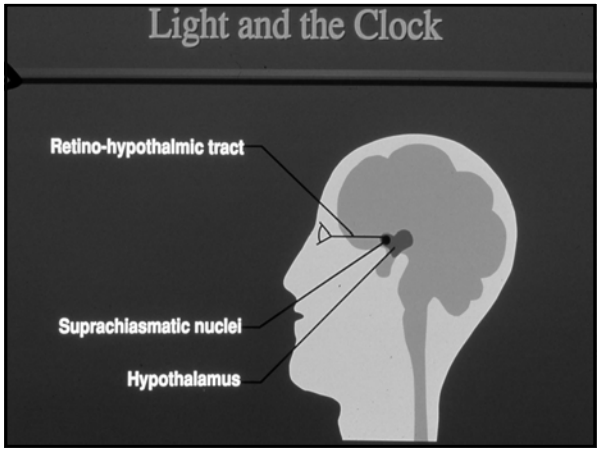
Circadian

From the latin *circa* (about) + *dies* (day)



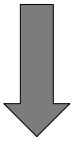
The first demonstration of a circadian rhythm by Jean Jacques d'Ortous de Mairan in 1729



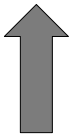


Over a 24 hour period two discrete systems flow one into the other.

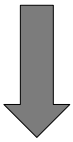
Evening



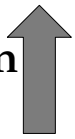
Activating systems decrease action



Sleep systems increase action



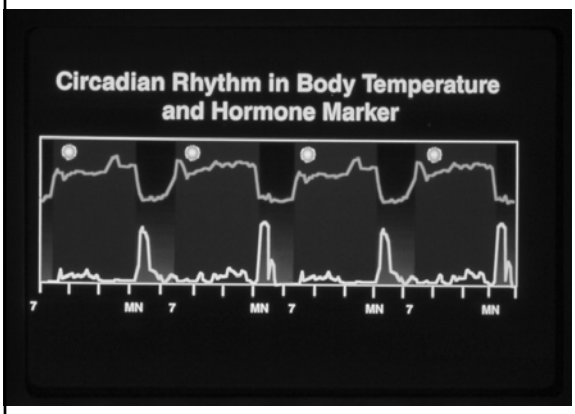
4:30 am

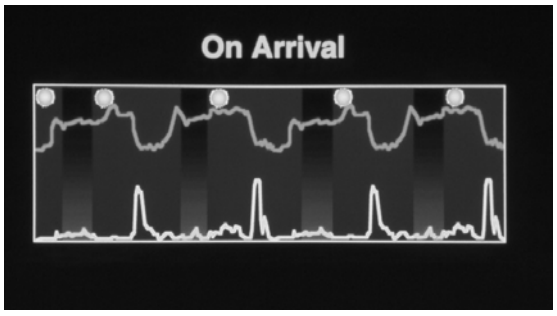


Sleep systems decrease action

Alerting systems increase action

Our biological clocks are demonstrated in jet lag





Neuroanatomical
Neurophysiogical
Neurochemical
Studies

To localize sleep and wakefulness
Beginning in the 1930's

3 types of studies to localize sites

1. Transection
2. Stimulation
3. Lesion

1940's Moruzzi and Magoun

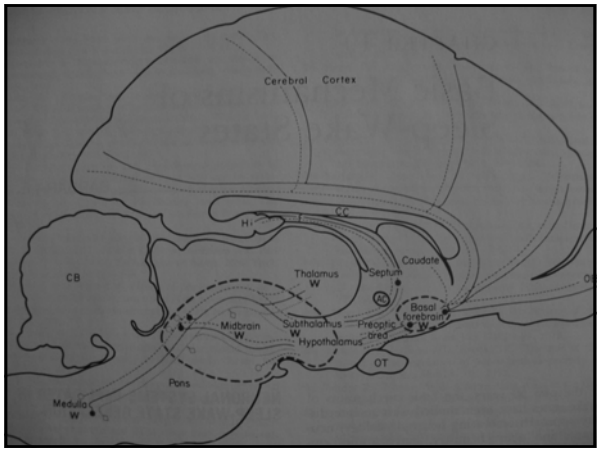
1. Electrical stimulation of the brainstem reticular formation, but not the sensory pathways, produced cortical activation consistent with wakefulness

2. Lesions in the same area produced cortical deactivation and slow waves

3. Most effective lesions that produced cortical deactivation were in the midbrain and extending forward into the posterior hypothalamus

This became known as the:

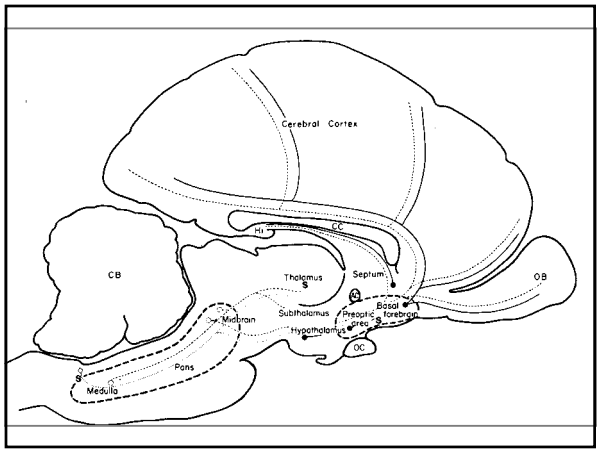
ASCENDING RETICULAR ACTIVATING SYSTEM



The same types of studies showed that:

Stimulation of certain areas of the brainstem such as the medullary reticular formation (Nucleus of the solitary tract) produced cortical synchronization (sleep)

Lesions of these specific regions produced cortical activation (wakefulness)



Most recently the HYPOTHALAMUS has emerged as an area of great importance for both sleep and wakefulness

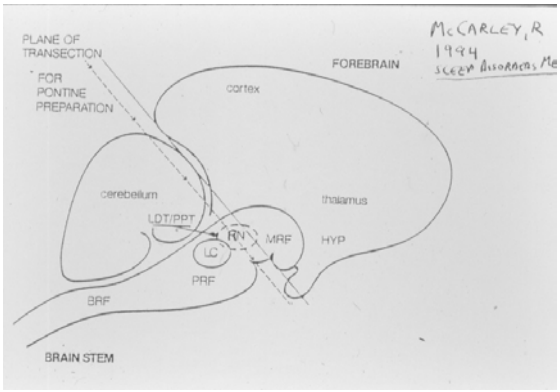
This next slightly different schematic of the cat brain shows the sites of study by Jouvet and colleagues

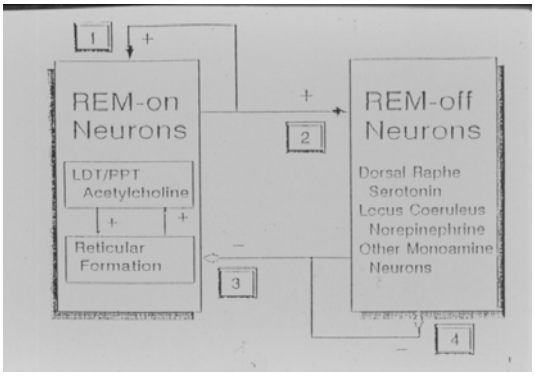
REM sleep promoters – cholinergic neurons of the roof of the pons – REM ON

- Laterodorsal tegmentum (LDT)
- Pedunculopontine Tegmentum (PPT)

REM sleep suppressors – monoaminergic neurons

- REM OFF
- Locus Ceruleus (noradrenergic)
- Raphe Nucleus (serotinergic)





Neurochemical regulation of awake and sleep and REM and Non-REM

- Adrenergic
- Cholinergic
- Serotonergic
- Glutamatergic
- Dopaminergic

GABA (gamma-aminobutyric acid) – mainly inhibitory – hypothalamus, basal forebrain and thalamus

Adenosine – in wakefulness accumulates in basal forebrain

Histamine – wake promoting

Hypocretin/Orexin – hypothalamus – wake promoting

Sleep is not a blank homogeneous state but a complex, cyclical physiologic process

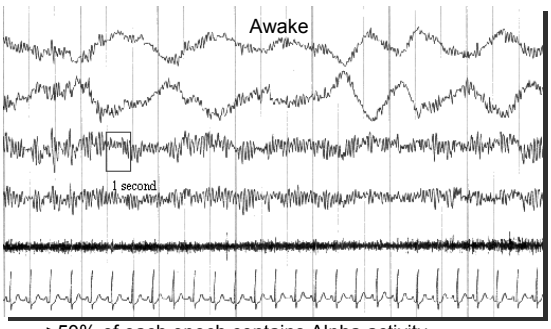
There are 5 different stages of sleep

Non-REM Sleep REM Sleep

- stage 1
- stage 2
- stage 3
- stage 4

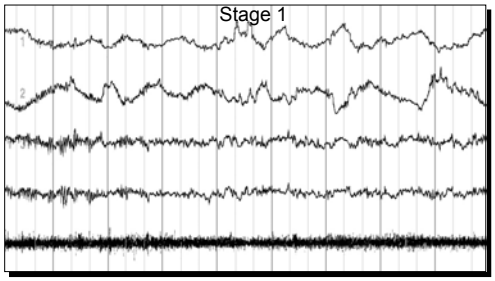
DISTRIBUTION OF SLEEP STAGES

NREM	75%	REM 25%
STAGE 1	5%	
STAGE 2	45%	
STAGE 3	12%	
STAGE 4	13%	



- >50% of each epoch contains Alpha activity
- Slow rolling eye movements or eye blinks will be seen in the EOG channels
- Relatively high submental EMG muscle tone

Stage 1

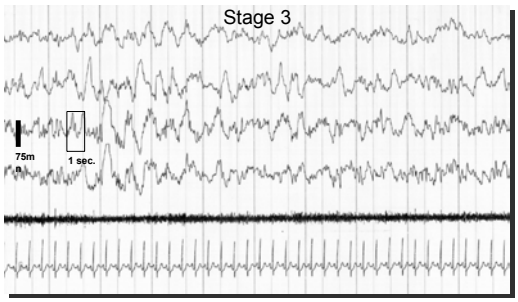


- ≥ 50% of the epoch contains Theta activity (3-7 cps.) There may be Alpha activity within <50% of the epoch.
- Slow rolling eye movements in the EOG channels
- Relatively high submental EMG tone

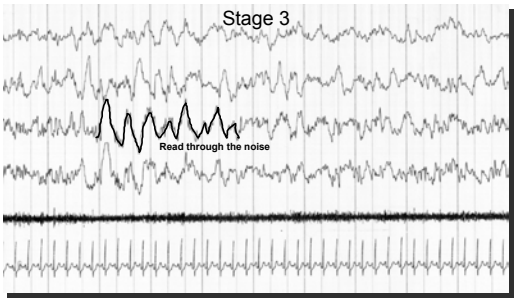
Stage 2

- Background EEG is Theta (3-7 cps.)
- K-Complexes and Spindles occur episodically
- Mirrored EEG in the EOG leads
- High tonic submental EMG

Stage 3



- 20% to 50% of each epoch and must contain Delta activity
- EOG channels will mirror Delta activity
- Submental muscle tone may be slightly reduced



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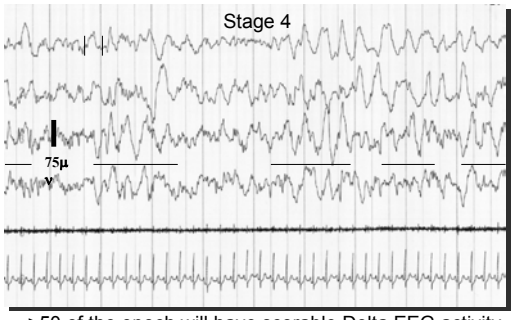
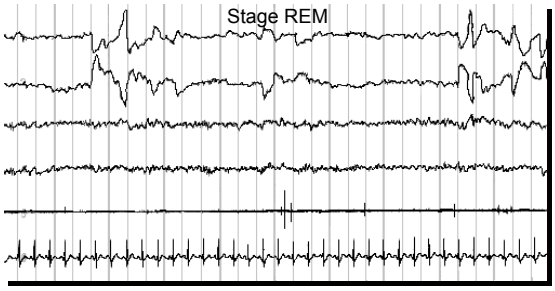


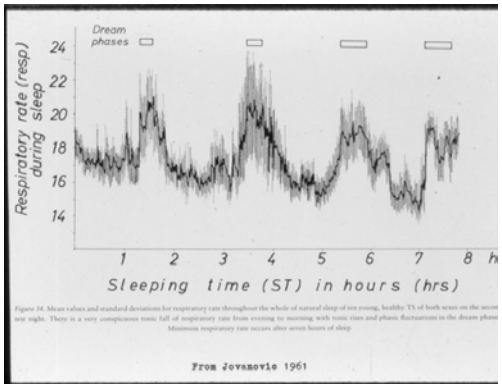
- >50 of the epoch will have scorable Delta EEG activity
- The EOG leads will mirror all of the Delta EEG Activity
- Submental EMG activity will be slightly reduced from that of light sleep



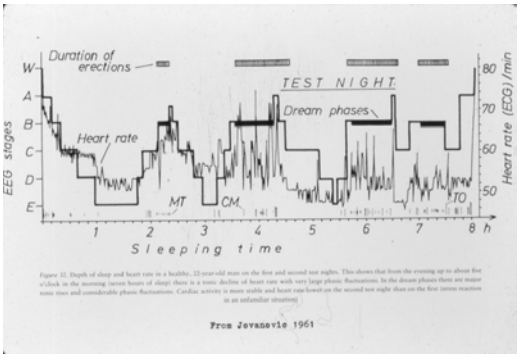
- Rapid eye movements
- Mixed frequency EEG
- Low tonic submental EMG

REM Sleep

- Characteristic EEG
- Variable heart and respiratory rates
- Muscle paralysis
- REM's



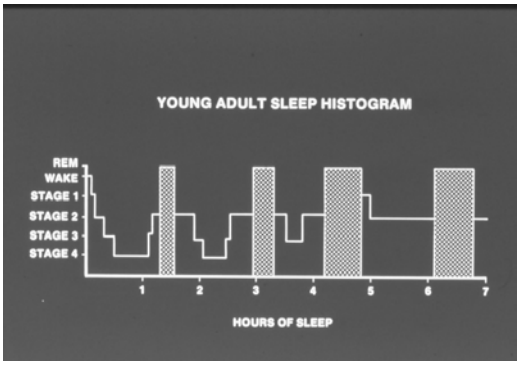
From Jovanovic 1961

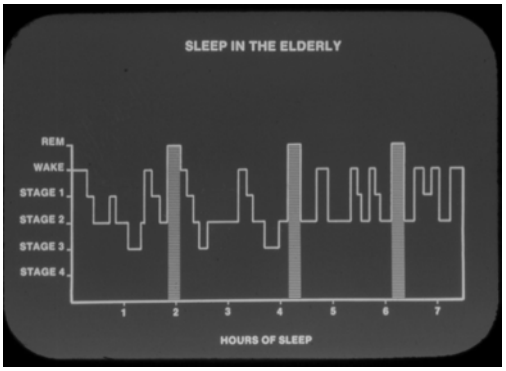


From Jovanovic 1961

- Video

Sleep architecture





Consequences of Sleep Deprivation

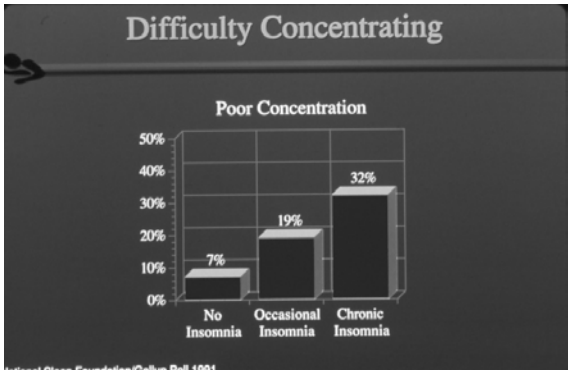
give hints as to the function of sleep

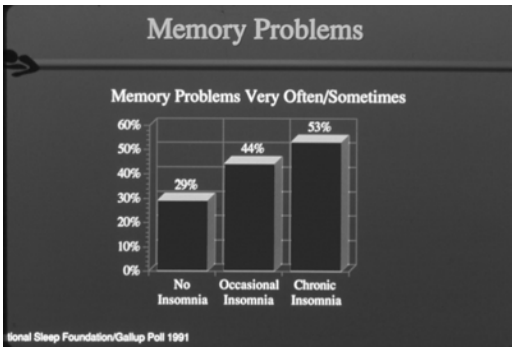
Consequences of Sleep Deprivation

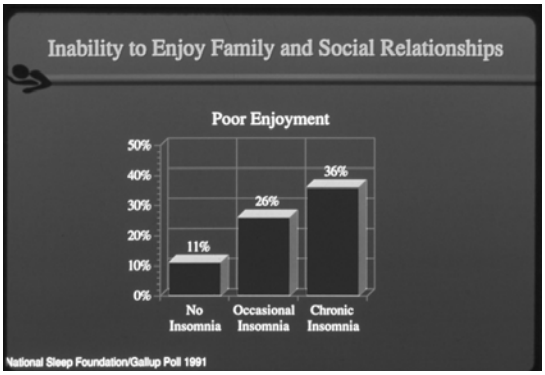
A. **Cognitive changes**

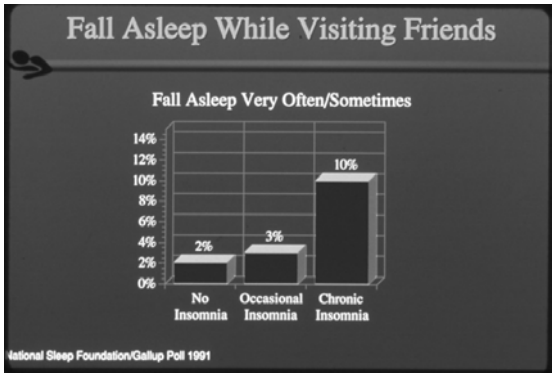
B. **Emotional/Personality changes**

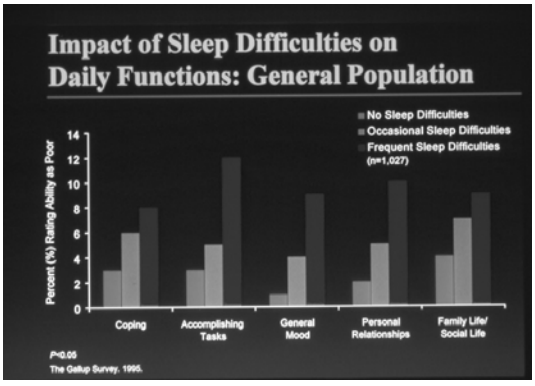
C. **Physical performance decrements**


Difficulty Concentrating
Poor Concentration
50%
40%
30%
20%
10%
0%
7%
19%
32%
No Insomnia
Occasional Insomnia
Chronic Insomnia


Memory Problems
Memory Problems Very Often/Sometimes
60%
50%
40%
30%
20%
10%
0%
29%
44%
53%
No Insomnia
Occasional Insomnia
Chronic Insomnia
tional Sleep Foundation/Gallup Poll 1991

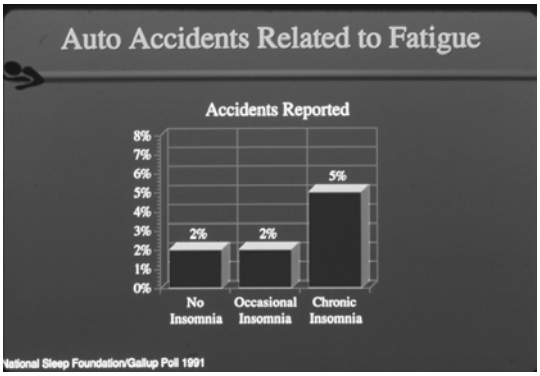

Inability to Enjoy Family and Social Relationships
Poor Enjoyment
50%
40%
30%
20%
10%
0%
11%
26%
36%
No Insomnia
Occasional Insomnia
Chronic Insomnia
National Sleep Foundation/Gallup Poll 1991





Sense of Humor
in Sleep Deprivation

■Gone



E. Physical Changes in Body

1. **Thyroid function**
2. **Glucose metabolism**
   Insulin response
3. **Stress hormone elevation**
4. **Decreased immune function**
5. **Increased cardiac risk**

REM Deprivation

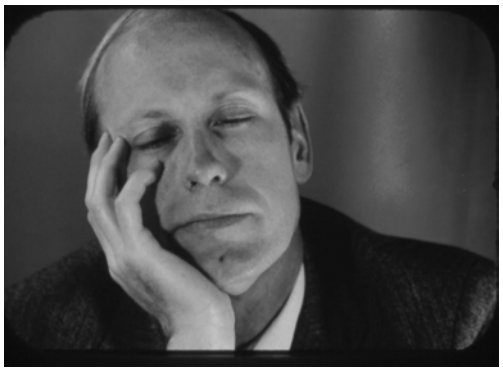
- REM pressure
- REM rebound

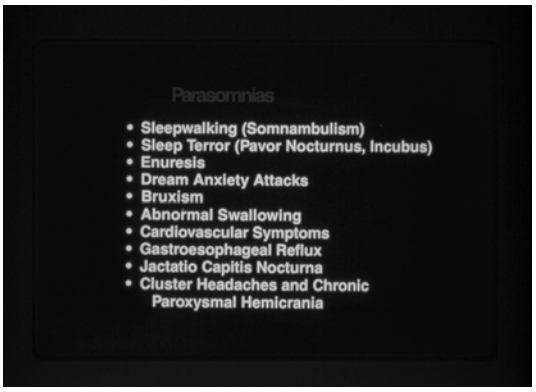
We are not aware of the extent to which our functioning is compromised by sleep deprivation. (U of PA study)

Sleep Disorders

The insomnias

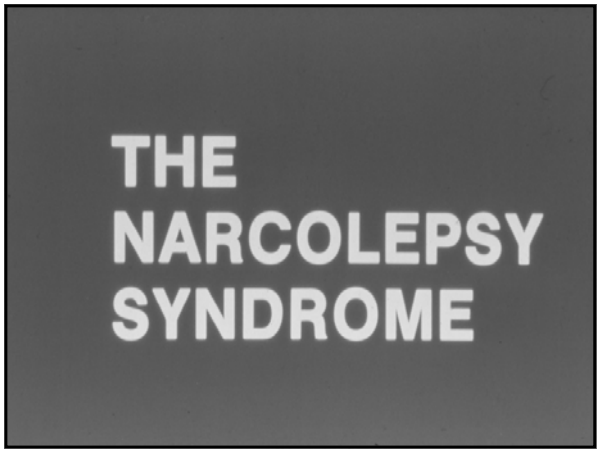
The hypersomnias





Disorders of

the biological clock



NARCOLEPSY TETRAD

1) EXCESSIVE DAYTIME SLEEPINESS
2) CATAPLEXY
3) SLEEP PARALYSIS
4) HYPNAGOGIC HALLUCINATIONS

EXCESSIVE DAYTIME SLEEPINESS IS USUALLY, BUT NOT ALWAYS, THE MOST PROMINENT AND TROUBLESOME COMPONENT OF THE TETRAD

CATAPLEXY IS A BRIEF (SECONDS TO MINUTES) EPISODE OF MUSCLE WEAKNESS AND/OR PARALYSIS. WHEN ATTACK IS OVER, PATIENT IS COMPLETELY NORMAL

NARCOLEPSY TETRAD

1) EXCESSIVE DAYTIME SLEEPINESS
2) CATAPLEXY
3) SLEEP PARALYSIS
4) HYPNAGOGIC HALLUCINATIONS

Snoring
and
Sleep Apnea

Video

Sleep walking - Somnambulism

Sleep terrors

Video

REM sleep

behavior disorder

Video

The End