

Optimizing cognitive control with electrical stimulation

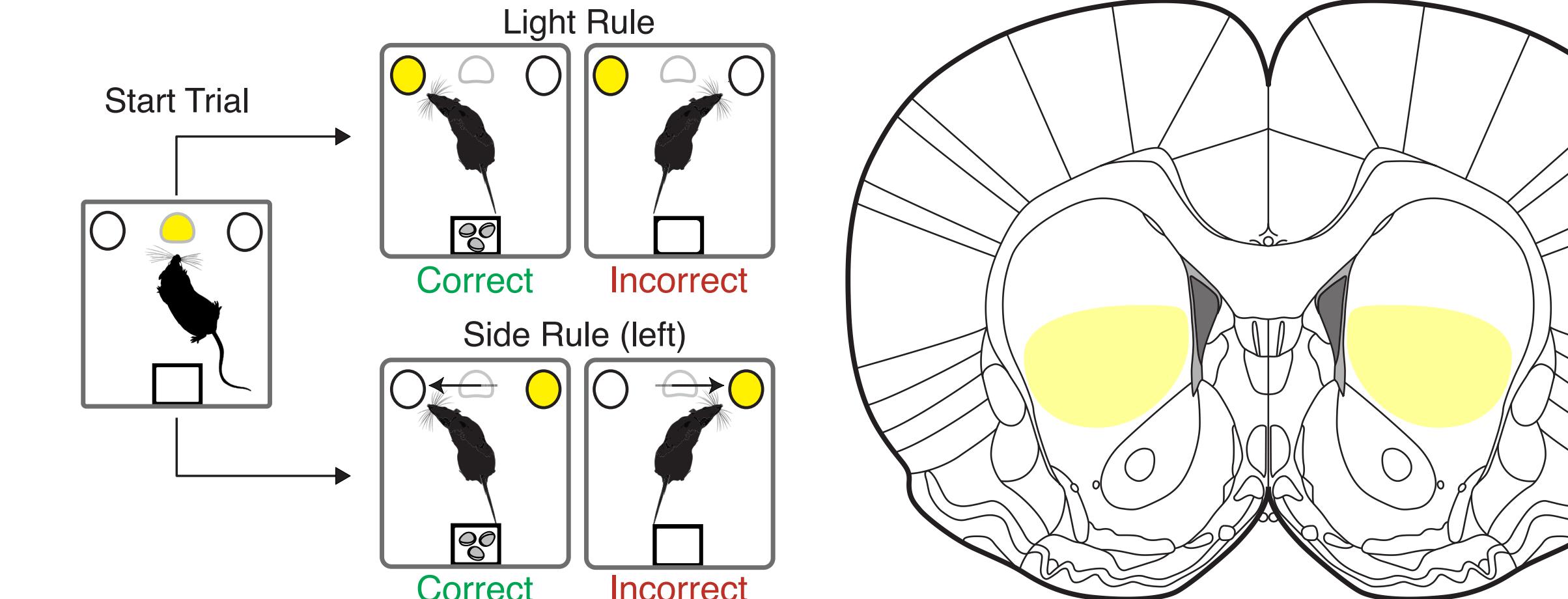
Evan M Dastin-van Rijn, Megan E Mensinger, Elizabeth M Sachse, Alik S Widge



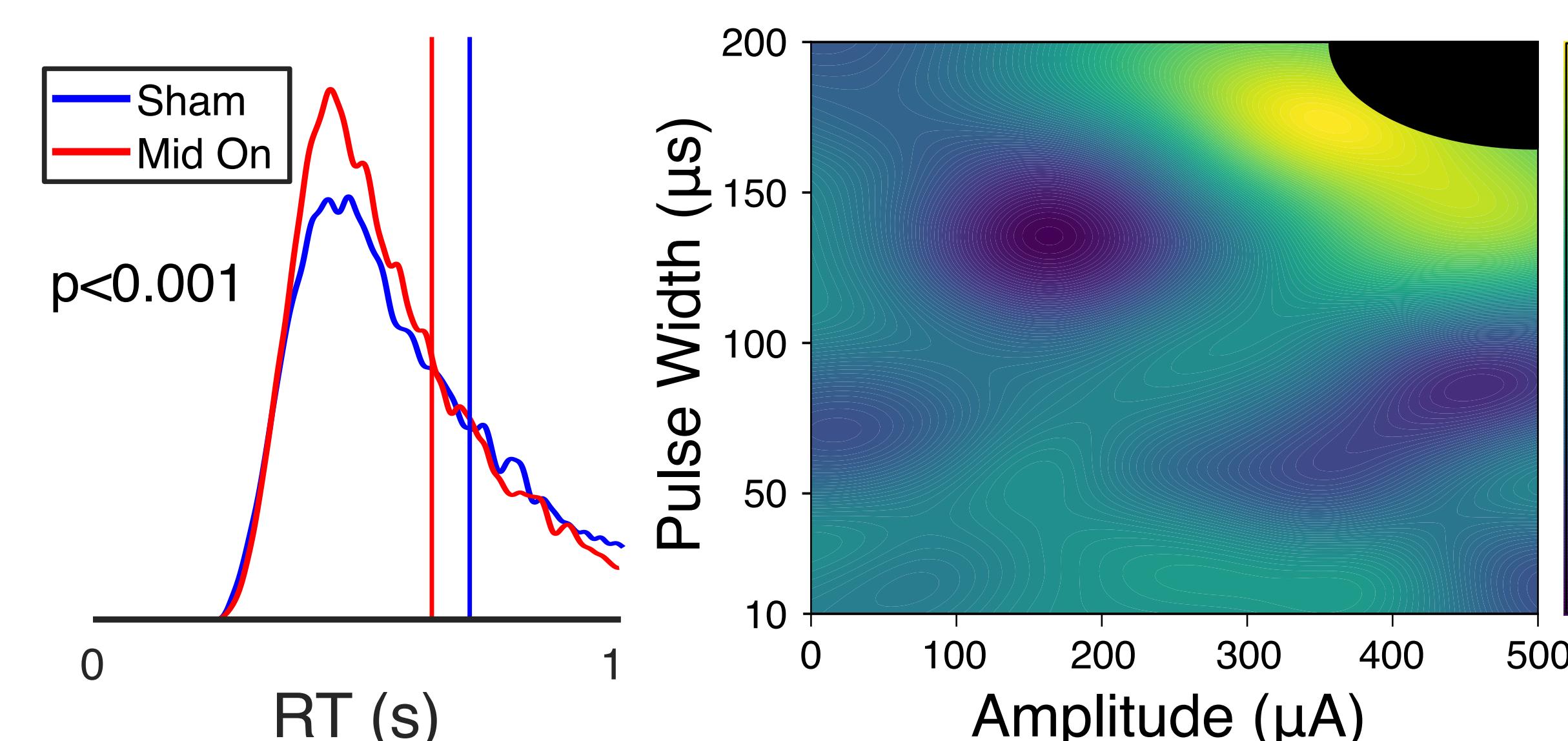
Intro

- The balance between flexible and rigid thinking is disrupted in psychiatric disorders
- Cognitive control tasks have been used to probe this balance in rats and humans
- Previous work has shown that electrical stimulation can enhance cognitive control in both rats and humans
- Reaction times (RT) are a valid trial-to-trial readout of cognitive control that could be used as a guiding signal for identifying clinically effective parameters

Background

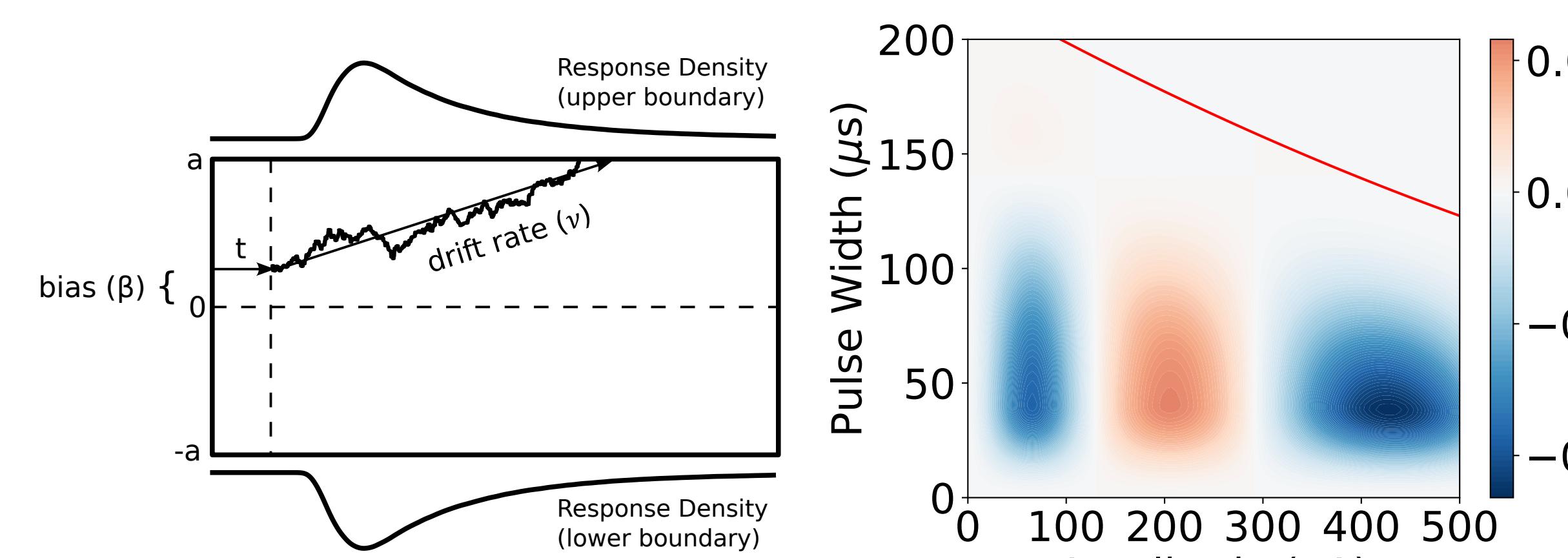


- Long-Evans rats were implanted with bipolar, platinum stimulating electrodes in mid-striatum and completed an extradimensional set-shifting task

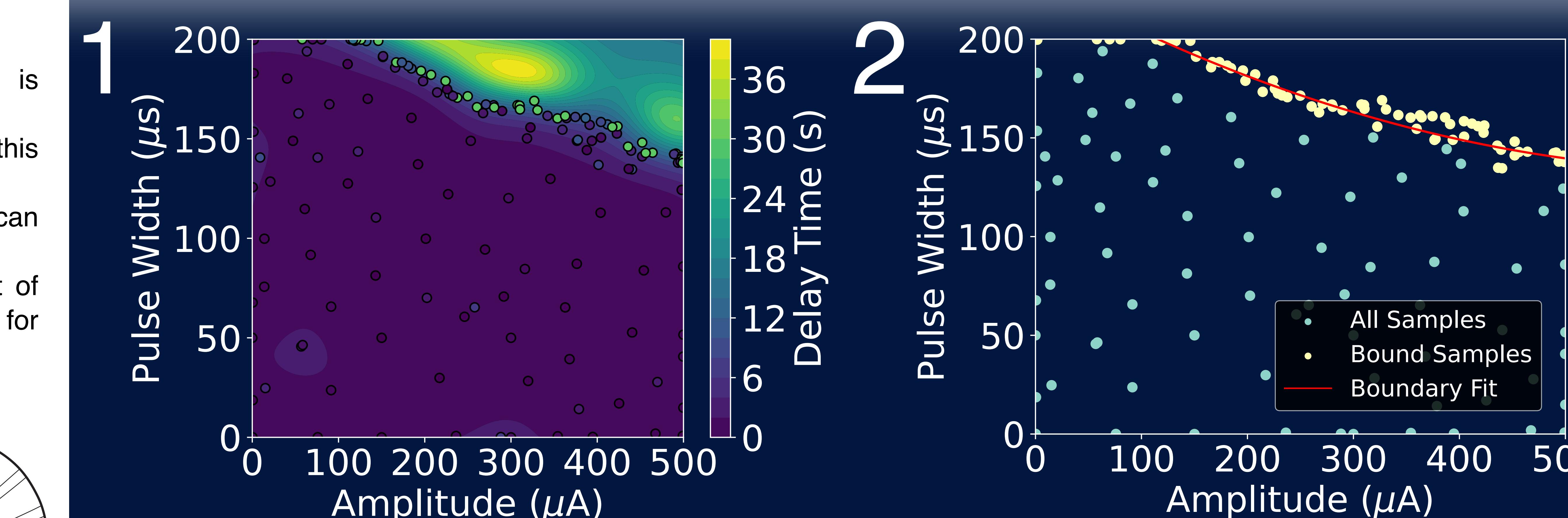


- Stimulation of the mid-striatum significantly decreases reaction time. This decrease appears to be sensitive to the choice of stimulation parameters.

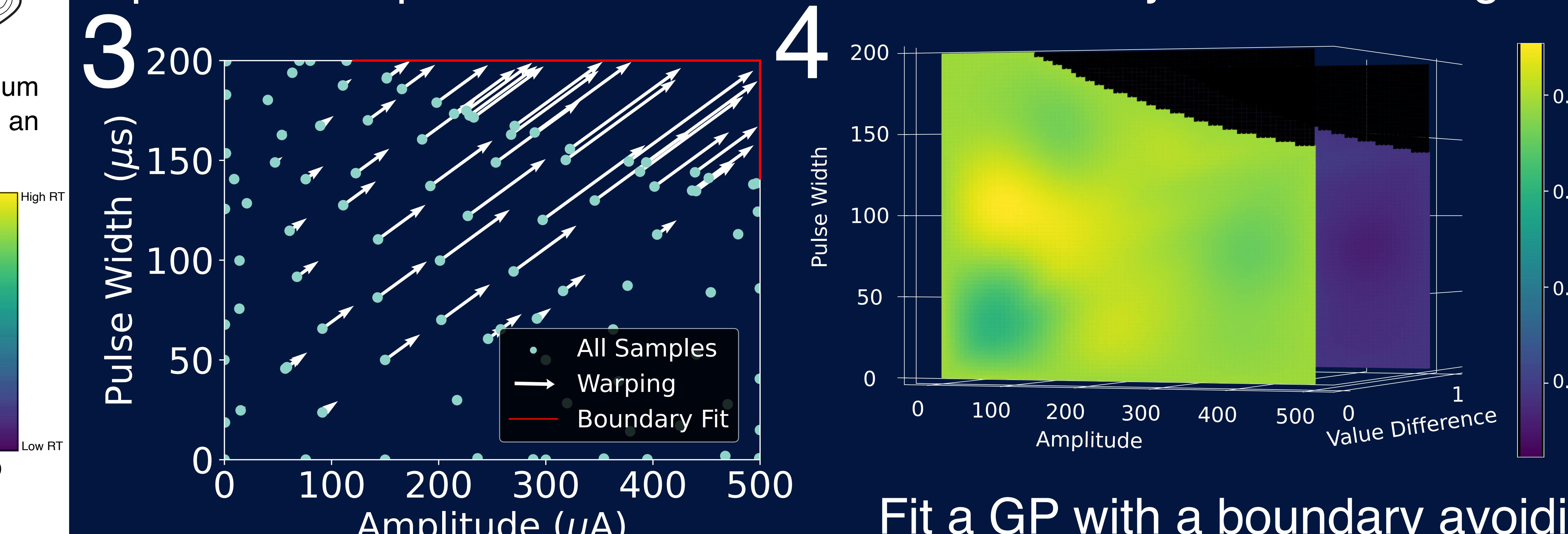
Methods



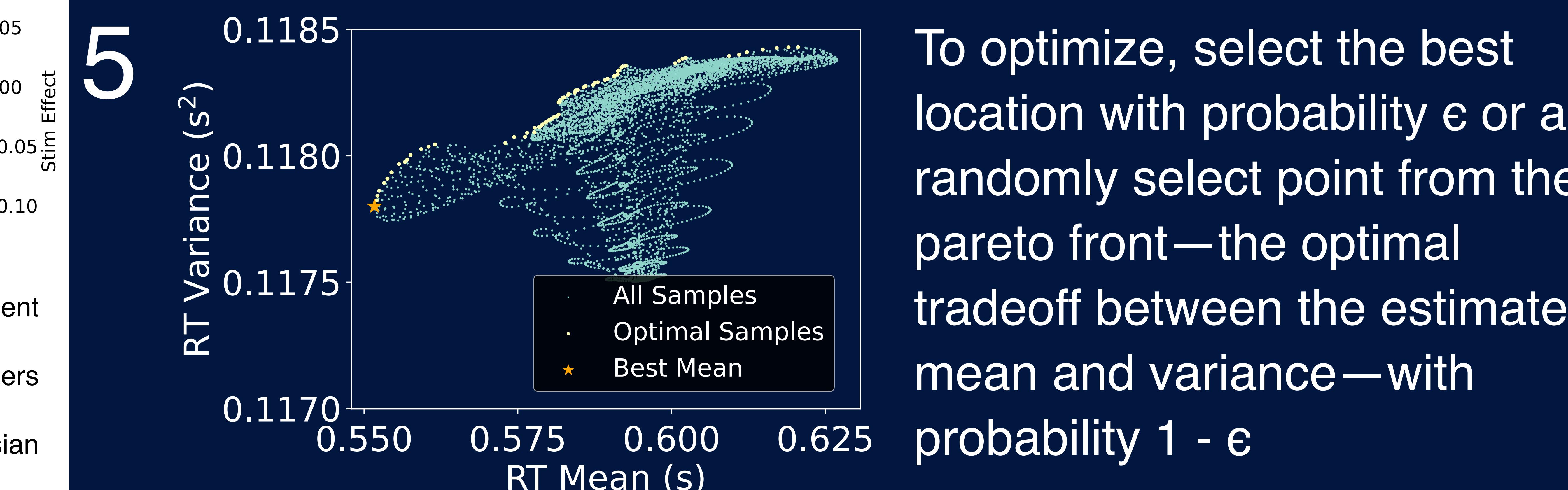
- Simulate set-shift data with a combination reinforcement learning-drift diffusion (RLDDM) model
- Model stimulation dependent effects on DDM parameters to produce changes in reaction time
- Learn optimal parameters in simulations with Bayesian Optimization



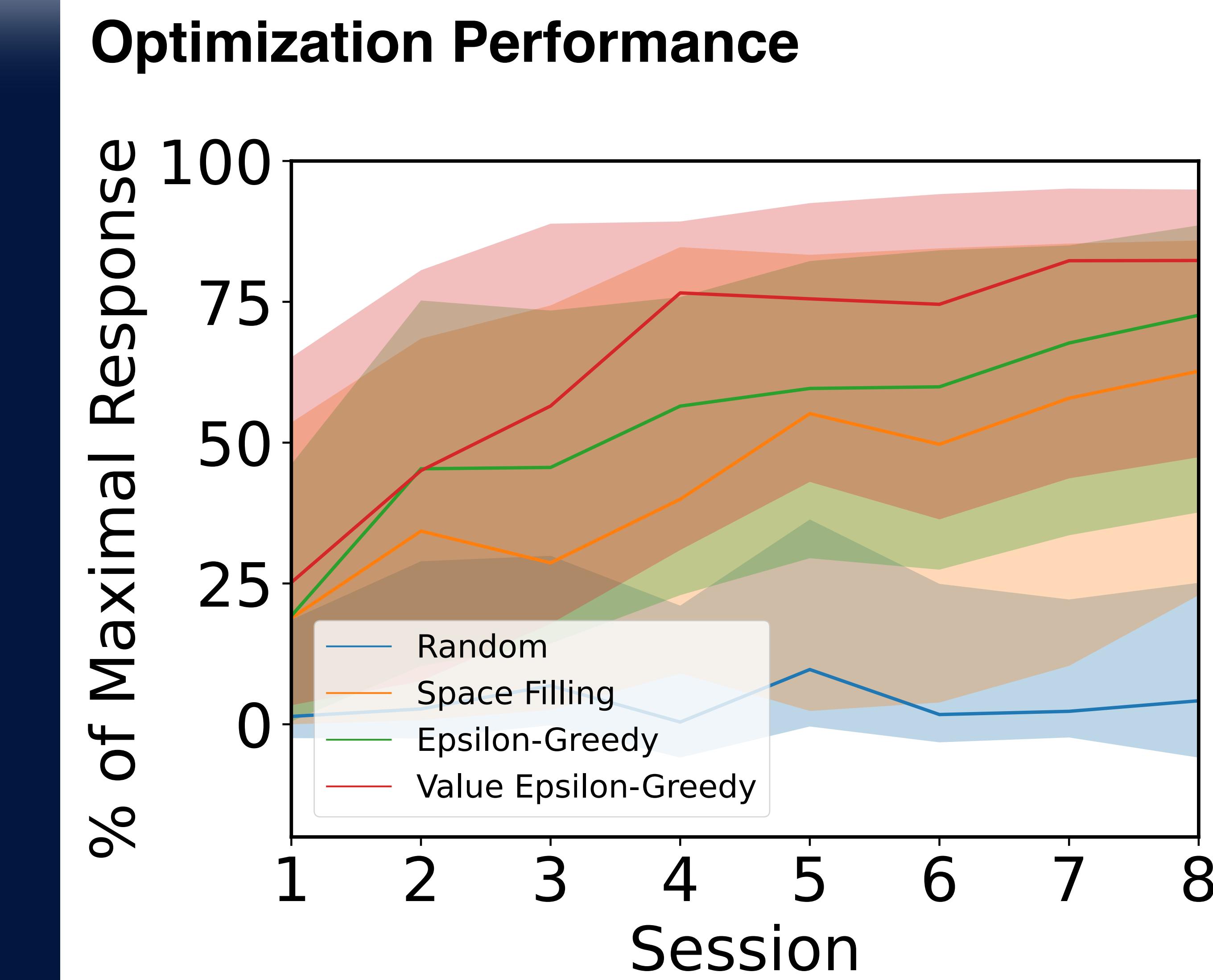
Determine the safe portion of parameter space



Warp the space to shift the safety bound to the input bound



Fit a quadratic equation to the boundary of the safe region



	Coefficient	Std. Err.	t	p	CI [2.5-97.5]
Intercept	0.2805	0.106	2.634	0.01	0.069-0.492
Effect Size	1.0486	0.374	2.8	0.006	0.305-1.1792
Bound Distance	0.8323	0.266	3.135	0.002	0.305-1.359

Discussion

- The optimization strategy performed better than chance or naively filling the safe region with samples
- Adding contextual/value information to the optimizer led to a substantial improvement
- Performance of the optimizer was greater for larger effect sizes and optimal locations further from the boundary
- Due to these effects and other sources of random variation, performance was below 50% of the optimal effect for a quarter of the simulations

Next Steps

- Test varying degree of exploration (variance minimization) as a function of the number of completed sessions
- Test sensitivity of performance to the accuracy of the learning parameters for estimating value differences
- Run simulations with more trials per session
- Run more simulations per condition (1000 vs. 100)
- See if it works in actual rats!

Acknowledgements

This poster is based upon work supported by the National Science Foundation Graduate Research Fellowship under Grant No. 2237827 and the National Institute of Neurological Disorders and Stroke of the National Institutes of Health under award number 1R01NS120851-01A1.