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SONOGENETICS: THE LATEST IN MIND CONTROL

Researchers at the Salk Institute developed a technique called "sonogenetics" to stimulate neurons and control behavior in C. elegans. (Source: Flickr https://flic.kr/p/5giagf)

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Researchers at the Salk Institute developed a technique called "sonogenetics" to stimulate neurons and control behavior in C. elegans. (Source: Flickr)

Though mind control was once the realm of science fiction, researchers at the Salk Institute for Biological Studies recently used low-pressure ultrasound waves to alter the neural activity and behaviors of *C. elegans*. The neuroscientists call this new technique "sonogenetics" (1).

Sonogenetics relies on touch-sensitive channel proteins, whose levels in nervous system cells can be altered through genetic engineering. The channels open when hit by an ultrasonic pulse, which allows ions to flood into a neuron, stimulating the neuron and turning it "on" (1). By using lipid bubbles to amplify the ultrasound waves, the neuroscientists generated an amazing effect: in response to a single ultrasonic pulse, the C. elegans worms dramatically altered their behaviors — changing and reversing directions, making more rapid turns, and moving their heads rapidly from side to side (1). The researchers were able to use noninvasive ultrasound waves to specifically target certain types of neurons, which was simply impossible using previous methods, such optogenetics and TMS (1).

Before this breakthrough, scientists were able to alter neural activity in very specific cell types of the brain by genetically sensitizing neurons to light through a method called optogenetics. However, this method is incredibly invasive, requiring surgically-inserted fiber optic cables (1).

A similar technique, transcranial magnetic stimulation (TMS), uses shifting magnetic fields instead of ultrasound waves to stimulate specific regions of the brain. TMS is already employed in many medical applications, from relieving migraines to improving symptoms of depression (3). Though TMS is noninvasive, it is not able to specifically target different types of neurons and brain tissue.

Sonogenetics is both specific, like optogenetics, and noninvasive, like TMS, making it a much more useful clinical and experimental technique. In the future, the neuroscientists anticipate being able to move the ultrasound target, or "focal zone," in order to activate different brain regions and neuronal types, including the deepest regions and cells of the brain, in rapid succession (1). This ability has tremendous potential clinical applications and again is impossible with current techniques for neural stimulation.

The researchers have suggested that many different touch-sensitive channel proteins may be even more sensitive, especially at different ultrasound frequencies and pressures. Sreekanth Chalasani, one of the neuroscientists involved in this research, hopes to create a toolbox of different touch-

sensitive proteins for multiple ultrasound frequencies and targeted uses (1). In the future, the researchers also hope to exploit the intrinsic differences between cell types of the brain to stimulate brain cells without genetically altering the levels of touch-sensitive proteins in the brain (1).

The researchers hope to soon test sonogenetics in different animals, like mice, that express different touch-sensitive proteins. However, clinical use in humans is a long-term goal, so mind control is still a far-off phenomenon.

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