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Evolution of the Reward Prediction Error During Reward Learning

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Recent developments questioned if medial ventral tegmental area (VTA) neurons encode a reward-prediction error signal during the initial phase of learning. Mesolimbic dopamine neurons have long been associated with this univeral reward prediction error signal and thought to be necessary for reinforcement learning. However, the VTA could also contribute differently depedent on the current learning phase.

Therefore, careful tracking of dopaminergic neurons during different learning phases of a classical Pavlovian reward conditioning task is a necessity. We developed a novel optrode microdrive which combines tetrode unit recordings and optogenetic confirmation of dopamine-cell identity. The construction of the drive prevents electrode tip movements and associated loss of units from the plugging forces of electrical and optogenetic plugs, resulting in a higher yield of identified units. The drive was implanted in the posterior medial portion of the VTA in DAT-Cre mice. Selective expression of ChR2 in dopaminergic cells from a floxed viral vector allowed the optical identification of individual dopaminergic units during each session.
The mice underwent a head-fixed reward learning paradigm. In this paradigm, an auditory stimulus preceded rewarding water delivery in a trace conditioning manner. Recording unit activity throughout the VTA then allowed us to evaluate the relationship of dopamine cell firing and reward prediction error coding during the early to late stages of conditioning.