Fooling the System: Reassigning value through exogenous dopamine activation

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Introduction

Natural Rewards

\[ Q_{at,j} = Q_{at,j-1} + \alpha (r_t - Q_{at,j-1}) \]

Rescorla & Wagner, 1972

Drugs of Abuse?

\[ Q_{at,j} = Q_{at,j-1} + \alpha (r_t - Q_{at,j-1}) + D_t \] or \[ Q_{at,j} = Q_{at,j-1} + \max \{ \alpha (r_t - Q_{at,j-1}) + D_t, 0 \} \]

Redish, 2004

Results

Modelling Stimulation

\[ Q_{at,j} = Q_{at,j-1} + \alpha (r_t - Q_{at,j-1}) \]

* direction of stimulation

VTA stimulation

behavior

model fit

Model

\[ Q_{at,j} = Q_{at,j-1} + \alpha (r_t - Q_{at,j-1}) + D_{at} \]

\[ Q_{green,j} = Q_{green,j-1} + \alpha (r_{green} - Q_{green,j-1}) + D_{green} \]

\[ DV = Q - Q + bias_{green} \]

choice probability = \[ \frac{1}{1 + e^{-\alpha t}} \]

Minimizing predicted probability of choosing the red target against the actual choice (1 or 0)

Evaluating the system

Matching Law

Reward

Dopamine

Matching Law

Reward

Dopamine

Matching Law

Can we model the effects of dopamine stimulation with a standard reinforcement learning model adjusted for a dopamine surge?

Effects of Dopaminergic Blockade

D2 Receptor partial blockade reduces D(t)

Conclusion

- A term for dopamine stimulation is a necessary adjustment to the reinforcement learning model.
- Blocking D2 dopamine receptors attenuates effects of stimulation