SLEEP DEPRIVATION
AND
EXPEDITION ADVENTURE RACING

AR competitors have varying opinions on when, where and for how long their team should sleep in a 24 hour period. Events such as XPD involve biking, hiking, paddling and navigating more than 800kms in some wild and remote parts of Australia. Teams have up to 9 ½ days to complete the course and they must decide for themselves when to sleep and for how long. On occasions though, the course, cut-off points and dark zones may not lend themselves to allow a team to sleep at all in a 24 hour period if they wish to continue without restrictions or penalties.

In the four XPD events that I have competed in I have heard of many sleep strategies and the theories behind them. After XPD 04 (Broken Hill) I decided to research this area to get a better understanding of the physiological affects of sleep deprivation.

Some key points found were:

- Important chemical processes take place only when we are sleeping and issues such as impaired glucose tolerance may occur with sleep deprivation.
- Lack of sleep can have significant effects on the immune system. For example my white blood cell count is always down after an XPD race and therefore I must give my body time to recover after the event.
- Brain function is significantly impaired with lack of sleep. Therefore your ability of make important decisions such as navigational decisions may become difficult. Your ability to recognize potentially dangerous situations with respect to the team's condition and environmental conditions may also be significantly reduced.
- Your ability to deal with stressful or emotional situations is reduced and may lead to physical or verbal conflict.
- Physical performance is significantly reduced with sleep deprivation. Not only are fatigue and exhaustion issues, you may be performing with the same level of impairment as a person with a blood alcohol level of 0.05 or higher.
- A person can die from long-term sleep deprivation before a person on a hunger strike.
- A complete sleep cycle, made up of 5 stages, takes an average of 90 to 110 minutes. It is important that the body is allowed to complete all 5 stages without disruption.
- Coming out of a sleep cycle to sunlight can help to maintain your circadian rhythm.




Our team strategy for sleeping during XPD was as follows:

- If were going to sleep we would make it a quality sleep. We did not consider shivering under a “chip-packet” style space blanket for an hour checking your watch every 5 minutes to see if the hour was up, as quality sleep. We made sure we were warm and comfortable and set two alarms to wake the team up.
- We would try to sleep for periods that would allow a full sleep cycle to be completed. For example 3 – 4 hours. We appreciated that it was important physiologically to let the body complete chemical processes as well as allowing the brain to “download & reboot”.
- We worked on coordinating the time we would wake up with the sun rising. This also meant that we would stop and sleep when we would be feeling the most tied, fatigued, lethargic, and struggling to make accurate and timely decisions. This helped reduce the potential for injury and navigational errors. We know of competitors who have fallen asleep while biking and ‘stacked’ it; a competitor who was knocked unconscious after falling to the ground after they fell asleep walking – their team members kept walking unaware that they were missing.
- There were times when this strategy of 3 – 4 hours sleep in every 24 period was not an available option. These were when we had to make a cut-off time such as dark zones (Tasmania and Whitsunday). In these cases we just had to keep moving and took a couple of powernaps (15 minutes of closed eye time) to get some down-time.
- We constantly monitored our team members level of energy, hydration and consciousness through regular (every 40 – 60 minutes) questioning and each person giving a rating of how they were feeling out of 10. Based on the answers, or some times lack of answers, the team stopped, refueled and power-napped for 5 – 15 minutes.

Important Note: Our team strategy will not get you across the line first, second or third. It should hopefully get you across the line in one piece and with fewer errors. If you are looking to finish in 5 – 5 &1/2 days for a podium spot, start planning to sleep no more than a total of 8 hours including the compulsory mid-camp 6 hour stop.

If you are interested in reading in more detail about the effects and dangers of Sleep Deprivation, please feel free to read extracts from articles and papers on this subject matter below:

The Causes, Effects and Dangers of Sleep Deprivation

Sleep deprivation is a common condition that afflicts 47 million American adults, or almost a quarter of the adult population. Symptoms can interfere with memory, energy levels, mental abilities, and emotional mood. A study conducted by the University of Chicago Medical Center in 1999 indicates that the condition drastically affects the body's ability to metabolize glucose, leading to symptoms that mimic early-stage diabetes.

Symptoms

Exhaustion, fatigue and lack of physical energy are common sleep deprivation symptoms. Exhaustion and fatigue affect our emotional moods, causing pessimism, sadness, stress and anger. The National Sleep Foundation (NSF) has suggested that social problems such as road rage may be caused, in part, by a national epidemic of sleepiness.

The brain's frontal cortex relies on sleep to function effectively. Insufficient rest adversely affects the frontal cortex's ability to control speech, access memory, and solve problems. The effect on physical energy is also startling: otherwise healthy people quickly show symptoms of age and early diabetes as glucose metabolism falls by up to forty percent. These physical reactions disappear when the test subject is allowed to rest properly. Driving and other activities can become dangerous without sufficient rest.

The Dangers of Long Term Sleep Loss

Everyone has the occasional sleepless night. However, long-term sleep deprivation studies suggest that chronic insomnia increases the risk of a number of health problems, and heightens the likelihood of accidents.

Driver Fatigue

The fewer hours of rest you get, the greater your chances are of being the cause of a car accident. Young adults, parents of small children, and shift workers are among the highest risk groups for driver fatigue. You stand the highest chance of falling asleep at the wheel on long highways while traveling at high speeds.

Research studies have concluded that driving while sleepy is as detrimental as driving drunk. According to researchers in Australia and New Zealand, people who went seventeen to nineteen hours without sleep operated their vehicles worse than people with blood alcohol levels of greater than 0.05 percent—the legal limit in most western European countries. Most of the US has a legal limit of 0.1 percent, with a few states at 0.08 percent.

Impaired Glucose Tolerance

Sleep deprivation studies at the University of Chicago discovered that sleeping shortages quickly alter the body's ability to regulate glucose and produce insulin, mimicking the symptoms of impaired glucose tolerance. After a week of sleep deprivation, otherwise healthy test subjects took forty percent longer than normal to regulate blood sugar levels. Both insulin production and the body's response to insulin fell to thirty percent below normal.

Although adequate rest restored the test subjects' scores to normal levels, the test suggests that impaired glucose tolerance as a result of sleep loss could eventually lead to diabetes, obesity and hypertension.

Effects of Sleep Deprivation
http://en.wikipedia.org/wiki/#_note-SleepDep

Lack of sleep may result in

- Irritability
- Blurred vision
- Slurred speech
- Memory lapses / memory loss
- General confusion
- Hallucinations
- Hand tremors
- Hernia
- Headache
- Color blindness
- Fainting
- Nausea
- Psychosis
- Clinical depression
- Nystagmus
- Pale skin tone (looking pasty)
- Decreased mental activity
- Decreased concentration
- Decreased ability for the immune system to fight off sickness
- Weight gain
- Increased blood pressure
- Aching muscles
- Impatience
- Slowed reaction time
- ADHD like symptoms
- Yawning
- Daytime Naps
- Hypertension/Hyperactivity
- Dizziness
- Death

Impairment of ability

According to a 2000 study published in the British scientific journal, researchers in Australia and New Zealand reported that sleep deprivation can have some of the same hazardous effects as being drunk. Getting less than 6 hours a night can affect coordination, judgment and reaction time. People who drove after being awake for 17–19 hours performed worse than those with a blood alcohol level of .05 percent, which is the legal limit for drunk driving in most western European countries (the U.S. set their blood alcohol limits at .08 percent). ***In addition, as a result on continuous muscular activity without proper rest time, effects such as cramping are much more frequent in sleep-deprived individuals. Extreme cases of sleep deprivation have been reported to be associated with hernias, muscle fascia tears, and other such problems commonly associated with physical overexertion. Beyond impaired motor skills, people who get too little sleep may have higher levels of stress, anxiety and depression, and may take unnecessary risks.*** According to the National Highway Traffic Safety Administration, over 100,000 traffic accidents each year are caused by fatigue and drowsiness. A new study has shown that while total sleep deprivation for one night caused many errors, the errors were not significant until after the second night of total sleep deprivation.

The Effects of Sleep Deprivation on Brain and Behavior

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Sleep deprivation is a commonplace occurrence in modern culture. Every day there seems to be twice as much work and half as much time to complete it in. This results in either extended periods of wakefulness or a decrease in sleep over an extended period of time. While some people may like to believe that they can train their bodies to not require as much sleep as they once did this belief is false. Sleep is needed to regenerate certain parts of the body, especially the brain, so that it may continue to function optimally.

After periods of extended wakefulness or reduced sleep neurons may begin to malfunction, visibly effecting a person's behavior. Some organs, such as muscles, are able to regenerate even when a person is not sleeping so long as they are resting. This could involve lying awake but relaxed within a quite environment. Even though cognitive functions might not seem necessary in this scenario the brain, especially the cerebral cortex, is not able to rest but rather remains semi-alert in a state of "quiet readiness" . Certain stages of sleep are needed for the regeneration of neurons within the cerebral cortex while other stages of sleep seem to be used for forming new memories and generating new synaptic connections. The effects of sleep deprivation on behavior have been tested with relation to the presence of activity in different sections of the cerebral cortex.

The temporal lobe of the cerebral cortex is associated with the processing of language. During verbal learning tests on subjects who are fully rested functional magnetic resonance imaging scans show that this area of the brain is very active. However, in sleep deprived subjects there is no activity within this region. The effects of this inactivity can be observed by the slurred speech in subjects who have gone for prolonged periods with no sleep.

Even severely sleep deprived people are still able to perform to some degree on a verbal learning test. This implies that some other area of the brain must become active to compensate for the loss of temporal lobe functioning. In fact, activity can be seen in the parietal lobe that is not present during verbal learning tests using rested subjects. Greater activity within this region corresponded to better performance by subjects in research studies. Still, sleep deprived people do not perform as well on these tests as do fully rested subjects. One possible reason for the poorer performance after missing sleep, aside from unregenerated neurons, could be the fact that since the parietal lobe is not usually used to performing tasks such as these it is not as adept at carrying them out. Therefore, when control switches from the temporal lobe to the parietal lobe some speed and accuracy is naturally lost. Interestingly, sleep deprived subjects have been shown to have better short-term memory abilities than their well-rested counterparts. Since memory is associated with this region of the cerebral cortex the fact that it is already active in sleep deprived people could make it easier for new synapses to be created, thus forming new short-term memories more easily.

While activity is seen within the parietal lobes of rested people as they think through math problems no corresponding activity is visible within the brains of sleep-deprived subjects. Also, no new area of the brain becomes active while the sleep deprived people work on math problems. Since sleep deprived people can still complete math problems, albeit with less speed and accuracy than a well-rested individual, this data implies that a region of the brain already in use is used for this task.

The frontal lobe is the most fascinating section of the brain with relation to sleep deprivation. Its functions are associated with speech as well as novel and creative thinking. Sleep deprived test subjects have difficulties thinking of imaginative words or ideas. Instead, they tend to choose repetitious words or clichéd phrases. Also, a sleep-deprived individual is less able to deliver a statement well. The subject may show signs of slurred speech, stuttering, speaking in a monotone voice, or speaking at a slower pace than usual. Subjects in research studies also have a more difficult time reacting well to unpredicted rapid changes. Sleep deprived people do not have the speed or creative abilities to cope with making quick but logical decisions, nor do they have the ability to implement them well. Studies have demonstrated that a lack of sleep impairs one's ability to simultaneously focus on several different related tasks, reducing the speed as well as the efficiency of one's actions. A person may be able to react to a complex scenario when suddenly presented with it but, similar to the verbal tests, the subject will most likely pick an unoriginal solution. If presented with a similar situation multiple times with slight variations in the information presented the subject chooses the same solution, even though it might not be as applicable to the new senario.

Part of the frontal lobe, the prefrontal cortex, has several functions specifically coupled with it. Judgment, impulse control, attention, and visual association have all been related to this region of the cerebral cortex. A recent study has shown that the prefrontal cortex, usually the most active area of the brain in rested individuals, becomes more active as a person remains awake for long periods of time. This region regenerates during the first stage of sleep, giving a person the ability to feel somewhat refreshed after only a short nap. The length of the first stage of sleep cycle is somewhat dependant upon how long the person had previously been awake. The longer the period of wakefulness, the longer the brain remains in the first stage of sleep. When the brain enters into the REM stage of sleep the prefrontal cortex is active once more.

The implications of this data seem to be fairly important in supporting the location of the I-function within the brain. The prefrontal cortex is active whenever a person is awake, no matter how little sleep they have had. Also, this area is active while dreaming. Since the individual is aware of him or herself during both of these instances, but is not aware during the stages of sleep when the prefrontal cortex is shut down, it seems logical that the I-function is located within this region. This indicates that the I-function is what is resting and regenerating during the first stage of sleep. It would be interesting to study prefrontal cortex activity while a person is conscious, but unaware of his or her actions, due to an influence such as drugs or alcohol. According to the results of the sleep deprivation studies little or no activity should be seen in the prefrontal cortex at anytime when the individual is unaware of his or herself.

One of the symptoms of prolonged sleep deprivation is hallucinations. This could also be related to the I-function since it is the system that integrates the input from all other areas of the brain. If the neurons composing the I-function become too taxed then the picture in the head that the I-function produces may be more dissimilar from reality than usual. The neurons, under pressure to continue functioning but unable to perform optimally, create an image useful enough for a person to see most of his or her surroundings. Metabolic activity in the prefrontal cortex can drop as much as eleven percent after a person has missed sleep for only twenty four hours. As a person loses more sleep or continues to receive less-than-adequate amounts of sleep the neurons become even more taxed and the I-function may begin to generate even less coherent images possibly resulting in temporary insanity.

Another piece of evidence supporting the location of the I-function is that mammals have REM sleep whereas cold-blooded animals do not and mammals have a neocortex, located within the prefrontal cortex, while cold-blooded animals do not. REM sleep stimulates areas of the brain used for learning and memory. When a person is taught a new skill his or her performance does not improve until he or she receives at least eight hours of sleep. An extended period of sleep ensures that the brain will be able to complete the full sleep cycle, including REM sleep. The necessity of sleep for learning could be due to the fact that sleep increases the production of proteins while reducing the rate at which they are broken down. Proteins are used to regenerate the neurons within the brain. Without them new synapses may not be able to be formed, thus limiting the amount of information a sleep-deprived individual can maintain.

One of the possible side effects of a continued lack of sleep is death. Usually this is the result of the fact that the immune system is weakened without sleep. The number of white blood cells within the body decreases, as does the activity of the remaining white blood cells. The body also decreases the amount of growth hormone produced. The ability of the body to metabolize sugar declines, turning sugar into fat. One study stated that people who sleep less than four hours per night are three times more likely to die within the next six years. Although the longest a human has remained awake was eleven days rats that are continually deprived of sleep die within two to five weeks, generally due to their severely weakened immune system.

In a way sleep deprivation studies help us to study the relationship between the brain and behavior in a very unique way by observing how a person's behavior changes as the brain shuts down. By taking images of the brain showing where activity is located it is possible to correlate the behavior exhibited by a subject with his or her brain patterns. Just like a person cannot jog for three continuous days a person's brain cannot operate without rest breaks. Since different regions of the brain rest during different stages of the sleep cycle, sleep cannot be cut short. In fact, if the brain does not receive a break it will soon begin to shut down for periods of microsleep. This is essentially several seconds of actual sleep; delta waves that interrupt the regular EEG of an awake person thereby impairing his or her continuity of cognitive function. Microsleep generally happens directly before performance failure occurs. Without sleep our brains deteriorate, and if the argument that brain=behavior is true, then our behavior will also suffer accordingly.

Definition of Circadian

Circadian: Refers to events occurring within a 24-hour period, in the span of a full (24-hour) day, as in a circadian rhythm. Circadian rhythmicity is a fundamental property possessed by all organisms. These rhythms are driven by an internal time-keeping system: a clock. Changes in the external

environment, particularly in the light-dark cycle, entrain this biologic clock. Under constant environmental conditions devoid of time cues, rhythms driven by the clock show a period near, but usually not exactly equal to, 24 hours.
Humans have an internal 24-hour clock which regulates our daily activities such as sleep and waking. Difficulties in readjusting our clock causes jet lag, work shift problems and some types of sleep disorders. Circadian clocks affect almost every level of our bodily functions.

Reference: www.medterms.com

Sleep: a dynamic activity

Until the 1950s, most people thought of sleep as a passive, dormant part of our daily lives. We now know that our brains are very active during sleep. Moreover, sleep affects our daily functioning and our physical and mental health in many ways that we are just beginning to understand.

Nerve-signaling chemicals called neurotransmitters control whether we are asleep or awake by acting on different groups of nerve cells, or neurons, in the brain. Neurons in the brainstem, which connects the brain with the spinal cord, produce neurotransmitters such as serotonin and norepinephrine that keep some parts of the brain active while we are awake. Other neurons at the base of the brain begin signaling when we fall asleep. These neurons appear to "switch off" the signals that keep us awake. Research also suggests that a chemical called adenosine builds up in our blood while we are awake and causes drowsiness. This chemical gradually breaks down while we sleep.

During sleep, we usually pass through five phases of sleep: stages 1, 2, 3, 4, and REM (rapid eye movement) sleep. These stages progress in a cycle from stage 1 to REM sleep, then the cycle starts over again with stage 1. We spend almost 50 percent of our total sleep time in stage 2 sleep, about 20 percent in REM sleep, and the remaining 30 percent in the other stages. Infants, by contrast, spend about half of their sleep time in REM sleep.

During stage 1, which is light sleep, we drift in and out of sleep and can be awakened easily. Our eyes move very slowly and muscle activity slows. People awakened from stage 1 sleep often remember fragmented visual images. Many also experience sudden muscle contractions called hypnic myoclonia, often preceded by a sensation of starting to fall. These sudden movements are similar to the "jump" we make when startled. When we enter stage 2 sleep, our eye movements stop and our brain waves (fluctuations of electrical activity that can be measured by electrodes) become slower, with occasional bursts of rapid waves called sleep spindles. In stage 3, extremely slow brain waves called delta waves begin to appear, interspersed with smaller, faster waves. By stage 4, the brain produces delta waves almost exclusively. It is very difficult to wake someone during stages 3 and 4, which together are called deep sleep. There is no eye movement or muscle activity. People awakened during deep sleep do not adjust immediately and often feel groggy and disoriented for several minutes after they wake up. Some children experience bedwetting, night terrors, or sleepwalking during deep sleep.

When we switch into REM sleep, our breathing becomes more rapid, irregular, and shallow, our eyes jerk rapidly in various directions, and our limb muscles become temporarily paralyzed. Our heart rate increases, our blood pressure rises, and males develop penile erections. When people awaken during REM sleep, they often describe bizarre and illogical tales—dreams.

The first REM sleep period usually occurs about 70 to 90 minutes after we fall asleep. A complete sleep cycle takes 90 to 110 minutes on average. The first sleep cycles each night contain relatively short REM periods and long periods of deep sleep. As the night progresses, REM sleep periods increase in length while deep sleep decreases. By morning, people spend nearly all their sleep time in stages 1, 2, and REM.

People awakened after sleeping more than a few minutes are usually unable to recall the last few minutes before they fell asleep. This sleep-related form of amnesia is the reason people often forget telephone calls or conversations they've had in the middle of the night. It also explains why we often do not remember our alarms ringing in the morning if we go right back to sleep after turning them off.

Since sleep and wakefulness are influenced by different neurotransmitter signals in the brain, foods and medicines that change the balance of these signals affect whether we feel alert or drowsy and how well we sleep. Caffeinated drinks such as coffee and drugs such as diet pills and decongestants stimulate some parts of the brain and can cause insomnia, or an inability to sleep.

People lose some of the ability to regulate their body temperature during REM, so abnormally hot or cold temperatures in the environment can disrupt this stage of sleep. If our REM sleep is disrupted one night, our bodies don't follow the normal sleep cycle progression the next time we doze off. Instead, we often slip directly into REM sleep and go through extended periods of REM until we "catch up" on this stage of sleep.

The amount of sleep a person needs also increases if he or she has been deprived of sleep in previous days. Getting too little sleep creates a "sleep debt," which is much like being overdrawn at a bank. Eventually, your body will demand that the debt be repaid. We don't seem to adapt to getting less sleep than we need, while we may get used to a sleep-depriving schedule, our judgment, reaction time, and other functions are still impaired.

What Does Sleep Do For Us?

Although scientists are still trying to learn exactly why people need sleep, animal studies show that sleep is necessary for survival. For example, while rats normally live for two to three years, those deprived of REM sleep survive only about 5 weeks on average, and rats deprived of all sleep stages live only about 3 weeks. Sleep-deprived rats also develop abnormally low body temperatures and sores on their tail and paws. The sores may develop because the rats' immune systems become impaired. Some studies suggest that sleep deprivation affects the immune system in detrimental ways.

Sleep appears necessary for our nervous systems to work properly. Too little sleep leaves us drowsy and unable to concentrate the next day. It also leads to impaired memory and physical performance and reduced ability to carry out math calculations. If sleep deprivation continues, hallucinations and mood swings may develop. Some experts believe sleep gives neurons used while we are awake a chance to shut down and repair themselves. Without sleep, neurons may become so depleted in energy or so polluted with byproducts of normal cellular activities that they begin to malfunction. Sleep also may give the brain a chance to exercise important neuronal connections that might otherwise deteriorate from lack of activity.

Many of the body's cells also show increased production and reduced breakdown of proteins during deep sleep. Since proteins are the building blocks needed for cell growth and for repair of damage from factors like stress and ultraviolet rays, deep sleep may truly be "beauty sleep." Activity in parts of the brain that control emotions, decision-making processes, and social interactions is drastically reduced during deep sleep, suggesting that this type of sleep may help people maintain optimal emotional and social functioning while they are awake. A study in rats also showed that certain nerve-signaling patterns that the rats generated during the day were repeated during deep sleep. This pattern repetition may help encode memories and improve learning.

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