Sleep deprivation affects ability to make sense of what we see

Source: Duke University

Neuroscience researchers at the Duke-NUS Graduate Medical School in Singapore have shown for the first time what happens to the visual perceptions of healthy but sleep-deprived volunteers who fight to stay awake, like people who try to drive through the night.

The scientists found that even after sleep deprivation, people had periods of near-normal brain function in which they could finish tasks quickly. However, this normalcy mixed with periods of slow response and severe drops in visual processing and attention, according to their paper, published in the *Journal of Neuroscience* on May 21, 08.

"Interestingly, the team found that a sleep-deprived brain can normally process simple visuals, like flashing checkerboards. But the 'higher visual areas' – those that are responsible for making sense of what we see – didn't function well," said Dr. Michael Chee, lead author and professor at the Neurobehavioral Disorders Program at Duke-NUS. "Herein lies the peril of sleep deprivation."

The research team, including colleagues at the University of Michigan and University of Pennsylvania, used magnetic resonance imaging to measure blood flow in the brain during speedy normal responses and slow "lapse" responses. The study was funded by grants from the DSO National Laboratories in Singapore, the National Institutes of Health, the National Institute on Drug Abuse, the NASA Commercialization Center, and the Air Force Office of Scientific Research.

Study subjects were asked to identify letters flashing briefly in front of them. They saw either a large H or S, and each was made up of smaller Hs or Ss. Sometimes the large letter matched the smaller letters; sometimes they didn't. Scientists asked the volunteers to identify either the smaller or the larger letters by pushing one of two buttons.

During slow responses, sleep-deprived volunteers had dramatic decreases in their higher visual cortex activity. At the same time, as expected, their frontal and parietal 'control regions' were less able to make their usual corrections.

Scientists also could see brief failures in the control regions during the rare lapses that volunteers had after a normal night's sleep. However, the failures in visual processing were specific only to lapses that occurred during sleep deprivation.

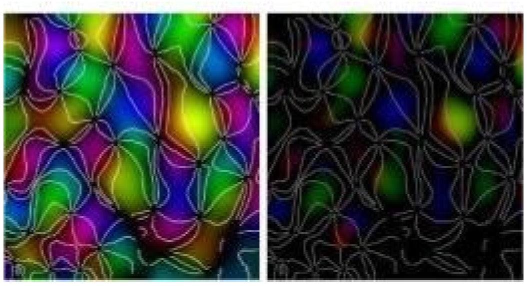
The scientists theorize that this sputtering along of cognition during sleep deprivation shows the competing effects of trying to stay awake while the brain is shutting things down for sleep. The brain ordinarily becomes less responsive to sensory stimuli during sleep, Chee said.

This study has implications for a whole range of people who have to struggle through night work, from truckers to on-call doctors. "The periods of apparently normal functioning could give a false sense of competency and security when in fact, the brain’s inconsistency could have dire consequences,” Chee said.

“The study task appeared simple, but as we showed in previous work, you can’t effectively memorize or process what you see if your brain isn’t capturing that information,” Chee said. “The next step in our work is to see what we might do to improve things, besides just offering coffee, now that we have a better idea where the weak links in the system are.”

Why Sleep is Needed to Form Memories

Source: University of Pennsylvania School of Medicine



The world as the brain sees it. Optical "polar" maps of the visual cortex are generated by measuring micro-changes in blood oxygenation as the left eye (left panel) or right eye is stimulated by bars of light of different orientations (0-180 degrees). The cortical response to each stimulus is pseudo-colored to represent the orientation that best activates visual cortical neurons. If vision is blocked in an eye (the right eye in this example) during a critical period of development, neurons no longer respond to input from the deprived eye pathway (indicated by a loss of color in the right panel) and begin to respond preferentially to the non-deprived eye pathway. These changes are accompanied by alterations in synaptic connections in single neurons. This process, known as ocular dominance plasticity, is enhanced by sleep via activation of NMDA receptors and intracellular kinase activity. Through these mechanisms, sleep strengthens synaptic connections in the non-deprived eye pathway. Credit: Marcos Frank, PhD, University of Pennsylvania School of Medicine

If you ever argued with your mother when she told you to get some sleep after studying for an exam instead of pulling an all-nighter, you owe her an apology, because it turns out she's right. And now, scientists are beginning to understand why.

In research published this week in *Neuron*, Marcos Frank, PhD, Assistant Professor of Neuroscience, at the University Of Pennsylvania School Of Medicine, postdoctoral researcher Sara Aton, PhD, and colleagues describe for the first time how cellular changes in the sleeping brain promote the formation of memories.

"This is the first real direct insight into how the brain, on a cellular level, changes the strength of its connections during sleep," Frank says.

The findings, says Frank, reveal that the brain during sleep is fundamentally different from the brain during wakefulness.

"We find that the biochemical changes are simply not happening in the neurons of animals that are awake," Frank says. "And when the animal goes to sleep it's like you've thrown a switch, and all of a sudden, everything is turned on that's necessary for making synaptic changes that form the basis of memory formation. It's very striking."

The team used an experimental model of cortical plasticity - the rearrangement of neural connections in response to life experiences. "That's fundamentally what we think the machinery of memory is, the actual making and breaking of connections between neurons," Frank explains

In this case, the experience Frank and his team used was visual stimulation. Animals that were young enough to still be establishing neural networks in response to visual cues were deprived of stimulation through one eye by covering that eye with a patch. The team then compared the electrophysiological and molecular changes that resulted with control animals whose eyes were not covered. Some animals were studied immediately following the visual block, while others were allowed to sleep first.

From earlier work, Frank's team already knew that sleep induced a stronger reorganization of the visual cortex in animals that had an eye patch versus those that were not allowed to sleep. Now they know why.

A molecular explanation is emerging. The key cellular player in this process is a molecule called N-methyl D-aspartate receptor (NMDAR), which acts like a combination listening post and gate-keeper. It both receives extracellular signals in the form of glutamate and regulates the flow of calcium ions into cells.

Essentially, once the brain is triggered to reorganize its neural networks in wakefulness (by visual deprivation, for instance), intra- and intercellular communication pathways engage, setting a series of enzymes into action within the reorganizing neurons during sleep.

To start the process, NMDAR is primed to open its ion channel after the neuron has been excited. The ion channel then opens when glutamate binds to the receptor, allowing calcium into the cell. In turn, calcium, an intracellular signaling molecule, turns other downstream enzymes on and off.

Some neural connections are strengthened as a result of this process, and the result is a reorganized visual cortex. And, this only happens during sleep.

"To our amazement, we found that these enzymes never really turned on until the animal had a chance to sleep," Frank explains, "As soon as the animal had a chance to sleep, we saw all the machinery of memory start to engage." Equally important was the demonstration that inhibition of these enzymes in the sleeping brain completely prevented the normal reorganization of the cortex.

Frank stresses that this study did not examine recalling memories. For example, these animals were not being asked to remember the location of their food bowl. "It's a mechanism that we think underlies the formation of memory." And not only memory; the same mechanism could play a role in all neurological plasticity processes.

As a result, this study could pave the way to understanding, on a molecular level, why humans need sleep, and why they are so affected by the lack of it. It could also conceivably lead to novel therapeutics that could compensate for the lack of sleep, by mimicking the molecular events that occur during sleep.

Finally, the study could lead to a deeper understanding of human memory. Though how and even where humans store long-lasting memories remains a mystery, Frank says, "we do know that changes in cortical connections is at the heart of the mystery. By understanding that in animal models, it will bring us close to understanding how it works in humans."

Sleep Deprivation Could Affect Brain Function

Source-IANS

Deprivation of sleep could affect your judgment, suggests a new study.

Earlier studies have shown that it can adversely affect brain function. Now William Killgore and colleagues at the Walter Reed Army Institute of Research in Silver Spring, Maryland, US, studied 26 healthy adults, all of whom were active-duty military personnel.

The researchers found that sleep deprivation has a particularly debilitating effect on decision-making processes that depend heavily on emotion, said the online edition of New Scientist.

"When people go for more than 24 hours without sleep there are dramatic decreases in brain activity in the prefrontal cortex [the area of the brain involved in processing emotions and decision-making]," says Killgore. "It basically goes to sleep."

Sleep deprived participants also showed slight shifts in what they deemed appropriate actions compared to when they were well rested. The changes were more pronounced in individuals who scored lower in "emotional intelligence" tests.

Killgore believes that those with a lower emotional capacity to begin with may have less resistance to the affects of sleep deprivation.

The findings could have implications for people in positions of responsibility, whose decisions often have life or death consequences, such as overworked medical professionals and sleep-deprived soldiers.

"We don't want tired irritable soldiers making bad decisions that endanger themselves or others that are not a threat to them. Nor do we want health care providers who are unable to make quick medical decisions on behalf of their patients," the researchers say.

Researchers, however, note that further research, including brain imaging, should be conducted as laboratory results do not always translate to real world situations.

Prolonged lack of sleep affects brain

Source: Times of India 05/08

Brain activity differs significantly in sleep-deprived and well-rested people, according to a new study that uses the latest imaging techniques.

The study, by Singapore-based researchers, shows that the sleep-deprived experience periods of near-normal brain function - interspersed with severe drops in attention.

"The main finding is that the brain of the sleep-deprived individual is working normally sometimes, but intermittently suffers from something akin to power failure," said Clifford Saper of Harvard University, an expert unaffiliated with the study.

Findings of the study have been published in the latest issue of The Journal of Neuroscience .

The research team, led by Michael Chee, used functional magnetic resonance imaging (fMRI) to measure brain blood flow in people who were either kept awake all night or allowed a good night's sleep. Researchers tested the same participants in both conditions.

During imaging, participants did a task that required visual attention. Researchers showed them large letters composed of many smaller letters. Participants were asked to identify either the large or small letters and to indicate their responses by pushing a button.

Well-rested and sleep-deprived volunteers showed a range of reaction times. Those participants with the fastest responses, both in sleep-deprived and well-rested conditions, showed similar patterns of brain activity.

However, well-rested and sleep-deprived participants with the slowest responses - also called attentional lapses - showed different patterns of brain activity.

Previous research showed that attentional lapses normally induce activity in frontal and parietal regions of the brain, command centers that may compensate for lost focus by increasing attention.

However, during attentional lapses, Chee and colleagues found reduced activity in these brain command centers in sleep-deprived compared to well-rested volunteers. This finding suggests that sleep deprivation reduces the brain's ability to compensate for lost focus.

Sleep-deprived people also showed reduced activity in brain regions involved in visual processing during attentional lapses.

Because the brain becomes less responsive to sensory stimuli during sleep, reduced activity in these regions suggests that, during attentional lapses, the sleep-deprived brain enters a sleep-like state.