# Sleep-deprived bees have difficulty relearning

October 25 2012

Everyone feels refreshed after a good night's sleep, but sleep does more than just rejuvenate, it can also consolidate memories. 'The rapid eye movement form of sleep and slow wave sleep are involved in cognitive forms of memory such as learning motor skills and consciously accessible memory', explains Randolf Menzel from the Freie Universtät Berlin, Germany.

According to Menzel, the concept that something during sleep reactivates a memory for consolidation is a basic theory in sleep research . However, the human brain is far too complex to begin dissecting the intricate neurocircuits that underpin our memories, which is why Menzel has spent the last four decades working with honey bees: they are easy to train, well motivated and it is possible to identify the miniaturised circuits that control specific behaviours in their tiny brains. Intrigued by the role of sleep in memory consolidation and knowing that a bee is sleeping well when its antennae are relaxed and collapsed down, Menzel decided to focus on the role of sleep in one key memory characteristic: relearning. They publish their discovery that sleep derivation prevents bees from altering well-established memories in *The Journal of Experimental Biology*.

The challenge that Menzel set the bees was to learn a new route home after being displaced from a familiar path. He and his colleague Lisa Beyaert provided a hive with a well-stocked feeder and trained the bees to visit the feeder and return home fully laden. Then, when the duo were convinced that the bees had memorized the routine, they cunningly

intercepted the bees at the feeder and transported them to a new location before releasing the insects to find their way home. According to Menzel, foragers learn the general lay of the land as novices before specialising in a few well-travelled routes later in their careers. He explains that the displaced bees had to rely on their earlier experiences to learn their new way home. How would loss of sleep affect the bee's ability to learn the new route? To determine this, Menzel and Beyeart first had to check that the bees could learn the new route and that sleep deprivation hadn't made them too tired or altered their motivation to forage.

Teaming up with electrical engineer Uwe Greggers, Menzel kitted the bees out with tiny RADAR transponders; the RADAR technology was particularly demanding to operate. Tracking the insects' progress as they tried to learn the alternative route home, Menzel and his colleagues saw that by the second run home, the displaced bees had learned the new route. And when the trio disturbed the insects' sleep during the night before the initial displacement by shaking them awake every 5 minutes, they found that the bees were unfazed. In fact they didn't seem to need sleep to maintain their foraging energy levels and the foragers that were deprived of sleep before the first displacement run had no problems learning the new route home.

However, when the team disrupted the bees' sleep after they had allowed the bees a single run along the new displaced route, the lack of sleep played havoc with their memories on the following day. Fewer than half of the sleep-deprived foragers made it home successfully, and those that did took more than twice as long as bees that had enjoyed an uninterrupted night's sleep.

Sleep deprivation had dramatically affected the bees' ability to alter a well-established memory and the team is now keen to see whether they can identify characteristic activity patterns in the slumbering insects'

brains that could represent memory formation.

**More information:** *The Journal of Experimental Biology* jeb.biologists.org/content/215/22/3981.abstract

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