The Guardian

Sleep: how much do we really need?

The optimum amount of sleep is supposed to be eight hours a night. Why is shuteye so important – and what happens if we don't get enough?

by Science correspondent

Mon 8 Oct 2018 06.00 BST

Why do we sleep?

"The only known function of sleep is to cure sleepiness," the Harvard sleep scientist Dr J Allan Hobson once joked. This isn't quite true, but the questions of why we spend about a third of our lives asleep and what goes on in our head during this time are far from being solved.

One big mystery is why sleep emerged as an evolutionary strategy. It must confer powerful benefits to balance out the substantial risks, such as being eaten or missing out on food while lying dormant. The emerging picture from research is that sleep is not a luxury but essential to both physical and mental health. But the complex and diverse functions of sleep are only just starting to be uncovered.

What's going on in our brains while we sleep?

The brain doesn't just switch off. It generates two main types of sleep: slow-wave sleep (deep sleep) – SWS – and rapid eye movement (dreaming).

About 80% of our sleeping is of the SWS variety, which is characterised by slow brain waves, relaxed muscles and slow, deep breathing. There is strong evidence that deep sleep is important for the consolidation of memories, with recent experiences being transferred to long-term storage. This doesn't happen indiscriminately though – a clearout of the less relevant experiences of the preceding day also appears to take place. A study published last year revealed that the connections between neurons, known as synapses, shrink during sleep, resulting in the weakest connections being pruned away and those experiences forgotten.

Dreaming accounts for the other 20% of our sleeping time and the length of dreams can vary from a few seconds to closer to an hour. Dreams tend to last longer as the night progresses and most are quickly or immediately forgotten. During REM sleep, the brain is highly active, while the body's muscles are paralysed and heart rate increases and breathing can become erratic. Dreaming is also thought to play some role in learning and memory – after new experiences we tend to dream more. But it doesn't seem crucial either: doctors found that one 33-year old man who had little or no REM sleep due to a shrapnel injury in his brainstem had no significant memory problems.

How much sleep is enough?

Eight hours is often quoted, but the optimum sleeping time varies between people and at different times of life. In a comprehensive review, in which 18 experts sifted through 320 existing research articles, the US National Sleep Foundation concluded that the ideal amount to sleep is seven to nine hours for adults, and eight to 10 hours for teenagers. Younger children require much more, with newborn babies needing up to 17 hours each day (not always aligned with the parental sleep cycle).

However, the experts did not consider quality of sleep or how much was SWS v REM. Some people may survive on less sleep because they sleep well, but below seven hours there was compelling evidence for negative impacts on health. According to experts, too much sleep is also bad, but few people appear to be afflicted by this problem. In the UK the average sleep time is 6.8 hours.

What about shift work – does it matter when you sleep?

In the 1930s, an American scientist Nathaniel Kleitman spent 32 days 42m below ground level in Mammoth Cave, Kentucky. The aim was to investigate the human body clock. Living in complete isolation, with no external cues of night and day, he adopted a 28-hour day. Despite sticking rigidly to a schedule of mealtimes, delivered in a bucket down a shaft, and bedtime, Kleitman failed to adapt and continued to feel awake only when his assigned "daytime" happened to coincide roughly with daytime in the outside world.

His body temperature also continued to follow a cycle of close to 24 hours. Many shift workers - particularly those working irregular shifts - face similar problems. In recent years this issue has been taken more seriously, with professional sports teams taking on consultants about schedules for training and travel abroad. The US navy has altered its shift system to align it with the 24-hour clock, rather than the 18-hour day used in the old British system.

Why are we stuck on this 24-hour cycle?

Over millions of years of evolution, life has become deeply synchronised with the day-night cycle as our planet rotates. So-called circadian rhythms are evident in almost every life-form and are so firmly imprinted on our biological machinery that they continue even in the absence of any external input. Plants kept in a dark cupboard at a stable temperature open and close their leaves as though they can sense the sun without seeing it.

In the 1970s, scientists uncovered a crucial piece of machinery for this internal molecular timekeeping. In experiments using fruit flies they found a gene, later given the name "period", whose activity appeared to reliably rise and fall on a 24-hour cycle. Scientists, two of whom received Nobel prizes last year, later showed that the period gene worked by releasing a protein that built up in cells overnight, before being broken down in the daytime.

Later, humans were shown to have the same gene, expressed in a tiny brain area called the suprachiasmatic nucleus (SCN). This serves as a conduit between the eye's retina and the brain's pineal gland, which pumps out the sleep hormone melatonin. So when it gets dark, we get sleepy.

So is it just our brain that is affected?

The SCN clock is our body's master timekeeper, but in the past decade, scientists have discovered clock genes are active in almost every cell type in the body, and the activity of

roughly half our genes appear to be under circadian control.

The activity of blood, liver, kidney and lung cells in a petri dish all rise and fall on a roughly 24-hour cycle, and virtually everything in our body - from the secretion of hormones to the preparation of digestive enzymes in the gut, from changes in blood pressure to body temperature - is influenced in major ways by what time of day these things are normally needed.

Just how the ticking of each neuron is linked to the more complex brainwave rhythms that emerge in our brain during sleep is not yet clear, but scientists are investigating. When brain cells are grown in a dish in the lab they begin to self-organise and, somewhat unnervingly, start to show patterns of activity similar to those seen during sleep.

Did we sleep more soundly in the past?

Poor sleep is often seen as a modern problem, a blight of sedentary lifestyles and being glued to smartphones late into the night. However, research into the sleep patterns of modern-day hunter gatherers suggests this may paint an overly romantic view of the past. One study, of the Hadza people in northern Tanzania, found frequent night-time waking and widely differing sleep schedules between individuals. Over a three-week period, there were only 18 minutes when all 33 tribe members were asleep simultaneously. The scientists behind the work concluded that fitful sleep could be an ancient survival mechanism designed to guard against nocturnal threats.

The main difference appeared to be that tribe members were unburdened by paranoia and anxiety about sleep problems, which area common cause of concern in western countries.

What happens when you don't get enough sleep?

In extreme cases, sleep deprivation can be fatal. Rats that are completely deprived of sleep die within two or three weeks. This experiment hasn't been repeated in humans - obviously - but even a day or two of sleep deprivation can cause otherwise healthy people to suffer hallucinations and physical symptoms. After a poor night's sleep, cognitive abilities take an immediate hit. Concentration and memory are noticeably affected and people are more likely to be impulsive and favour instant gratification over waiting for a better outcome. We are also worse people when we're tired - one study found that sleep deprived people are more likely to cheat and lie.

What about physical health?

Cumulative lack of sleep can have long-term health consequences, and links are seen with obesity, diabetes, heart disease and dementia. Last year, a review of 28 existing studies found that permanent night-shift workers were 29% more likely to develop obesity or become overweight than rotating shift workers. Findings based on more than 2 million individuals found that working night shifts raised the risk of a heart attack or stroke by 41%.

The reasons for some of these associations are complex and hard to separate from other lifestyle factors. The studies mentioned above attempted to filter out socioeconomic factors, for instance, but factors like stress and social isolation can be harder to capture. That said, there is growing evidence for a direct biological influence. Sleep deprivation has been shown to alter the body's basic metabolism and the balance between fat and muscle mass.

Insomnia has long been known as a common symptom of dementia, but some scientists also believe poor sleep could play a role in causing Alzheimer's. Research has shown that the brain "cleanses" itself of beta-amyloid proteins linked to Alzheimer's during sleep and that sleep deprivation causes the levels of these toxins to rise.

Do all animals sleep?

The answer partly depends on what counts as sleep. Most scientists seem to go with the definition of (a) being immobile and (b) being significantly less responsive than when awake. Based on these criteria, there have been some candidates for sleepless species, but none has been conclusively shown to be true. The bullfrog was an early contender - a 1967 study found the frogs reacted similarly when given electric shocks in the daytime and middle of the night. But doubt have since been cast on this finding. There are animals that require little sleep: the little black bat is thought to sleep for 19 hours each day; adult giraffes rarely sleep for more than five minutes at a time. And sleep is not the same for all animals. Dolphins have the ability to put only half their brains to sleep at a time, known as unihemispheric sleep. Migratory birds are thought to sleep-fly and sharks sleep-swim.

Reading list

The House of Sleep. Jonathan Coe

Why We Sleep, Matthew Walker

Overcoming Insomnia and Sleep problems, Colin Espie

Sleepfaring: A Journey Through the Science of Sleep, Jim Horne

Sleepyhead Henry Nicholls

Topics

- The briefing
- Health & wellbeing