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Jet-Lagged and Forgetful? It's No Coincidence: Memory, Learning Problems Persist Long After Periods of Jet Lag

Chronic jet lag alters the brain in ways that cause memory and learning problems long after one's return to a regular 24-hour schedule, according to research by University of California, Berkeley, psychologists.

Twice a week for four weeks, the researchers subjected female Syrian hamsters to six-hour time shifts -- the equivalent of a New York-to-Paris airplane flight. During the last two weeks of jet lag and a month after recovery from it, the hamsters' performance on learning and memory tasks was measured.

As expected, during the jet lag period, the hamsters had trouble learning simple tasks that the hamsters in the control group aced. What surprised the researchers was that these deficits persisted for a month after the hamsters returned to a regular day-night schedule.

What's more, the researchers discovered persistent changes in the brain, specifically within the hippocampus, a part of the brain that plays an intricate role in memory processing. They found that, compared to the hamsters in the control group, the jet-lagged hamsters had only half the number of new neurons in the hippocampus following the month long exposure to jet lag. New neurons are constantly being added to the adult hippocampus and are thought to be important for hippocampal-dependent learning, Kriegsfeld said, while memory problems are associated with a drop in cell maturation in this brain structure.

"This is the first time anyone has done a controlled trial of the effects of jet lag on brain and memory function, and not only do we find that cognitive function is impaired during the jet lag, but we see an impact up to a month afterward," said Lance Kriegsfeld, UC Berkeley associate professor of psychology and a member of the Helen Wills Neuroscience Institute. "What this says is that, whether you are a flight attendant, medical resident, or rotating shift worker, repeated disruption of circadian rhythms is likely going to have a long-term impact on your cognitive behavior and function."

Kriegsfeld, graduate student Erin M. Gibson and their colleagues reported their findings in the online, open-access journal PLoS ONE.

"Other studies have shown that chronic transmeridian flights increase deficits in memory and learning along with atrophy in the brain's temporal lobe, suggesting a possible hippocampal deficit," said Gibson. "Our study shows directly that jet lag decreases neurogenesis in the hippocampus."

Jet lag is a result of crossing several time zones in a short period of time, with the worst effects occurring during eastward travel. Each of us has an internal, 24-hour clock that drives our so-called circadian rhythm, which is reset every day by small amounts. When a person enters a time zone that is not synched with his or her internal clock, it takes much longer to reset this daily rhythm, causing jet lag until the internal clock gets re-synched.

This acute disruption of circadian rhythms can cause general malaise as well as gastrointestinal problems because the body's hunger cycle is out of sync with meal times, Kriegsfeld said.

For air travelers, jet lag is a minor annoyance from which most recover within a few days, perhaps with the help of a melatonin pill. For people who repeatedly cross time zones, such as flight attendants, the effects have been shown to be more serious. Flight attendants and rotating shift workers -- people who regularly alternate between day and night shifts -- have been found to have learning and memory problems, decreased reaction times, higher

incidences of diabetes, heart disease, hypertension and cancer, and reduced fertility. The World Health Organization lists shift work as a carcinogen.

To date, these effects have been documented only in jet-lagged subjects, not after recovery from jet lag, Gibson said. The UC Berkeley study is the first to look at long-term effects as well as changes in brain anatomy.

"The evidence is overwhelming that disruptions in circadian timing have a direct impact on human health and disease," Kriegsfeld said. "We've now shown that the effects are long-lasting, not only to brain function, but likely to brain structure."

The researchers used hamsters in their study because they are a classic model of circadian rhythms. Their bodily rhythms are so precise, Kriegsfeld said, that they will produce eggs, or ovulate, every 96 hours to within a window of a few minutes.

Because jet lag can increase stress hormones like cortisol and disrupt reproduction, the researchers controlled for the effects of these by removing adrenal glands or ovaries in some of the hamsters and injecting normal levels of hormone supplements of corticosterone and estrogen, respectively. These hamsters showed a similar reduction in new, mature hippocampal neurons in the brain.

"The change was really dramatic and shows that the effect on behavior and the brain is direct, not a secondary effect of increased stress hormones," Gibson said. "They are not due to increased cortisol concentrations."

The experiments also suggest that the low number of mature neurons in the hippocampus in jet-lagged hamsters was not due to decreased production of new cells, but rather, fewer new cells maturing into working cells, or perhaps new cells dying prematurely. Further studies are planned to determine the root cause of the reduction in mature neurons.

How do you avoid jet lag problems? Kriegsfeld said that, in general, people should allow one day of recovery for every one-hour time zone shift. Those, such as night-shift workers, who cannot return to a normal day-night cycle, should sleep in a room with light-tight curtains shielded from outside noise in order to properly adjust to an altered sleep schedule.

Other authors of the paper are UC Berkeley undergraduate psychology students Connie Wang, Stephanie Tjho and Neera Khattar.

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