Caudate Stimulation Enhances Human Associative Learning

A presentation at the 2017 American Association of Neurological Surgeons Annual Scientific Meeting

Los Angeles, Calif. (April 24, 2017) — Winner of the Philip L. Gildenberg MD Resident Award, Sarah Kathleen Bourne Bick, MD, presented her research, Caudate Stimulation Enhances Human Associative Learning, during the 2017 American Association of Neurological Surgeons (AANS) Annual Scientific Meeting.

Associative learning allows an individual to acquire an association between a sensory cue and an outcome resulting from a specific response. Associative learning plays a vital role in the ability to learn new associations that allow human beings to optimally respond to the world around them. Research in humans and primates supports an important role for the caudate in associative learning. Our objective was to determine whether caudate stimulation could modulate associative learning in humans and to examine the neural circuitry involved in this process.

Two subjects who underwent depth electrode placement for monitoring of refractory epilepsy were included in the study. During recording from intracranial electrodes, subjects participated in an associative learning task requiring them to learn associates presented image with a button press. For half of the presented images, bilateral caudate stimulation was performed at 2 mA and 200 Hz for one second during the feedback epoch after correct responses. Authors calculated the learning curve for stimulated and non-stimulated images using a state space model and calculated average power at electrode contacts in different spectral bands during the response and feedback epochs of the task and examined for correlation with the learning curve.

Caudate stimulation during correct feedback significantly improved associative learning. Stimulated image associations were learned more rapidly than non-stimulated image associations. Learning was associated with increased low gamma (30-55 Hz) power in the nucleus accumbens and increased theta (3-8 Hz) power in the dorsolateral prefrontal cortex.

Caudate stimulation during reinforcement of correct association enhances learning and is associated with power changes in both dopaminergic circuitry involved in reward processing and areas involved in associative processes. This supports a role for the caudate in integrating reward information with associations. Furthermore, this suggests a new potential target for neuromodulation in human memory disorders.

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Founded in 1931 as the Harvey Cushing Society, the American Association of Neurological Surgeons (AANS) is a scientific and educational association with more than 10,000 members worldwide. The AANS is dedicated to advancing the specialty of neurological surgery in order to provide the highest quality of neurosurgical care to the public. Fellows of the AANS are board-certified by the American Board of Neurological Surgery, the Royal College of Physicians and Surgeons of Canada or the Mexican Council of Neurological Surgery, A.C. Neurosurgery is the medical specialty concerned with the prevention, diagnosis, treatment and rehabilitation of disorders that affect the spinal column, spinal cord, brain, nervous system and peripheral nerves.

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