# For sleep-deprived memory loss, look to the visual system

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When an air traffic controller at the end of a double shift forgets the location of an aircraft that had recently appeared on his screen, it may be that he did not properly take in the visual information.

While it is well documented that sleep deprivation leads to short-term memory loss, it had been believed that it was the result of the brain not being able to assemble and "file away" the information it received in its proper place.

However, experiments by researchers from the Duke University-National University of Singapore Graduate Medical School at the SingHealth Cognitive Neuroscience Laboratory suggest that the problem occurs earlier in the information-gathering process.

"We generally think of memory decline as a result of faulty storage of information," said cognitive neuroscientist Michael Chee, M.D., whose findings are published online in the journal *Proceedings of the National Academy of Sciences*. The research was supported by Singapore's DSO National Laboratories, the SingHealth Foundation and the Shaw Foundation.

"However, if the information is not properly handled by the visual system, either as a result of a failure to direct attention appropriately or a failure of visual areas to process what is seen, you can forget about the later stages of information consolidation and storage," Chee said. "When people are sleep deprived, they may not be seeing what they think they

should be seeing, and it appears that this is what contributes to memory declines following sleep deprivation."

In their experiments, the researchers found that people who are sleep deprived can see and take in only a small number of objects at a time. Objects over this threshold are lost.

"Our findings support and help explain what experts have known about designing critical information-delivery systems such as flight displays on aircraft or medical monitors in intensive care units: you have to carefully select what is displayed on the screen at any one time," Chee said. "The brain is not in a good state to process visual information, let alone too much of it, when it is sleep deprived."

The researchers tested 30 healthy volunteers on the same memory tests after a regular night's sleep and also after 24 hours without sleep. The researchers used a technique called functional magnetic resonance imaging to measure which areas of the volunteers' brains were active during the tests. This technique measures the changes in blood flow and blood oxygenation in the brain in response to different stimuli.

The researchers briefly flashed increasing numbers of colored squares on a computer screen and asked the volunteers to remember if a new square displayed on the screen was the same color as any of the earlier squares. The idea was that increasing memory load would tax the storage system and give insight into memory capacity.

"We found that visual short-term memory capacity dropped following sleep deprivation and that this was likely due to a reduced ability to focus attention," Chee said.

The sleep-deprived volunteers showed brain activation deficiencies with visual arrays involving as few as one or two squares, indicating that the

deficit in visual processing was quite severe, he said.

"A small group of sleep-deprived volunteers who had better performance were better able to tune out distractions, but even they suffered from compromised visual attention and processing," Chee said.

Chee's laboratory is continuing to investigate the changes that occur within the visual and attention systems during sleep deprivation. He hopes the use of functional magnetic resonance imaging could help identify people who might be more susceptible to the attention deficits that occur during sleep deprivation.

"It might be possible to determine whether or nor certain people would be suitable candidates for occupations where repeated and prolonged sleep deprivation is a routine part of the job," Chee said.

Source: Duke University Medical Center