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To sleep... ... perchance to dream

(Hamlet)

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falsifiable

To fall asleep is to enter a fascinating night-time world that has intrigued people for centuries. We all spend over a third of our life sleeping and yet few of us understand its fundamental characteristics. And nobody really knows what it is for!

Why do we sleep? Why do we sleep so much? What happens to us when we are asleep? How much sleep do we really need? Why do we feel compelled to do it on a regular basis but missing a few night's sleep does not seem to do us any lasting damage? Or does it? Start talking to anyone about sleep and these questions come tumbling out. For some people the question might well be, 'Why can't I get to sleep?'. The world of the insomniac is a tragic place to visit.

What is meant by *sleep*?

Sleep is a distinct state, as these two dictionary definitions show:

- A natural and periodic state of rest during which consciousness of the world is suspended. (Source: WordNet)
- A natural periodic state of rest for the mind and body, in which the eyes usually close and consciousness is completely or partially lost, so that there is a decrease in bodily movement and responsiveness to external stimuli. (Source: thefreedictionary.com)

So sleep is a very special state of consciousness, quite different from simply resting.

A scientific look at sleep

When scientists first used an electro-encephalograph or EEG machine, they were surprised to discover that our brain shows different forms of activity at different times during sleep. Electrodes are attached to the subject's scalp. These measure the electric potentials (voltages) on the surface of the scalp and display the activity of the brain in terms of 'brain waves' – see Box 1.

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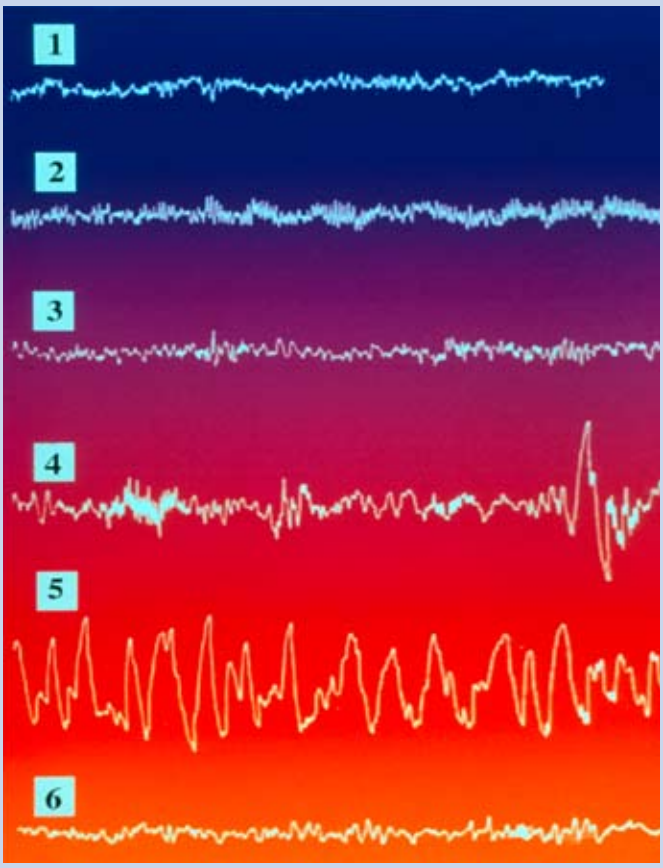
A subject undergoing EEG examination. Voltages detected by electrodes attached the skin of the head are recorded electronically.



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BOX 1
Understanding brain waves

Sleep is cyclic with the sleeper moving through specific stages each of which is characterised by a unique brain wave profile, see table.

Trace 1: When we are awake and alert, the brain exhibits high frequency, low amplitude waves called *beta* waves.

Trace 2: As we relax, these waves are replaced by slower frequency but higher amplitude *alpha* waves.

Trace 3: The transition into the first stage of sleep is marked by the appearance of yet slower waves called *theta* waves.

Traces 4 and 5: brain waves continue to slow down into stage two sleep and even more as we enter stage three when *delta* waves appear.

Trace 6: REM or paradoxical sleep.

Level of consciousness	Types of waves	Frequency (hertz)
Alert	beta	Over 13
Relaxed	alpha	8 to 13
Stage 1 sleep	theta	4 to 7
Stage 2 sleep	theta	1 to 3
Stage 3 sleep	20-50% delta	0.5 to 2
Stage 4 sleep	more than 50% delta	0.5 to 2
REM sleep	alpha and beta	

The REM paradox

There is a yet another remarkable stage of sleep, called REM (**R**apid **E**ye **M**ovement) sleep because of the rolling of the eyes inside their sockets. Adult humans spend 20-25% of their sleep time in this REM stage spread over 4 or 5 separate periods each night. When in REM sleep there is a paralysis of all the body's muscles and the senses barely respond to changes in the external environment.

The EEG also shows that this stage is unique, with a brain wave profile that resembles a very active brain, hence its other name, *paradoxical sleep*, because the EEG shows an active brain whilst the body appears very much asleep as shown by the fact that it is very hard to awaken someone in REM sleep.

Through the night

During a typical night's sleep we progress through these stages in a regular pattern. Initially we travel through stages 1, 2, 3, and 4 and then back up to 3 and 2 before we enter our first REM session, which is the shortest of the night. Off we go again back down to 3 and 4 and back up again to experience another REM. After these first two cycles stage 3 and 4 are not generally seen and we move from stage 2 to REM and back to 2 again until we eventually wake up when some aspect of the brain seems to be satiated.

Along with these brain wave changes there is a sequence of body changes: slowing down of heart and breathing rate and even changes in temperature.

What do we gain by sleeping?

There is an enormous variety sleep patterns in the animal kingdom. Some dolphin species allow half of the brain to sleep at a time. Others have many brief 'microsleeps' which add up to about 7 hours a day.

However, in some animals like the koala, sleep is used in a completely different way. They sleep for around 16 hours a day and for them it is a strategy to conserve energy because their diet of gum-tree leaves is low in nutrition.

A sleeping koala

There are many theories of sleep, and there are even more theories of dreaming.

Sleep is a highly-complex form of behaviour exhibited by nearly all higher animals. Since the sleeper is in a vulnerable state, one would imagine that it must be serving a vital function. What happens if people and other mammals are deprived of sleep?

The evidence from experimental studies is not straightforward. Experiments with rats and cats have shown that sleep deprivation is fatal but these animals suffered enormously stressful conditions in the attempt to keep them awake so they probably died from this rather than simply from a lack of sleep. Human deprivation studies, for obvious reasons, are not common – see Box 2.

Theories of sleep

It has proved difficult to devise a scientific theory of sleep. In the 1970s, Ian Oswald of Edinburgh University put forward the *restoration theory* of sleep. This suggests that sleep is essential for the physical restoration of the brain and the body. However, this still leaves us to explain why we need to be unconscious for this to happen.

The Meddis *ecological theory* of sleep suggests that it is a process that has evolved to adapt animals to their particular lifestyles. Herbivores need to eat continually and so sleep very little, while predators with protein rich diets can sleep a good deal more. However the complication is that it is possible to explain both long and short sleep requirements in the same way. A koala may need to conserve energy, because of a poor diet, so that it sleeps most of the time, whereas another herbivore might be assumed to hardly ever sleep because its diet is poor so that it needs to spend all its time eating! Such a theory is said to be **unfalsifiable**. Because there is no way to show that it is wrong, the theory cannot be tested and so it is **unscientific**. More theories needed!

Ann Skinner *teaches psychology.*

The scene at the Selby rail crash, the result of one driver's lack of sleep.

Credit York Post/Corbis

Box 2
Sleep deprivation and its effects

Two classic studies of the effects of going without sleep showed contrary outcomes.

In 1959, a disc jockey called Peter Tripp decided to engage in a "sleepathon" and stayed awake for eight days. By the end of this marathon effort he showed severely disturbing symptoms of delusions and hallucinations; so much so that the planned tests of his psychological functioning had to be abandoned.

However, in 1965 a 17 year old student, Randy Gardner, decided to challenge the Guinness Book of Records and achieved 264 hours and 12 minutes without sleep and, although he had some difficulty in performing some tasks he did not show the disturbances experienced by Peter Tripp. After only 14 hours and 40 minutes of sleep he appeared completely recovered.

Most people accept that going without sleep can be harmful, and the devastating rail crash (February 2001) near Selby in Yorkshire demonstrates the folly of thinking we can do without sleep. Gary Hart dozed off at the wheel of his Land Rover, plunging off the M62 on to railway tracks and causing a collision between a GNER passenger express and a coal train. 10 died and over 70 others were injured. The jury rejected Hart's claims that he needed little sleep and was used to staying up all night. Jim Horne, a sleep researcher from Loughborough University, said, "Sleep doesn't come spontaneously from nowhere. You can't be driving along alert one minute and falling asleep the next. There's always adequate time to realise how sleepy you are." Hart was convicted on ten counts of causing death by dangerous driving and sentenced to 5 years.