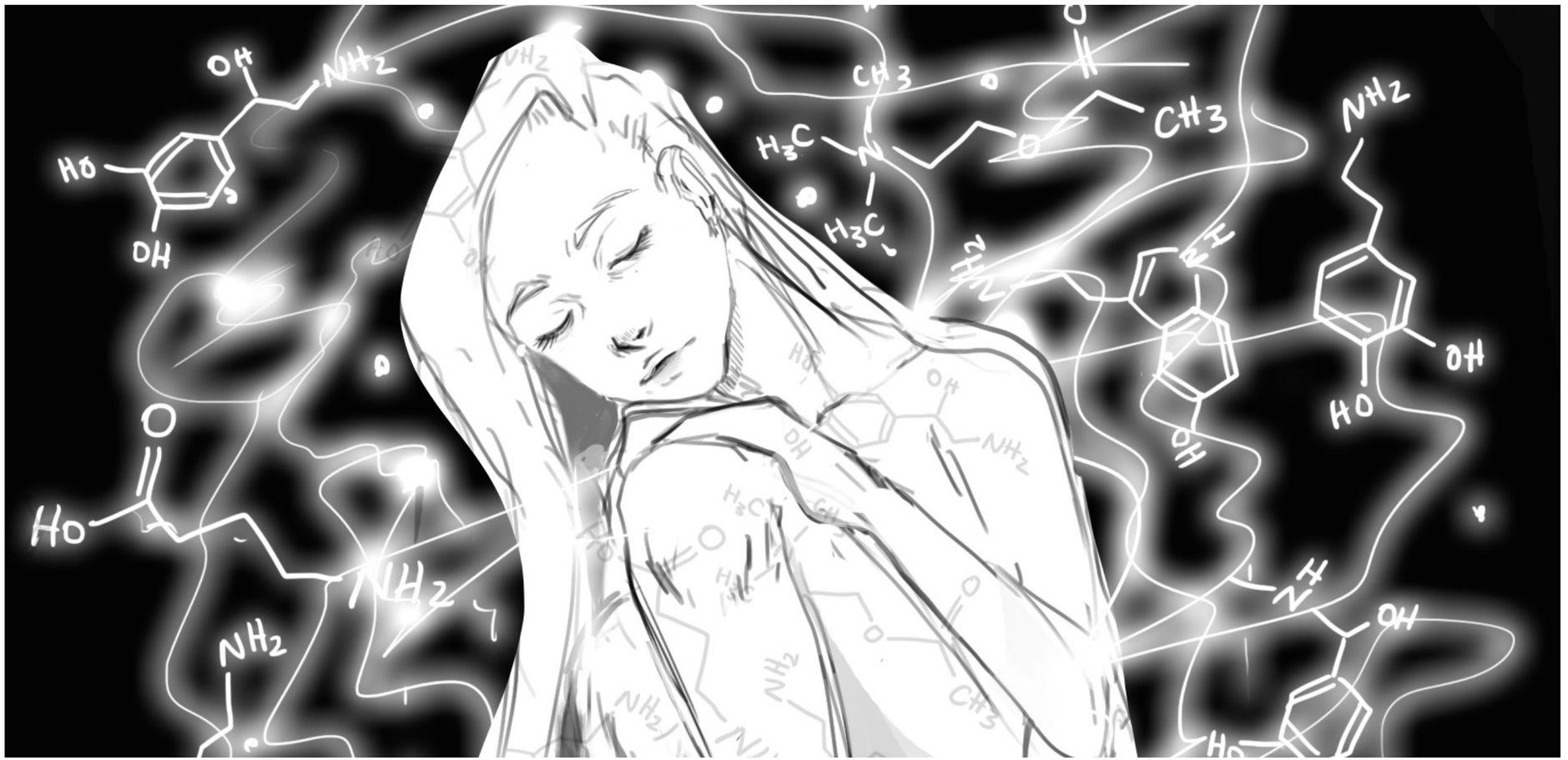
Why Do We Sleep?



steven j. barnes

- Compare recuperation with adaptation theories of sleep. Provide any relevant evidence.
- What have studies of sleep deprivation taught us about the function of sleep?
- Describe the default theory of REM sleep.

Learning Goals

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1. Recuperation (homeostatic) theories of sleep: Being awake disrupts your body's homeostasis; sleep acts to restore it. Sleep fixes the damage/ dysregulation that accumulates when we are awake.

2. Adaptation/circadian theories of sleep: Focus on when we sleep. In these theories: Sleep is the result of an internal timing mechanism--we are programmed to sleep at night (regardless of what happens to us during the day). We evolved to sleep at night because it protects us. Sleep keeps us out of trouble and conserves energy.

Why Do We Sleep?

Comparative Analysis of Sleep

1. The fact that many mammals and birds sleep suggests that it serves some important physiological function.

> "All mammals and birds sleep, and their sleep is much like ours—characterized by high-amplitude, low-frequency EEG waves punctuated by periods of low-amplitude, high-frequency waves...Even fish, reptiles,amphibians, and insects go through periods of inactivity and unresponsiveness that are similar to mammalian sleep..." (Pinel, 2007)

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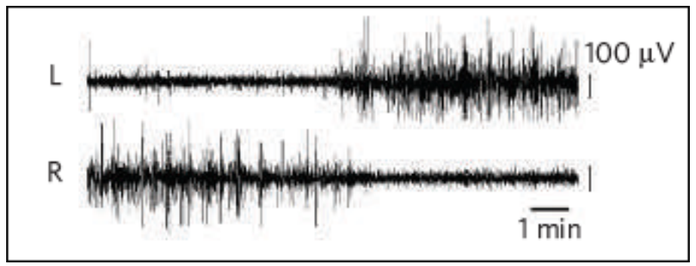

beluga sleep eeg; from Siegel, 2005

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Reality Check: Only about 60 of ~60,000 vertebrate species have been closely examined for sleep-like behaviour. Of those, some do not meet the criteria for 'sleep' at any time in their lives (e.g., harbor porpoise). And some go for long periods without any evidence of sleep (e.g., some neonatal marine mammals, migratory birds) or rebounds following such periods of sleeplessness.

Why Do We Sleep?

Comparative Analysis of Sleep

1. The fact that many mammals and birds sleep suggests that it serves some important physiological function.

2. The large between-species differences in sleep time suggests that although sleep may be essential for survival, it is not necessarily required in large quantities.

Mammalian species:	Hours per day:
Giant sloth	20
Cat, hamster	14
Mouse, rat	13
Rhesus monkey, chimpanzee	9
Human, rabbit, pig	8
Cow, goat, donkey	3
Horse	2

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Daily sleep time of a species does seem to be related to how vulnerable they are. For example, herbivores generally sleep less than omnivores, and omnivores generally sleep less than carnivores.

Why Do We Sleep?

Comparative Analysis of Sleep

Why Do We Sleep?

Circadian Sleep Cycles

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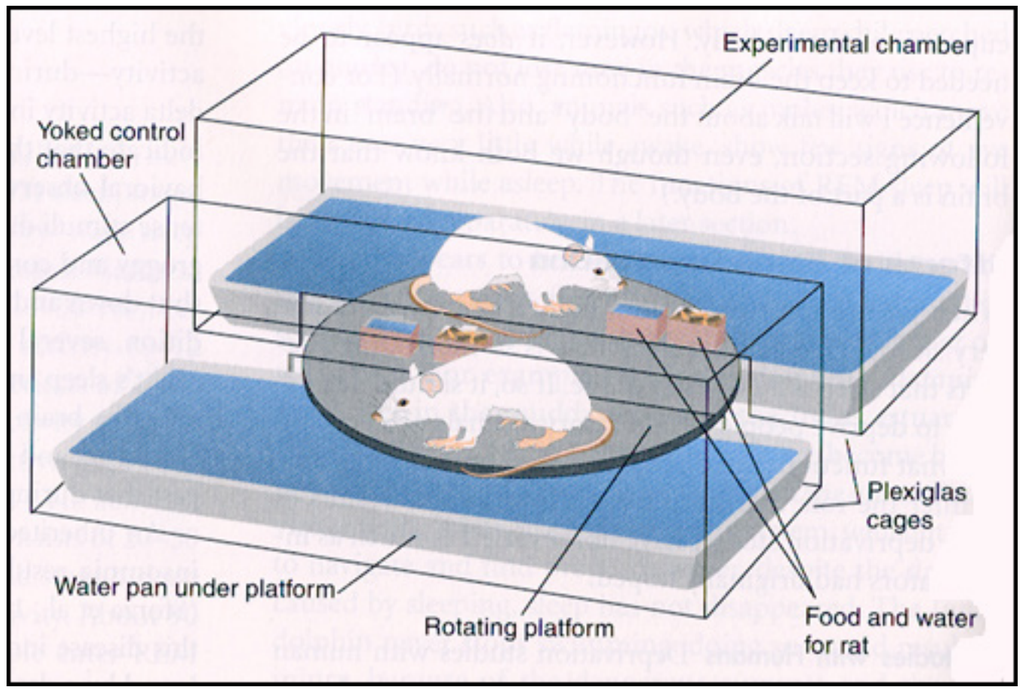
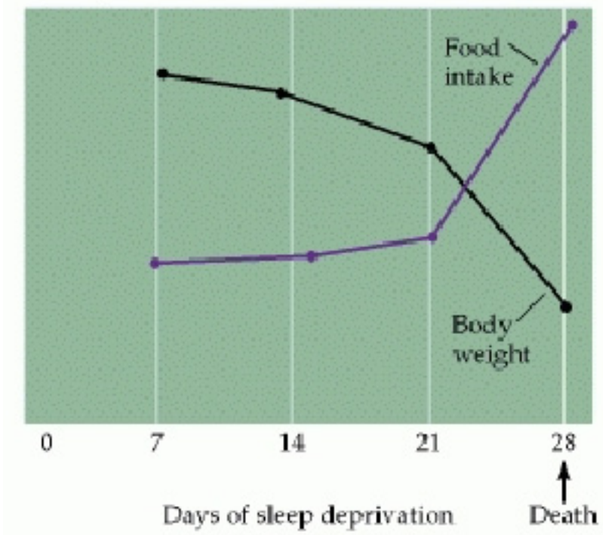
In the absence of all zeitgebers, we have free-running rhythms that last about 25 hours.

The fact that we have regular free-running regulation of sleep, provides support for the dominance of circadian factors over recuperative factors in the regulation of sleep.

Why Do We Sleep?

Sleep Deprivation



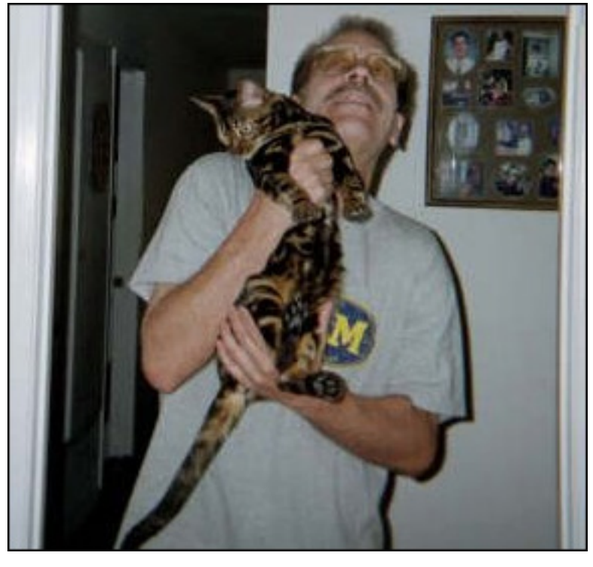


Why Do We Sleep?

Sleep Deprivation: Human Case Studies

Case Study 1: Randy Gardner

As part of a science fair project in 1965, a then 17-year-old Randy Gardner tried to break the previous world record of 260 hours of consecutive wakefulness. Randy did not sleep for 264 hours and 12 minutes. There have been mixed reports of the symptoms he experienced.



Why Do We Sleep?

Sleep Deprivation: Human Case Studies

Case Study 2: Tony Wright

In May of 2007, 42-year-old Tony Wright beat Randy Gardner's record. Tony didn't sleep for 266 hours.

There is a blog site that documented the entire experience.

Why Do We Sleep?

Sleep Deprivation: Human Experiments

Moderate amounts of sleep deprivation--3-4 hours in one night--have been found to have 3 consistent effects:

1. Subjects display an increase in sleepiness: They report feeling sleepier and fall asleep quickly if given the chance.
2. They display disturbances on written tests of mood.
3. They perform poorly on tasks that require sustained attention.

Why Do We Sleep?

Sleep Deprivation: Human Experiments

If you sleep deprive someone for 2-3 days, they start to experience microsleeps: brief periods of sleep (2-3 s) during which their eyelids droop and they become less responsive to external stimuli. These can occur even while they are standing.

There is also evidence of psychomotor and cognitive slowing, and deficits on tests of working memory and executive function (e.g., assimilating changing information, updating plans, innovative thinking; though there is disagreement about this sort of impairment--see below).

Other higher order cognitive functions can also be affected, but this is likely mediated by the deficits in sustaining wakefulness, alertness, attention, and response times.

Why Do We Sleep?

REM-Sleep Deprivation

Sleep researchers have specifically deprived people of REM sleep by waking them up each time a bout of REM sleep begins.

Why Do We Sleep?

REM-Sleep Deprivation

REM-sleep deprivation has two consistent effects:

1. With each successive night of REM deprivation, there is a greater tendency for the person to initiate REM (they have to be woken more and more frequently).

2. Following REM deprivation, a person will have a greater than normal amount of REM sleep during subsequent nights of sleep.

Why Do We Sleep?

REM-Sleep Deprivation

So numerous theories have been proposed for the function of REM sleep, for example:

(1) Those that say REM sleep is important for one's mental health.

(2) Those that say REM sleep is necessary for the processing of memories.

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REM-Sleep Deprivation

So numerous theories have been proposed for the function of REM sleep, for example:

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(2) Those that say REM sleep is necessary for the processing of memories.

These theories share one problem: Explaining why tricyclic antidepressant drugs are not debilitating. Tricyclics selectively block REM sleep. So patients taking these drugs in sufficient doses might not have any REM sleep for months.

Why Do We Sleep?

Default Theory of REM Sleep

According to this theory, it is difficult or dangerous to stay continuously in NREM sleep, so the brain periodically switches to one of the other states (e.g., REM):

1. REM is a break between bouts of NREM sleep.
2. REM maintains a certain level of alertness that would not be possible in continuous NREM (REM keeps you alert to external stimuli).
3. REM prepares us for wakefulness (hence the prominence of REM towards the end of a night's sleep).

Why Do We Sleep?

Sleep Deprivation Increases the Efficiency of Sleep

Important effect of sleep deprivation: Individuals who are sleep deprived become more "efficient" sleepers. They display more slow-wave sleep (SWS) and more intense SWS. Accordingly, many believe that SWS is the restorative factor.

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Sleep Deprivation Increases the Efficiency of Sleep

Important effect of sleep deprivation: Individuals who are sleep deprived become more "efficient" sleepers. They display more slow-wave sleep (SWS) and more intense SWS. Accordingly, many believe that SWS is the restorative factor.

1. Sleep regained following deprivation is primarily SWS.

2. Short sleepers get as much SWS as long sleepers.

3. People who reduce their sleep, get less stage 1/2 sleep, but their SWS stays about the same.

4. Waking people during SWS has major effects on sleepiness.

Why Do We Sleep?