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In the current aging society, the number of patients suffering from degenerative brain diseases continues to increase, while many of these disorders remain intractable and difficult to treat using conventional pharmacological approaches. Non-invasive brain stimulation has emerged as an attractive alternative strategy that modulates neural activity through physical energy delivery rather than systemic drug intervention. Among existing stimulation modalities such as electrical, magnetic, and optical approaches, ultrasound has been proposed as a promising new neuromodulation technique due to its high spatial resolution, ability to reach deep brain structures, and noninvasive focusing capability. These properties allow selective modulation of specific neural circuits without surgical implantation, offering significant therapeutic potential for neurological and psychiatric disorders.

As ultrasound neuromodulation is still in its early developmental stage, further investigation into its mechanisms of action, circuit-level effects, and long-term safety is essential. Recent studies suggest that ultrasound stimulation can modulate neural excitability, alter synaptic transmission, and influence network connectivity, thereby reshaping dysfunctional brain circuits associated with cognitive decline and neurodegeneration. In this lecture, I will discuss emerging evidence on how ultrasound can regulate specific neural pathways and explore its potential as a circuit-based therapeutic strategy for preventing or mitigating degenerative brain disorders such as dementia.