Medical Xpress

Brain responses during anesthesia mimic those during natural deep sleep

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The brains of people under anesthesia respond to stimuli as they do in the deepest part of sleep - lending credence to a developing theory of consciousness and suggesting a new method to assess loss of consciousness in conditions such as coma.

Scientists at the University of Wisconsin School of Medicine and Public Health, led by brain researcher Fabio Ferrarelli, reported their findings in this week's edition of the *Proceedings of the National Academy of Science*.

The group gave the anesthetic midazolam, commonly used at lower doses in "conscious sedation" procedures such as colonoscopies, to volunteers.

Then they used transcranial magnetic stimulation (TMS), a noninvasive technique to stimulate the brain cortical neurons from the scalp, in combination with electroencephalography (EEG), which recorded the TMS-evoked brain responses. What they found is a pattern that looks much as it does when the brain is in deep, non-rapid eye movement (non-REM) sleep, another condition when consciousness fades.

Co-author and consciousness expert Giulio Tononi says that when the brain is unconscious it appears to lose the connectivity that underlies the coordinated, yet differentiated responses to electrical stimuli observed when the brain is awake or in REM sleep. The group's earlier studies demonstrated the differences between the sleeping and awake brain.

"Based on a theory about how consciousness is generated, we expect to see a response that is both integrated and differentiated when the brain is conscious," says Tononi, professor of psychiatry. "When there is a loss of consciousness, either due to sleep or anesthesia, the response is radically different. We see a stereotyped burst of activity that remains localized and fades quickly."

The team believes that the response patterns observed in the awake brain, characterized by long-lasting activations moving over time to different cortical areas, reflect the connectivity of the cortical areas activated by TMS. This could be because when we are awake, the cortex is involved in many activities which require a constant communication between different cortical areas. But in the unconscious brain, this connectivity is temporarily lost, and therefore the TMS-evoked brain responses remain localized.

Ferrarelli says the results lend weight to the idea that a breakdown of cortical connectivity is a key aspect of loss of consciousness, and are consistent with the "integrated information theory of consciousness."

Co-author Dr. Robert Pearce, chair and professor of anesthesiology at UW SMPH, said it is interesting that the cortical responses under anesthesia were so similar to changes seen during natural sleep.

"The idea that some anesthetics "hijack" the natural sleep-promoting centers was proposed recently by others," says Pearce. "While our present findings do not directly confirm this hypothesis, they are consistent with a set of shared mechanisms. That is, that the loss of functional connectivity between brain regions is a characteristic that sleep and anesthesia share, and that we think might be causal in the loss of consciousness in both cases."

Tononi says that a similar test of cortical connectivity could be used to provide a non-invasive way to test an unresponsive patient for consciousness during anesthesia or in medical conditions such as coma.

"One practical application would be a test to help assess how conscious a patient is," Tononi says. Current tests rely partly on clinical observations, and may be altered by drugs or medical conditions that render an otherwise conscious patient unable to respond.

"We want to know whether a person is really there, and to us, it is important that the method is grounded on a theoretical model of what is required for consciousness," Tononi says.

Provided by University of Wisconsin-Madison