

To sleep, perchance to dream:
why do we and other animals sleep ?



Professor Keith Kendrick



Sleep is a universal imperative for all animal species

'Almost all other animals are observed to partake of sleep, aquatic, winged, and terrestrial creatures alike.

Aristotle (384-322 BC) On Sleep and Waking



Rip van Winkle and Sleeping Beauty

On average we spend 25 years of our lives asleep !



Is this really necessary ?

Our current 24/7 culture denigrates the value of sleep.



'Marxists get up early in the morning to further their cause. We must get up even earlier.'

Margaret Thatcher

'It's the worry that gets you,
not the loss of sleep.'

Dale Carnegie



Is this really necessary ?

Our current 24/7 culture denigrates the value of sleep.



'...I hate sleeping. It wastes time.'

Isaac Asimov

'Sleep is an acquired habit...
a man doesn't need any sleep.'

Thomas Edison



Is this really necessary ?



'Early to bed, and early to rise, makes a man healthy, wealthy and ... socially dead !

Animaniacs

Is this really necessary ?

Sleep scarcely rates a mention in modern literature



'Sleep that knits up the ravelled sleeve of care.....chief nourisher in life's feast'

William Shakespeare (Macbeth)

Is this really necessary ?

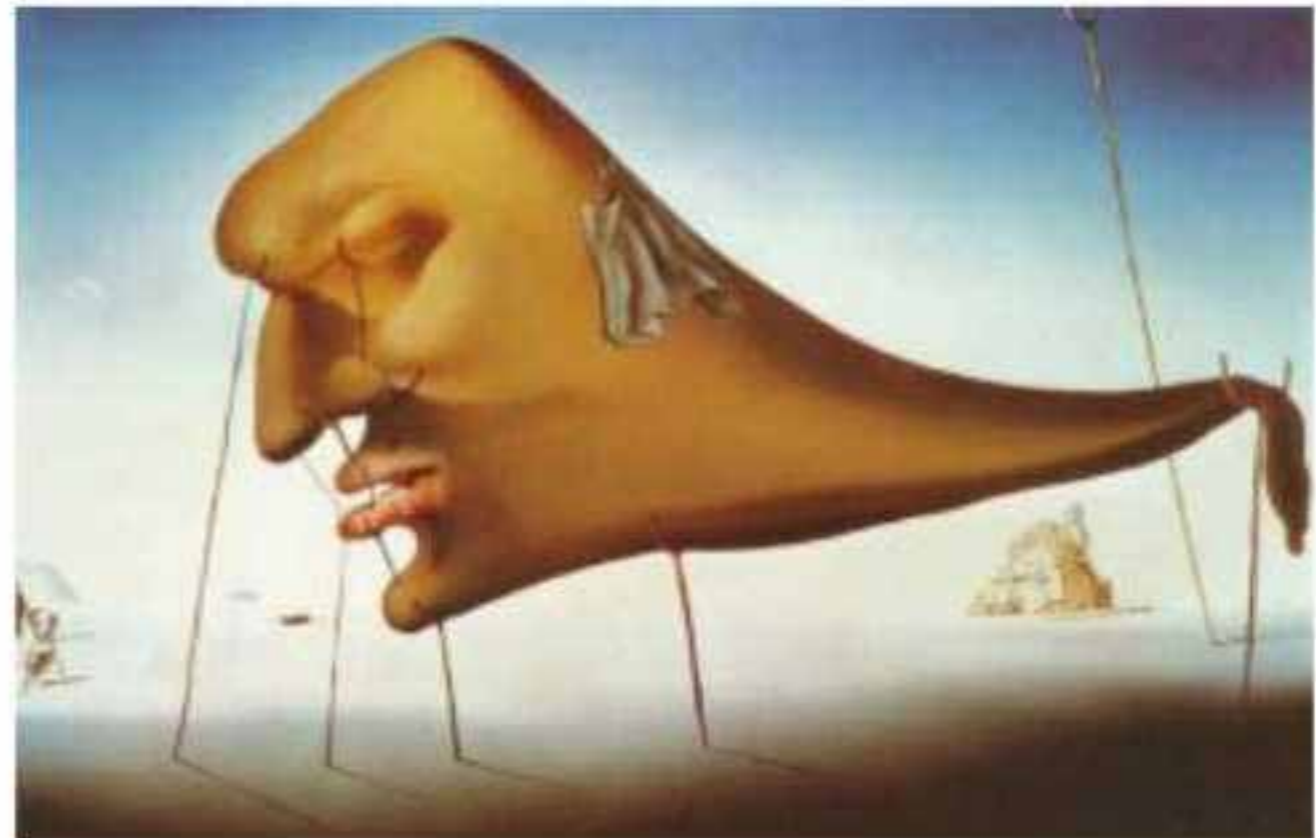
Are sleep and dreaming really useless vestiges of a past without electricity and light bulbs ?



Is this really necessary ?

Are sleep and dreaming really useless vestiges of a past without electricity and light bulbs ?

If not, what potential impact is our persistent effort to do without it having on us ?

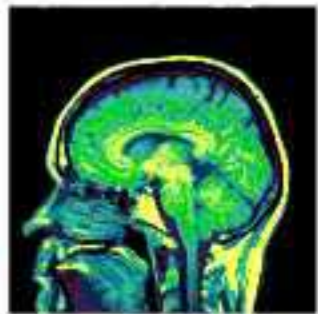


Stages of the sleep cycle

Awake and alert

EEG - beta waves (13-30Hz), desynchronised

Sensory awareness



EEG



EMG



EOG



HR

100%

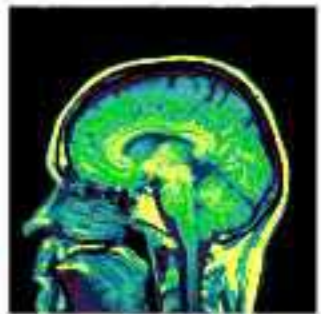
Body temperature

Normal

Stages of the sleep cycle

Lying down to sleep (10-20 minutes)
EEG - alpha waves (8-13Hz), desynchronised

Sensory awareness



EEG



EMG



EOG



HR

75%

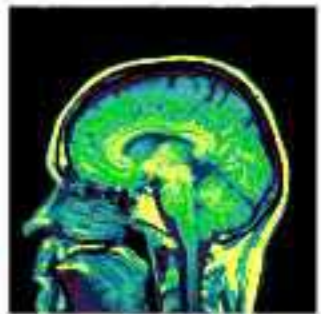
Body temperature



Stages of the sleep cycle

Stage 1 (10 seconds to 10 minutes)
EEG - theta waves (3-7Hz) more synchronised
Very close to waking

Sensory awareness



EEG



EMG



EOG



HR



50%

Body temperature

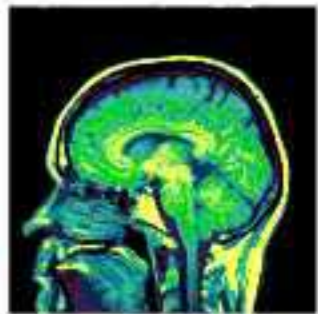


Stages of the sleep cycle

Stage 2 (10-20 minutes)

EEG - theta waves + K-complexes and spindles

Sensory awareness



EEG



EMG



EOG



HR



50%

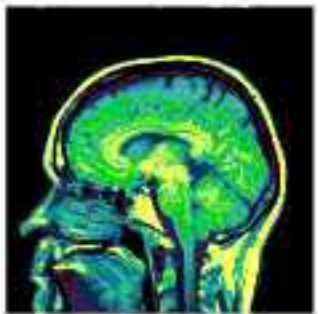
Body temperature



Stages of the sleep cycle

Stage 3 (20-30 minutes)
EEG - theta and delta (3Hz) waves

Sensory
awareness



EEG



EMG



EOG



HR



50%

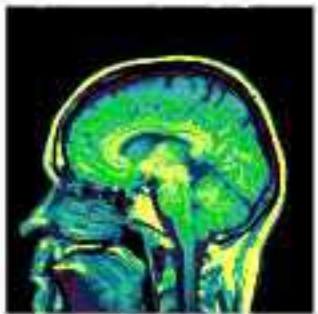
Body
temperature



Stages of the sleep cycle

Stage 4 (30-40 minutes)
EEG - delta waves

Sensory awareness



EEG



EMG



EOG



HR



50%

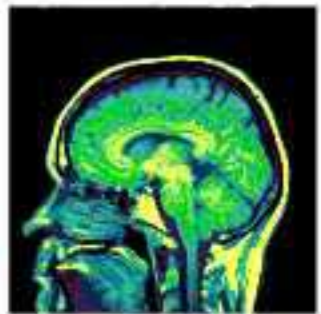
Body temperature



Stages of the sleep cycle

Back through stage 3....

Sensory awareness



EEG



EMG



EOG



HR



50%

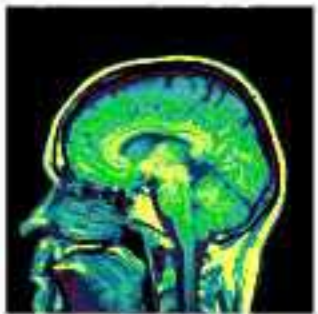
Body temperature



Stages of the sleep cycle

Back through stage 3....
and stage 2 over 10 minutes or so

Sensory
awareness



EEG



EMG



EOG



HR

50%

Body
temperature

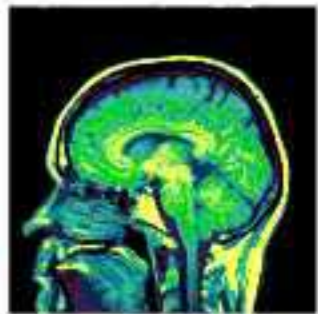


Stages of the sleep cycle

Stage 5 REM (10 minutes)

EEG - beta waves (as when awake and alert)

Sensory awareness



EEG



EMG



EOG



HR



50%

Body temperature



Stages of the sleep cycle

Stage 5 REM (10 minutes)

EEG - beta waves (as when awake and alert)

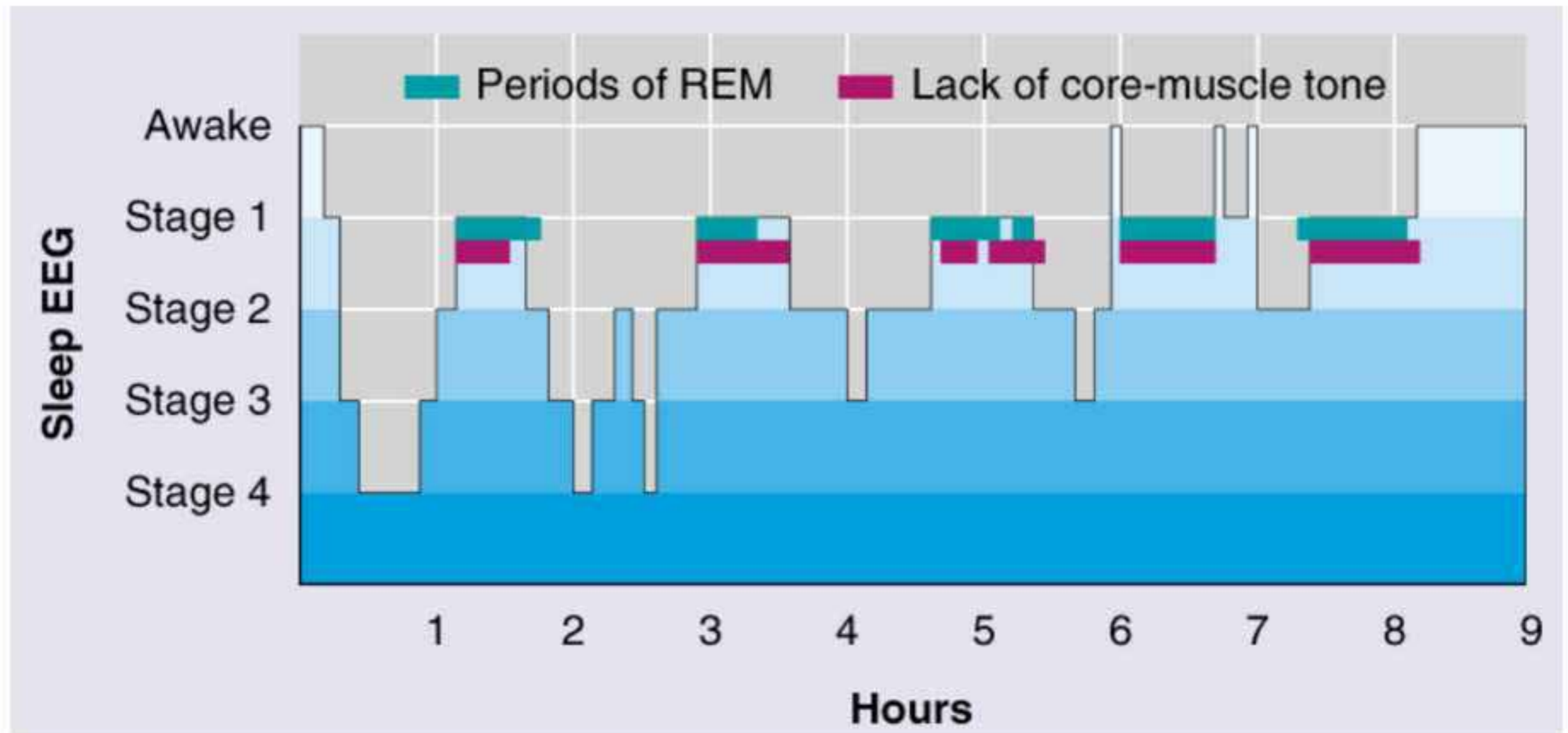
Rapid eye movements

Muscle paralysis - except for heart, respiration and eyes

Penile and nipple erections, clitoral engorgement and vaginal lubrication

If woken from this stage dreams reported 80 - 90% of time

Stages of the sleep cycle



Two hours a day paralysed with physical signs of sexual arousal !

Do we only dream during REM sleep ?

No we dream in all stages of sleep



Dreams are instantly forgettable

So what do we dream about ?

REM dreams are vivid, emotional and often fantastical



The majority are nightmares

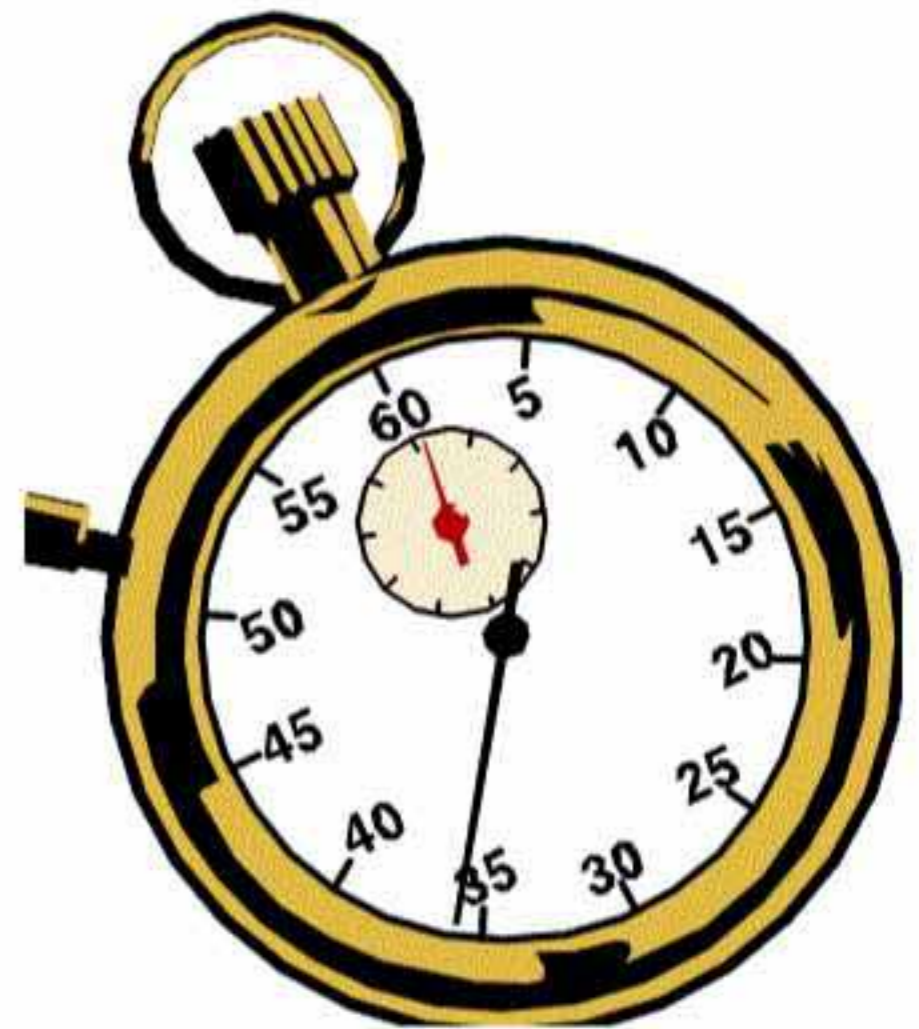
So what do we dream about ?

Non-REM dreams are more realistic and mundane



So what do we dream about ?

Dream experiences occur in real time



So what do we dream about ?

Dream experiences occur in real time

Based in the present and involve the dreamer



So what do we dream about ?

Sex differences:

Men dream about men
more than women do !



So what do we dream about ?

Sex differences:

Men dream about men more than women do !

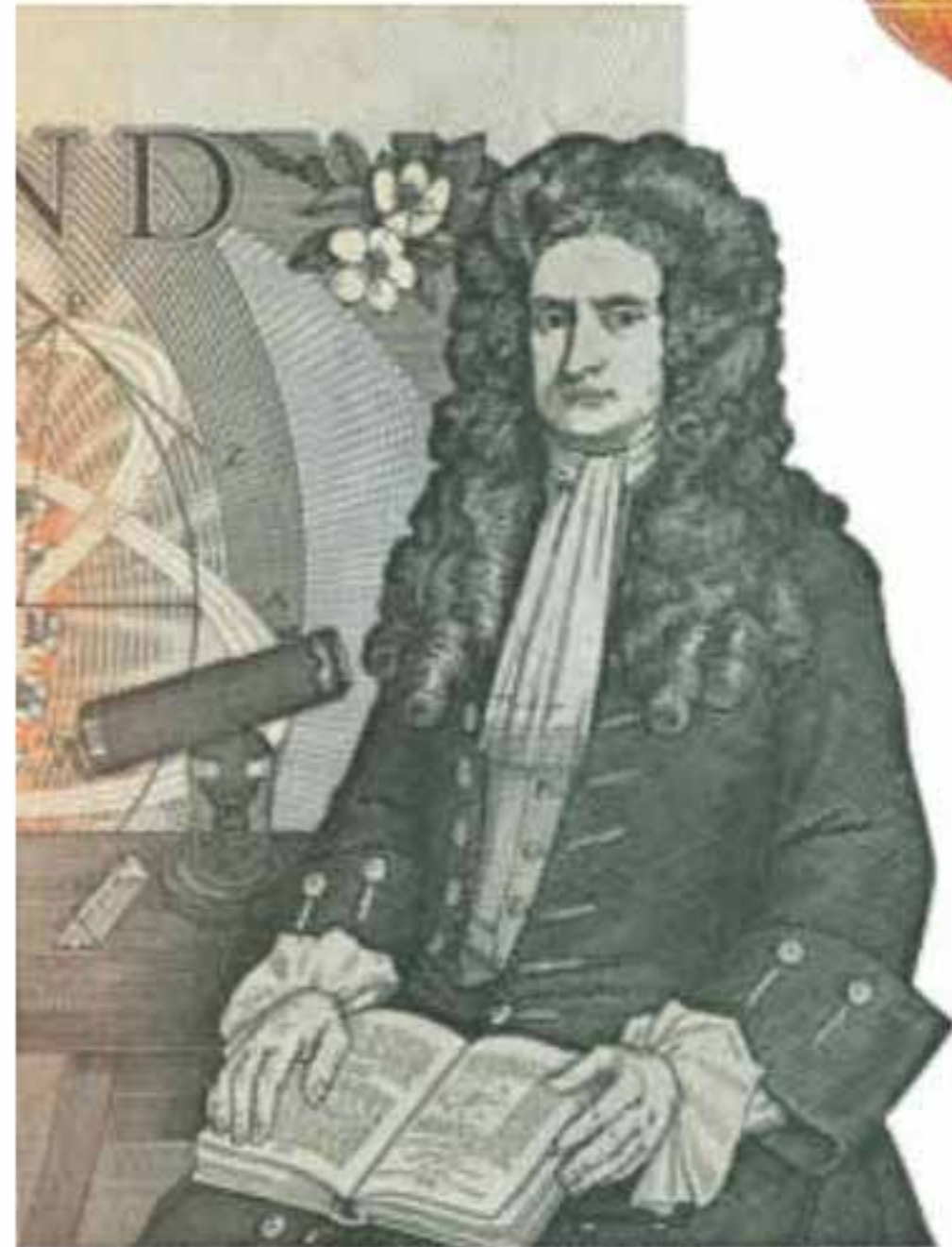
Having a partner makes dreams more forgettable



So what do we dream about ?

Do dreams provide:

Novel discoveries ? **X**



So what do we dream about ?

Do dreams provide:

Novel discoveries ? **X**

Visions of the future ? **X**



So what do we dream about ?

Do dreams provide:

Novel discoveries ? **X**

Visions of the future ? **X**

Telepathic communication ? **X**



So what do we dream about ?

Do dreams provide:

Novel discoveries ? **X**

Visions of the future ? **X**

Telepathic communication ? **X**

Divine communication ? **?**



So what do we dream about ?

Do dreams provide:

Novel discoveries ? **X**

Visions of the future ? **X**

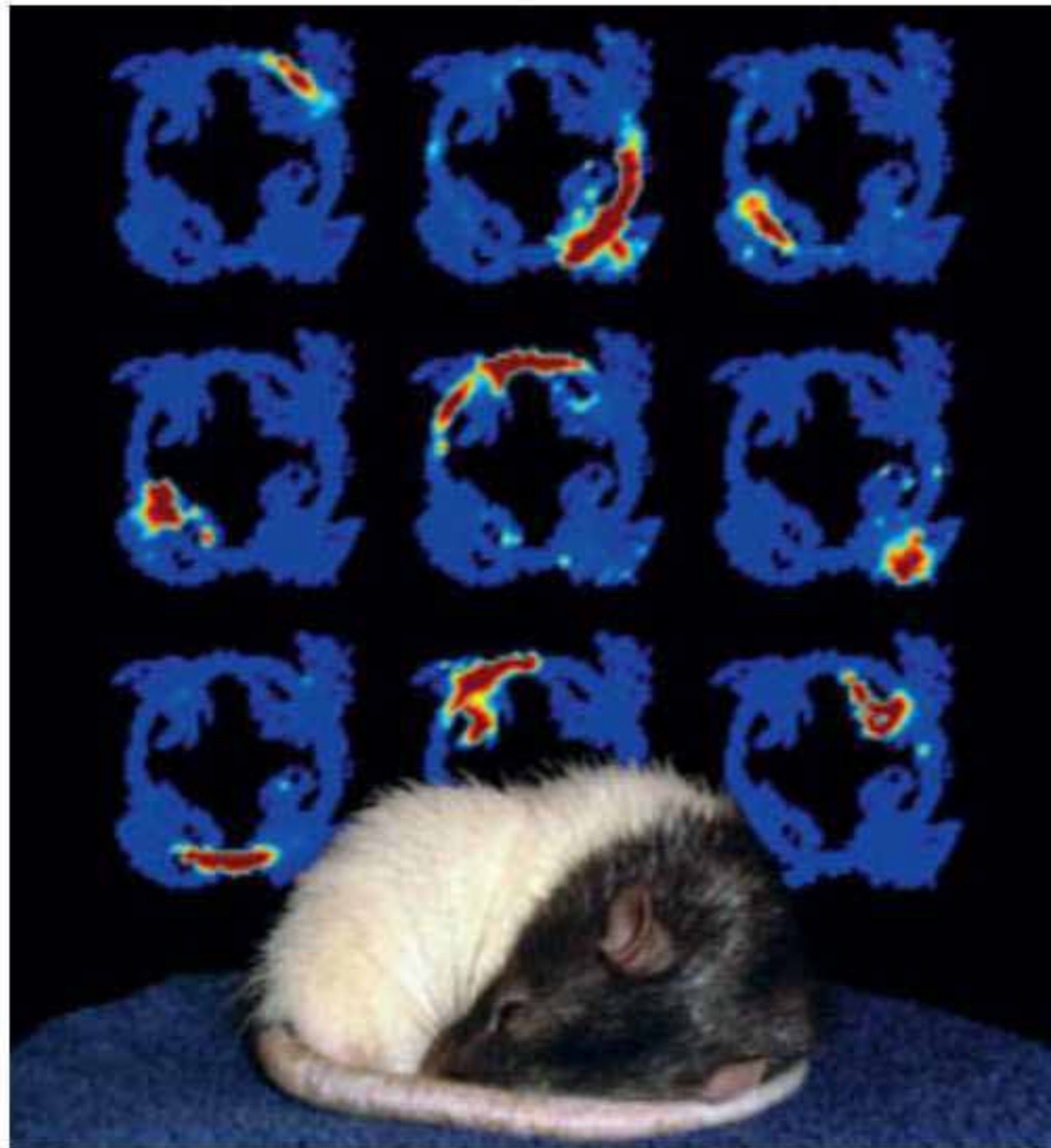
Telepathic communication ? **X**

Divine communication ? **?**

Jazzed up action replays ?



Playing back memories



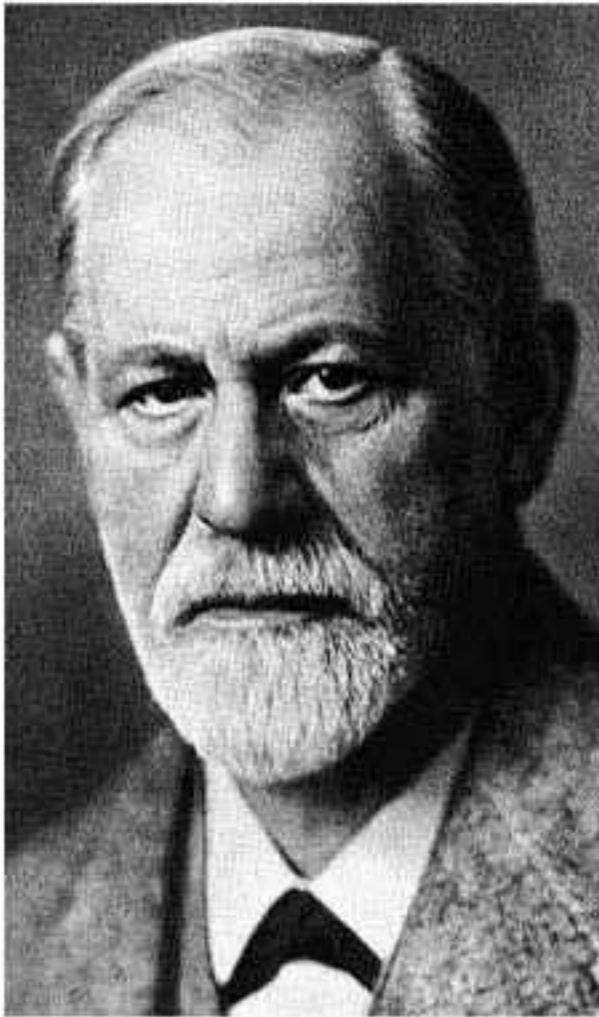
Are our dreams filled with sex ?

We show signs of sexual arousal for 2 hours of dreaming each night !



Are our dreams filled with sex ?

We show signs of sexual arousal for 2 hours of dreaming each night !



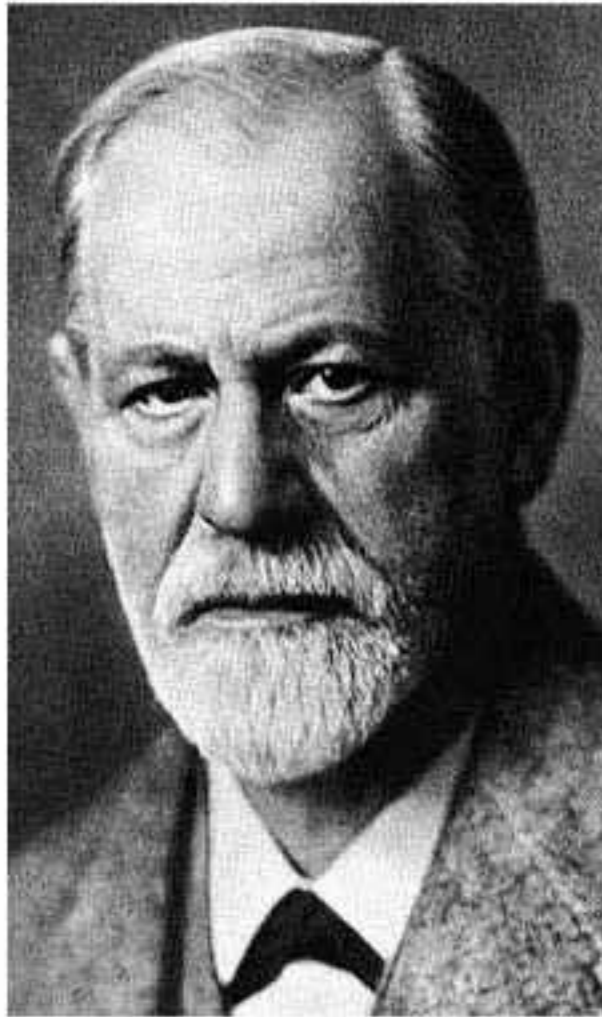
Freud and the unconscious

If awake men think of sex every six seconds do they dream about it as well ?



Are our dreams filled with sex ?

We show signs of sexual arousal for 2 hours of dreaming each night !



Freud and the unconscious

If awake men think of sex every six seconds do they dream about it as well ?

No - dream content does not cause erections

Are our dreams filled with sex ?

Dream reports

- is sex really a nightmare ?

Erections often still occur in impotence

Alcohol abuse and ageing have little effect

Even babies show these changes

Severe brain damage often has no effect



So what makes us physically aroused ?

Sleep scientist:

'I have no idea where dreams come from but the erect penis might serve as the antenna for receiving them !'

Waking up for sex rather than a cup of tea ?



So what makes us physically aroused ?

Sleep scientist:

'I have no idea where dreams come from but the erect penis might serve as the antenna for receiving them !'

Waking up for sex rather than a cup of tea ?

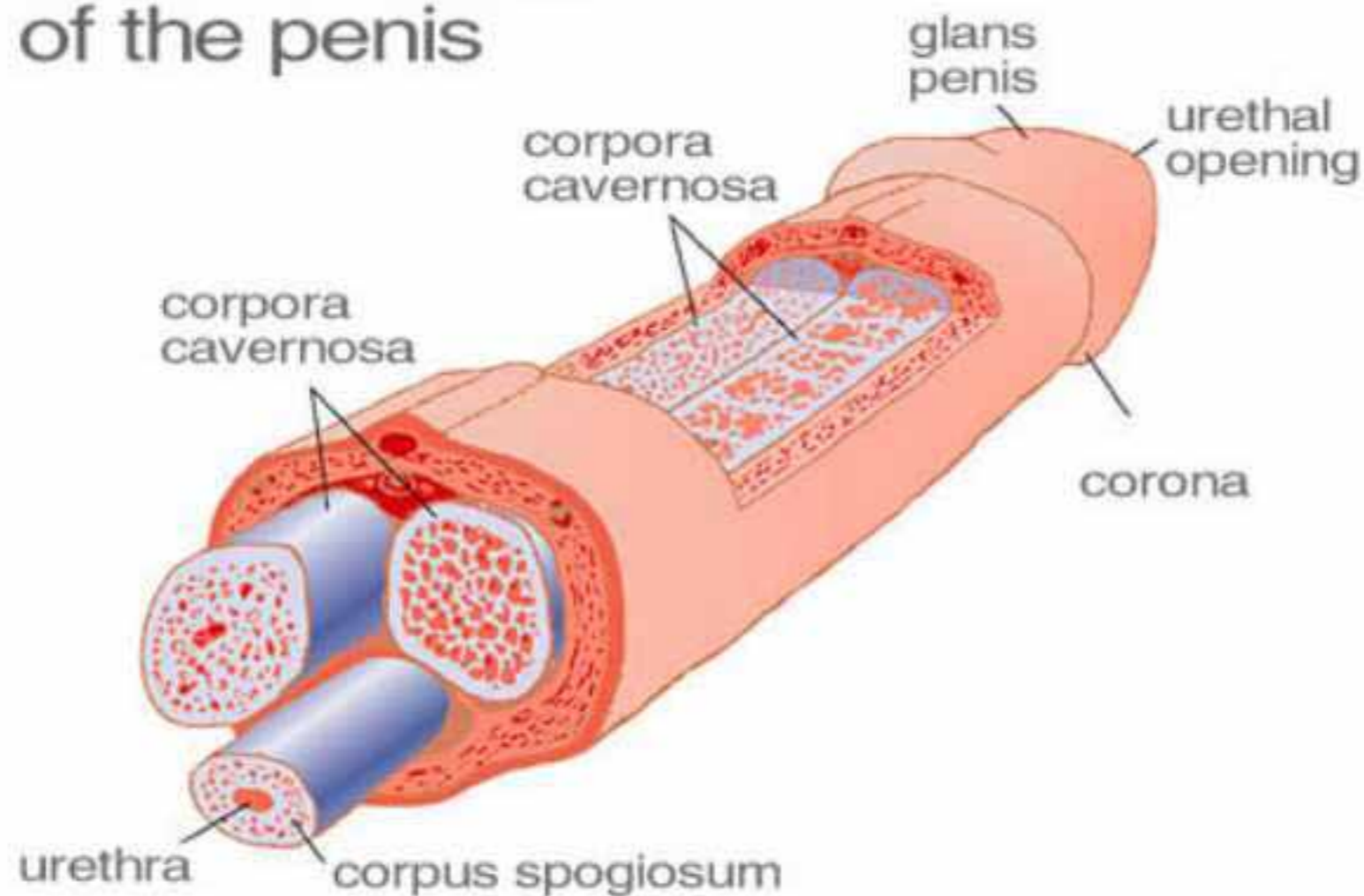
Genital workout ?



So what makes us physically aroused ?

Vascular or neuromuscular changes during REM paralysis ?

internal structure
of the penis



Lucid dreams

These are REM dreams where you have some control

Generally very pleasant
and are often about sex !



Lucid dreams

....something put my last nights dream into my head, which I think was the best that ever was dreamed - which was that I had my Lady Castlemayne in my arms and was admitted to use all the dalliance I desired with her, and then dreamed that this could not be awake but was only a dream.'

Samuel Pepys 15th August 1665

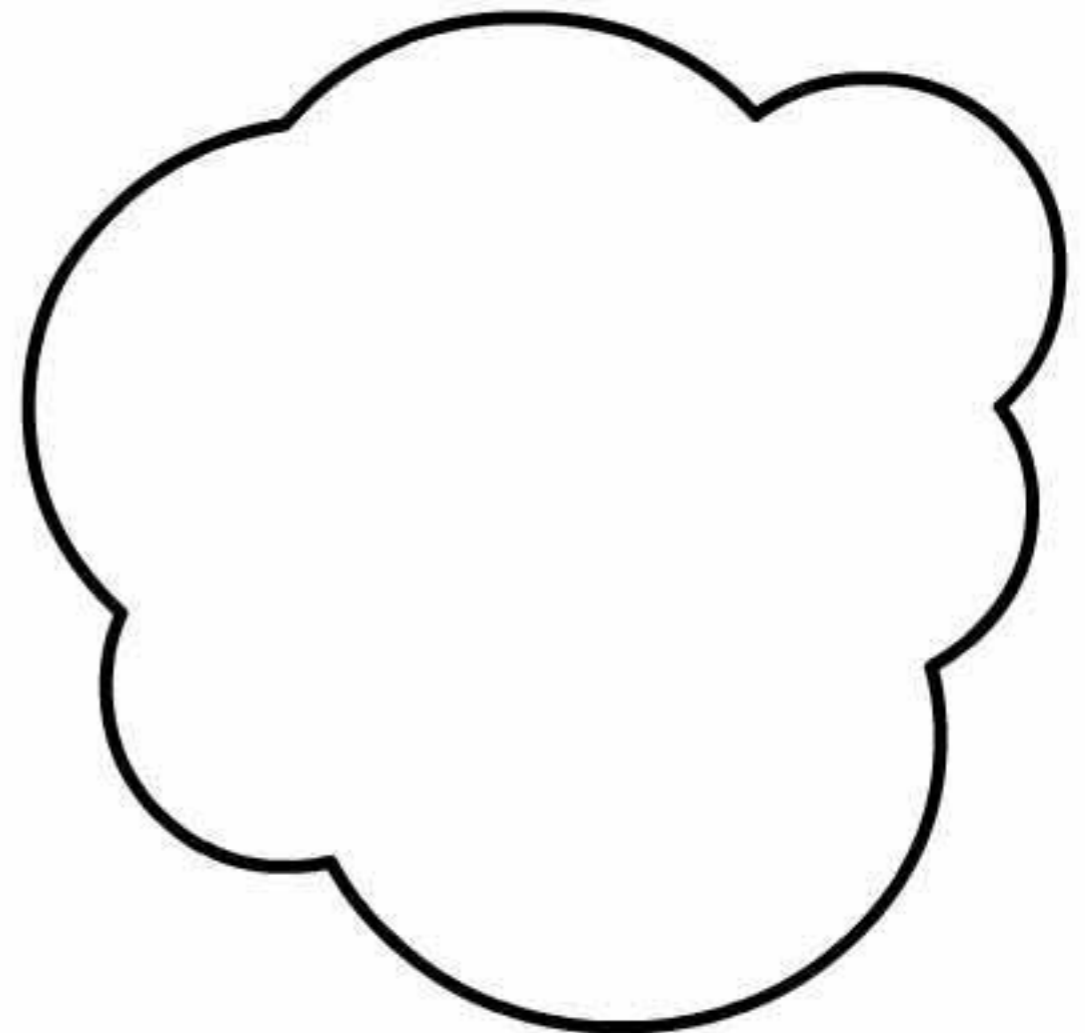


o o o



Lucid dreams

Problem: lucid dreams are rare



Lucid dreams

Problem: lucid dreams are rare

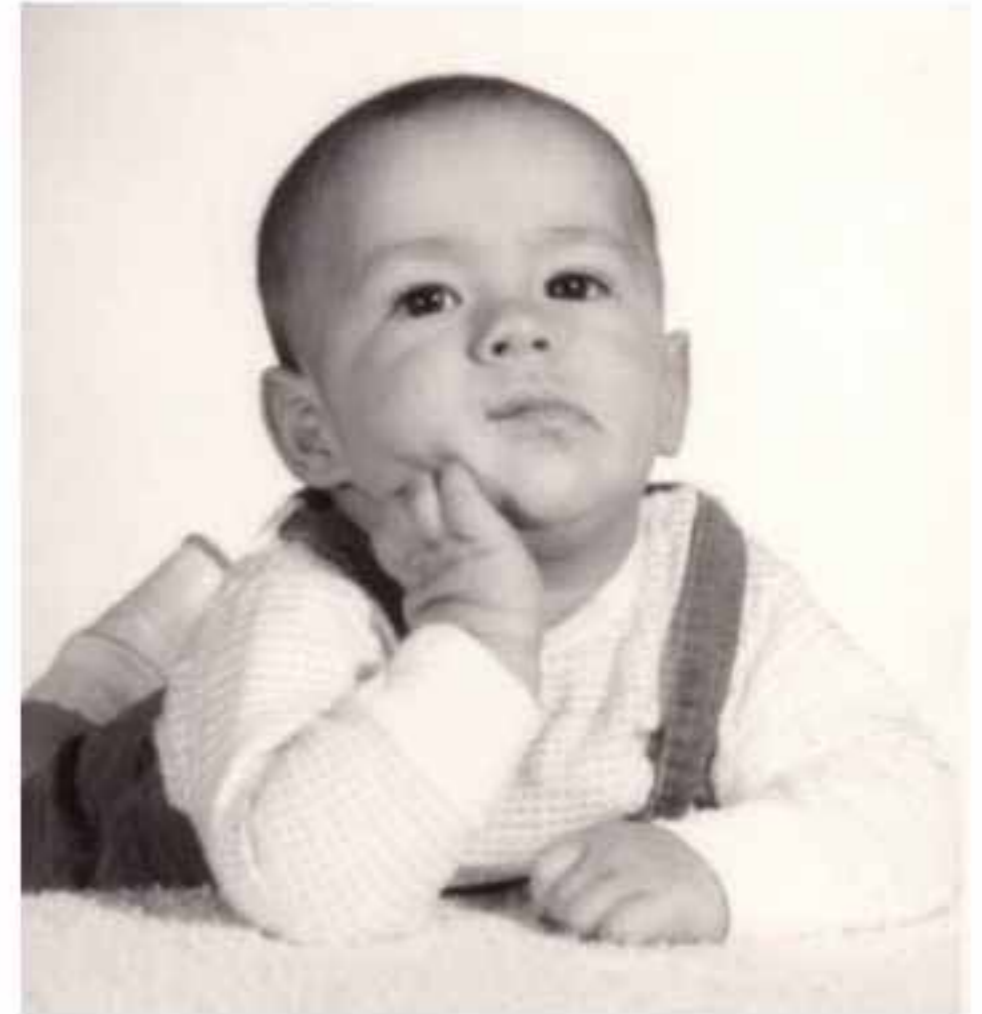
If you overdo the control or emotional side you wake up !

Lucid dreams

Answer: practice can improve things

Think about what you want
in your dreams during the day

Make a habit of remembering
all your dreams each day



Are we viewing our dreams during REM sleep ?

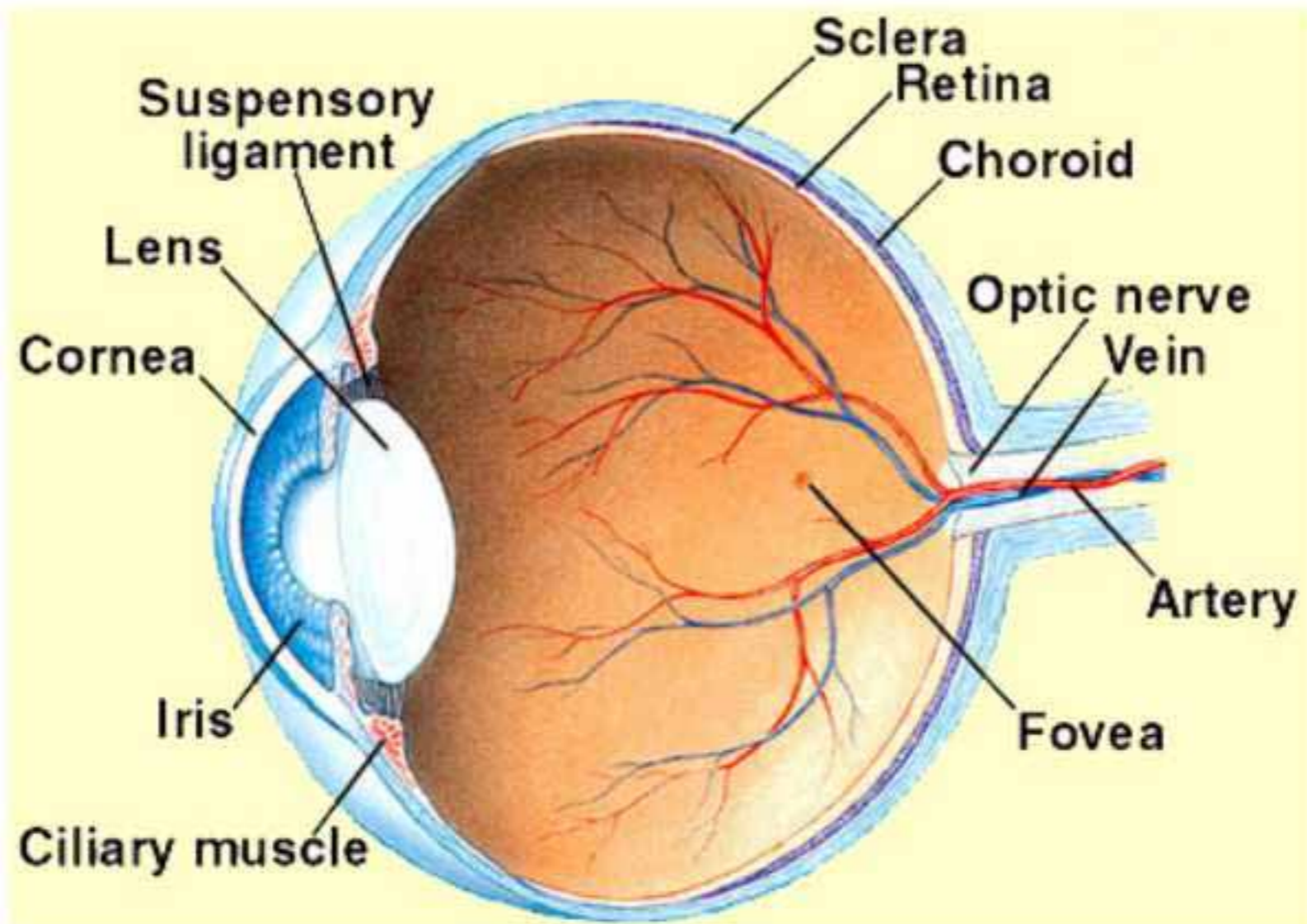
Not unless we all dream of Wimbledon !



Are we viewing our dreams during REM sleep ?

Not unless we all dream of Wimbledon !

Stirring up the aqueous humour in the eye



So how much do other animals sleep ?

Medium sleepers

Human
Pig

8.0h
7.8h



So how much do other animals sleep ?

Short sleepers - typically grazing animals living in the open

Horse	1.9h
Giraffe	2.9h
Sheep	3.8h
Cow	3.9h
African Elephant	3.3h



So how much do other animals sleep ?

Long sleepers - typically small burrow/cave dwellers

Star-nosed mole	10.3h
Mouse	12.1h
Rat	12.5h
Squirrel	14.9h
Opossum	16.0h
Brown bat	19.9h



So how much do other animals sleep ?

Predators -

Wolf/dog	10.6h
Jaguar	10.8h
Cheetah	12.1h
Cat	12.1h
Lion	13.5h
Tiger	15.8h



So how much do other animals sleep ?

Other primates -

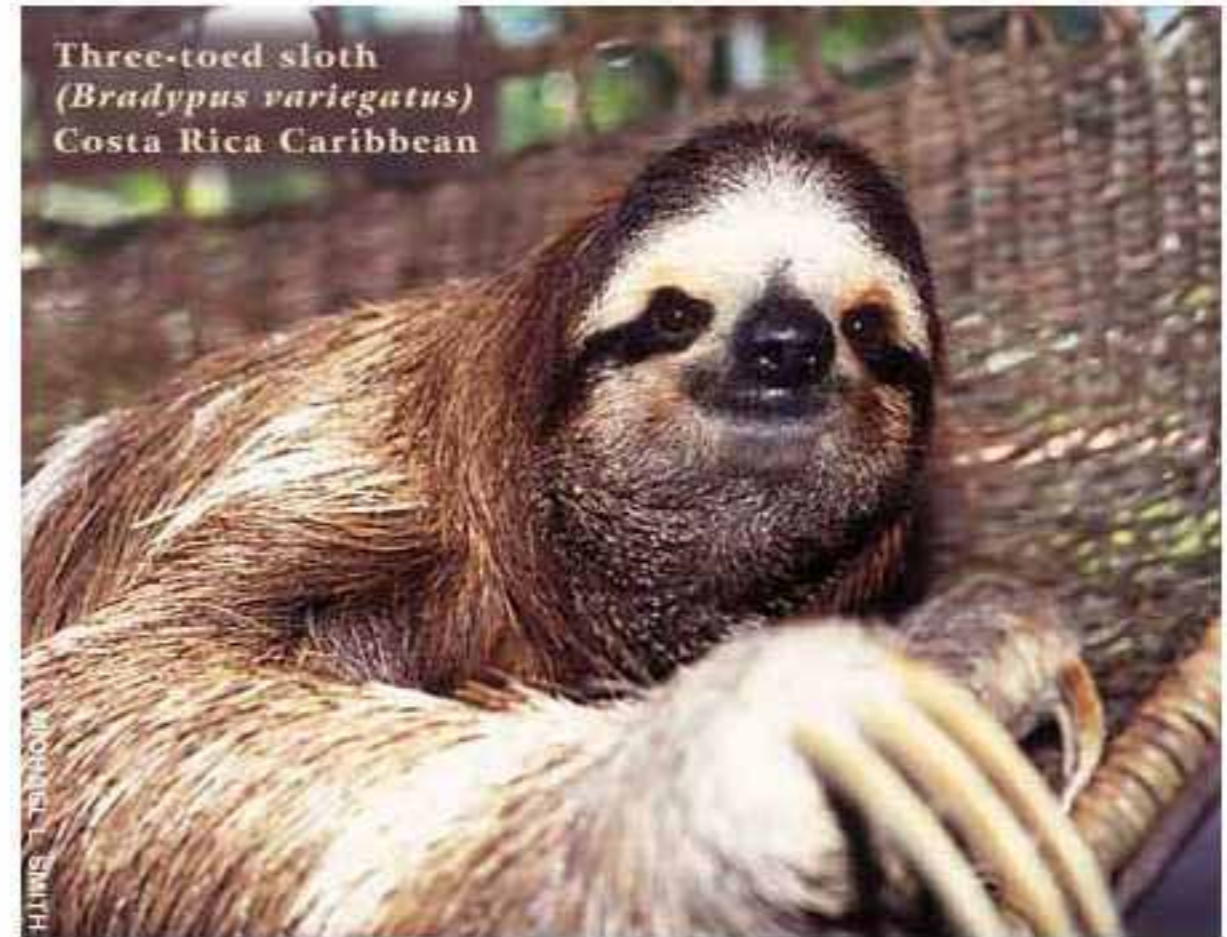
Chimpanzee	9.7h
Squirrel monkey	9.9h
Baboon	10.3h
Rhesus monkey	11.8h
Owl monkey	17.0h



So how much do other animals sleep ?

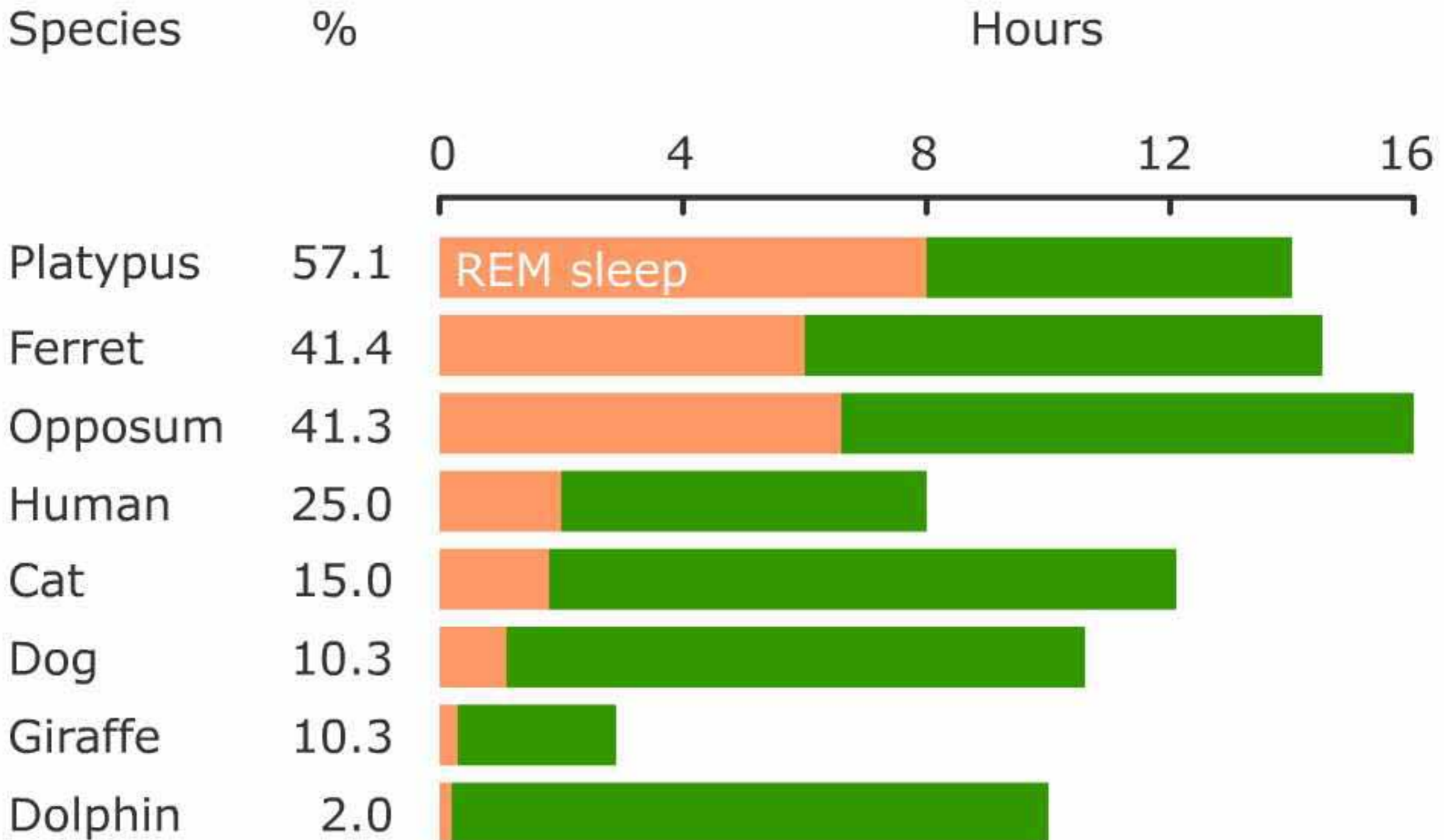
Champion sleeper: two-toed sloth - 20 hours

The three-toed sloth only sleeps 14.4 hours



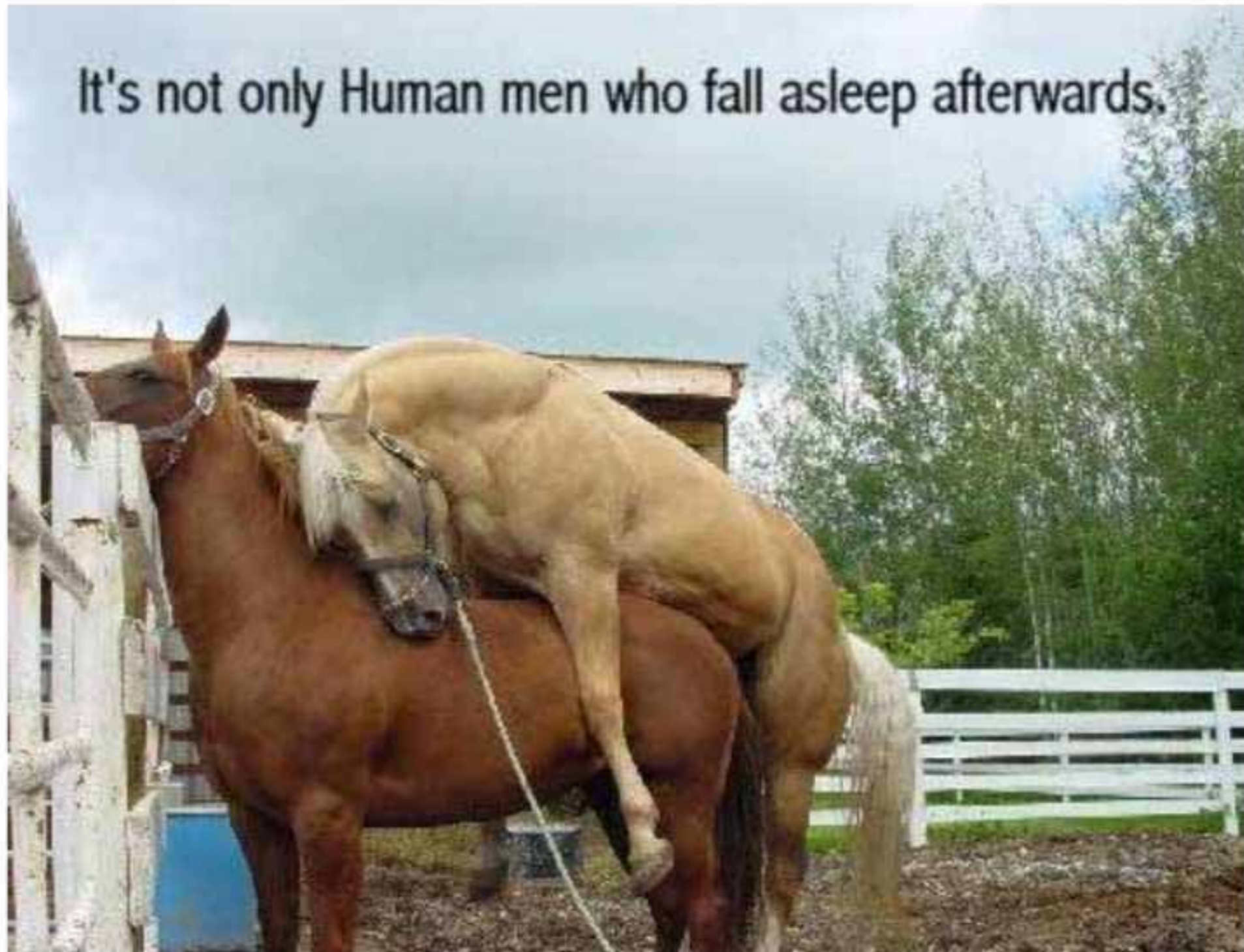
So is it all about toes ?

Proportion of time in REM sleep (2 - 60%)



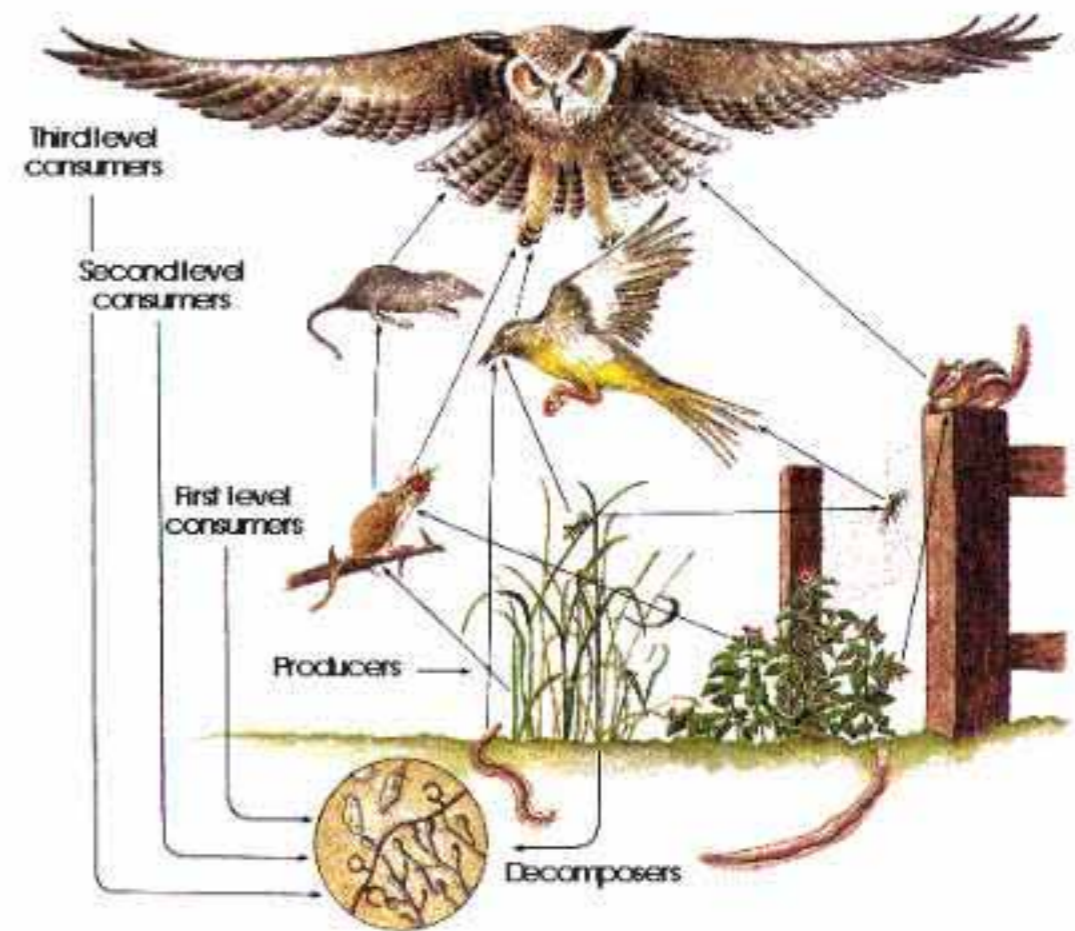
Proportion of time in REM sleep (2 - 60%)

Other species also get erections at this time



Sleep duration

This is dictated by lifestyle, predation risk and size



Sleep duration

This is dictated by lifestyle, predation risk and size

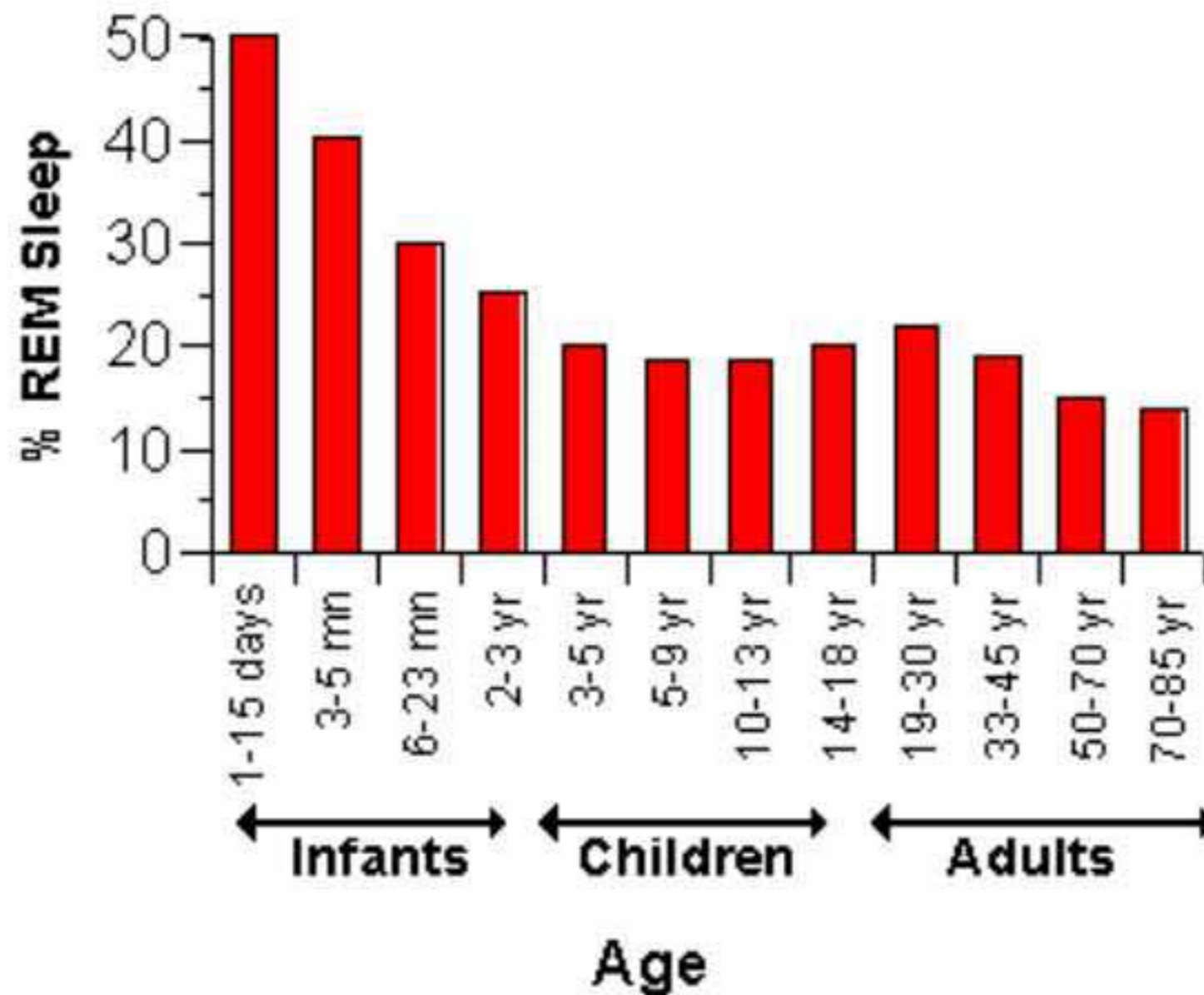
What about the proportion of REM sleep ?



Sleep duration

This is dictated by lifestyle, predation risk and size

What about the proportion of REM sleep ?



Sleep duration

This is dictated by lifestyle, predation risk and size

What about the proportion of REM sleep ?

Could we be more like a sheep or a platypus than a pig after 1000 years ?



Sleeping with one eye open

What about birds, dolphins and whales ?

Answer: Uni-hemispheric sleep

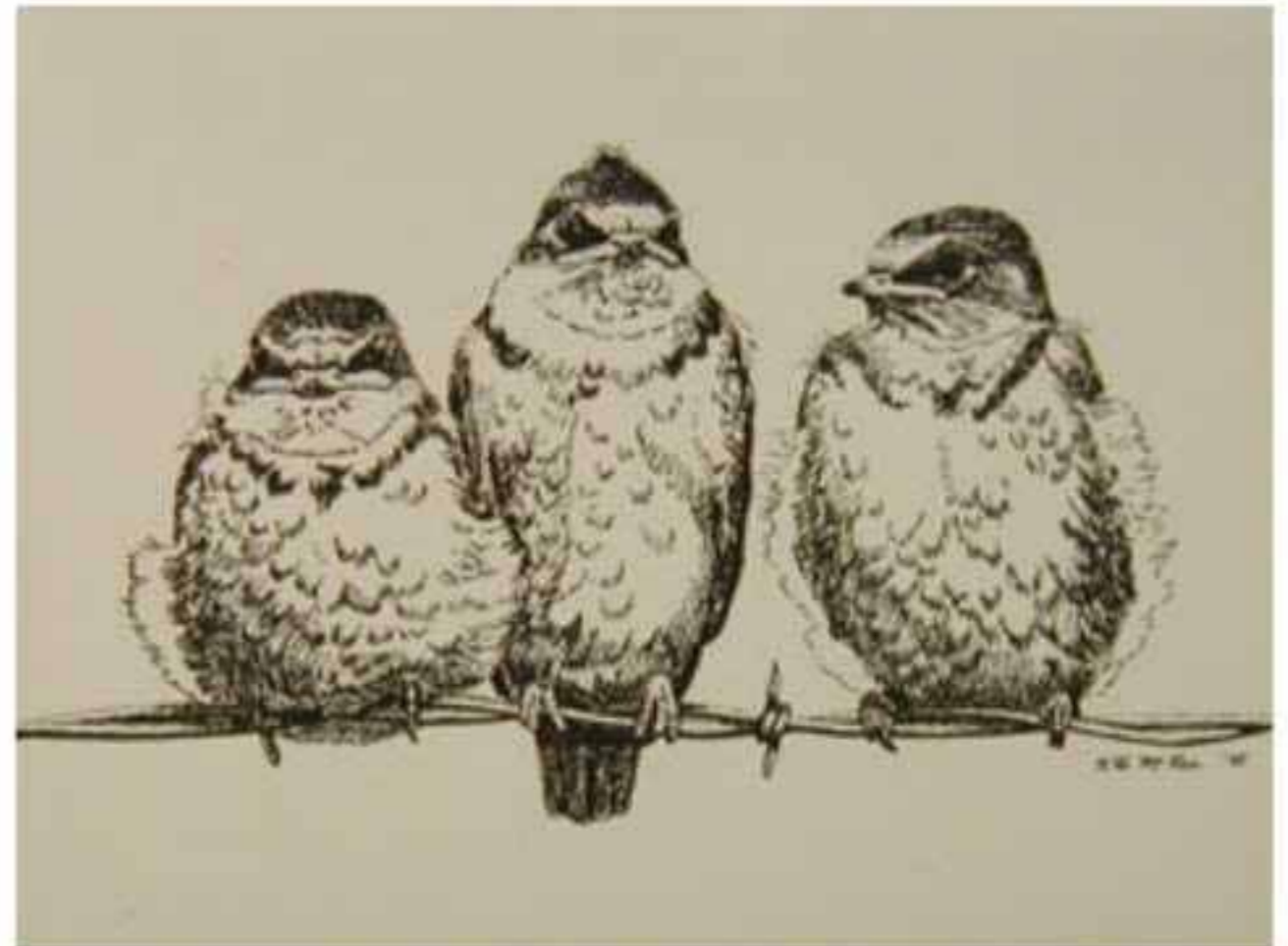


Sleeping with one eye open

What about birds, dolphins and whales ?

Answer: Uni-hemispheric sleep

Must have very little REM sleep
(usually 1% or less)



Sleeping with one eye open

Visual system is completely crossed



Sleeping with one eye open

What about humans ?

Problems:

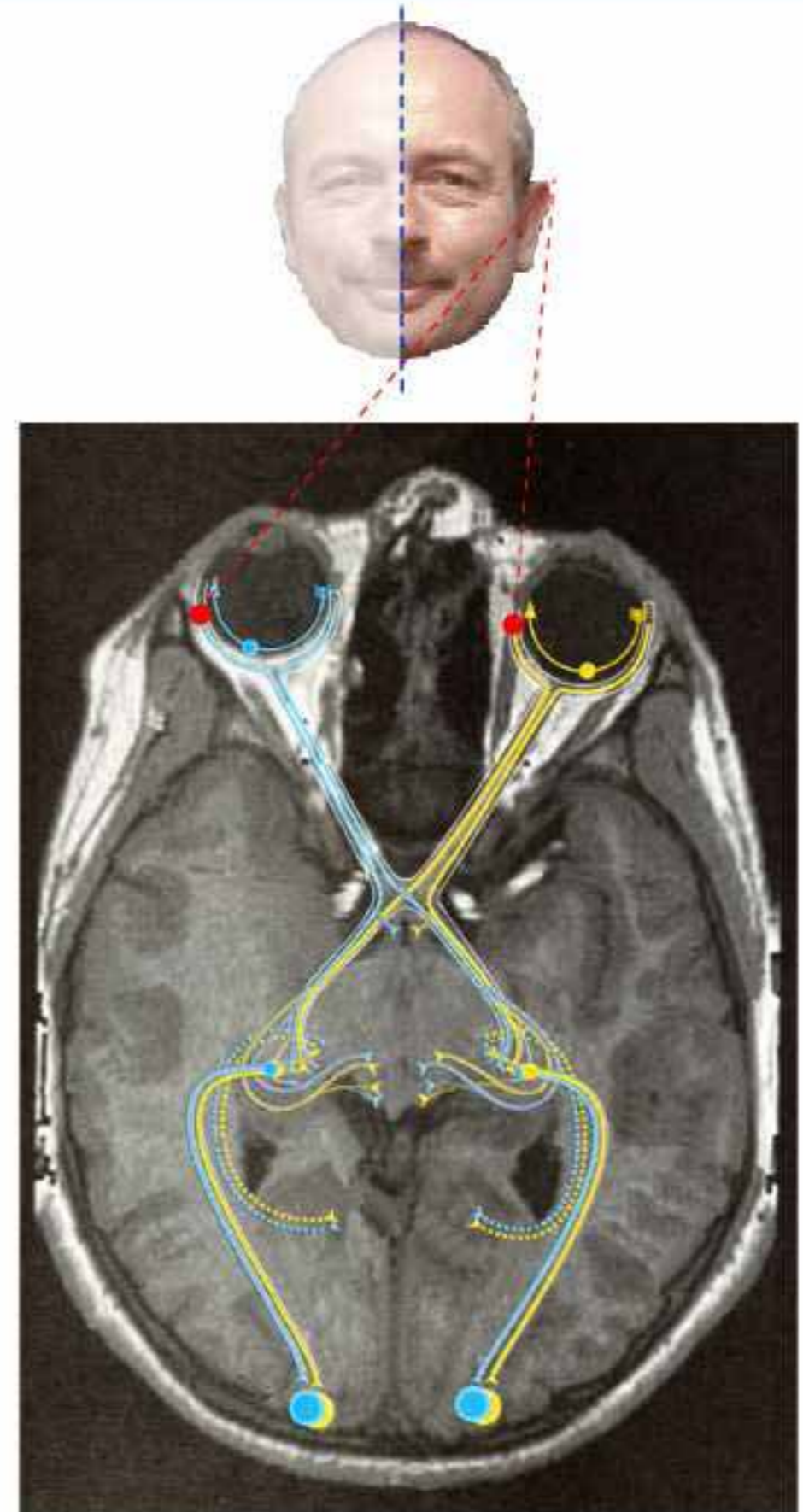


Sleeping with one eye open

What about humans ?

Problems:

Each eye communicates with both sides of the brain



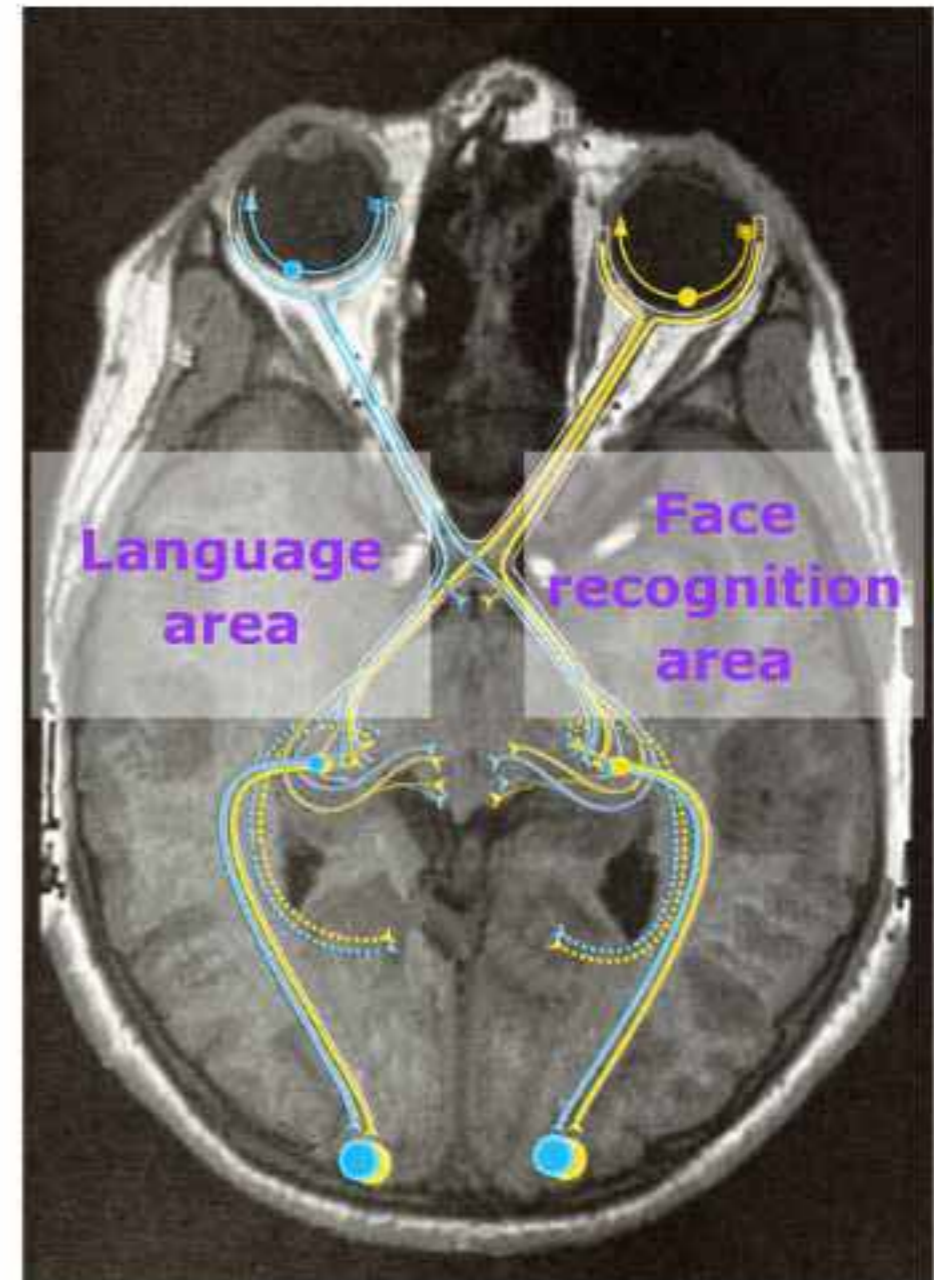
Sleeping with one eye open

What about humans ?

Problems:

Each eye communicates with both sides of the brain

Language and face recognition are localised on different sides



Sleeping with one eye open

What about humans ?

Answer:

We could use glasses with half-obscured lenses but:



Agean



Coquina



Havana



Islamorada



South Beach



Polaris



MP2



Deep Blue



Eliminator



Catalina



Ex-Frame



Grace



Multi-Sport



Wave Killer



Fathom



Tempest



Fluid



Pro Sport

Sleeping with one eye open

What about humans ?

Answer:

We could use glasses with half-obscured lenses but:



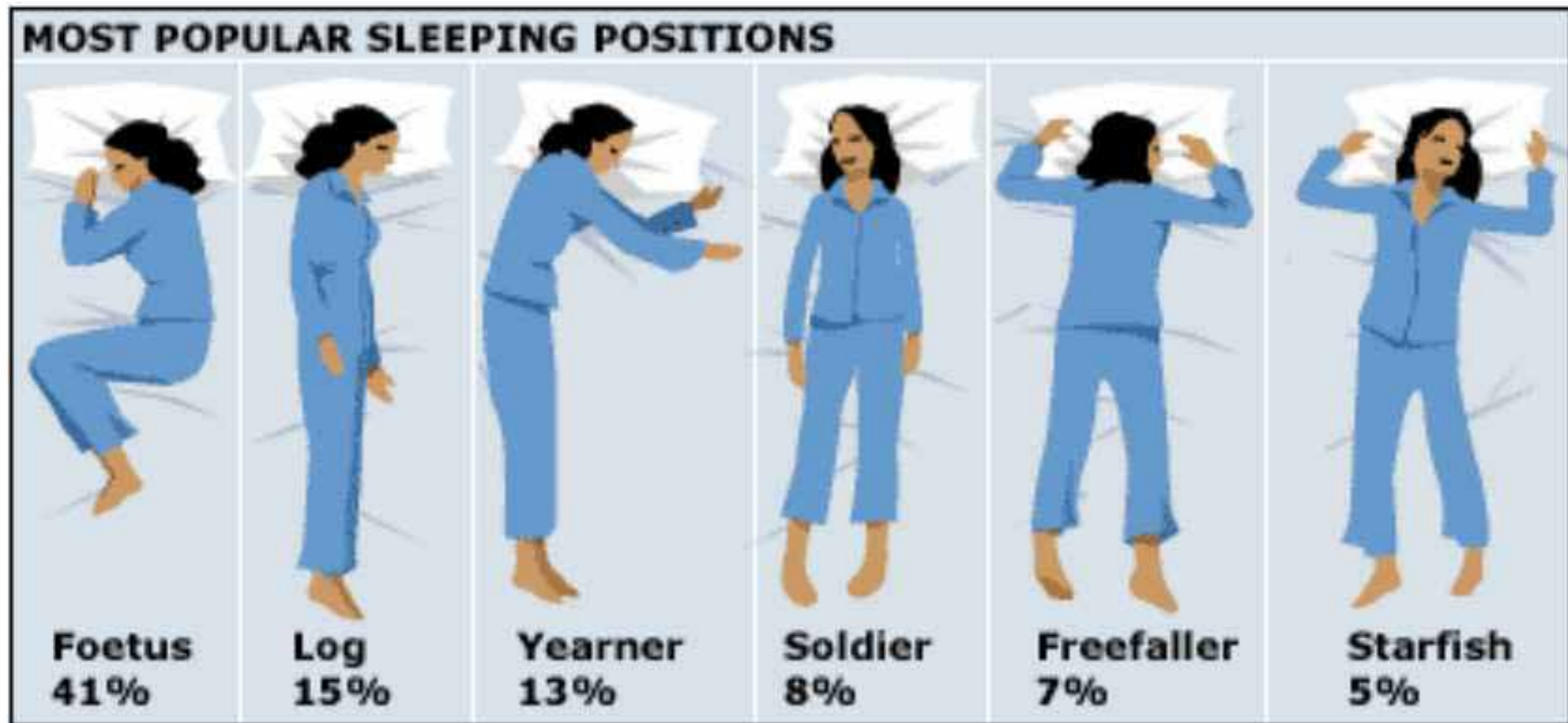
For half of the day we could not use language !

For the other half we could not recognise anyone !



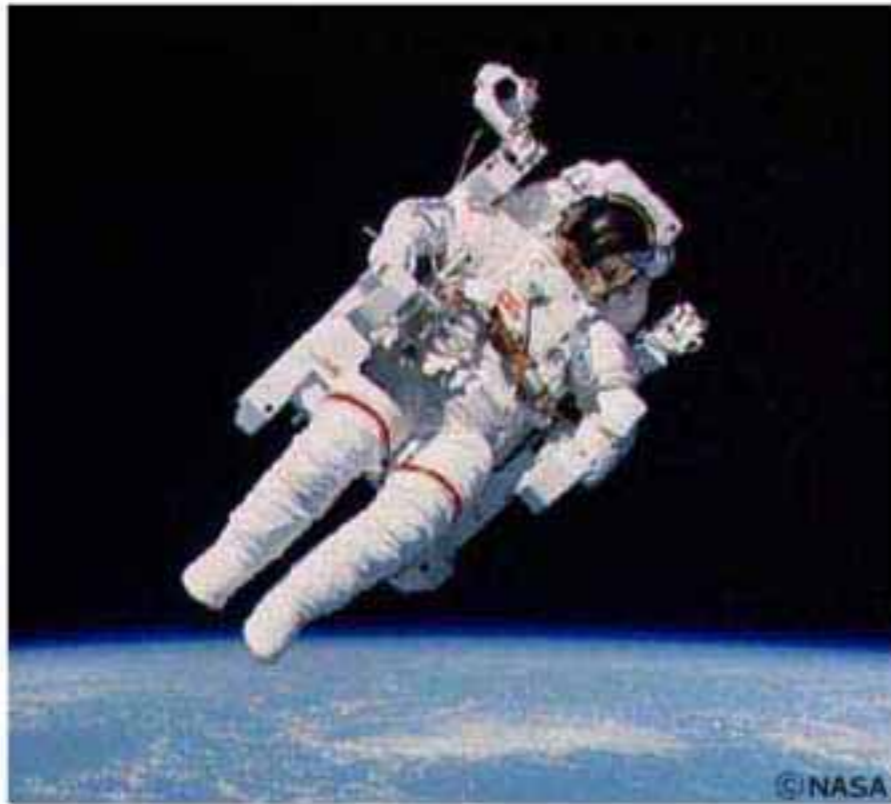
Sleeping position is important

Humans have to be horizontal to sleep properly



Sleeping position is important

Humans have to be horizontal to sleep properly



Sleeping position is important

Humans have to be horizontal to sleep properly

So travel 1st class on long-haul journeys



Sleeping position is important

So travel 1st class on long-haul journeys or hope that Richard Branson performs an economy-class miracle !



Sleeping position is important

So travel 1st class on long-haul journeys or hope that Richard Branson performs an economy-class miracle !



Do other animals dream ?



Do other animals dream ?

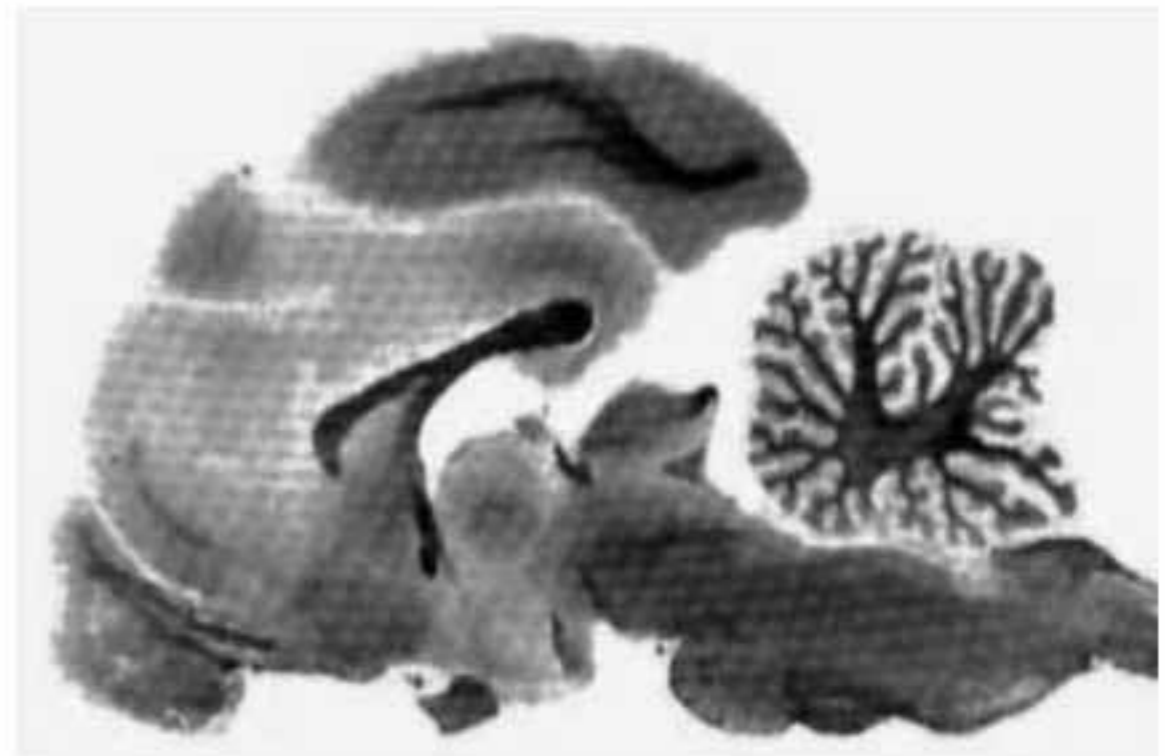
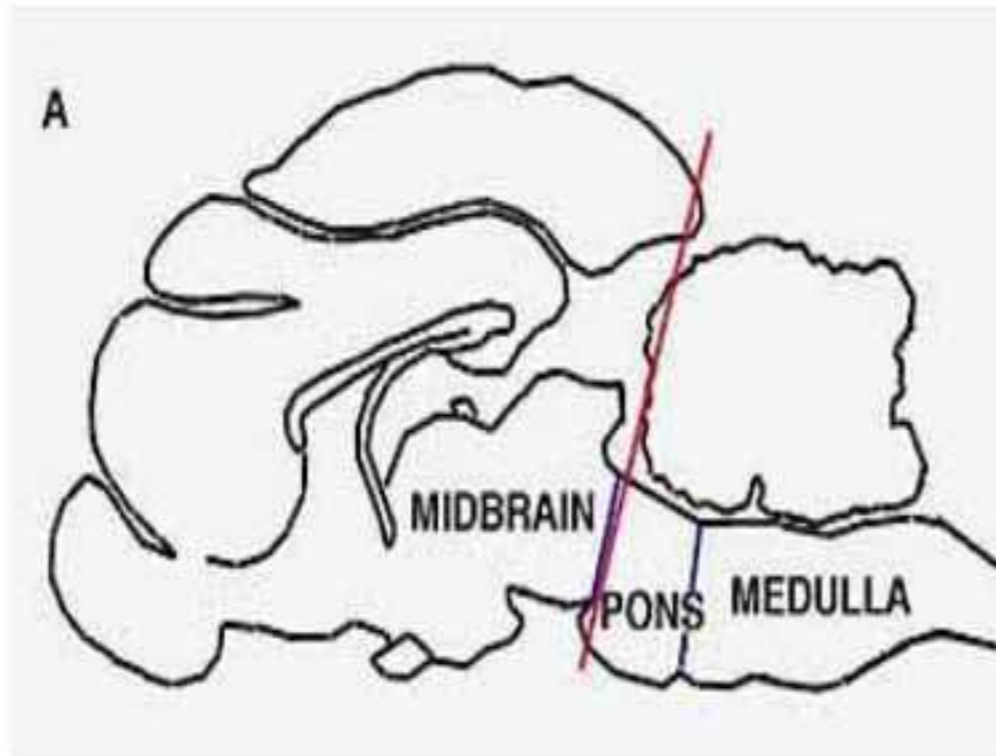
Animals often move and vocalise during sleep



Do other animals dream ?

Animals often move and vocalise during sleep

Experimental proof is seen when brain control over REM paralysis is removed



Do other animals dream ?

Animals often move and vocalise during sleep

Experimental proof is seen when brain control over REM paralysis is removed

Imagine our own world if humans were not paralysed during REM sleep.....

Do other animals dream ?



'Jack sleepwalks to a urinal that doesn't exist.....

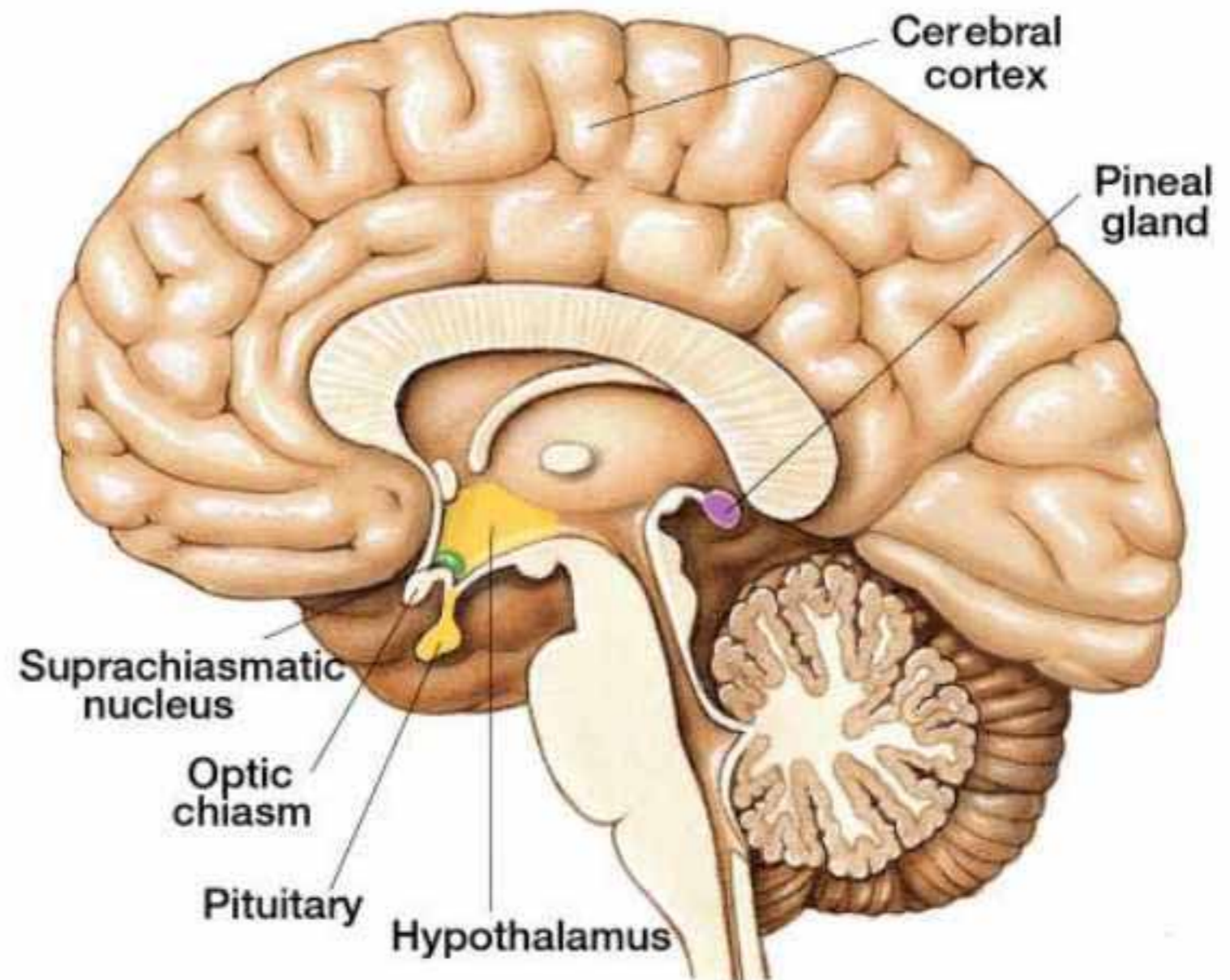
...and recovers nicely by blaming the whole thing on the dog !'

from 'Snapshots by' Jason Love

What regulates sleep ?

Brainstem centres that regulate arousal

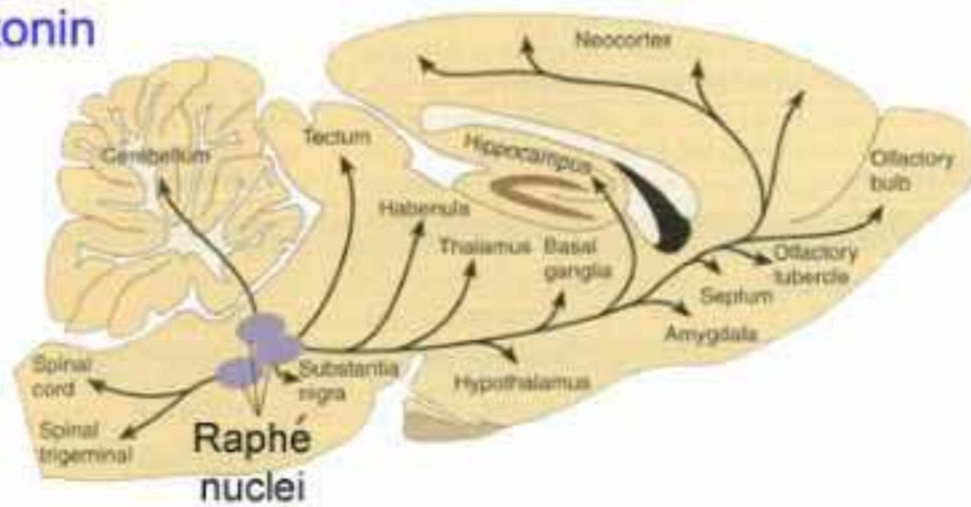
Biological clocks - melatonin



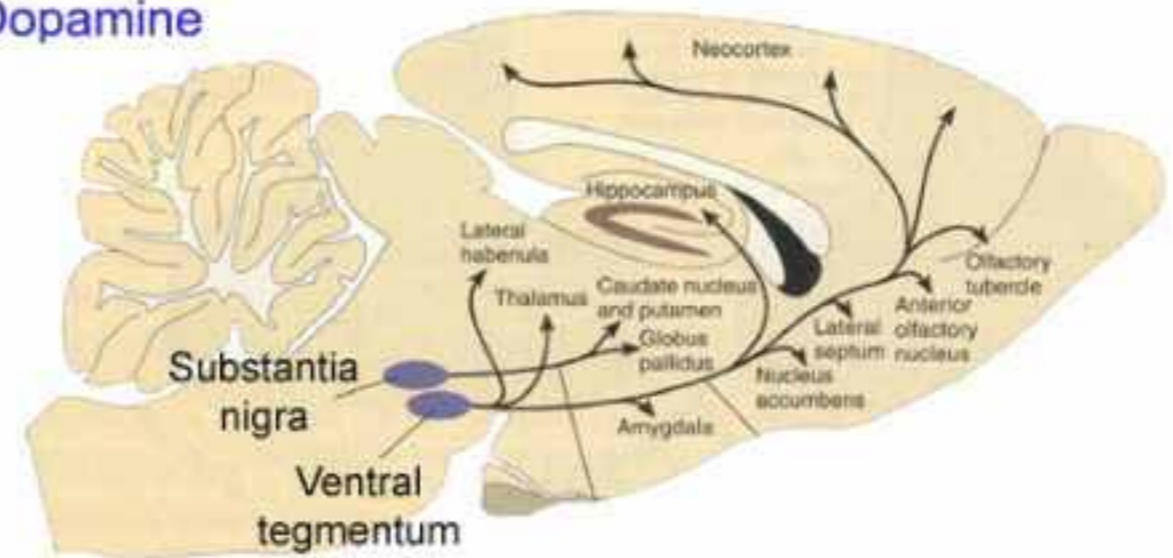
What regulates sleep ?

Brain arousal transmitters

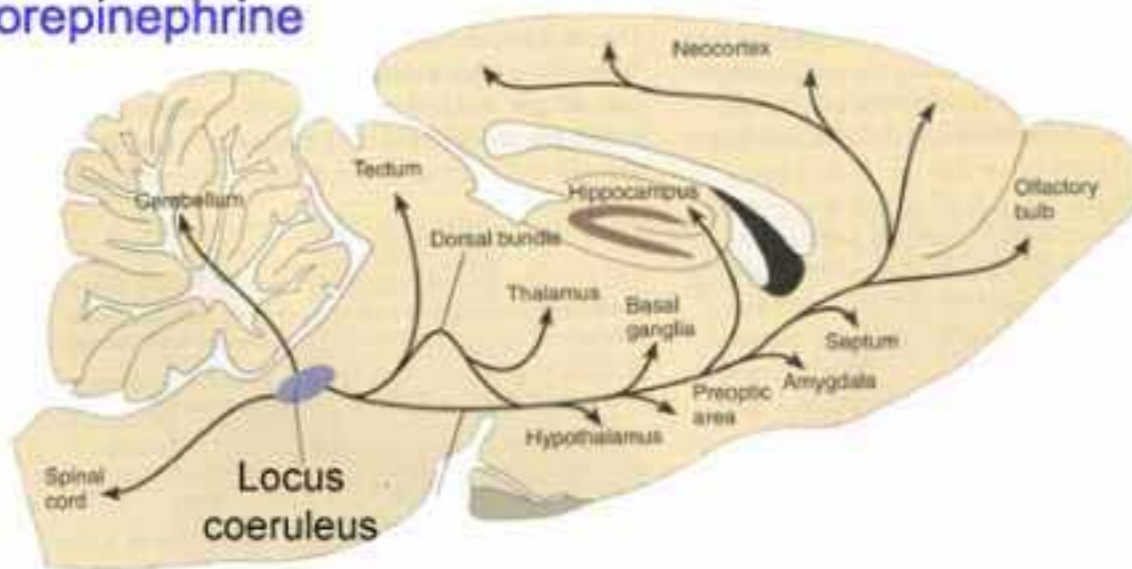
Serotonin



Dopamine



Norepinephrine



Uppers

Alcohol

Amphetamine (speed)

Modafinil (Provigil)

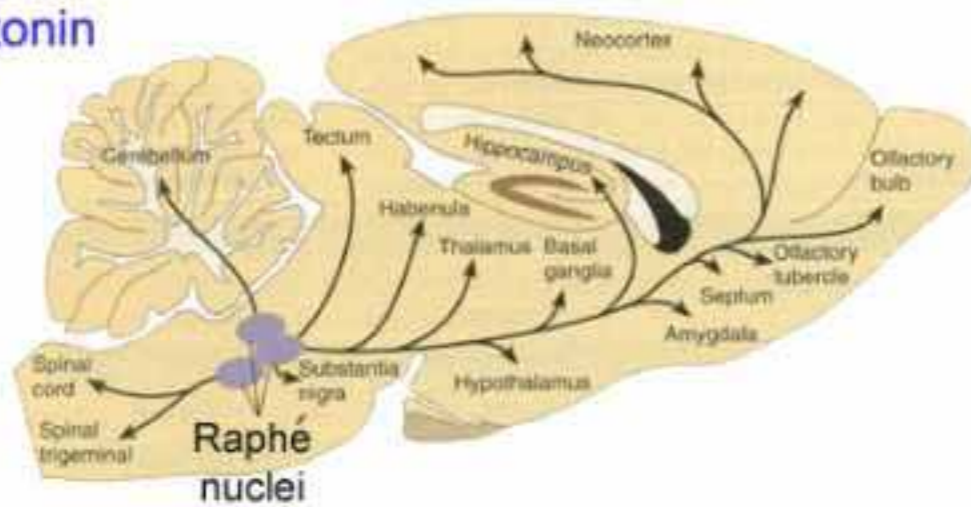
Ritalin

Ecstasy

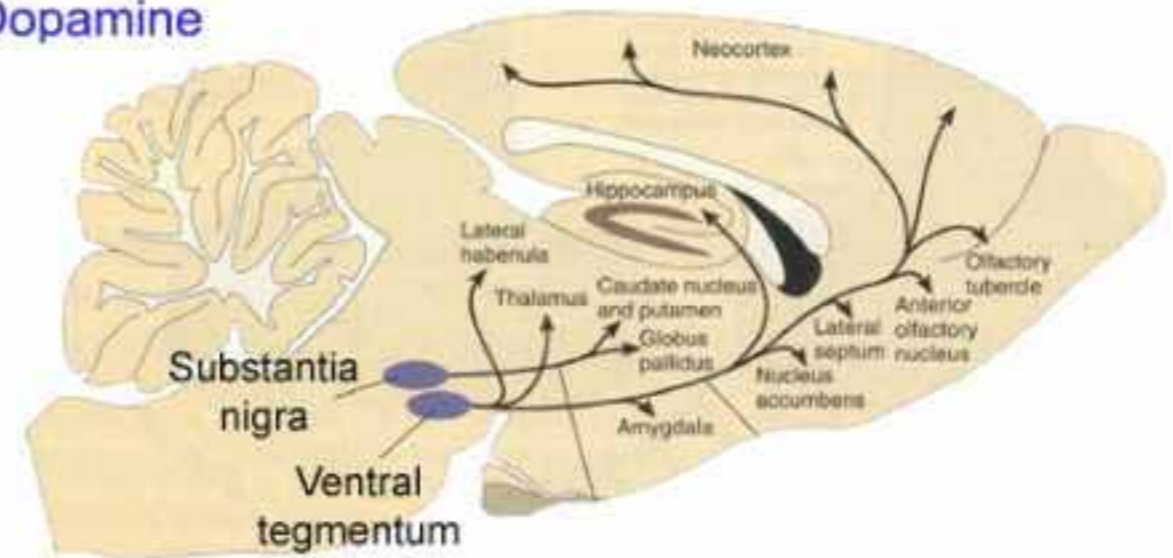
What regulates sleep ?

Brain arousal transmitters

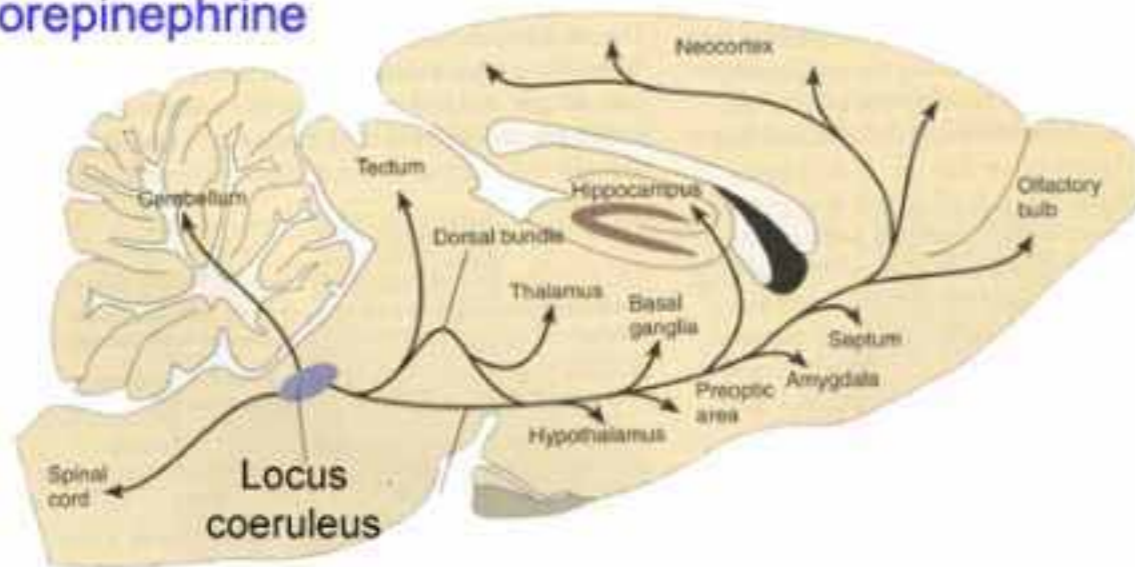
Serotonin



Dopamine



Norepinephrine

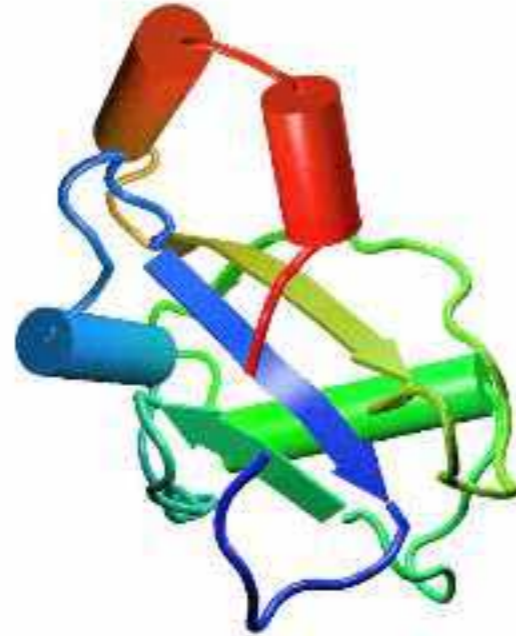


Downers
Alcohol
Ketamine
Haloperidol

What regulates sleep ?

Brain arousal transmitters

Brain inhibitory transmitters



Barbiturates
Benzodiazepines

Cocaine
Caffeine

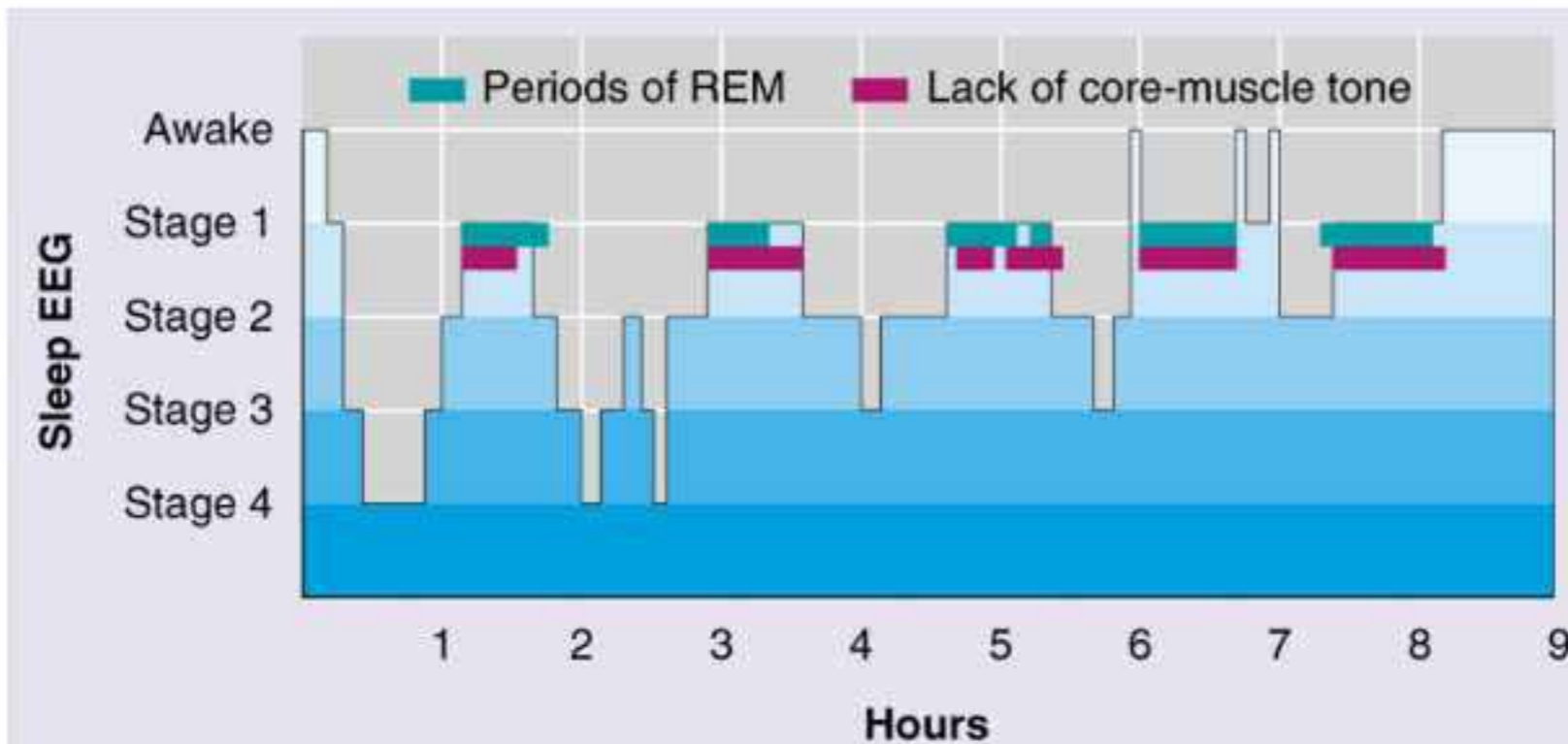
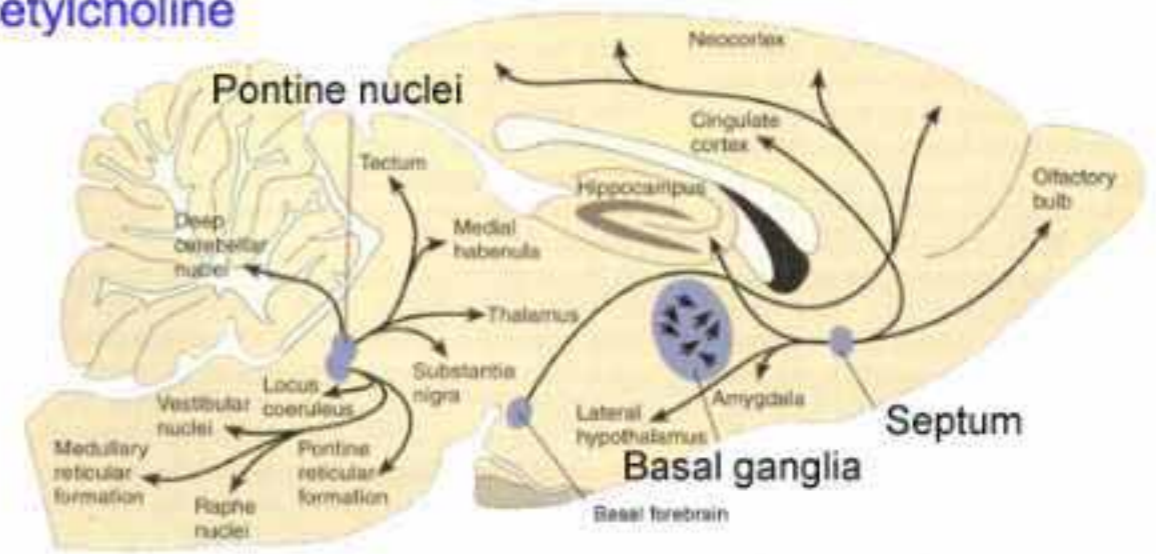
What regulates sleep ?

Brain arousal transmitters

Brain inhibitory transmitters

REM sleep and acetylcholine

Acetylcholine

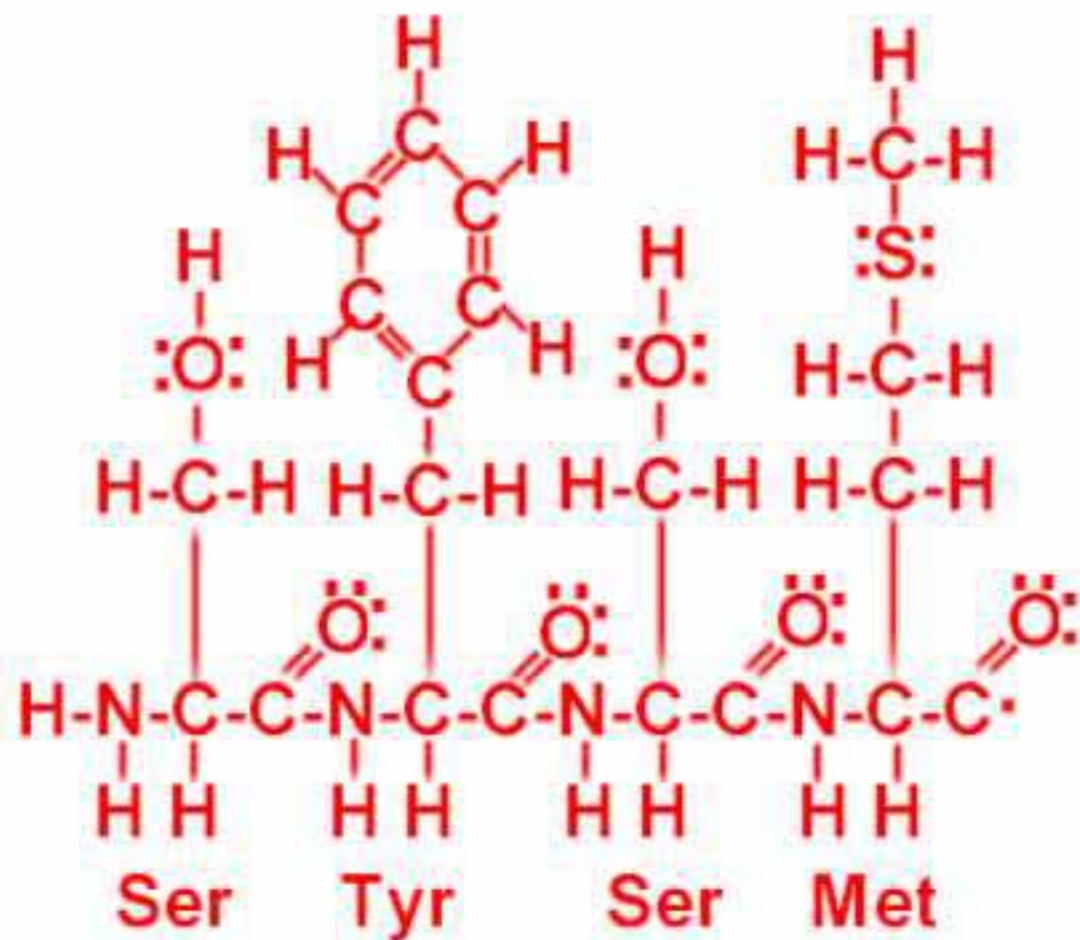


Nicotine

What wakes us up ?

Your ACTH internal alarm clock

Waking up with a start but ready !



What wakes us up ?

External alarm clock only - wake up feeling like a zombie

'So how often do you wake up grumpy ?'

'Not often - she gets up when she wants'



What wakes us up ?

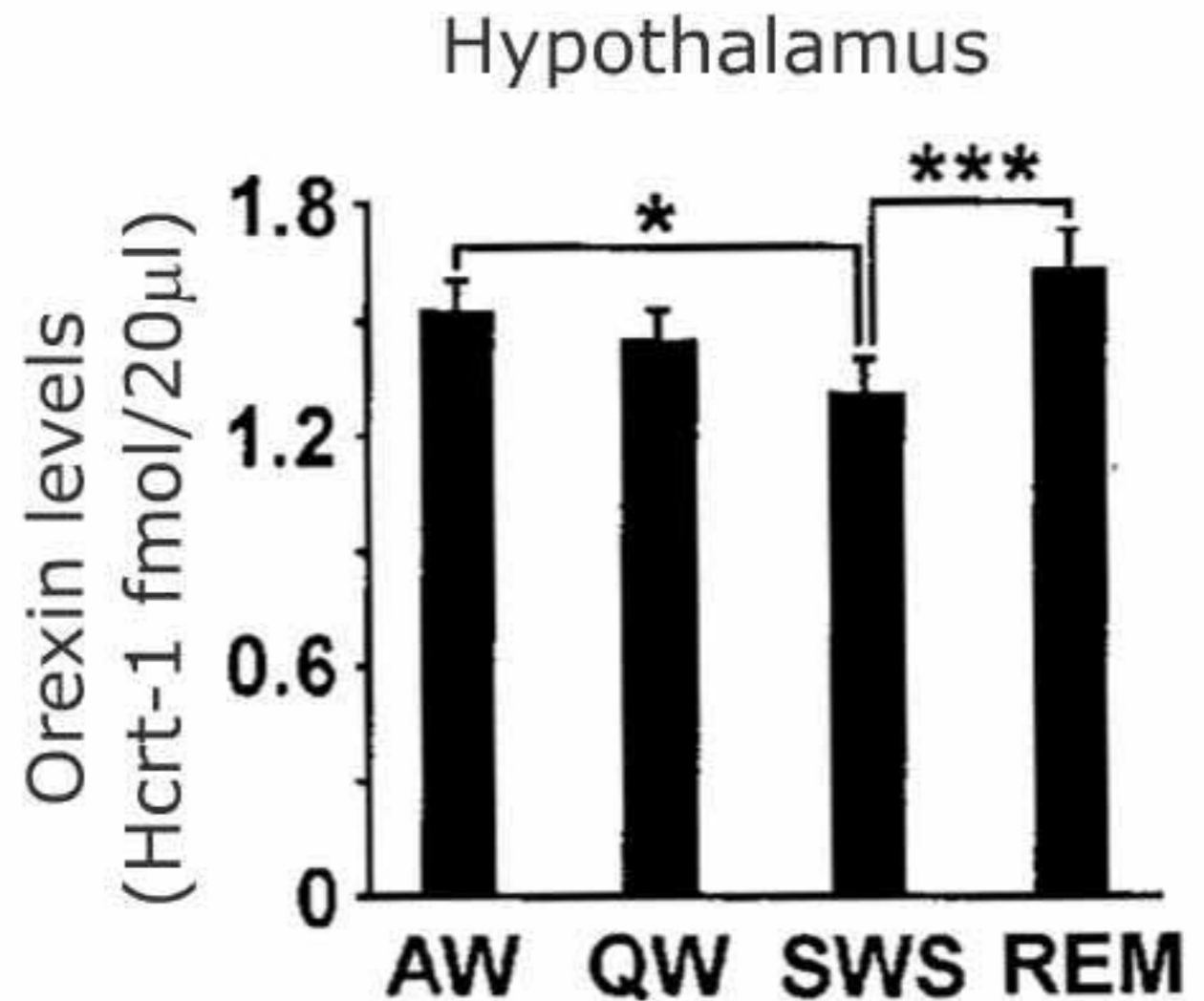
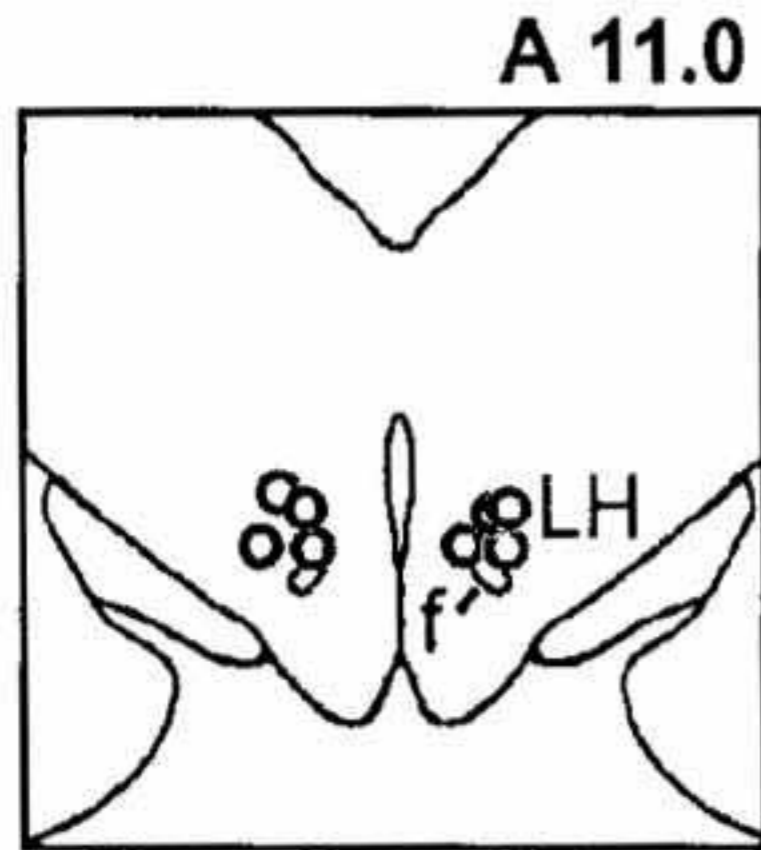
Orexin/hypocretin



What wakes us up ?

Orexin/hypocretin

Orexin levels tend to be high during REM sleep

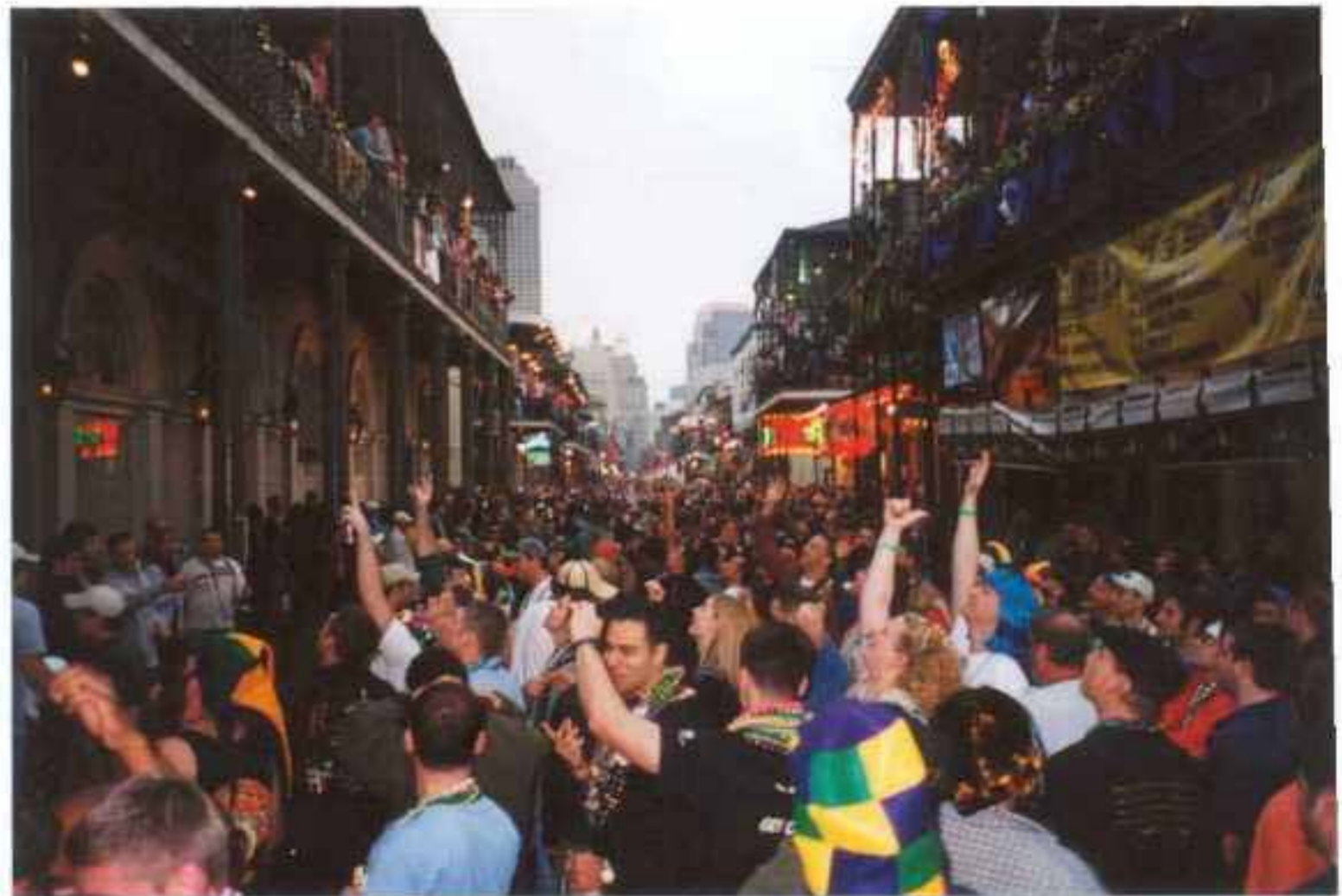


What wakes us up ?

Orexin/hypocretin

Orexin levels tend to be high during REM sleep

The 24h waking drug ?
(Modafinil)



Can we and other animals survive without sleep ?

NO !



Can we and other animals survive without sleep ?

NO !

2-3 weeks of sleep deprivation will kill you

Sleep is more important for survival than food



Can we and other animals survive without sleep ?

Prior to death:

debilitated appearance
skin lesions
increased food intake
weight loss

increased metabolic rate
reduced body temperature
reduced immune defences

Death is caused mainly by infection
through bacteria, viruses and parasites



The perils of sleep deprivation

World record for staying awake



Randy Gardner

1965

Randy Gardner (11 days, 12 minutes)

2000

Maureen Weston (18 days 17 hours)

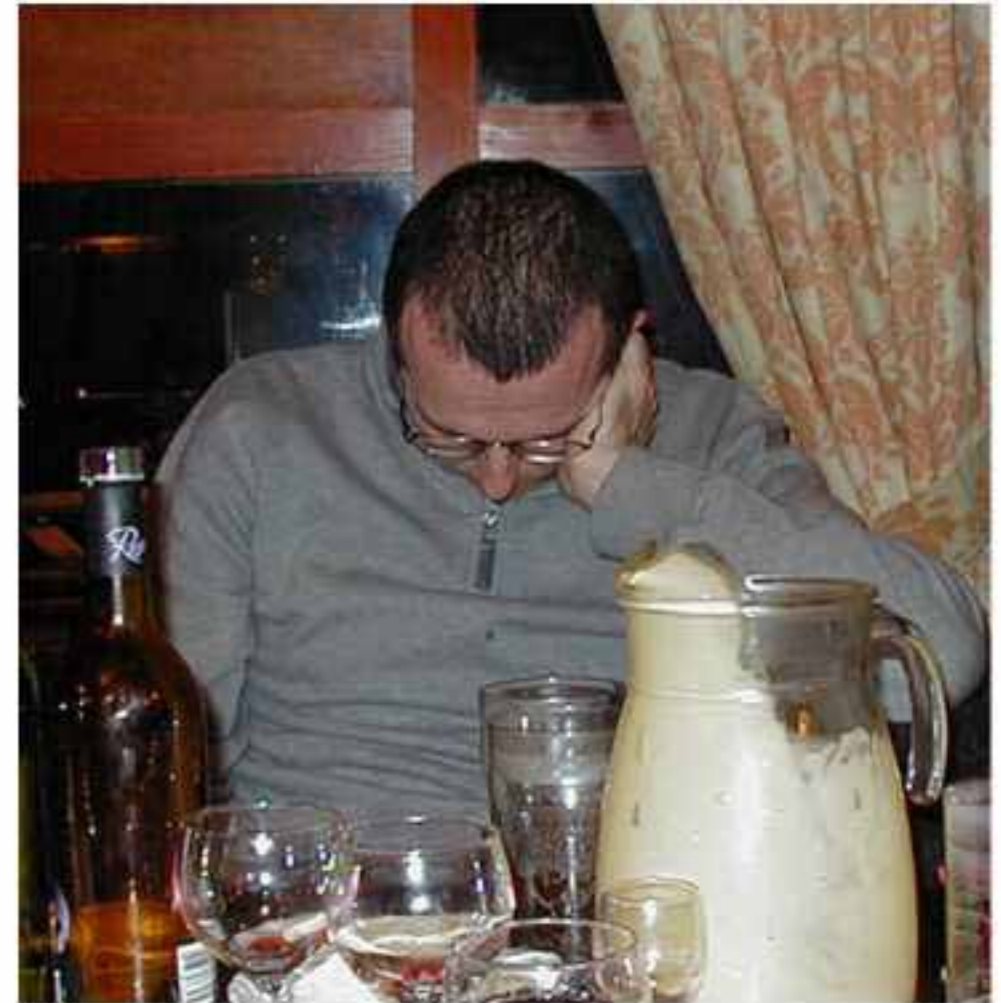
1988

Robert McDonald (18 days 21.6 hours)

The perils of sleep deprivation

Both acute and chronic sleep deprivation can affect all body functions:

- attention
- motor co-ordination
- learning and memory
- emotional and psychological state
- sexual drive and fertility



The perils of sleep deprivation

Both acute and chronic sleep deprivation can affect all body functions:

attention

motor co-ordination

learning and memory

emotional and psychological state

sexual drive and fertility

appetite

growth

metabolic rate

immunocompetence

life expectancy...

It can also shrink the size of your brain !

The perils of sleep deprivation

Sleep deprivation is a popular torture used by the Indonesian Secret Police....



The perils of sleep deprivation

Sleep deprivation is a popular torture used by the Indonesian Secret Police....

...and small babies !



The perils of sleep deprivation

Quick fixes:

Play catch-up at the weekend



Try a 15-minute afternoon nap



Driving under the influence of sleep deprivation



Driving under the influence of sleep deprivation

Sleep deprivation may be as big a killer on our roads as excess alcohol !

Causes 30% of crashes on New York Thruway

Causes 20% (~23,000) of all crashes in the UK



Driving under the influence of sleep deprivation

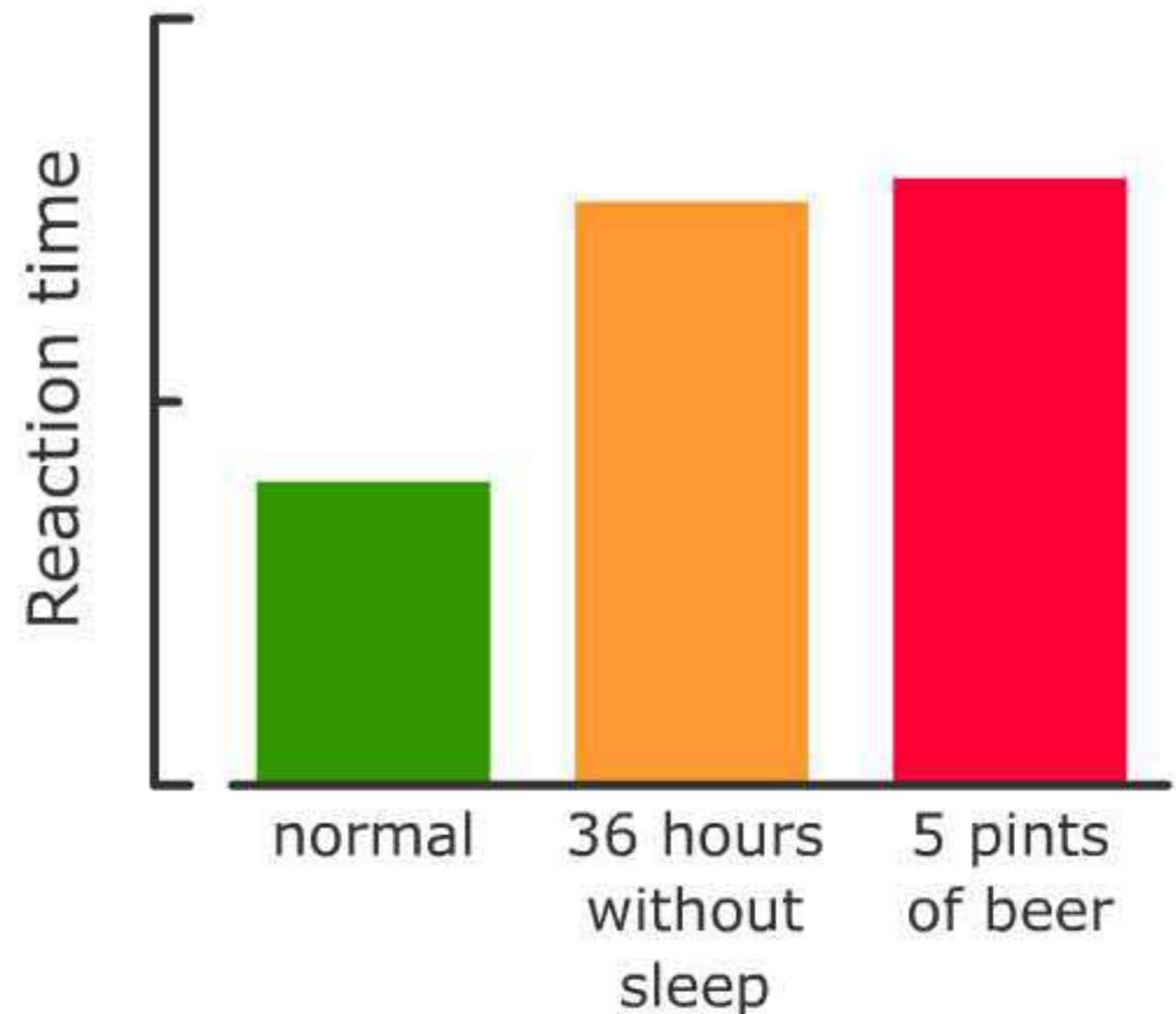
29% of all UK drivers admitted to nearly falling asleep while driving at least once during the last 12 months



Driving under the influence of sleep deprivation

29% of all UK drivers admitted to nearly falling asleep while driving at least once during the last 12 months

Attention and reaction times



Driving under the influence of sleep deprivation

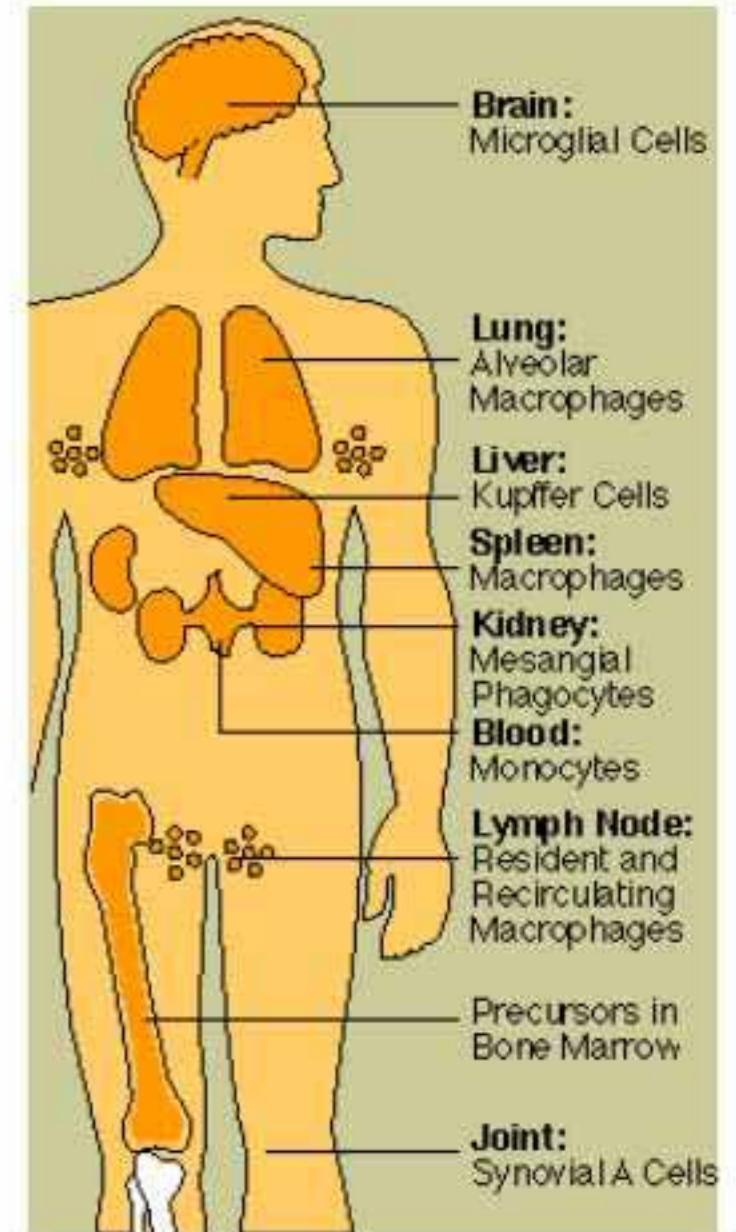
Driving under the influence of lack of sleep is not generally considered a crime



Growth, repair and immune function

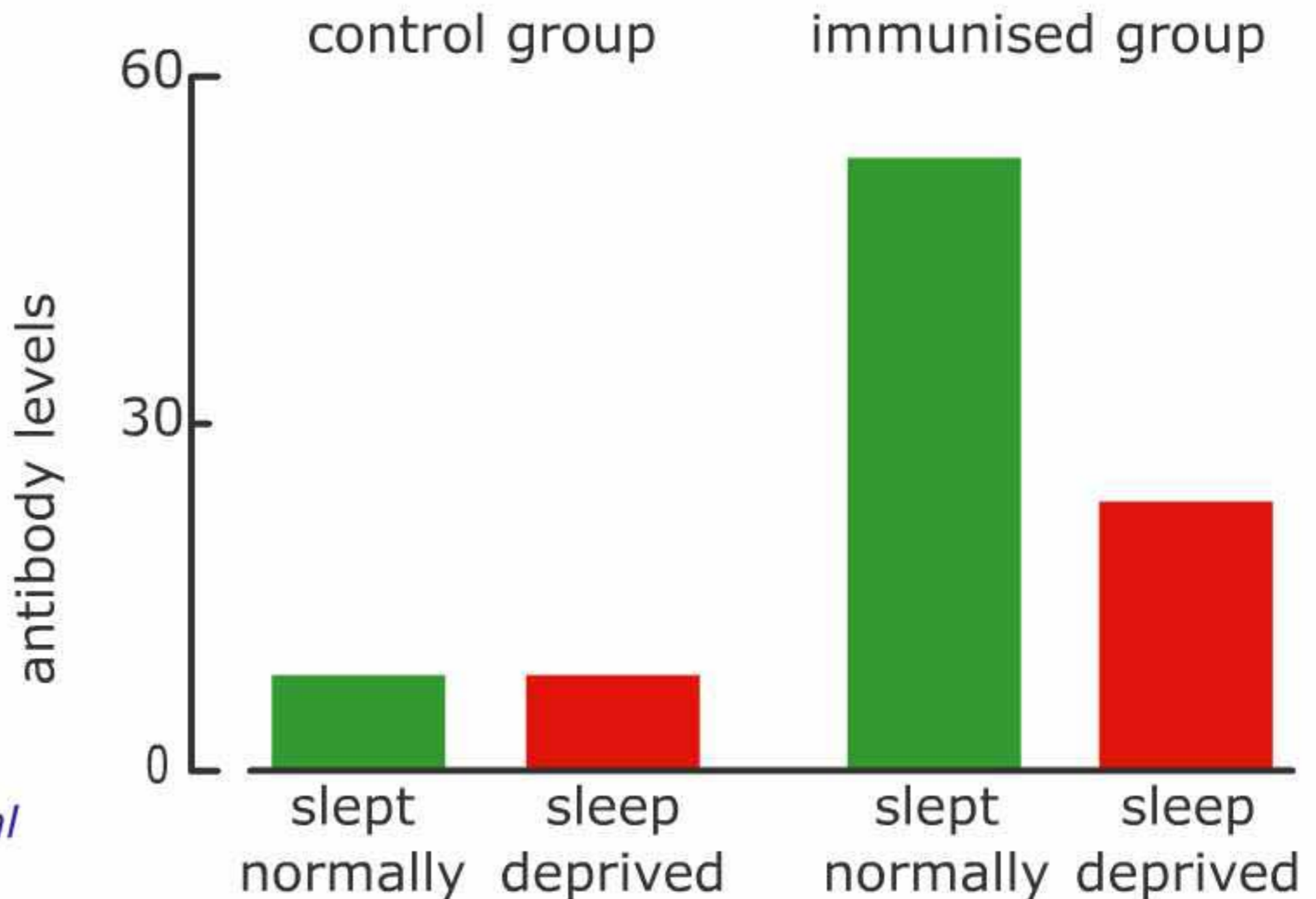
Sleep helps boost your immune defences

Sleep deprivation is usually accompanied by a high incidence of minor illnesses



Growth, repair and immune function

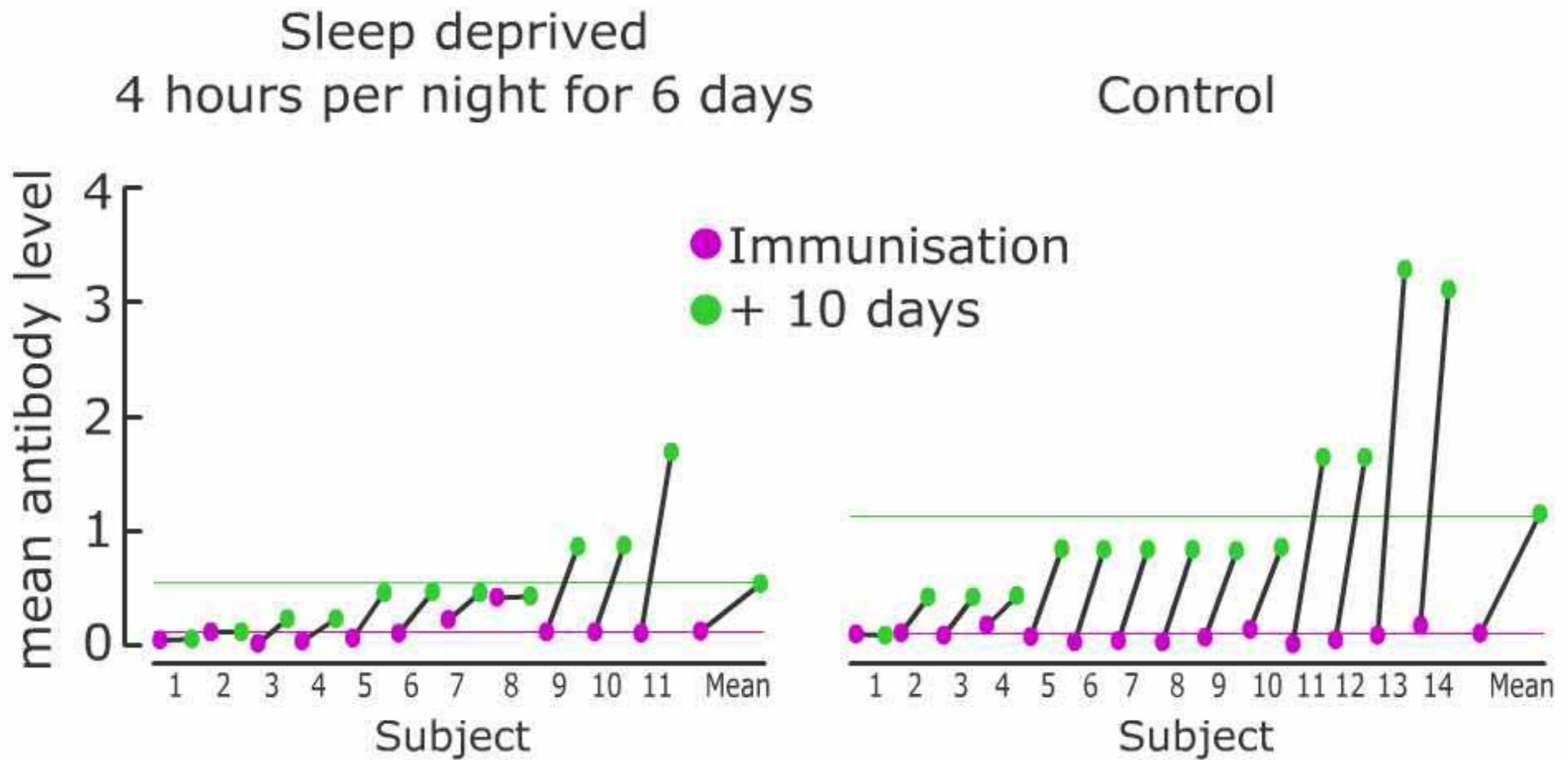
In animals 7 hours of sleep deprivation blocked effects of flu immunisation



Brown *et al*
1989

Growth, repair and immune function

In humans the same effect is seen



Spiegel *et al* JAMA 2002

Growth, repair and immune function

Many important hormones are secreted during sleep:

Testosterone



Growth, repair and immune function

Many important hormones are secreted during sleep:

Testosterone

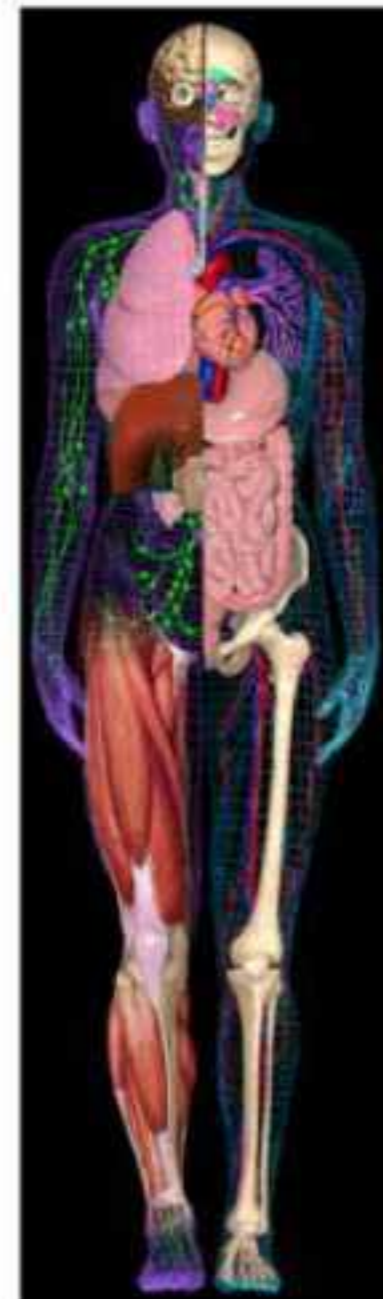
Growth hormone

- important for growth, repair and new synapse formation

(peaks in Stage 4 sleep)



Staying Young
Gilbert Elian MD & James Jamieson with Steven Gross
Age Reversal Press



STAYING YOUNG

Growth Hormone
and Other Natural Strategies to Reverse the Aging Process

Gilbert Elian MD & James Jamieson with Steven Gross

Growth, repair and immune function

Hormones

Thyroid stimulating hormone

Follicle stimulating hormone

Luteinizing hormone

Growth hormone

Testosterone

Melatonin

Prolactin

Cortisol

ACTH



Energy metabolism

Triacyl glycerol

Glucose

Blood and Immune system

Blood viscosity

Fibrinolytic activity (goes down)

NK cell activity (killer cells – innate immunity)

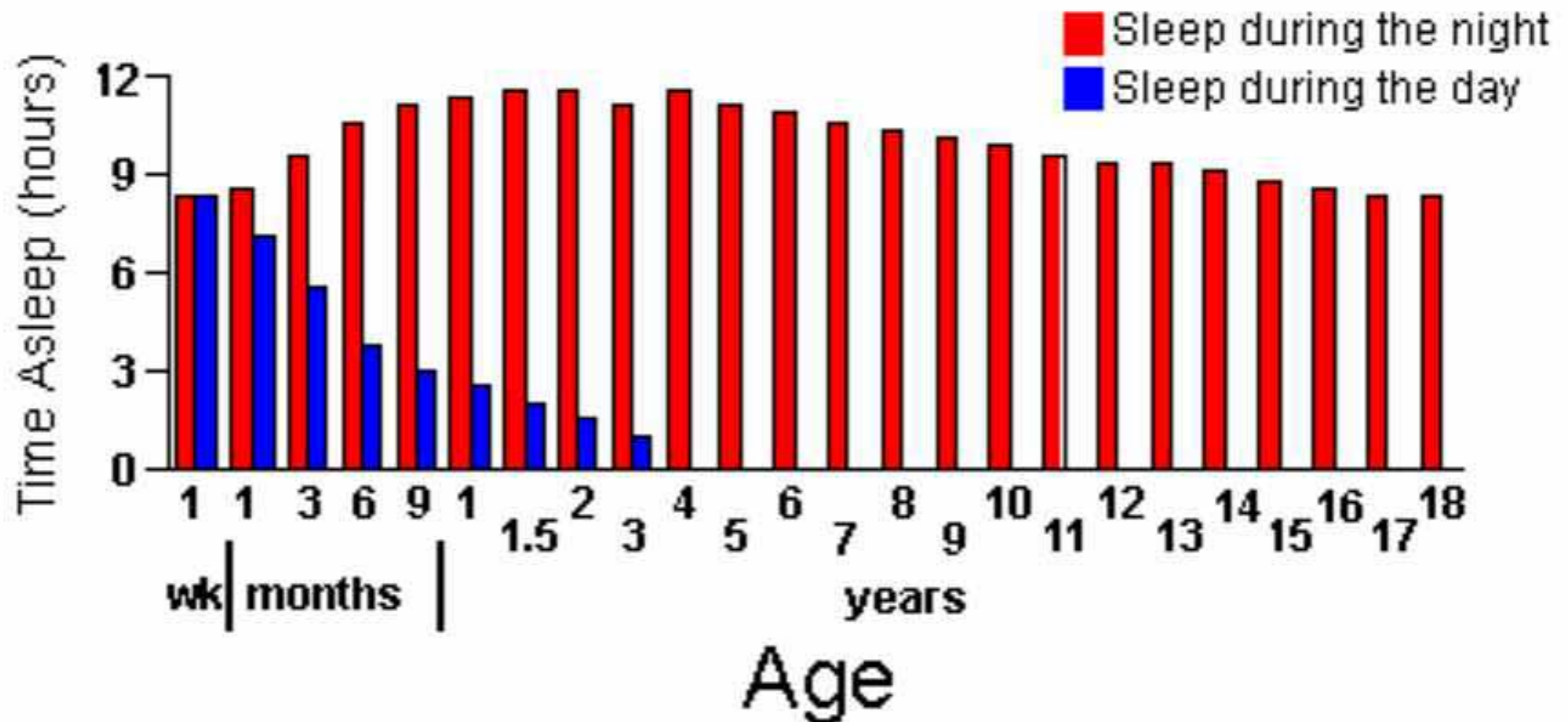
Other Lymphocytes (white blood cells – antibodies)

Eosinophils (white blood cells – allergies and infection)

Education and adolescence

Young babies need to sleep up to 16 hours a day

Adolescents still need around 10 hours of sleep



Education and adolescence

Young babies need to sleep up to 16 hours a day

Adolescents still need around 10 hours of sleep

If they get up at 7.30 am
are they asleep by 9.30 pm ?



Education and adolescence

Young babies need to sleep up to 16 hours a day

Adolescents still need around 10 hours of sleep

If they get up at 7.30 am
are they asleep by 9.30 pm ?

Sleeping in at weekends - rebellion, laziness or catch-up ?



Education and adolescence


Does sleep deprivation affect educational attainment ?



Education and adolescence

Does sleep deprivation affect educational attainment ?

All GCSE and SATS advisory sites emphasise importance of sleep




[Sign in](#) | [Register](#)

Go to:

EducationGuardian.co.uk Schools special reports

Home	Higher	Schools news	FE news	TEFL news	Education weekly	Jobs	Talk	Help
Links	Interactive guides	Special reports	Archive search	Learn.co.uk	Clearing			



Time to do the paper round?

Teenagers stressed out by exams need plenty of pampering by their parents, says Wendy Berliner

Tuesday May 20, 2003
[The Guardian](#)

Education and adolescence

Does sleep deprivation affect educational attainment ?

All GCSE and SATS advisory sites emphasise importance of sleep

Studies in USA suggest that reduction of sleep by 30-40 minutes significantly reduced success

Being 'cool' and regularly staying up late might lead to 50 years in a dead end job !

Caffeine and sugar junkies

The human race is awash with caffeine



Photomicrograph of crystalline caffeine

Caffeine and sugar junkies

The human race is awash with caffeine

It is a plant toxin evolved to poison insect parasites



Caffeine and sugar junkies

The human race is awash with caffeine

It is a plant toxin evolved to poison insect parasites

It is present in coffee, tea, soft drinks, chocolate, medicines and even sold in tablet form



Caffeine and sugar junkies

The human race is awash with caffeine

It is a plant toxin evolved to poison insect parasites

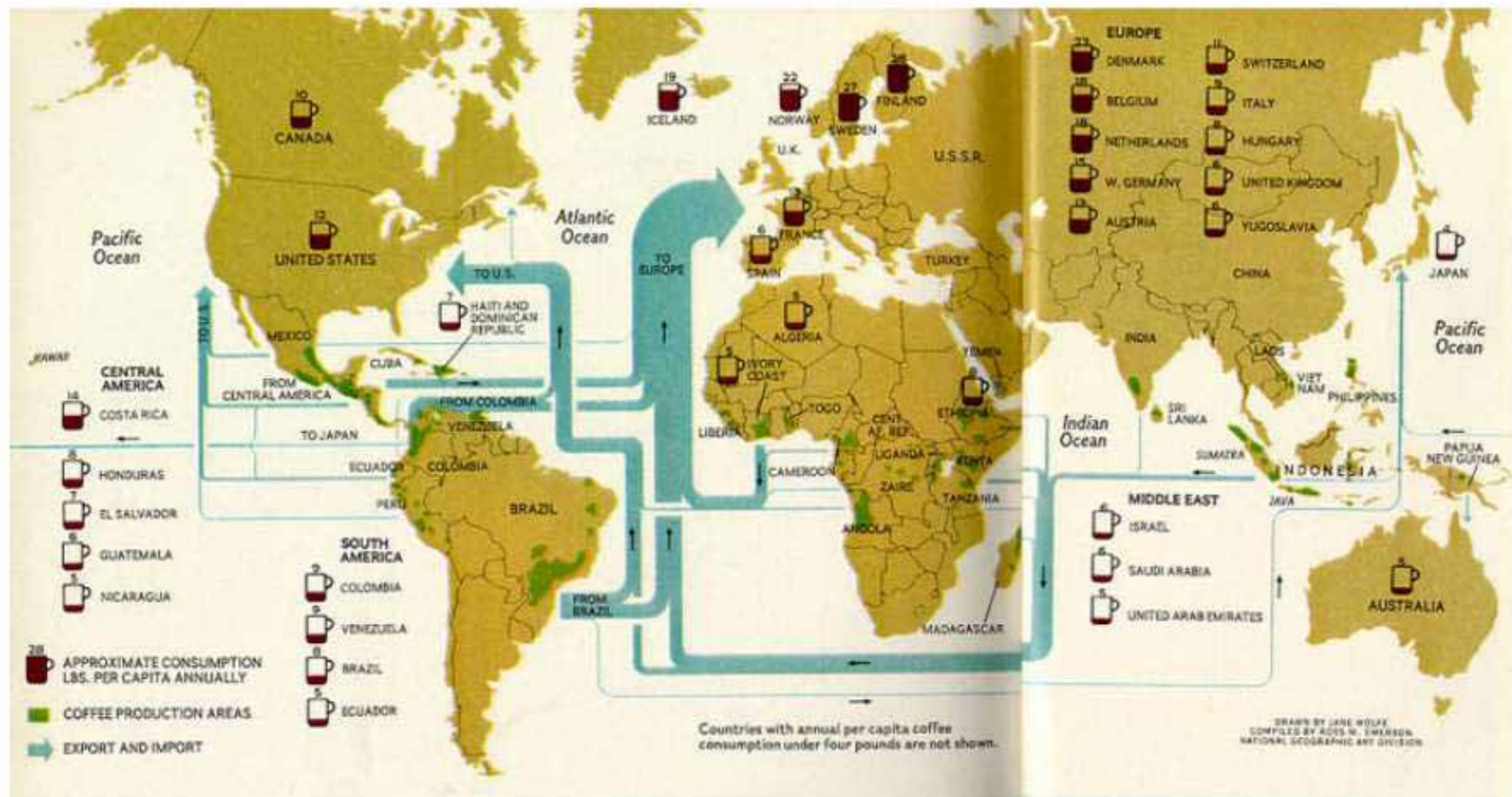
It is present in coffee, tea, soft drinks, chocolate, medicines and even sold in tablet form

Coffee contains 60-100mg/cup caffeine.....



Caffeine and sugar junkies

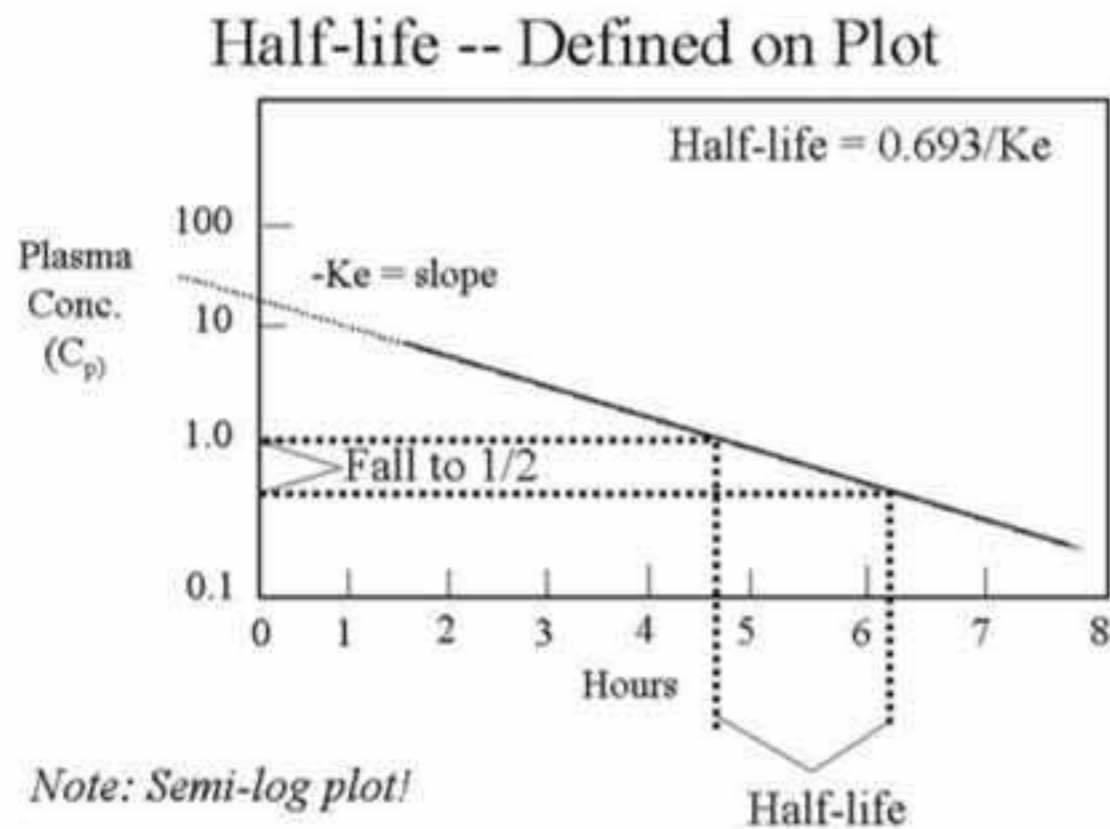
...and is the second most traded commodity worldwide



Caffeine and sugar junkies

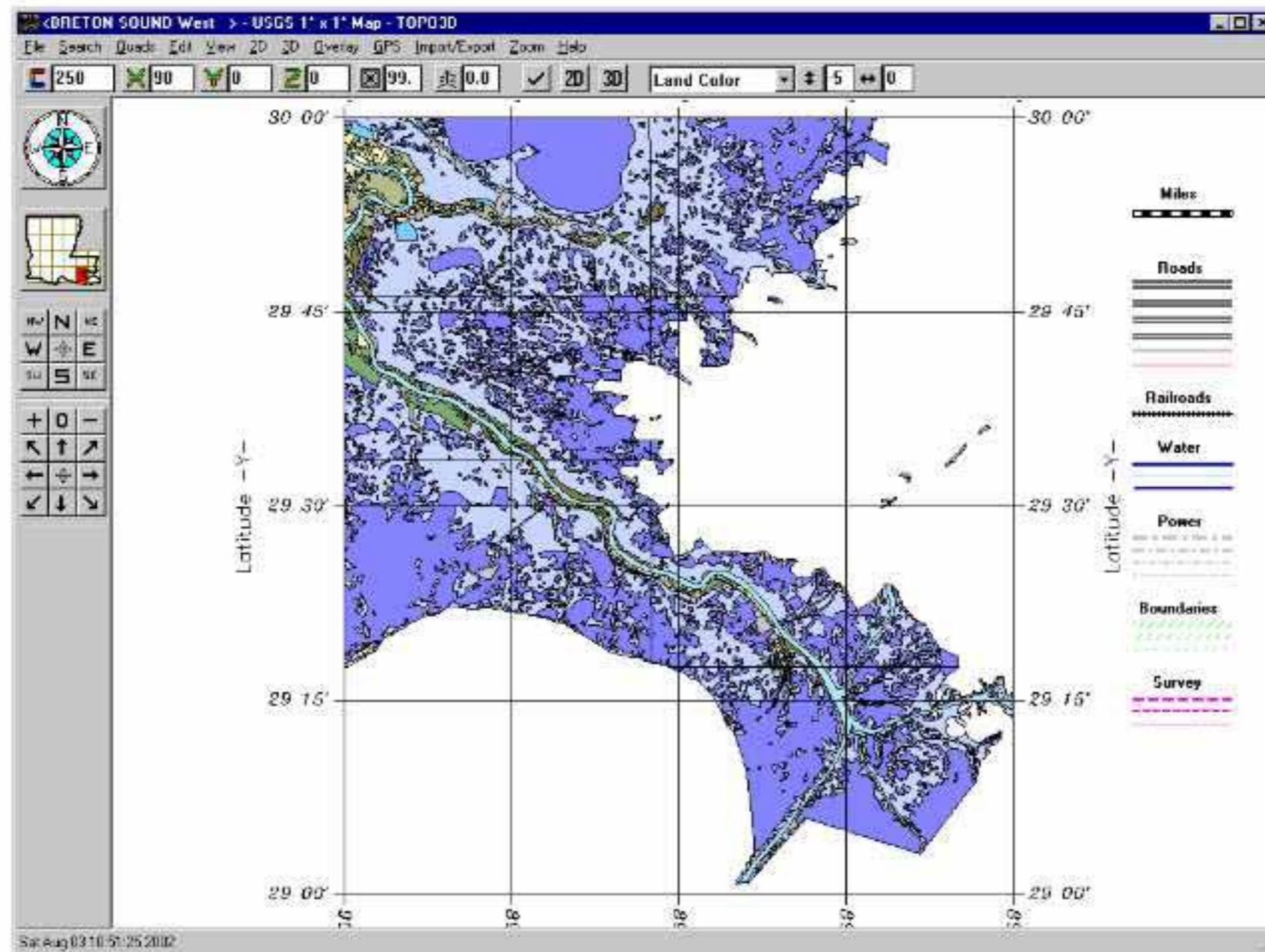
Humans are only species that consumes this drug
(50% of Americans consume more than 300 mg/day)

It has a half-life of 6 - 7 hours



Caffeine and sugar junkies

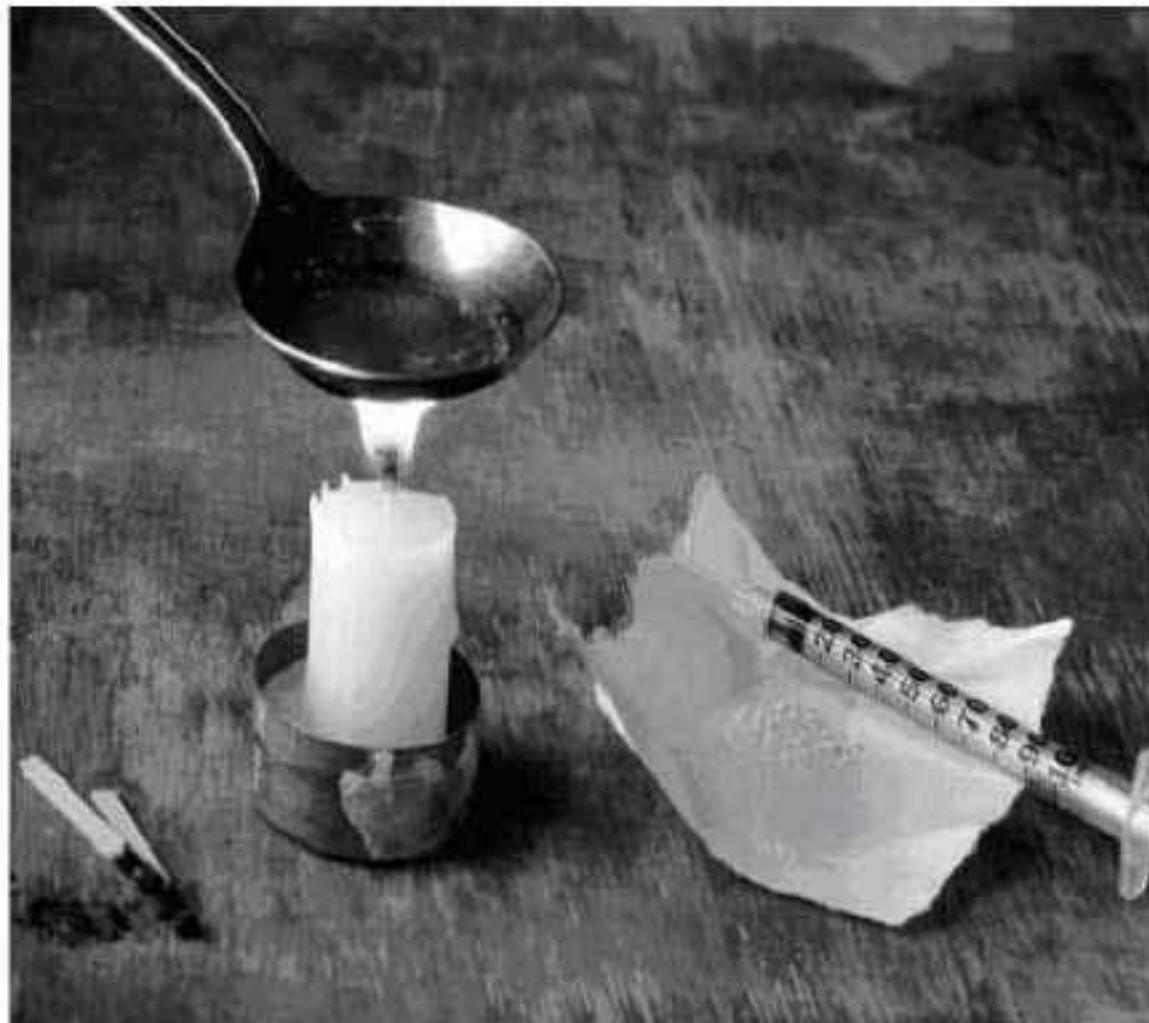
We excrete so much of it (average blood levels are around 10mg/kg).....that it is used to show the spread of human effluent out into the sea !



Caffeine and sugar junkies

Caffeine is effectively an addictive drug like amphetamines, cocaine and heroin, although much less potent

It is a strong stimulant, increases our alertness and gives us a buzz



Caffeine and sugar junkies

Soft-drink manufacturers say it is added to improve taste

Studies do not appear to support this



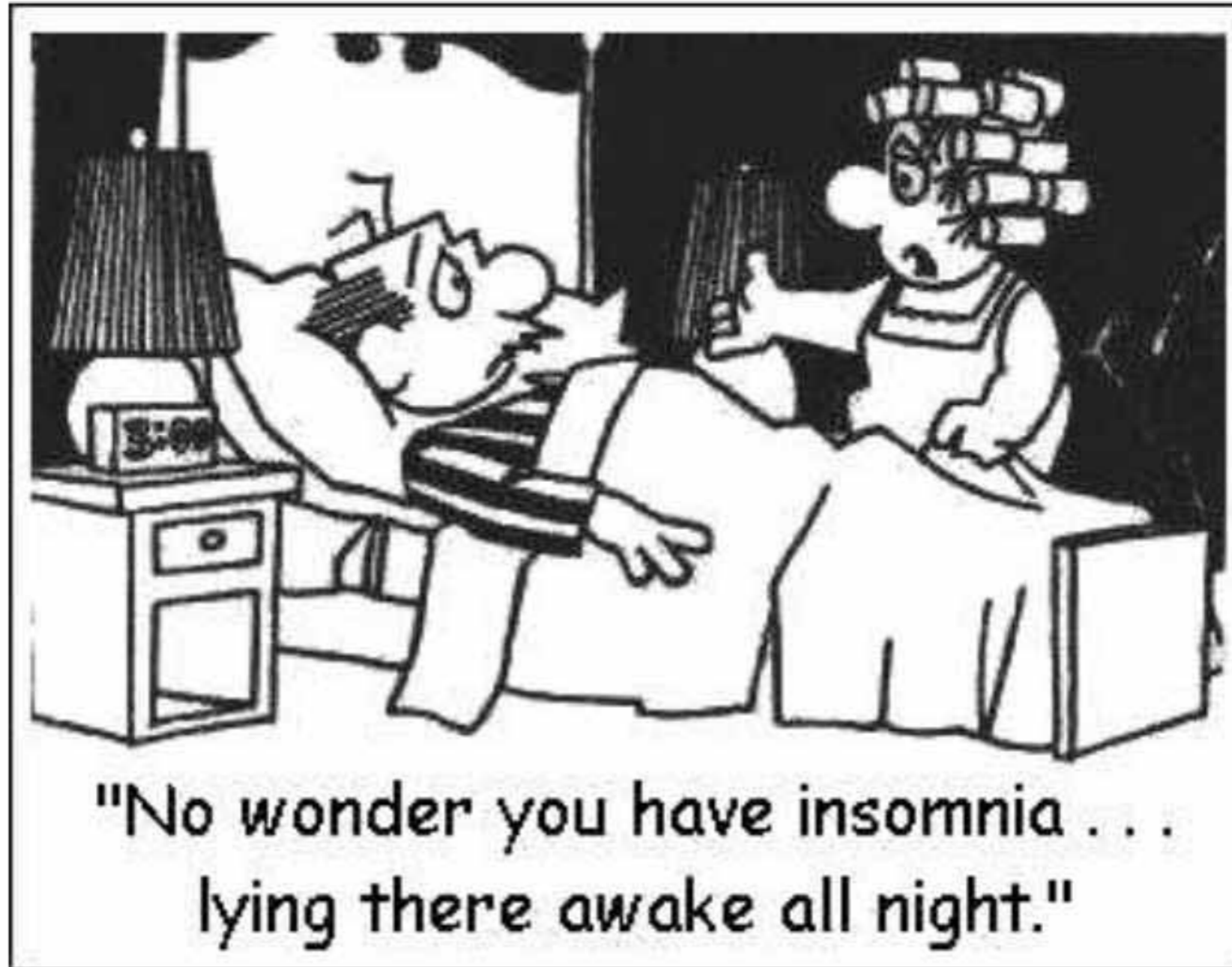
Caffeine and sugar junkies

Energy drinks



Caffeine and sugar junkies

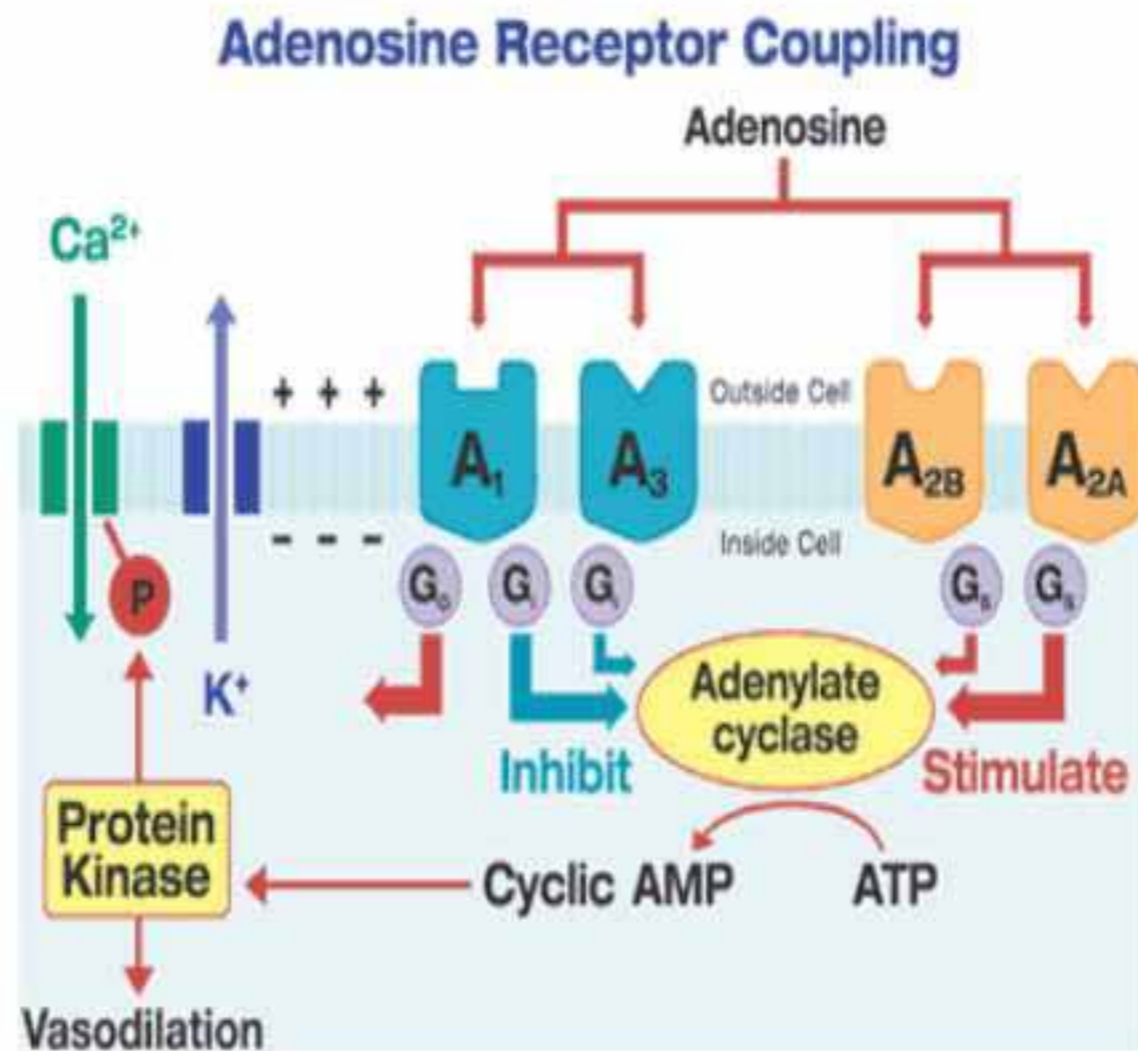
Caffeine disrupts sleep



Caffeine and sugar junkies

Caffeine disrupts sleep

Blocks ability of adenosine to act on its receptors



Sleep disorders

35 million Americans have chronic insomnia

65 million Americans have significant sleep disorders

25% of US citizens take drugs to aid sleep



[Sandman](#)
[A book in progress](#)

[Tips for Healthy Sleep](#)
click

[Newsletters](#)
[Snoozeletter & Forum](#)
click to subscribe

Since 1995 - Everything you wanted to know about sleep but were too tired to ask™

Sleep disorders

In your 50's and 60's you average 46 minutes less sleep than in your 20's

'Chastity is the torment of youth, insomnia of age, and at neither stage does it ever seem possible to get enough of what you want'

A Alvarez



Sleep disorders

Narcolepsy

WHAT IS NARCOLEPSY?



THIS ISN'T....



THIS IS!

Sleep disorders

Narcolepsy

Orexin deficiency caused by auto-immune disorder ?



Sleep disorders

Snoring

Relaxation of throat musculature

70 - 90 decibels

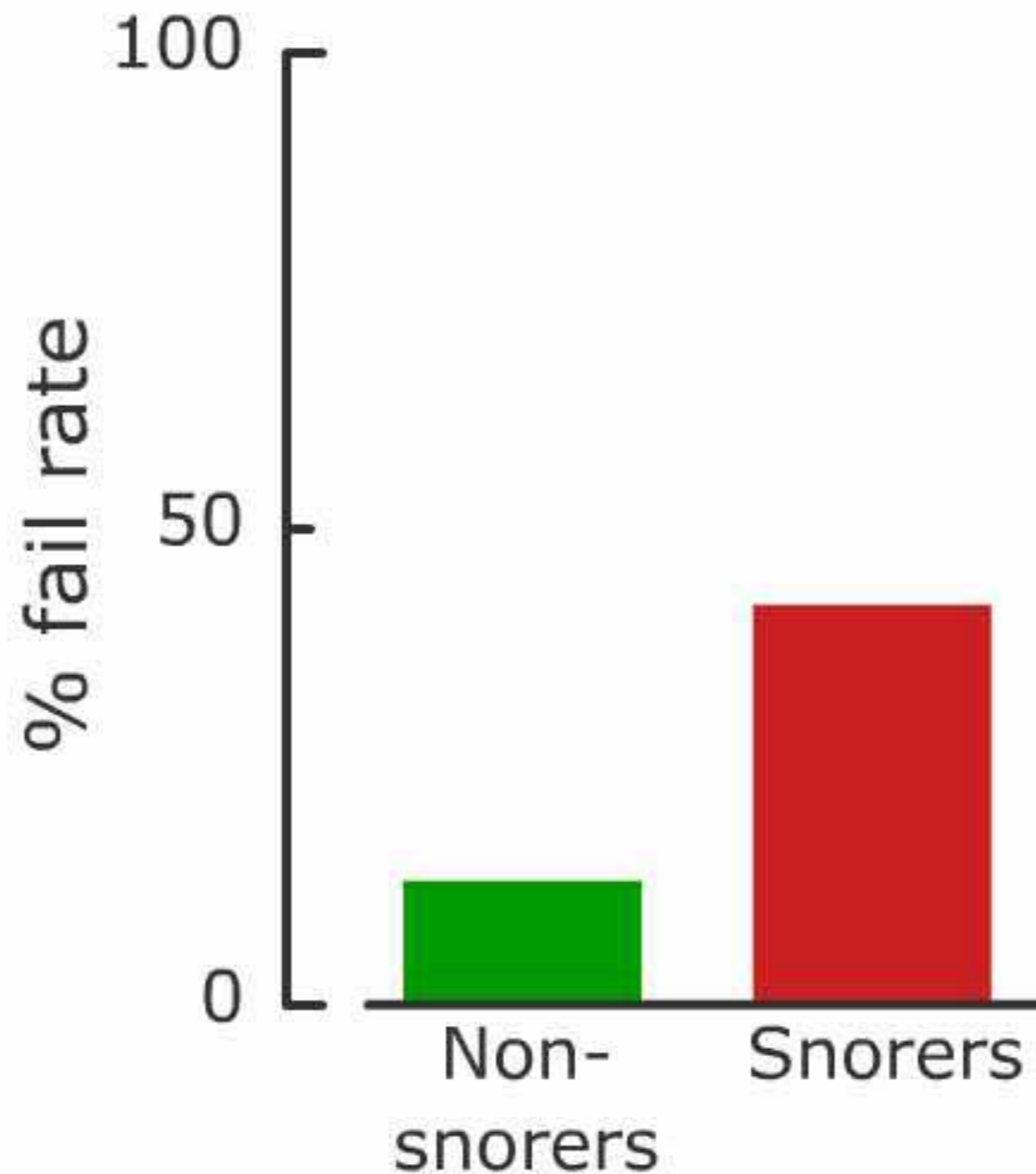
Main sufferers are:

Male, overweight and drink too much



Sleep disorders

Snoring affects examination performance in trainee doctors



Sleep disorders

Snoring - remedies ?

Nasal dilator strips



Sleep disorders

Snoring - remedies ?

Nasal dilator strips



Unusual workout remedy

Sleep disorders

Snoring - remedies ?

Nasal dilator strips



Unusual workout remedy

- press tongue against teeth for 2 minutes

Sleep disorders

Snoring - remedies ?

Nasal dilator strips



Unusual workout remedy

- press tongue against teeth for 2 minutes
- grasp pencil between teeth for 10 minutes

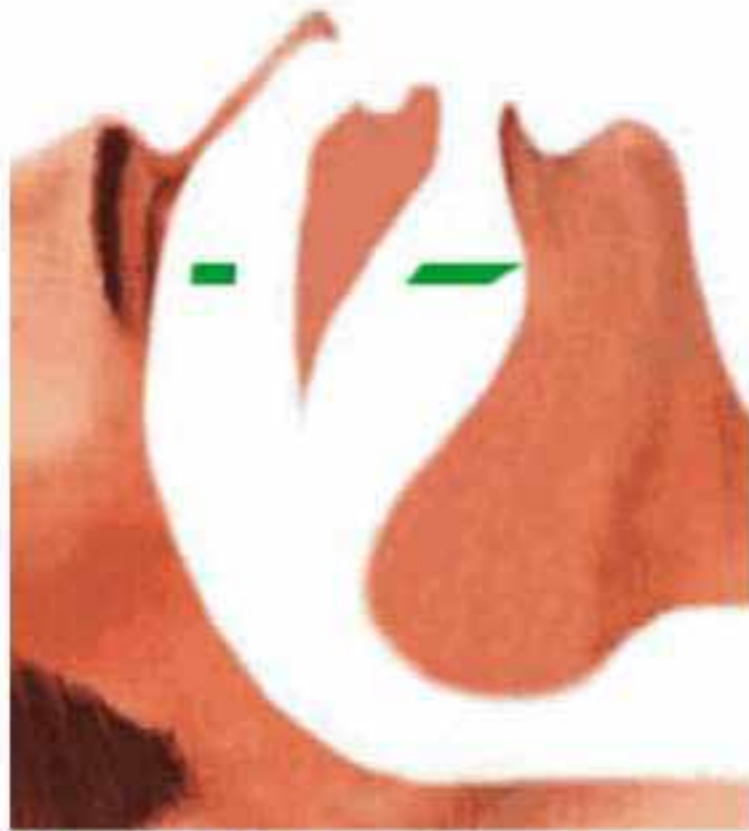
Sleep disorders

Sleep apnoea

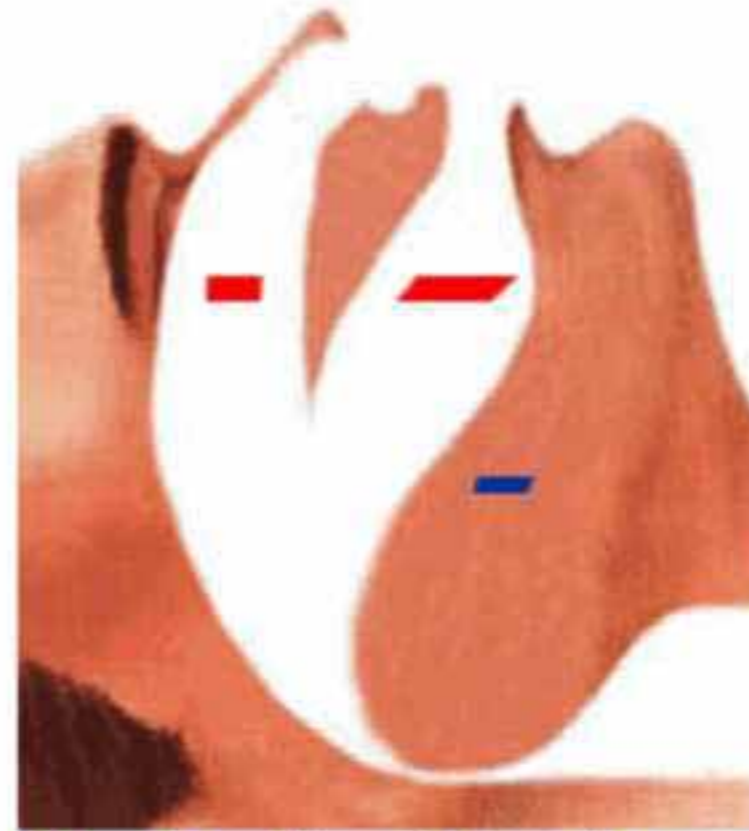
Suffered by 10% of middle-aged men

Sleep disorders

Airways totally blocked for up to 10 seconds



Normal Breathing
- Airway is open
- Air flows freely to lungs

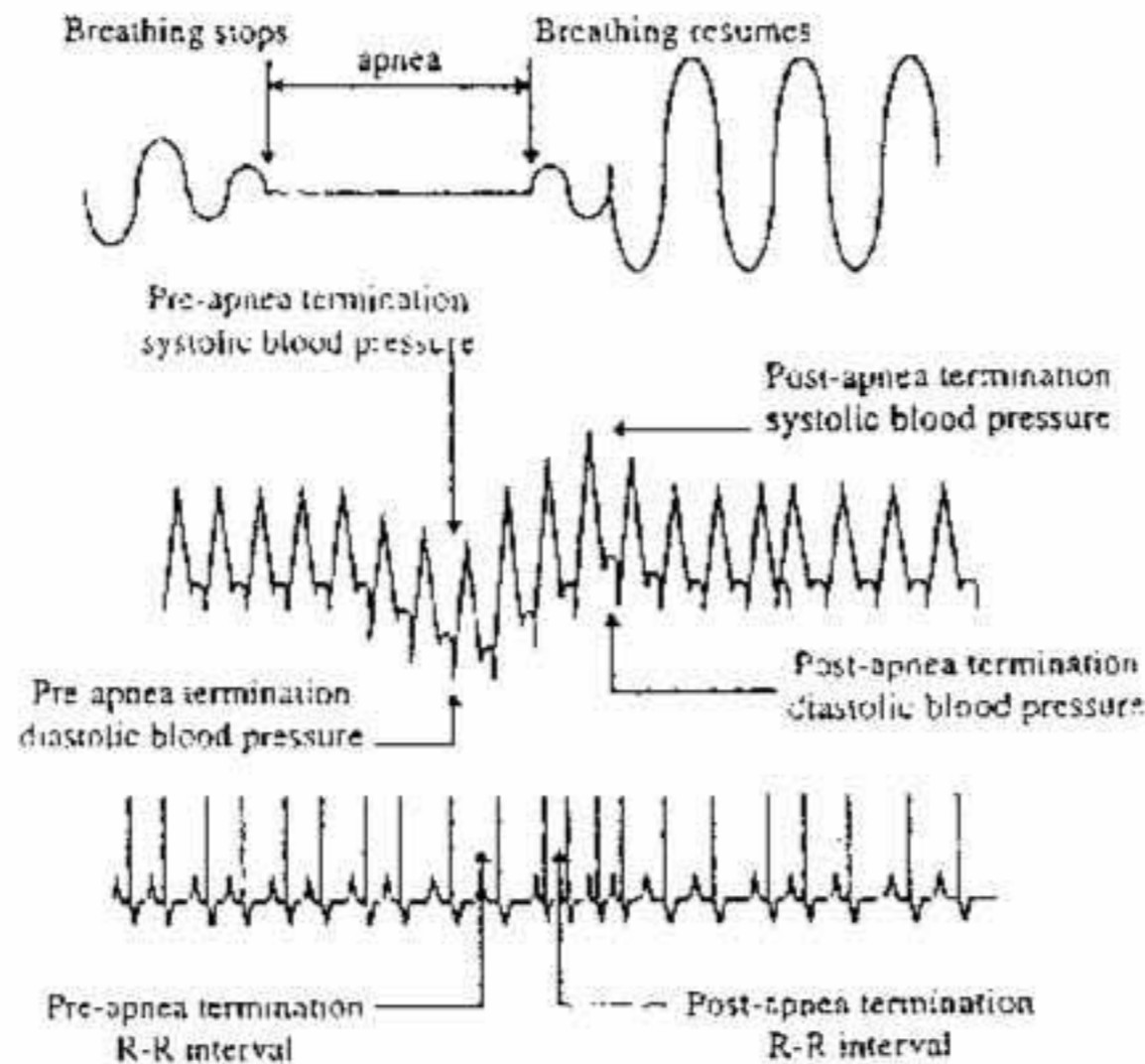


Obstructive Sleep Apnea
- Airway collapses
- Blocked air flow to lungs

Sleep disorders

Airways totally blocked for up to 10 seconds

Can happen over 100 times per night



Sleep disorders

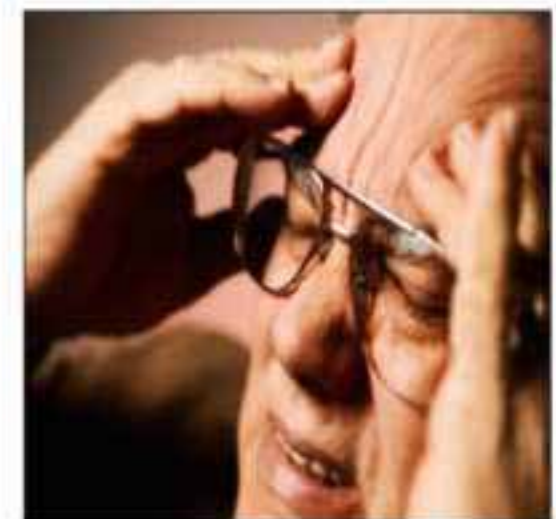
Difficult to diagnose:



Sleep disorders

Difficult to diagnose:

- heavy snorer
- waking up feeling shattered and depressed
- waking up with splitting headache



Sleep disorders

Difficult to diagnose:

- heavy snorer
- waking up feeling shattered and depressed
- waking up with splitting headache

(not associated with excessive alcohol)



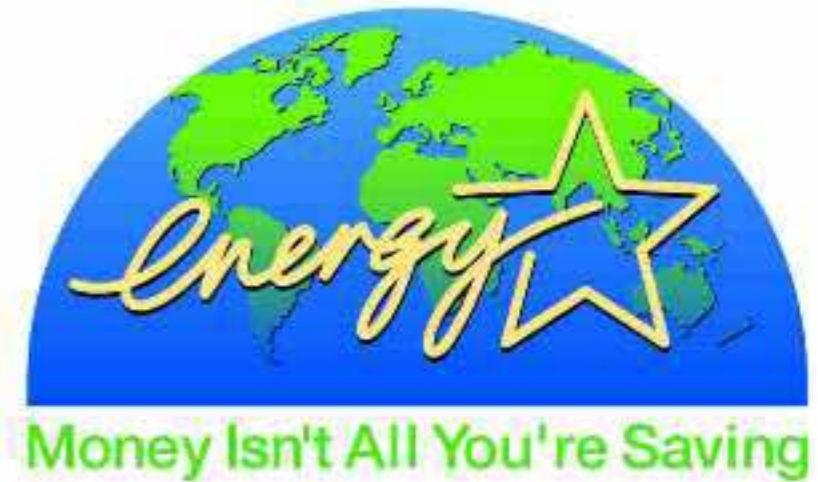
So why do we sleep and dream ?

Saving energy ?

Recharging the batteries ?

Re-setting the clocks ?

Putting out the trash ?



So why do we sleep and dream ?

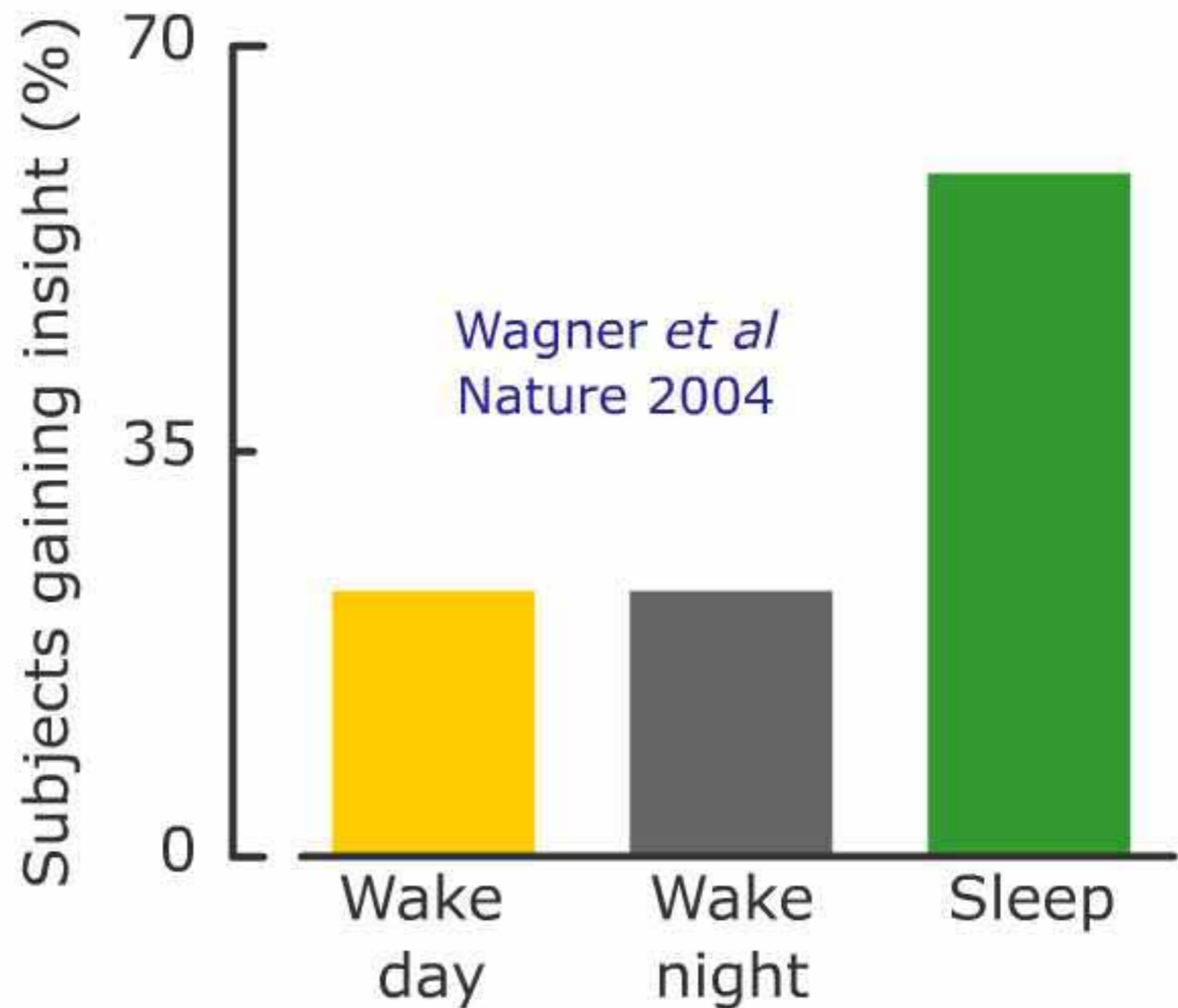
Consolidating memories ?



So why do we sleep and dream ?

Consolidating memories ?

Inspiring insight ?



A unified explanation ?

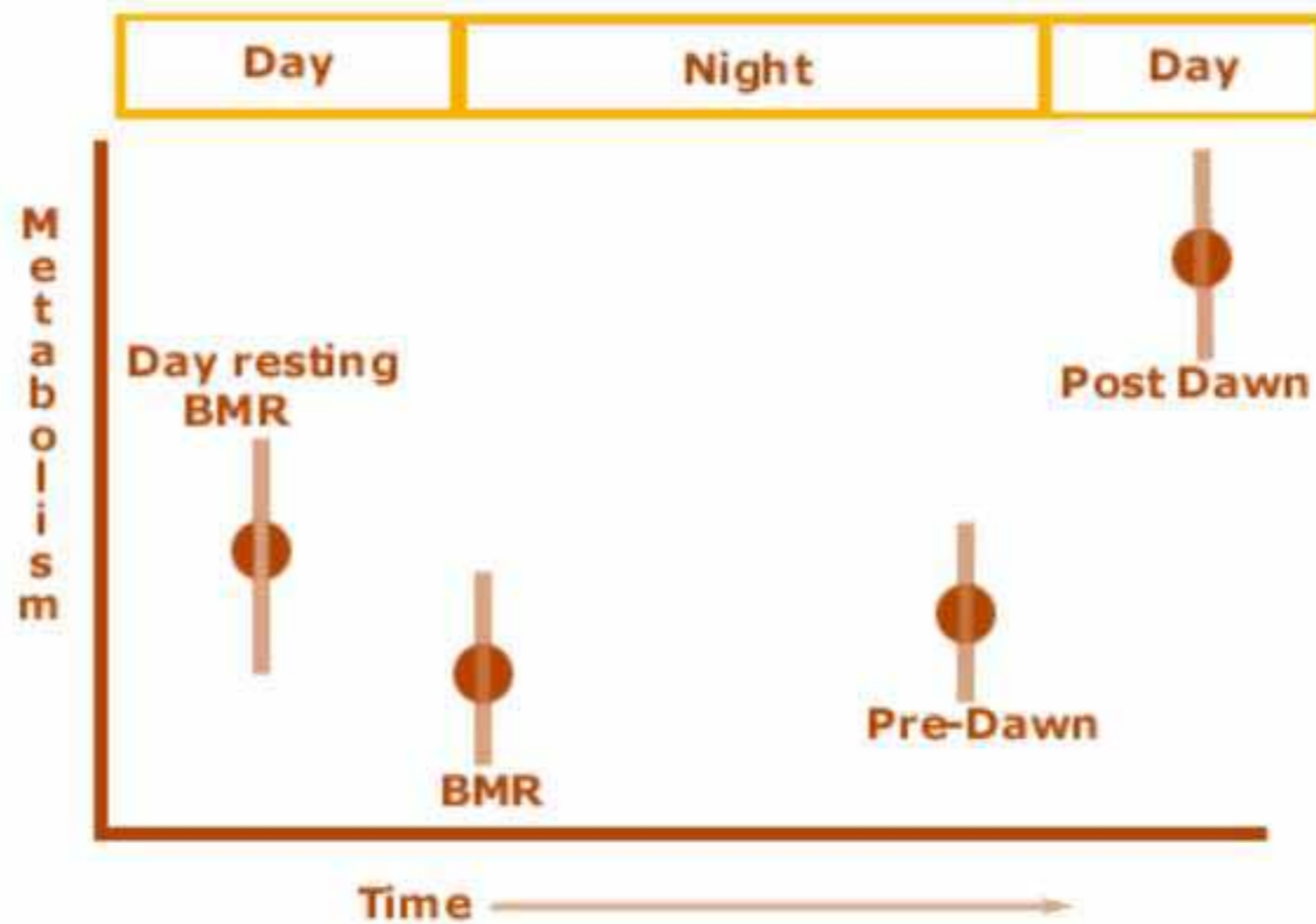
Why maintain a waking state ?



A unified explanation ?

Why maintain a waking state ?

Metabolic rate



A unified explanation ?

Why maintain a waking state ?

Metabolic rate

REM sleep

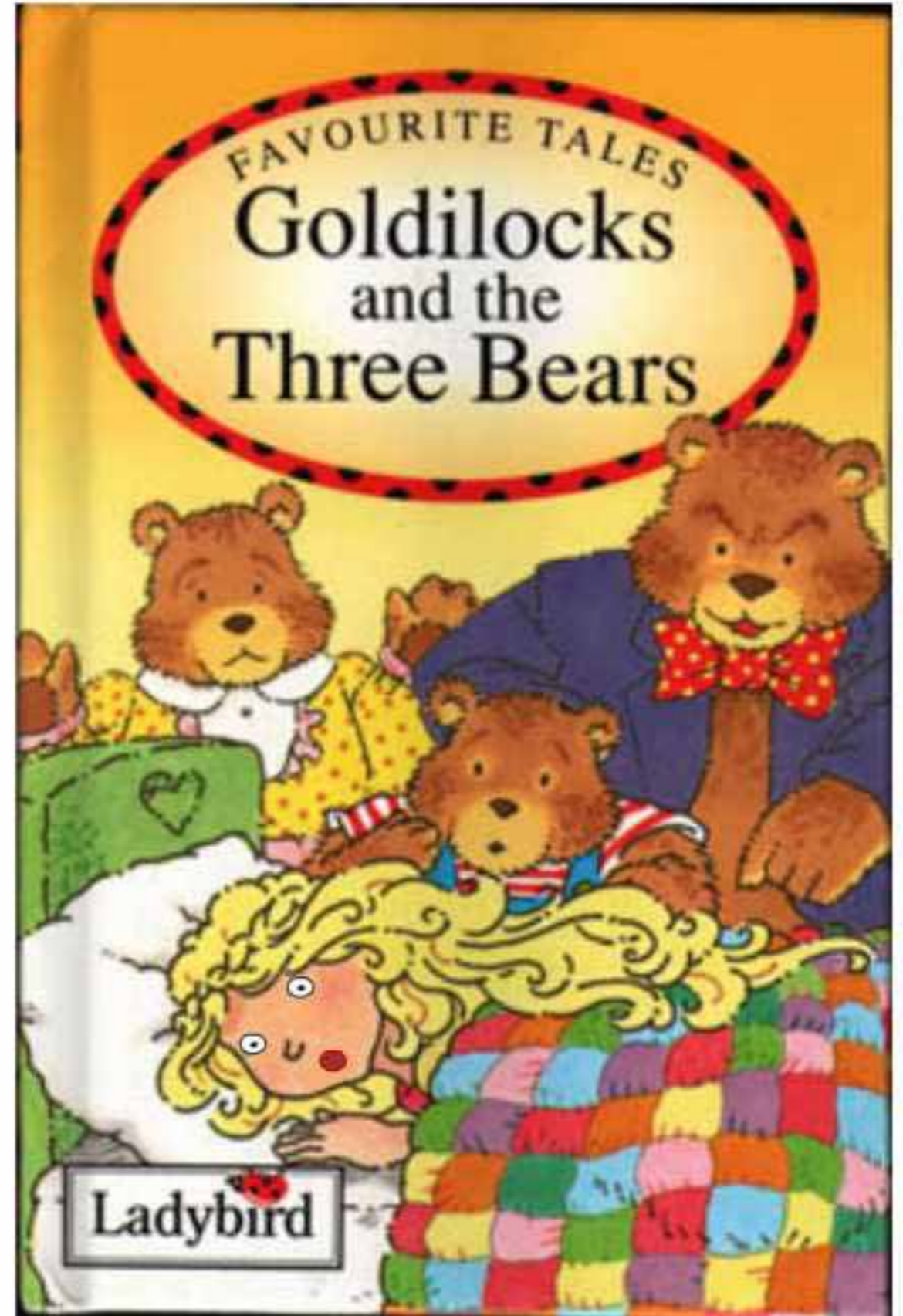


A unified explanation ?

Why maintain a waking state ?

Metabolic rate

REM sleep - ready to go ?



A unified explanation ?

Why maintain a waking state ?

Metabolic rate

REM sleep - ready to go ?

Sensory deprivation



A unified explanation ?

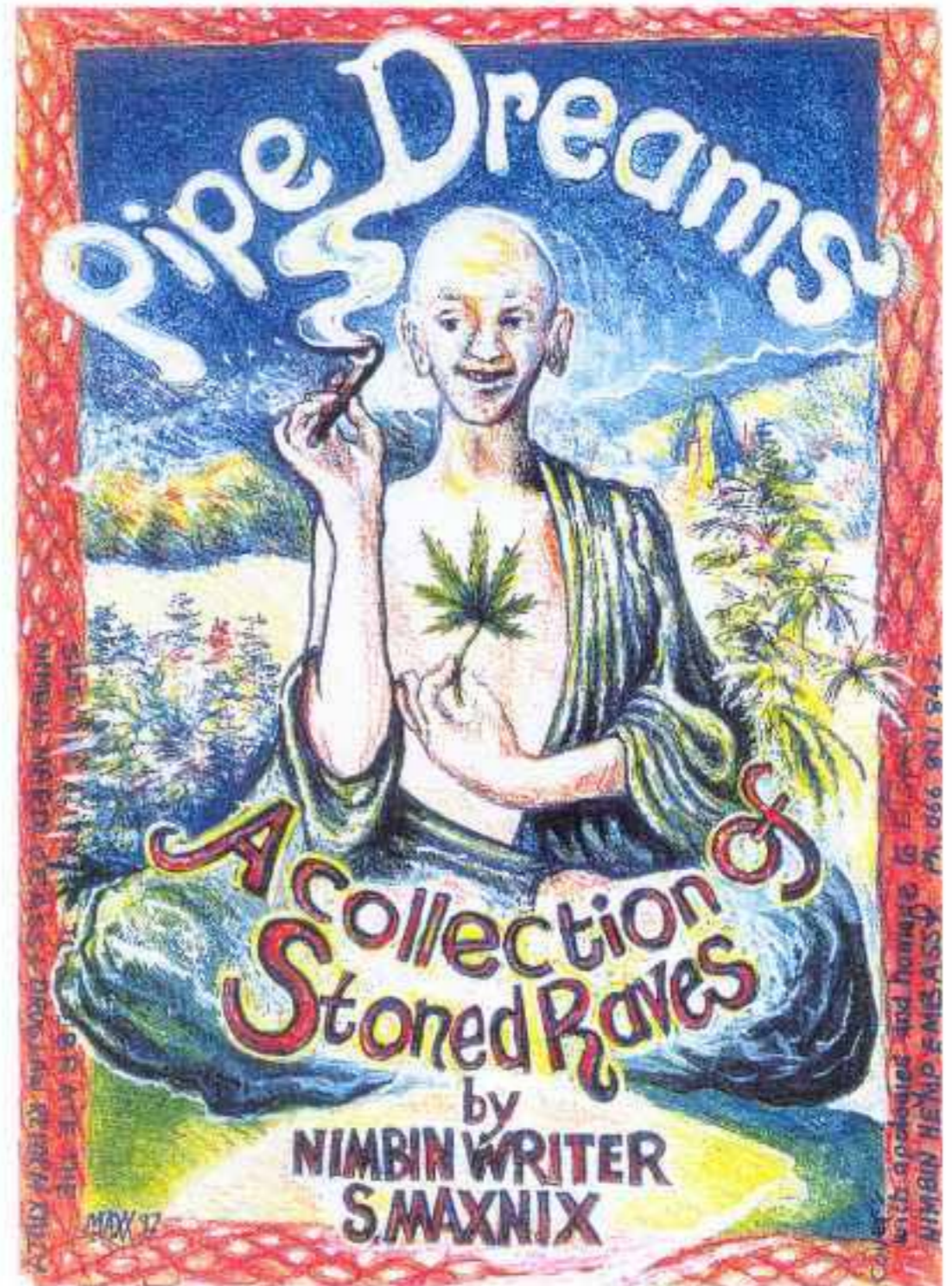
Why maintain a waking state ?

Metabolic rate

REM sleep - ready to go ?

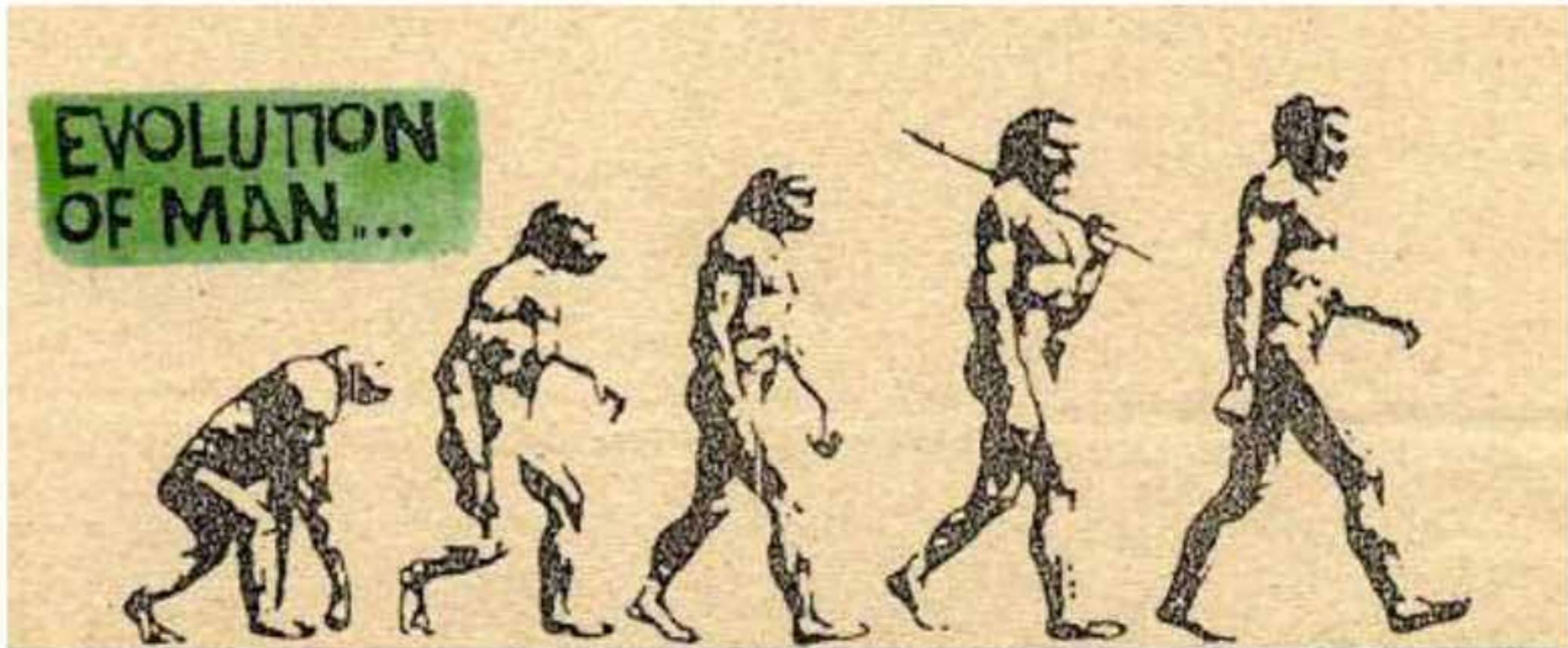
Sensory deprivation

Memory consolidation



Could we evolve to do without sleep ?

Yes - probably



Conclusions

Don't miss out on your sleep

Get horizontal when you want to sleep

Try to remember to enjoy your sleep and dreams....

....but don't read too much into them

Conclusions

Try an afternoon nap

Regulate your caffeine, sugar and alcohol intake

Don't miss out on sleep and drive

Don't disturb sleeping teenagers at the weekend !

Conclusions

Sleeping may help solve some of your problems

