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GABAergic interneurons: the orchestra or the conductor in fear learning and memory?

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Highlights

- Experience-dependent synaptic plasticity mediates memory storage.
- Historically, excitatory neurons considered primary memory storage substrate.
- GABAergic interneurons are emerging as key regulators of memory processes.
- We review recent evidence of learning-dependent inhibitory microcircuit plasticity.

Abstract

Fear conditioning is a form of associative learning that is fundamental to survival and involves potentiation of activity in excitatory projection neurons (PNs). Current models stipulate that the mechanisms underlying this process involve plasticity of PN synapses, which exhibit strengthening in response to fear conditioning. However, excitatory PNs are extensively modulated by a diverse array of GABAergic interneurons whose contributions to acquisition, storage, and expression of fear memory remain poorly understood. Here we review emerging evidence that genetically-defined interneurons play important subtype-specific roles in processing of fear-related stimuli and that these dynamics shape PN firing through both inhibition and disinhibition. Furthermore, interneurons exhibit structural, molecular, and electrophysiological evidence of fear learning-induced synaptic plasticity. These studies warrant discarding the notion of interneurons as passive bystanders in long-term memory.