Rodents solve an extradimensional set-shifting task by forgetful, adaptive reinforcement learning

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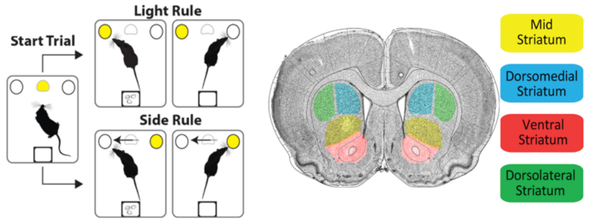
Intro

- The balance between flexible and rigid thinking is disrupted in psychiatric disorders
- The extradimensional set-shifting task has been used to probe this balance in rats and humans for the purpose of developing novel therapeutic approaches
- Previous work has demonstrated that electrical stimulation can decrease reaction times on this task for both rats and humans
- However, the specific behavioral strategies used to complete this task and the manner in which interventions modulate these strategies is not well understood.

Methods



- Long-Evans rats completed an extradimensional set-shifting task with active and sham stimulation
- Behavior was fit with 11 different computational models and analyzed with the best fitting model

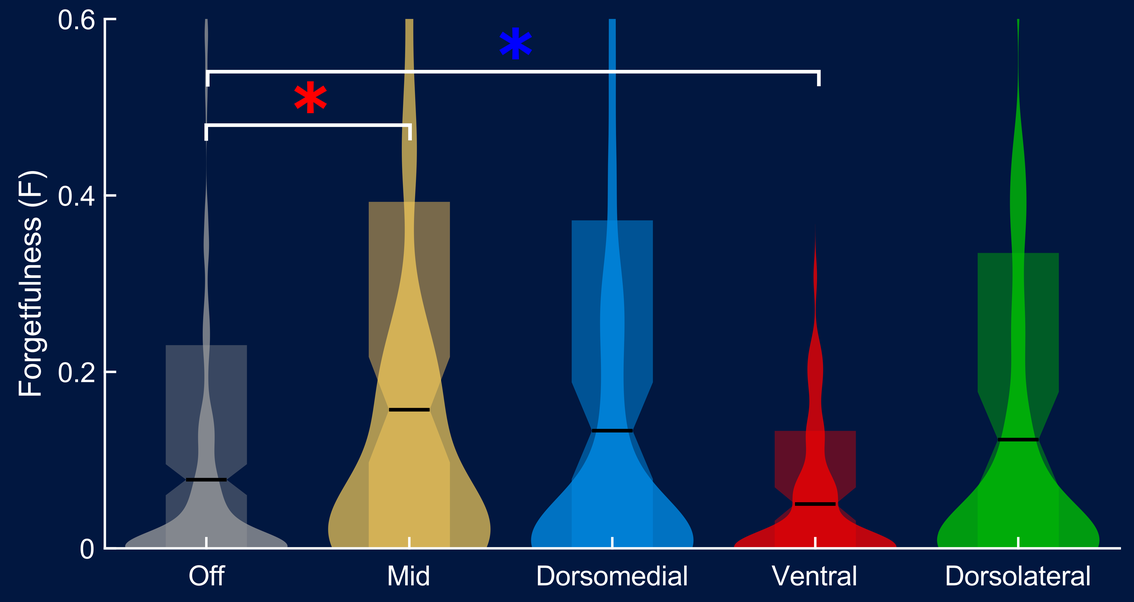
Results

- Rat behavior was best described by a forgetful adaptive reinforcement learning model
- Mid-striatal stimulation improved cognitive flexibility by reducing the valuation of unchosen actions (model forgetfulness coefficient)
- However, this result did not fully explain previously observed effects on reaction time

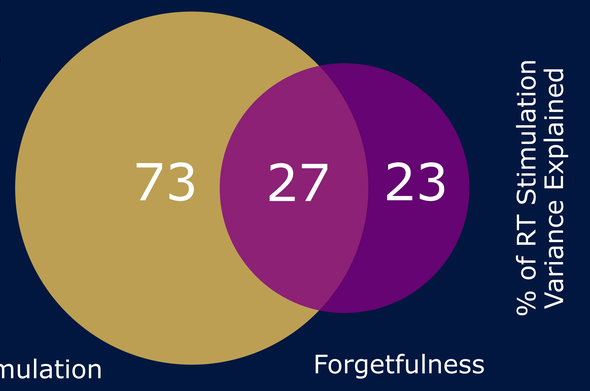
Discussion

- This finding supports the hypothesis that deep brain stimulation for psychiatric indications may provide therapeutic benefit by improving cognitive flexibility
- However, assays of this domain based on reaction times may be confounded by a number of factors

Electrical stimulation of mid-striatum specifically **enhances** cognitive flexibility in rats.

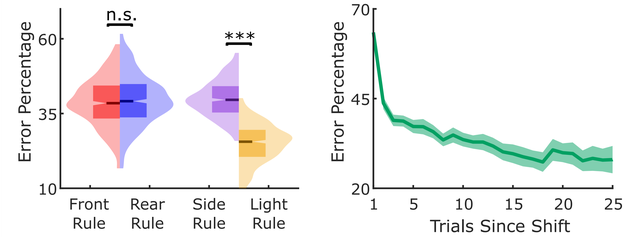


But this effect does not fully explain why stimulation reduces reaction time.



Illustrating figures

Task performance



Forgetful adaptive reinforcement learning equations

Chosen features:

$$Q_f(t+1) = Q_f(t) + \alpha PE|PE|^{\gamma}$$

Value function:

$$V_C(t) = \sum_f Q_f(t) \times \mathbf{1}_C(f)$$

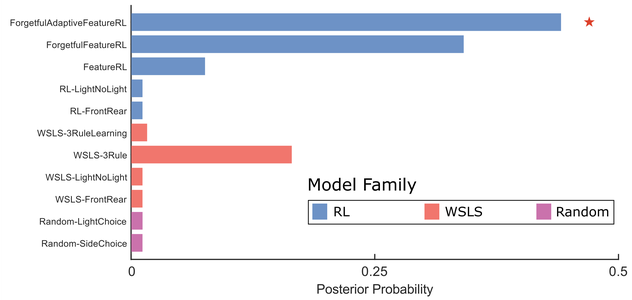
Unchosen features:

$$Q_f(t+1) = (1-F)Q_f(t)$$

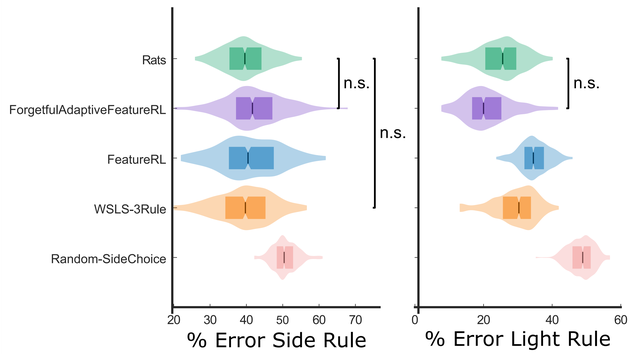
Action selection:

$$P_C(t) = \frac{\exp(V_c(t)\beta)}{\sum_C V_c(t)\beta}$$

Model selection



Posterior predictive checks



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