

50 Years of Research on Dopamine's Role in Passive Aversive Conditioning and Extinction: A Systematic Review

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Abstract

Dopamine, a catecholamine neurotransmitter, has historically been associated with the encoding of reward, whereas its role in aversion has received less attention. Here, we systematically gathered the vast evidence of the role of dopamine in the simplest forms of aversive learning: classical fear conditioning and extinction. In the past, crude methods were used to augment or inhibit dopamine to study its relationship with fear conditioning and extinction. More advanced techniques such as conditional genetic, chemogenic, and optogenetic approaches now provide causal evidence for dopamine's role in these learning processes. Dopamine neurons encode conditioned stimuli during fear conditioning and extinction, and convey the signal via activation of D₁₋₄ receptor sites particularly in the amygdala, prefrontal cortex, and striatum. The coordinated activation of dopamine receptors allows for the continuous formation, consolidation, retrieval, and updating of fear and extinction memory in a dynamic and reciprocal manner. Based on the reviewed literature, we conclude that dopamine is crucial for the encoding of classical fear conditioning and extinction and contributes in a way that is comparable to its role in encoding reward.