One night of total sleep deprivation shown to have antidepressant effect for some people

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A study led by the Perelman School of Medicine, University of Pennsylvania, Philadelphia, has investigated a seemingly contradictory phenomenon of sleep deprivation leading to mood improvement in

patients with depressive disorders.

In a paper, "Enhanced amygdala–cingulate connectivity associates with better mood in both healthy and depressive individuals after sleep deprivation," published in *PNAS*, the research team mapped brain region activity through resting-state-functional magnetic resonance imaging to see why some people receive a healthy boost from an otherwise negative public health epidemic.

The study finds that one night of total sleep deprivation enhanced amygdala connectivity to the anterior cingulate cortex, which correlated with better mood in some healthy and depressed individuals.

In sleep deprivation experiments conducted on both healthy individuals (n=38) and patients with major depressive disorder (n=30), along with 16 controls who were allowed uninterrupted sleep, researchers explored the effects of total sleep deprivation (TSD) on mood and functional connectivity networks.

The experiments were performed in the Clinical Translational Research Center laboratory at the University of Pennsylvania Hospital for five consecutive days. All participants underwent three rs-fMRI scanning sessions. A total of 210 fMRI images were acquired per participant.

Participants underwent three resting-state fMRI scanning sessions over the five days. The first scan came after a normal night's sleep on the morning of day two as the baseline. In the TSD groups, participants had their second scanning session on the morning of day three after no sleep.

Then participants were allowed two nights of restful sleep and had their final scanning session on the morning of day five. All participants completed a 37-item shortened version of the Profile of Mood States

every two hours during days two to five.

As expected, most participants showed a worsening mood immediately after missing a night's sleep. Thirteen out of 30 (43%) depressed participants experienced mood improvement, and the remaining 17 participants experienced mood worsening or no change after one night of TSD.

After one night of restful sleep, 20 major depressive disorder participants experienced mood improvement, and the remaining participants experienced mood worsening or no change.

Amygdala to anterior cingulate cortex connectivity increased significantly in patients with improved mood but less in those with unimproved mood. The amygdala is the core of the fight or flight response, processing fearful or threatening stimuli and signaling other parts of the brain for a response action.

The anterior cingulate cortex (ACC) brain region is involved with both the "emotional" limbic system and the "cognitive" prefrontal cortex. Among other things, it plays a significant role in the ability to control and manage emotional states or affect regulation.

The findings suggest that amygdala–ACC network connectivity may reflect the neural resilience to mood disruption after sleep loss and thus may be a potential target for antidepressant interventions.

According to the researchers, one potential explanation for the individual differences in TSD influence may reside in the rapid eye movement (REM) sleep duration.

Major depression has previously been associated with abnormalities in REM sleep. Excess REM sleep would diminish noradrenaline, resulting

in decreased binding to the α-2 receptor in the medial frontal lobes comprised of the ACC and the medial prefrontal cortex. The absence of REM sleep with TSD may give some participants a break to improve top-down control of the amygdala, resulting in an antidepressant effect.

More information: Ya Chai et al, Enhanced amygdala–cingulate connectivity associates with better mood in both healthy and depressive individuals after sleep deprivation, *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2214505120