Protein keeps sleep-deprived flies ready to learn

May 5 2011

(PhysOrg.com) -- A protein that helps the brain develop early in life can fight the mental fuzziness induced by sleep deprivation, according to researchers at Washington University School of Medicine in St. Louis.

"It's interesting that NOTCH, a protein that plays such a prominent role in development, also has important functions in the adult brain," says senior author Paul Shaw, PhD, associate professor of neurobiology. "To our surprise, we found if NOTCH activity is boosted in the brains of sleep-deprived fruit flies, the flies can continue to stay sharp and learn after sleep deprivation. They behave as if they had a full night's sleep."

Shaw studies interactions between sleep and learning to develop treatments that help the brain resist the mental impairments imposed by sleep deprivation. He wants to assist people forced to work with minimal sleep, such as members of the military or disaster relief workers.

The findings appear online May 5 in Current Biology.

Shaw and his colleagues test flies' ability to learn by pairing a negative stimulus (the chemical quinine, which flies prefer to avoid) with a positive stimulus (a light, which flies instinctively seek). When offered an opportunity to enter a darkened tube or a lighted tube with quinine, flies that can learn suppress their natural desire to choose the light. Flies, like humans, show a progressive decline in cognitive performance during the course of a typical waking day. Prolonged disruption of sleep causes a much sharper drop in learning.

Shaw became interested in NOTCH when his group found that sleep deprivation in flies caused increased activity in a gene that suppresses NOTCH. They found a similar increase in humans following sleep loss. They went on to show that when that suppressor is genetically disabled, allowing increased NOTCH activity, flies continue to learn even when sleep-deprived.

To further confirm NOTCH's involvement in these processes, Shaw and lead author Laurent Seugnet, PhD, a researcher now at the Lyon Neuroscience Research Center in Lyon, France, analyzed where NOTCH is made in the brain. They found that in adult fruit flies, specialized brain cells known as glia make NOTCH. Scientists have typically regarded glia as passive support cells that merely nourish and supply neurons, the cells that do the "work" of the brain. According to Shaw, though, this study and others have scientists reconsidering how actively glia may be involved in certain mental processes, including sleep.

"We may want to target glia to reduce or slow the cognitive deficits associated with increased wakefulness, allowing people such as emergency personnel and air traffic controllers to stay awake and functional for extended periods of time," Shaw says. "If modifying glia can slow negative outcomes associated with prolonged wakefulness, that may provide us with a more natural way of helping people stay awake than directly targeting neurons."

More information: Seugnet L, Suzuki Y, Merlin G, Gottschalk L, Duntley SP, Shaw PJ. Notch signaling modulates sleep homeostasis and learning after sleep deprivation in Drosophila. *Current Biology*, May 5, 2011.

Provided by Washington University School of Medicine