Tiny worms shed light on the mysteries of anesthesia

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Video Abstract

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Abstract

These microscopic roundworms have a lot to teach us about how general anesthesia works. In case you didn't already know, the effects of anesthesia on the brain are largely a mystery. That's right. For nearly two centuries, putting people under and bringing them back safely has remained more an art than exact science. And it isn't for lack of trying. Brain research in this area has followed two main tracks. Some researchers have used techniques like EEGs or fMRI to monitor neuron activity across entire regions of the brain. Others have analyzed individual chemical receptors to spot molecular-level interactions with anesthetic gases. The problem is that little has been done in between, at the level of individual neurons. Now, researchers have found a way to do that. Their method: attaching tiny light bulbs to single brain cells in roundworms and watching how they light up under anesthesia. It's a deceptively simple technique that involves genetically engineering worms to express fluorescent proteins in their brains. But because the worms' brain circuitry is well mapped out, the approach is also highly effective. Researchers know which neurons control the animal's movement and its forward and backward crawling. Under anesthesia, the worms react much like humans do. Their movements gradually get slower until eventually they stop altogether. It's tempting to surmise that neuron activity follows the same pattern—that neurons gradually stop firing. But light-bulb experiments showed otherwise. Under moderate concentrations of isoflurane, a common anesthetic, worm neurons didn't stop firing. They simply stopped firing together. The neurons in charge of movement remained active but not in the orchestrated manner they do when worms are awake. Instead, the neurons fired randomly and out of sync. These results are consistent with bulk recordings captured by EEG and fMRI, but offer much better resolution. The brain circuitry of roundworms isn't nearly as complex as that of humans. Still, this new approach could help fill an important gap in anesthesia research, providing a foundation for exciting new directions in this field and some reassurance for the millions of people who undergo surgery every year.