Researchers identify brain differences linked to insomnia

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Johns Hopkins researchers report that people with chronic insomnia show more plasticity and activity than good sleepers in the part of the brain that controls movement.

"Insomnia is not a nighttime disorder," says study leader Rachel E. Salas, M.D., an assistant professor of neurology at the Johns Hopkins University School of Medicine. "It's a 24-hour brain condition, like a light switch that is always on. Our research adds information about differences in the brain associated with it."

Salas and her team, reporting in the March issue of the journal *Sleep*, found that the motor cortex in those with chronic insomnia was more adaptable to change—more plastic—than in a group of good sleepers. They also found more "excitability" among neurons in the same region of the brain among those with chronic insomnia, adding evidence to the notion that insomniacs are in a constant state of heightened information processing that may interfere with sleep.

Researchers say they hope their study opens the door to better diagnosis and treatment of the most common and often intractable sleep disorder that affects an estimated 15 percent of the United States population.

To conduct the study, Salas and her colleagues from the Department of Psychiatry and Behavioral Sciences and the Department of Physical Medicine and Rehabilitation used transcranial magnetic stimulation (TMS), which painlessly and noninvasively delivers electromagnetic currents to precise locations in the brain and can temporarily and safely disrupt the function of the targeted area. TMS is approved by the U.S. Food and Drug Administration to treat some patients with depression by stimulating nerve cells in the region of the brain involved in mood control.

The study included 28 adult participants—18 who suffered from insomnia for a year or more and 10 considered good sleepers with no reports of trouble sleeping. Each participant was outfitted with electrodes on their dominant thumb as well as an accelerometer to measure the speed and direction of the thumb.

The researchers then gave each subject 65 electrical pulses using TMS, stimulating areas of the motor cortex and watching for involuntary thumb movements linked to the stimulation. Subsequently, the researchers trained each participant for 30 minutes, teaching them to move their thumb in the opposite direction of the original involuntary movement. They then introduced the electrical pulses once again.

The idea was to measure the extent to which participants' brains could learn to move their thumbs involuntarily in the newly trained direction. The more the thumb was able to move in the new direction, the more likely their motor cortexes could be identified as more plastic.

Because lack of sleep at night has been linked to decreased memory and concentration during the day, Salas and her colleagues suspected that the brains of good sleepers could be more easily retrained. The results, however, were the opposite. The researchers found much more plasticity in the brains of those with chronic insomnia.

Salas says the origins of increased plasticity in insomniacs are unclear, and it is not known whether the increase is the cause of insomnia. It is also unknown whether this increased plasticity is beneficial, the source of the problem or part of a compensatory mechanism to address the consequences of sleep deprivation associated with chronic insomnia. Patients with chronic phantom pain after limb amputation and with dystonia, a neurological movement disorder in which sustained muscle contractions cause twisting and repetitive movements, also have increased brain plasticity in

the motor cortex, but to detrimental effect.

Salas says it is possible that the dysregulation of arousal described in chronic insomnia—increased metabolism, increased cortisol levels, constant worrying—might be linked to increased plasticity in some way. Diagnosing insomnia is solely based on what the patient reports to the provider; there is no objective test. Neither is there a single treatment that works for all people with insomnia. Treatment can be a hit or miss in many patients, Salas says.

She says this study shows that TMS may be able to play a role in diagnosing insomnia, and more importantly, she says, potentially prove to be a treatment for insomnia, perhaps through reducing excitability.

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