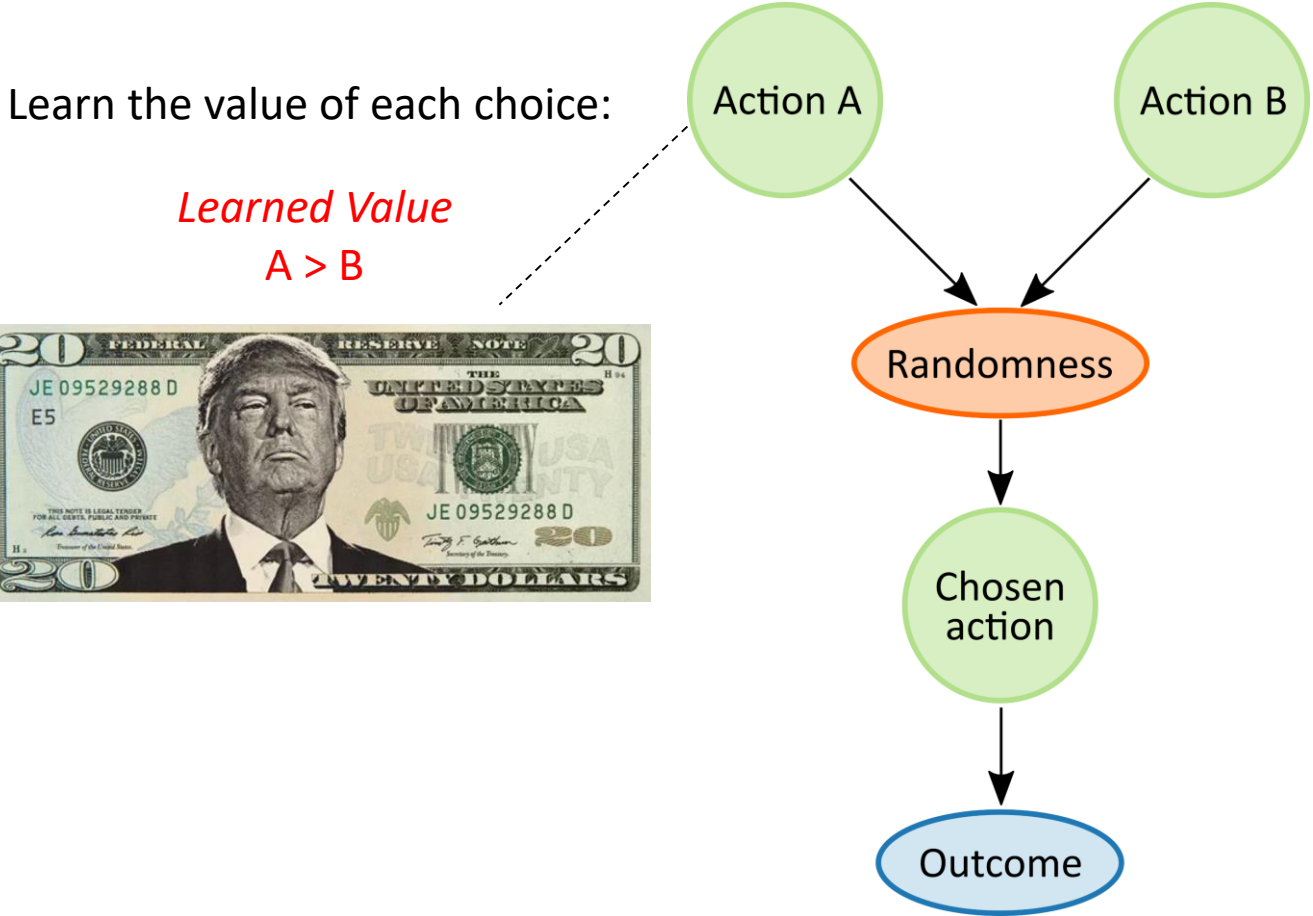# The role of glutamate receptor-dependent signaling in the dopamine system in reinforcement learning and adaptive decision-making

Przemysław Eligiusz Cieślak
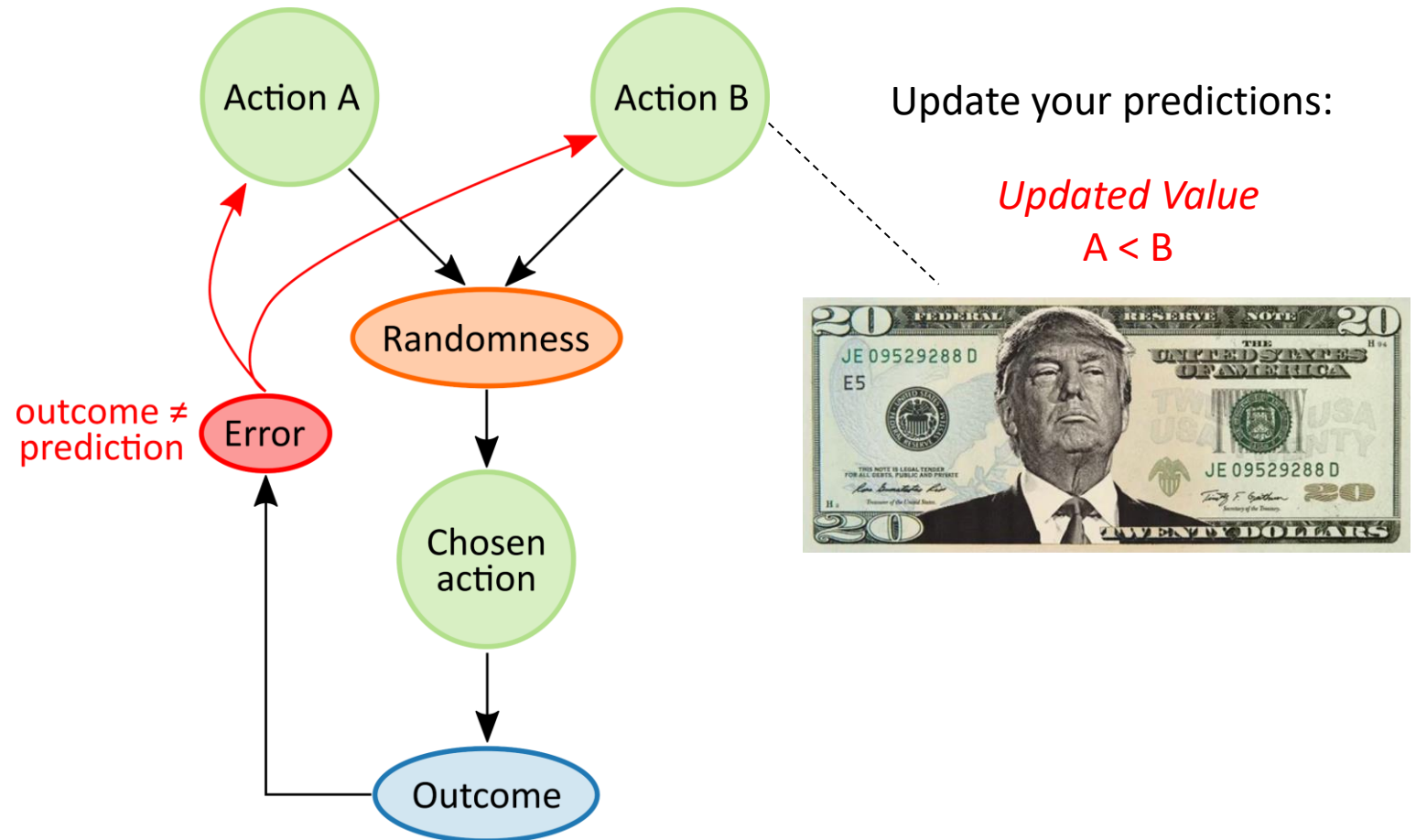
INSTITUTE OF PHARMACOLOGY
POLISH ACADEMY OF SCIENCES

Reinforcement leraning framework for studying value-based decision making

Learn the value of each choice:

Learned Value
A > B

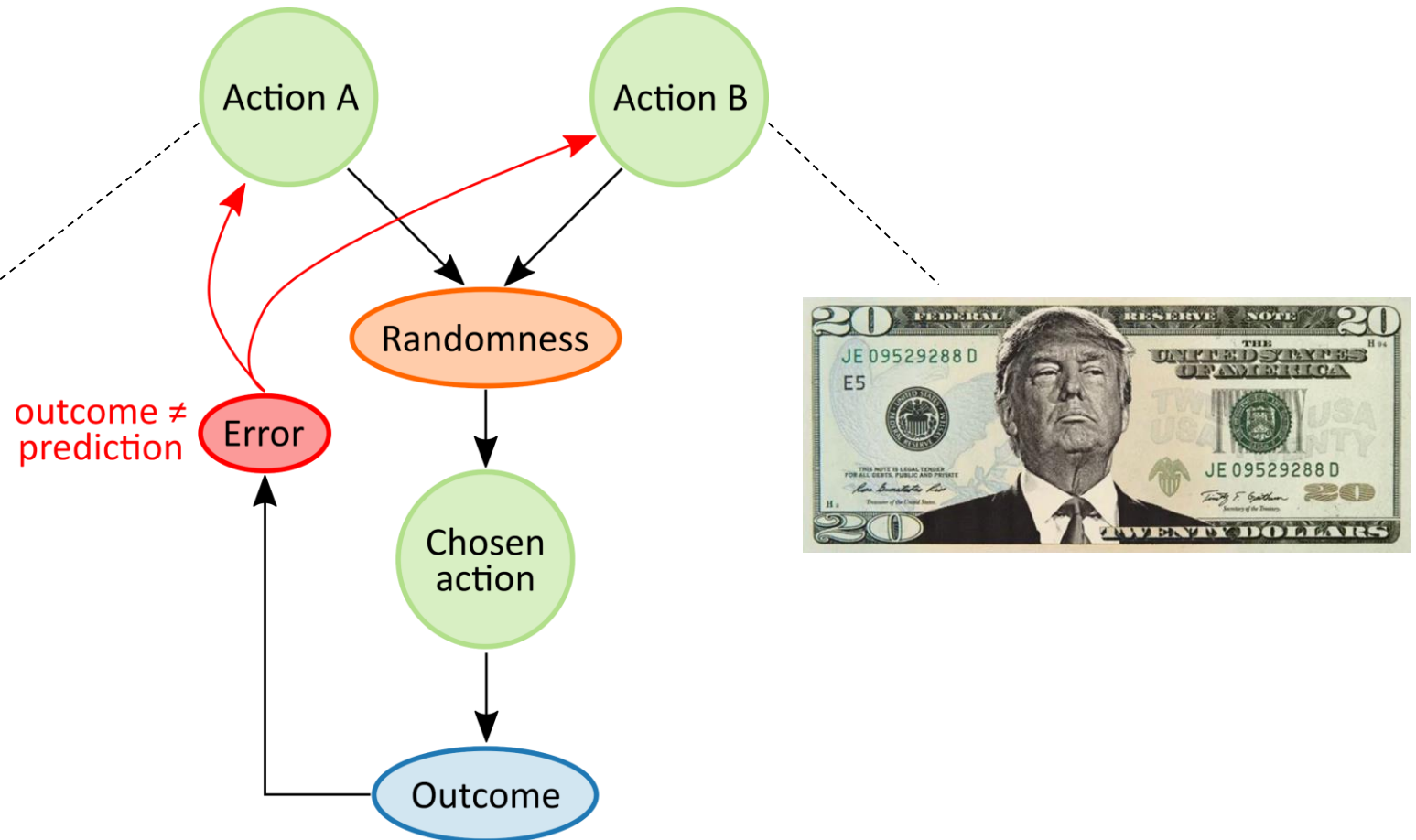Action A

Action B

Randomness

Chosen
action

Outcome

Reinforcement leraning framework for studying value-based decision making

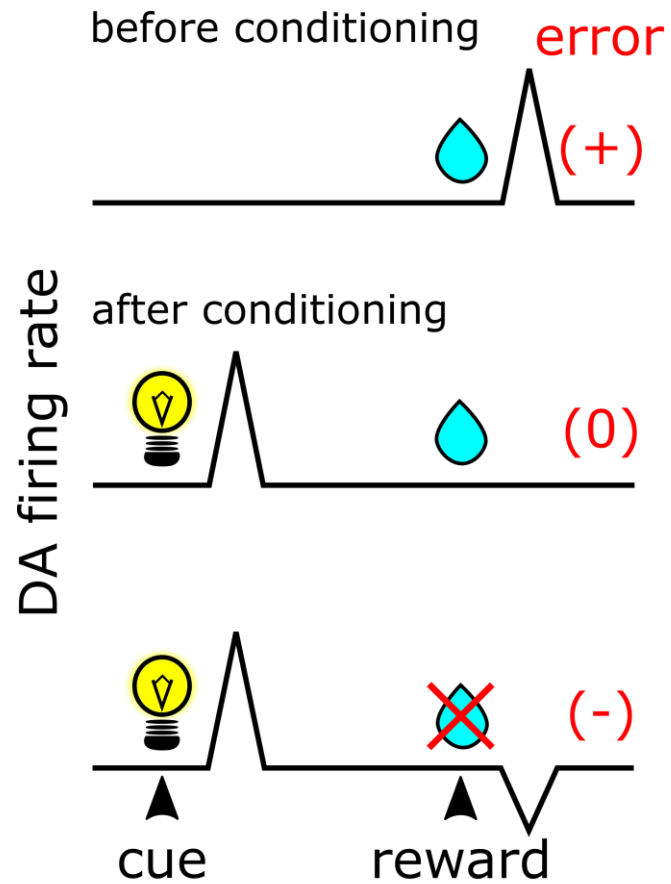# Reinforcement leraning framework for studying value-based decision making
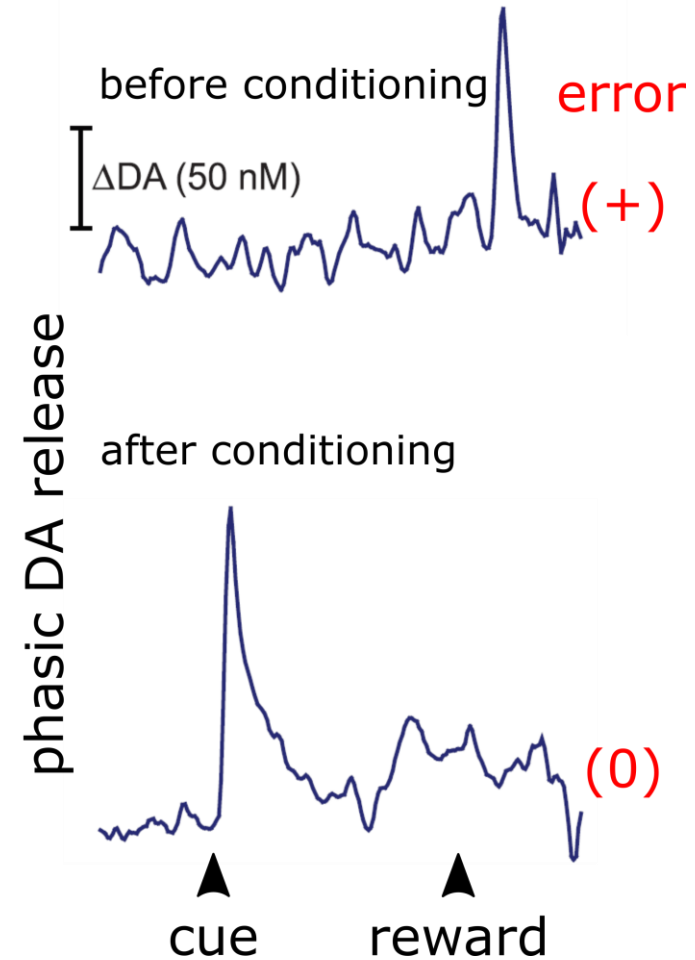
Dopamine reward prediction error (RPE)

before conditioning

error

(+)

after conditioning

(0)

(-)

cue   reward

DA firing rate

Schultz et al., 1997

before conditioning

error

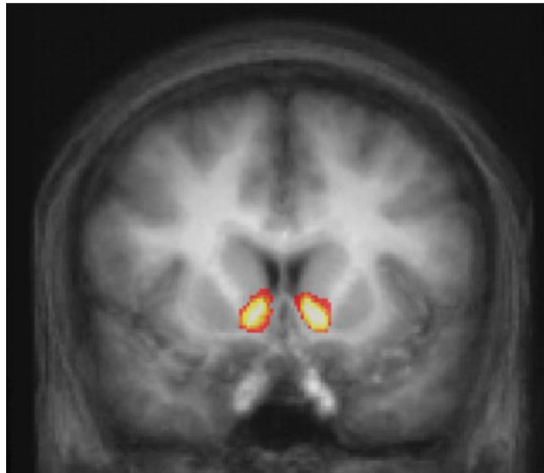ΔDA (50 nM)

(+)

after conditioning

(0)

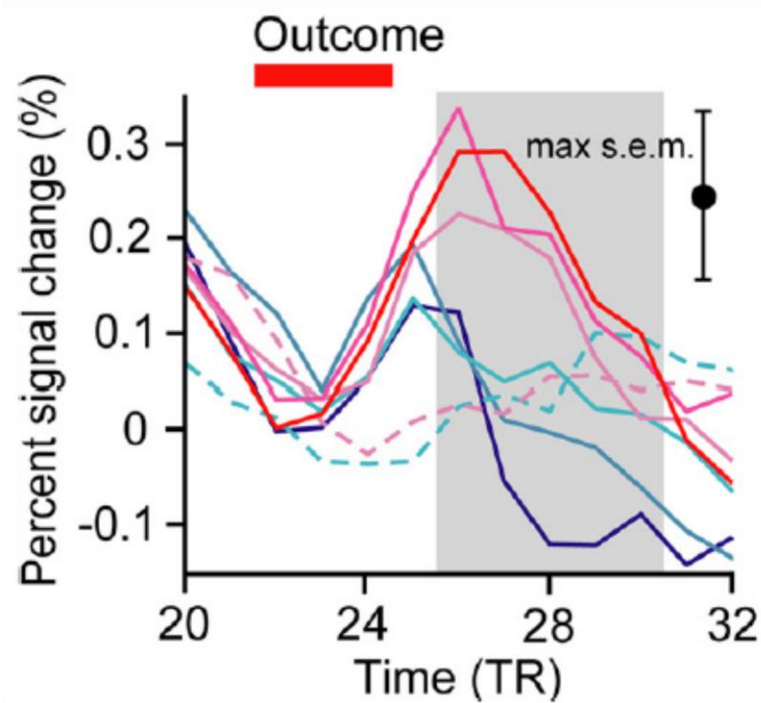cue   reward

phasic DA release
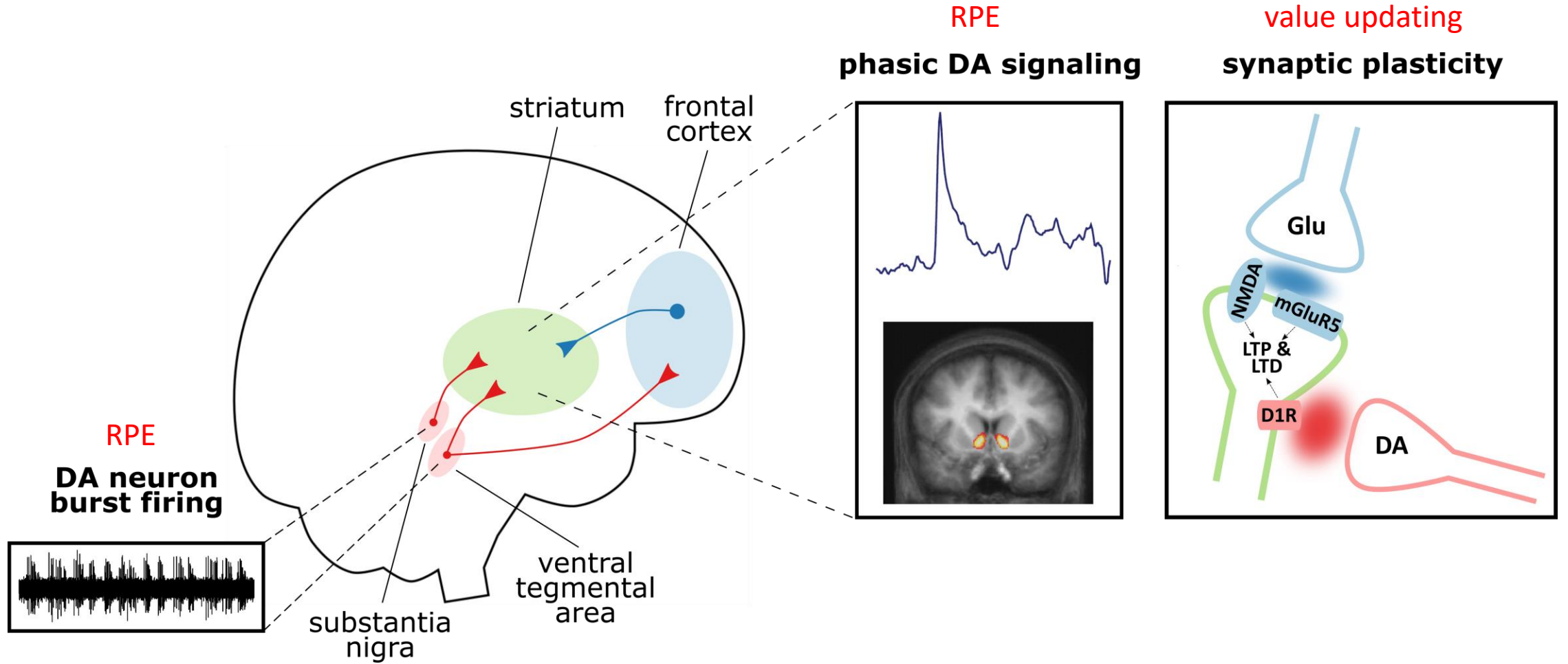
Stuber et al., 2008

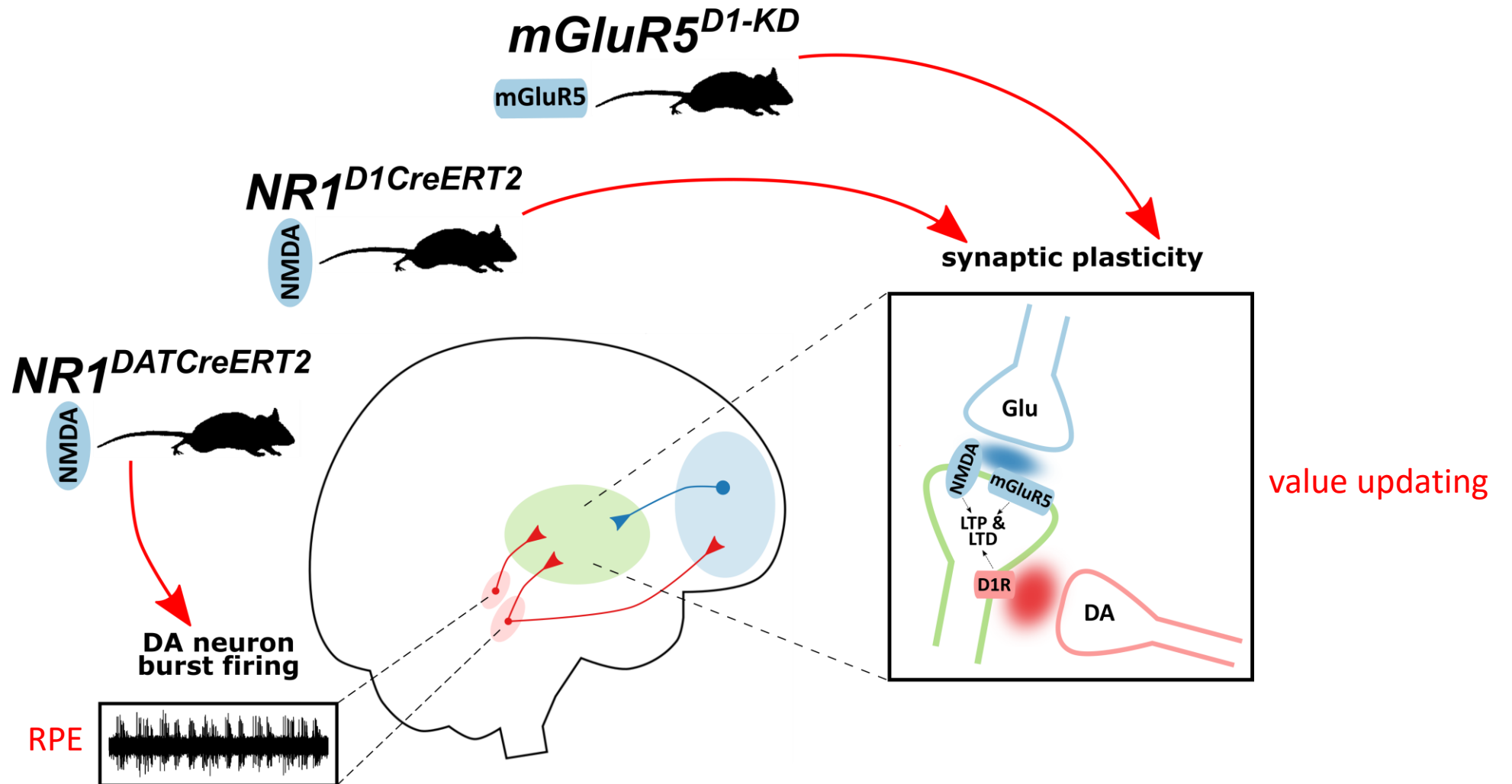# RPE in human brain

Nucleus accumbens
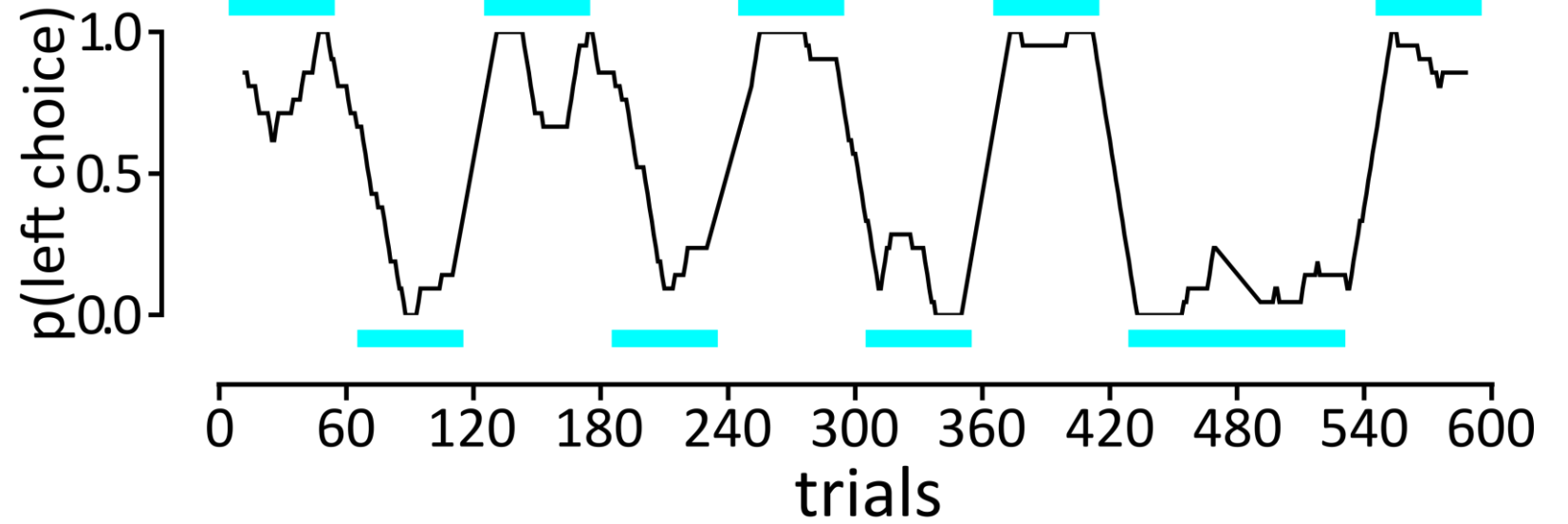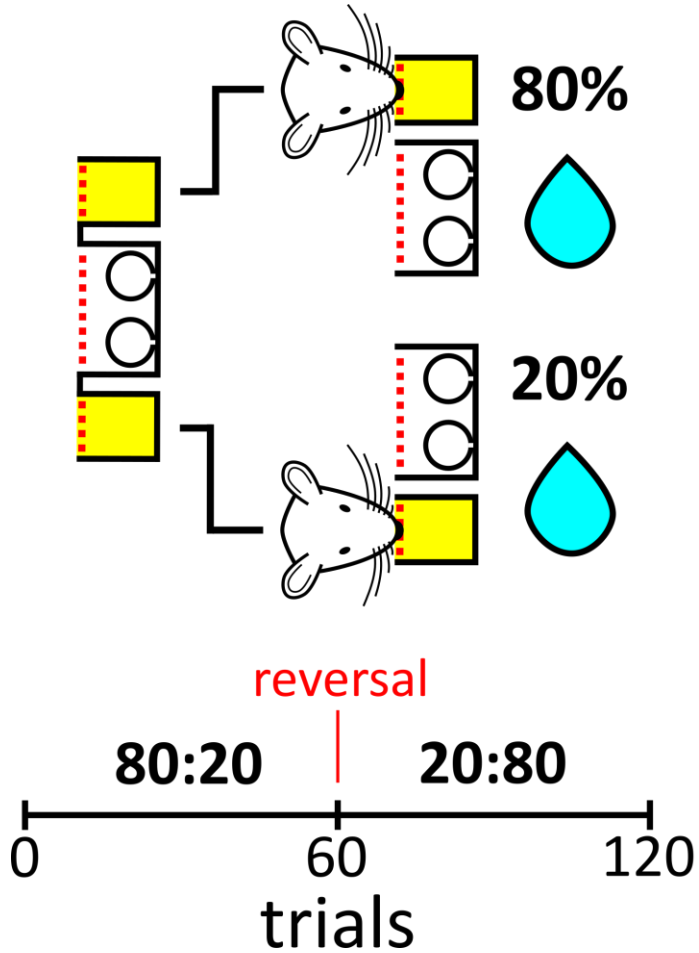
Rutledge et al., 2010

From RPE signaling to action value updating

Consequences of disrupted reinforcement learning?

Adaptive decision-making task
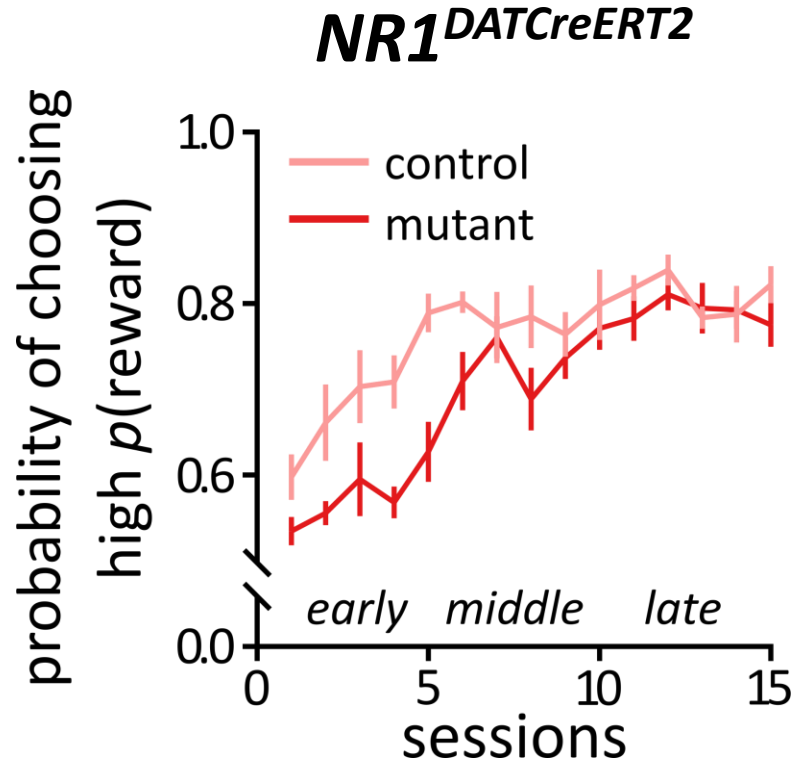
80%

20%

reversal
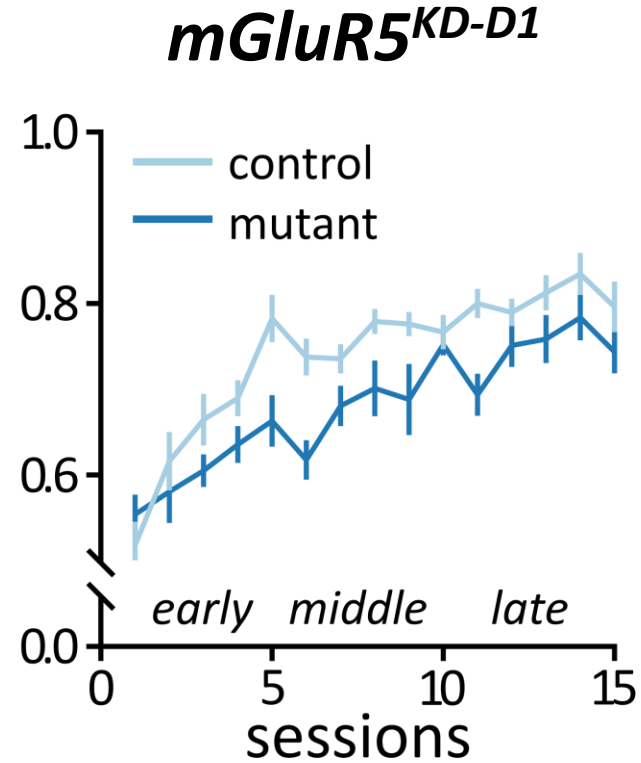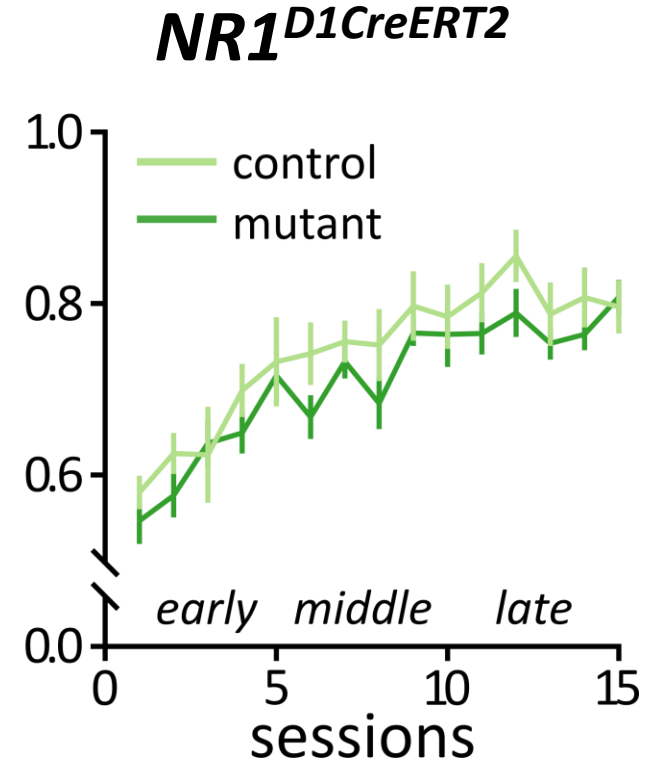
80:20 20:80

0 60 120
trials

p(left choice)

1.0

0.5

0.0

0 60 120 180 240 300 360 420 480 540 600
trials

high p(reward)
choice

Selection of the more often rewarded alternative

NR1^{DATCreERT2} mGluR5^{KD-D1} NR1^{D1CreERT2}

genotype x session $F_{14,168} = 1.90$, *p < 0.05*
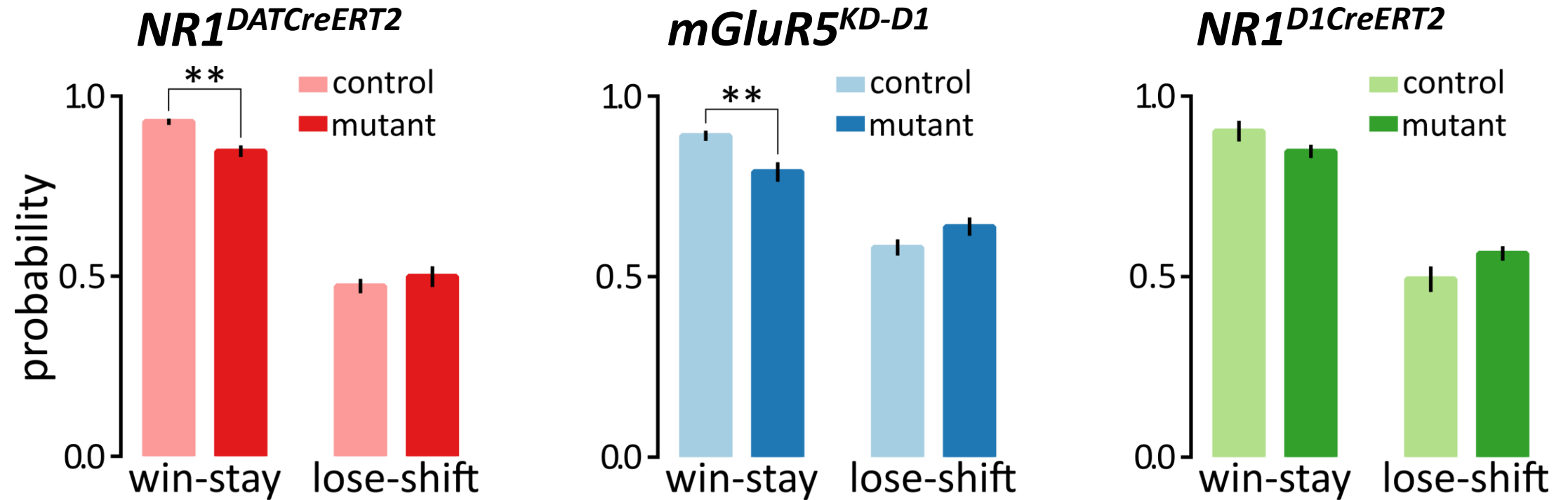*genotype* $F_{1,12} = 11.50$, *p < 0.01*

genotype x session $F_{14,210} = 1.49$, *ns*
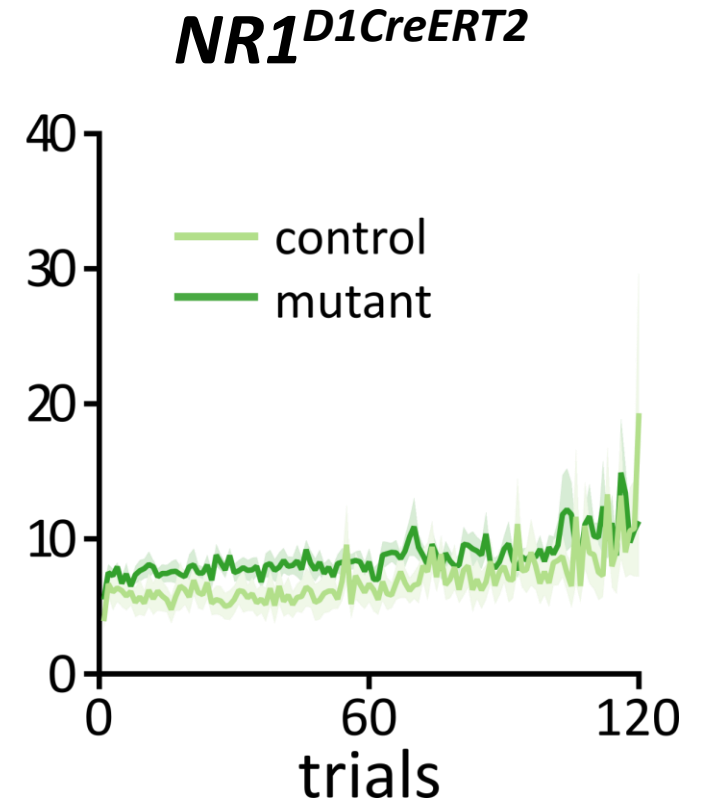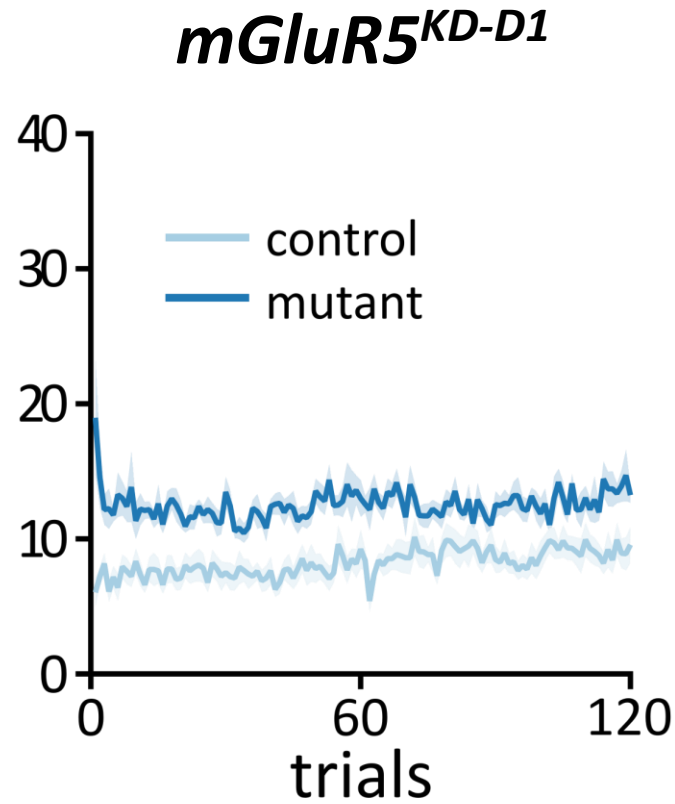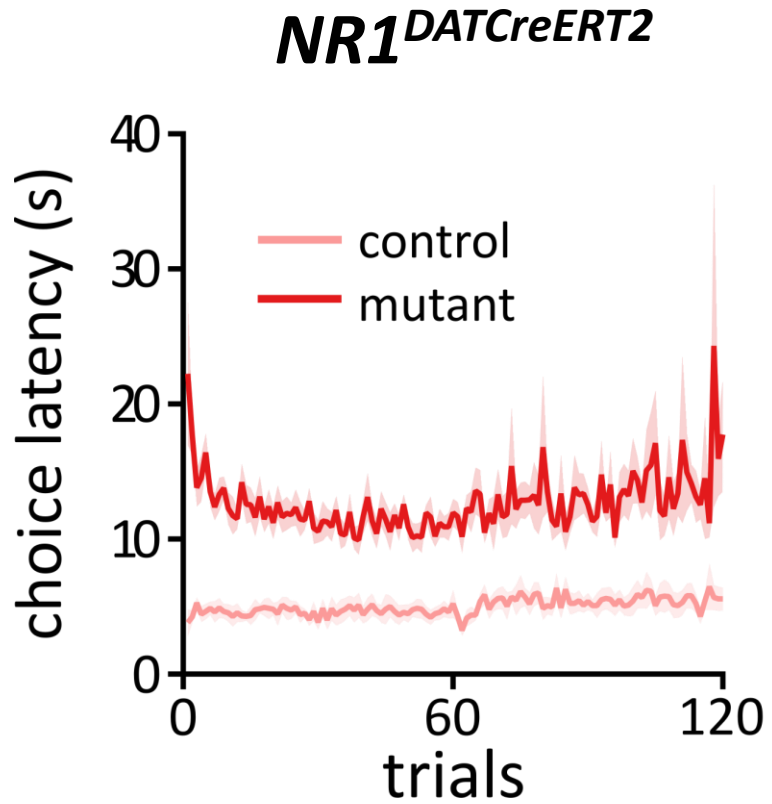*genotype* $F_{1,15} = 12.62$, *p < 0.01*

genotype x session $F_{14,182} = 0.53$, *ns*
genotype $F_{1,13} = 1.79$, *ns*

Effects of previous outcomes on choice

NR1^{DATCreERT2}

mGluR5^{KD-D1}

NR1^{D1CreERT2}

** $p < 0.01$

Choice latency (trial by trial)
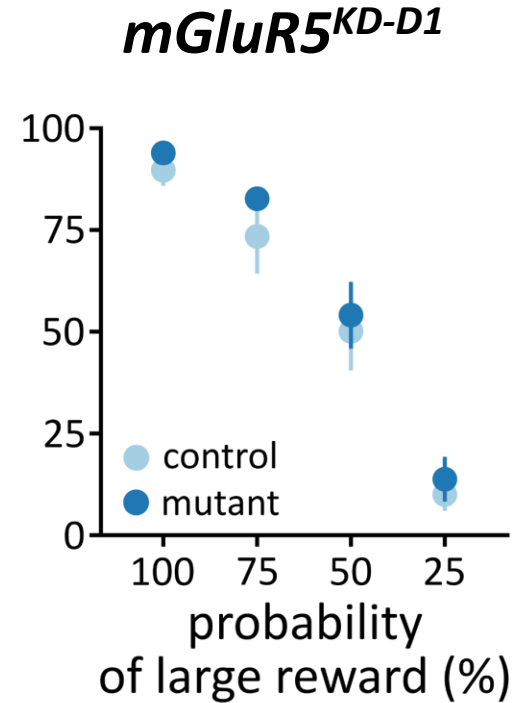
Reward latency

$NR1^{DATCreERT2}$

$mGluR5^{KD-D1}$

$NR1^{D1CreERT2}$
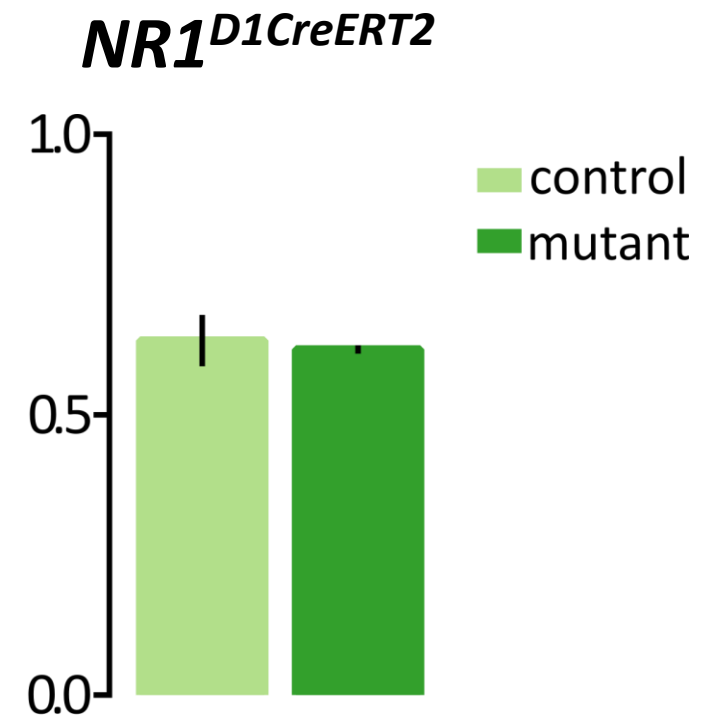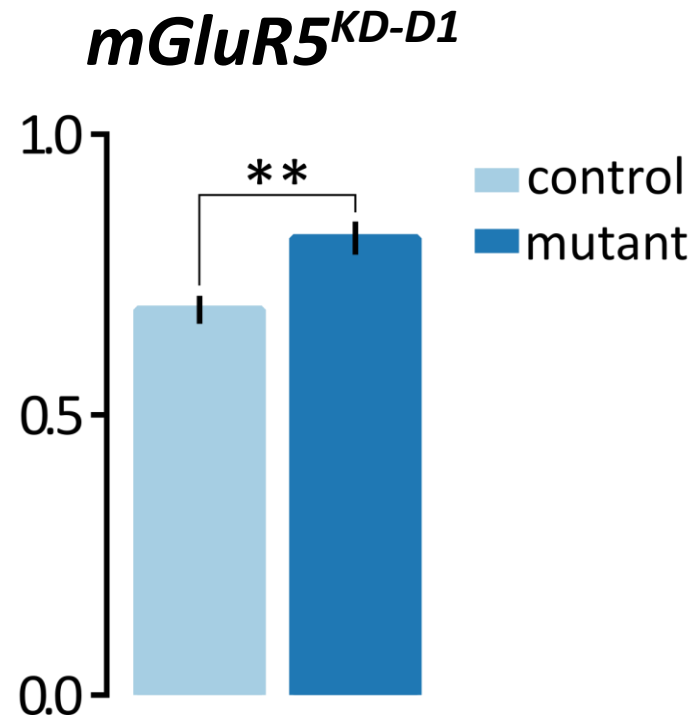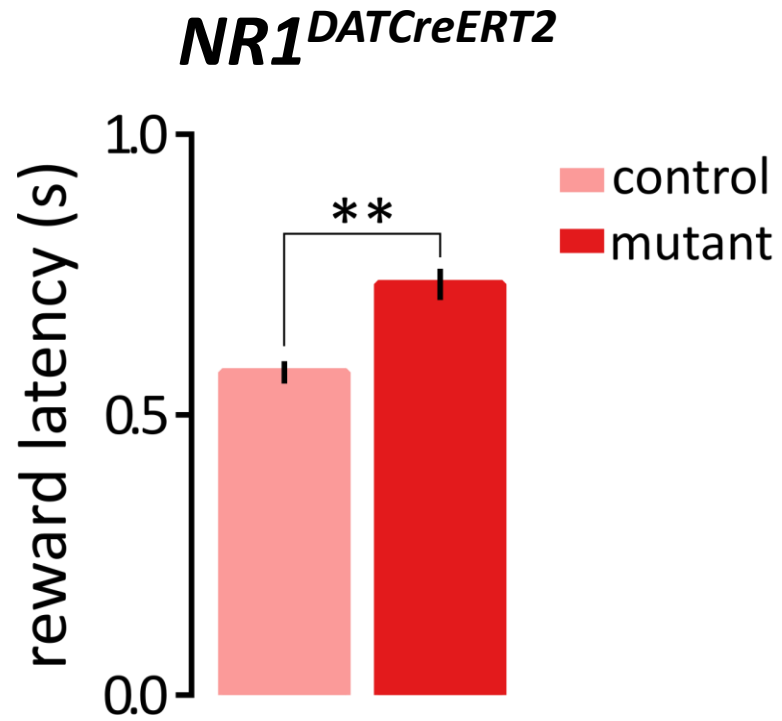
** $p < 0.01$

Reward magnitude discrimination & probability discounting
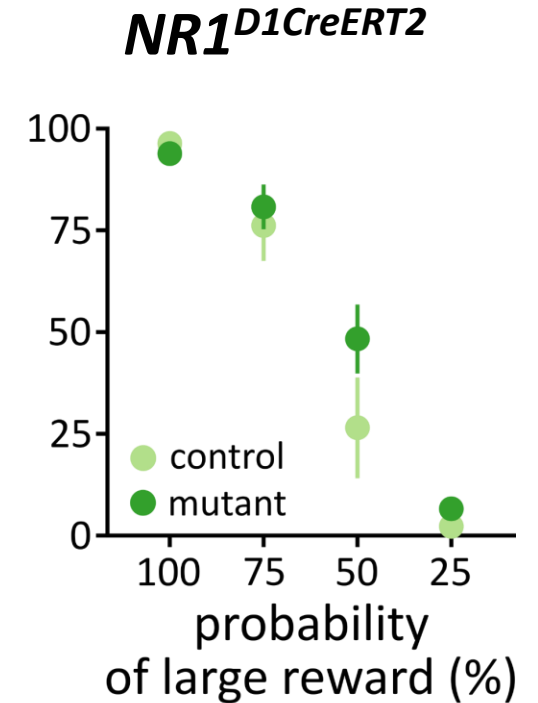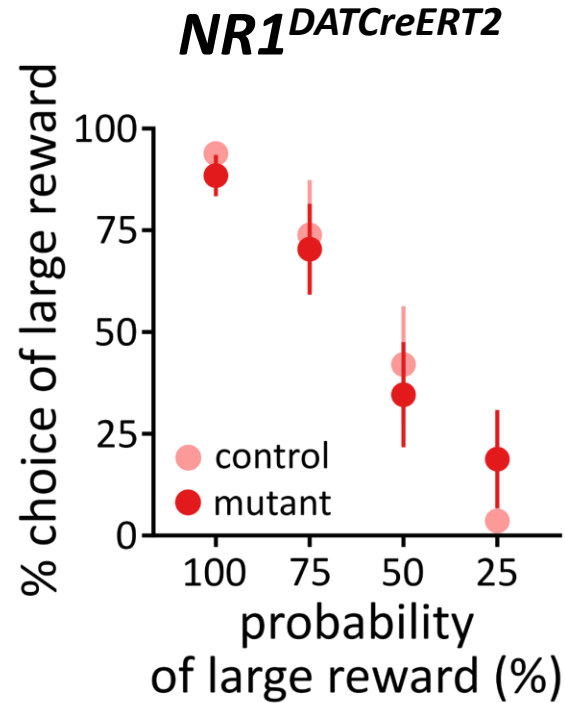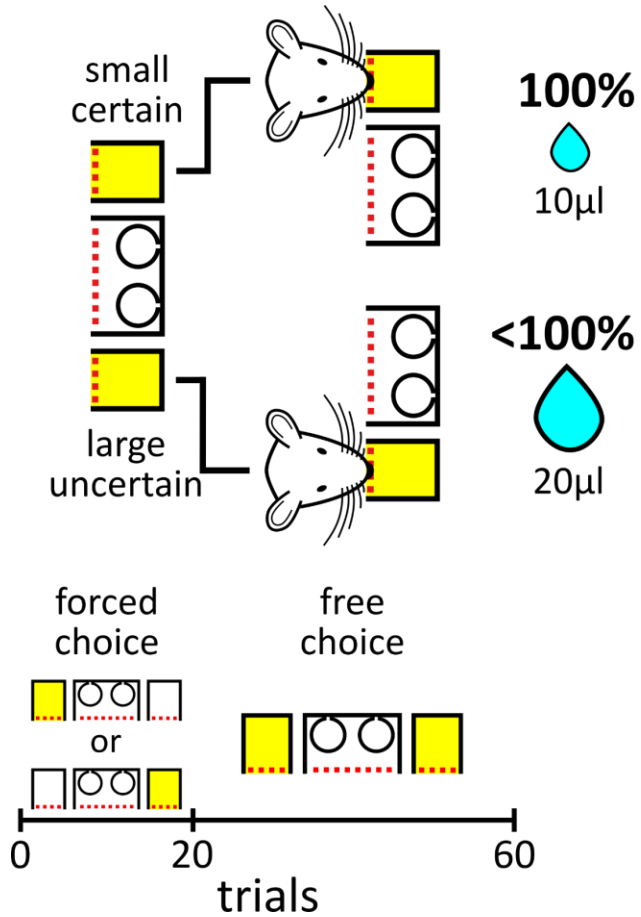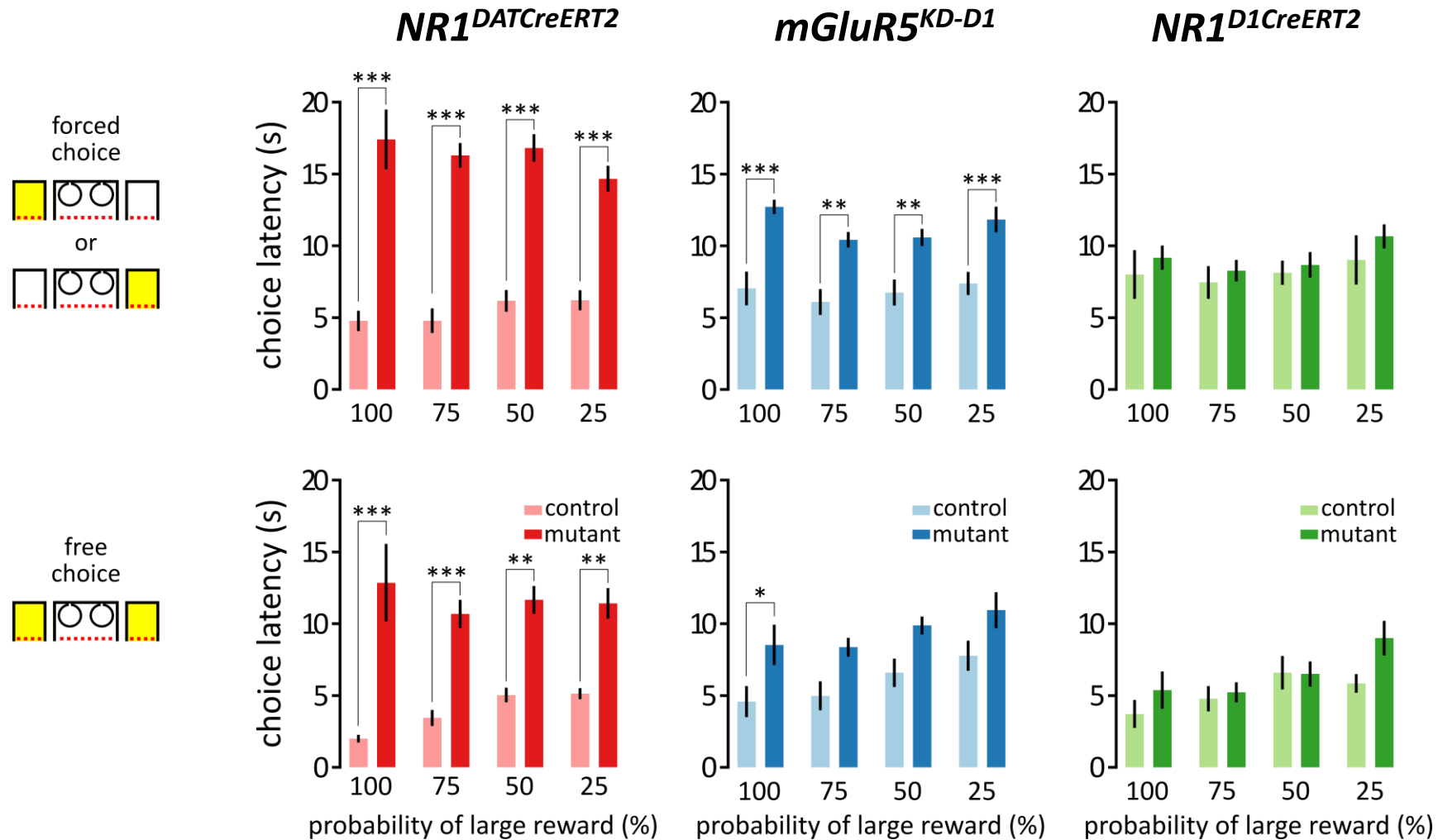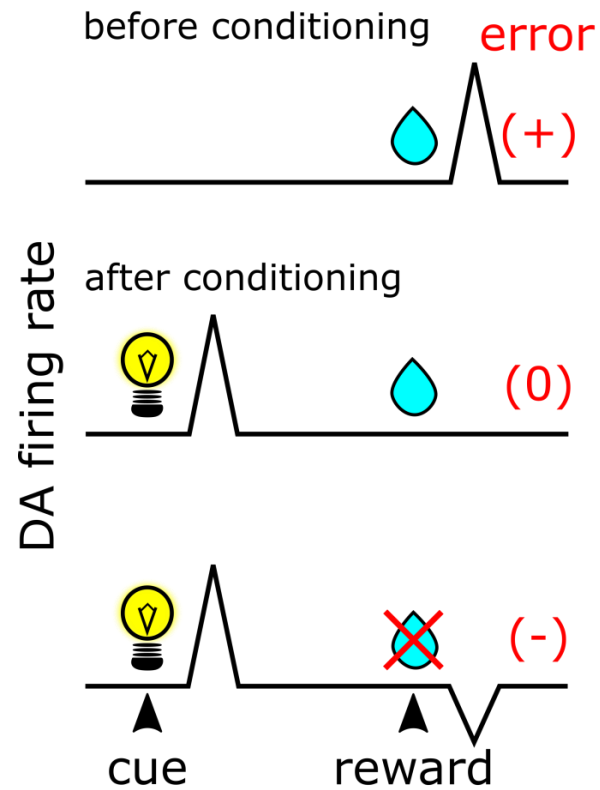
Choice latency (forced & free choice trials)

NR1^{*DATCreERT2*}   *mGluR5*^{*KD-D1*}   *NR1*^{*D1CreERT2*}

forced choice

or

free choice

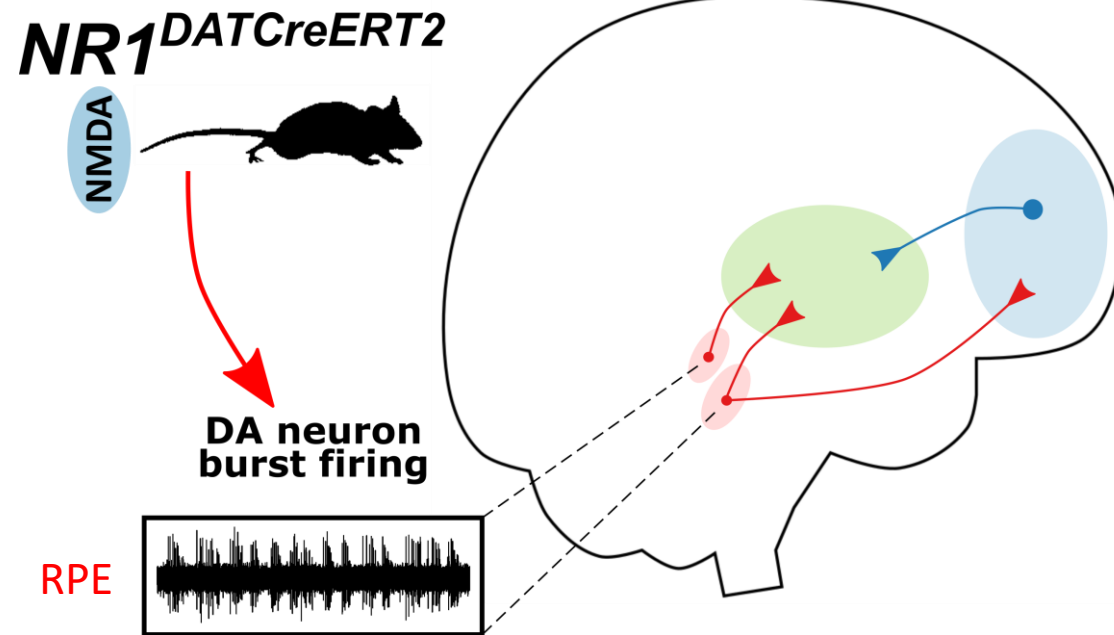choice latency (s)

control
mutant

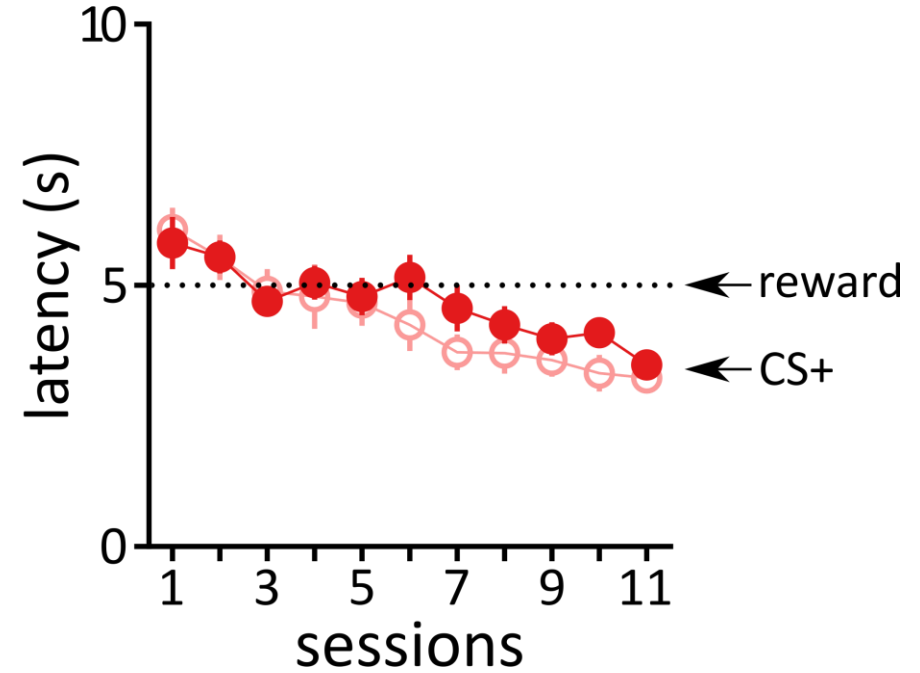probability of large reward (%)
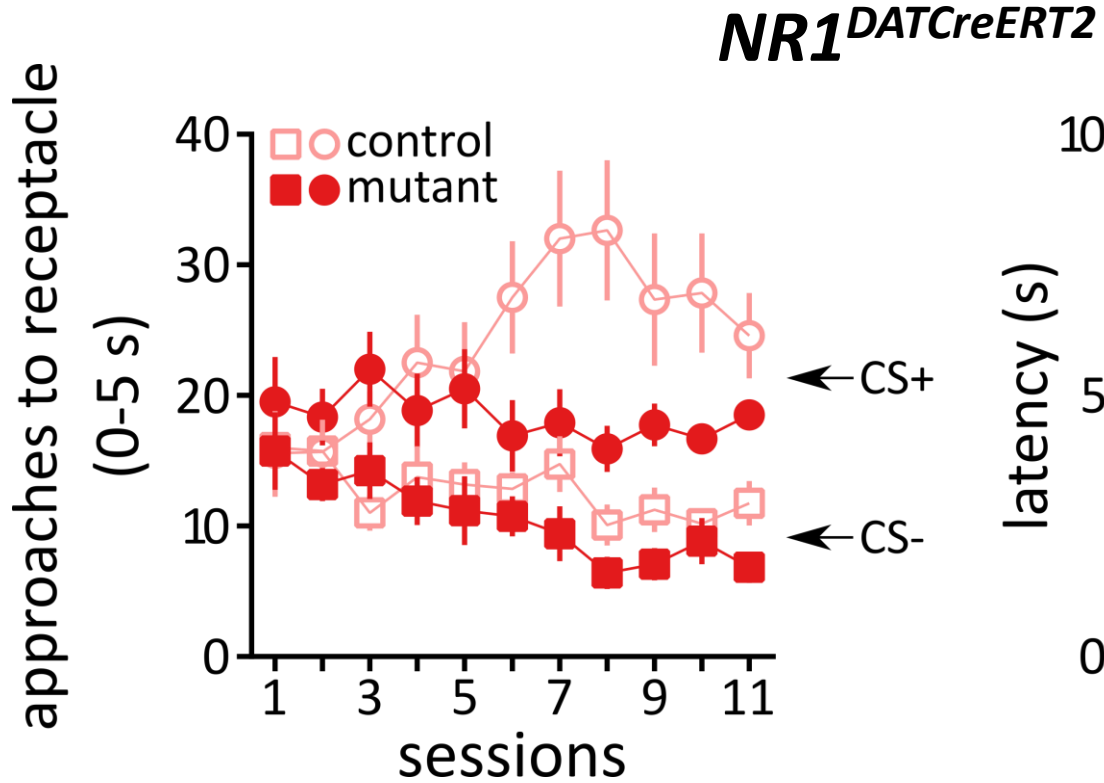
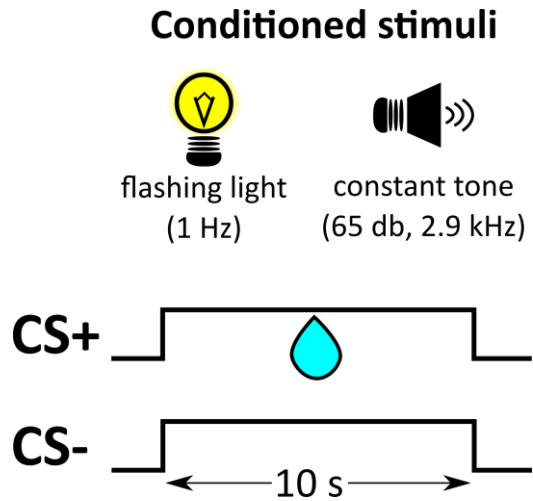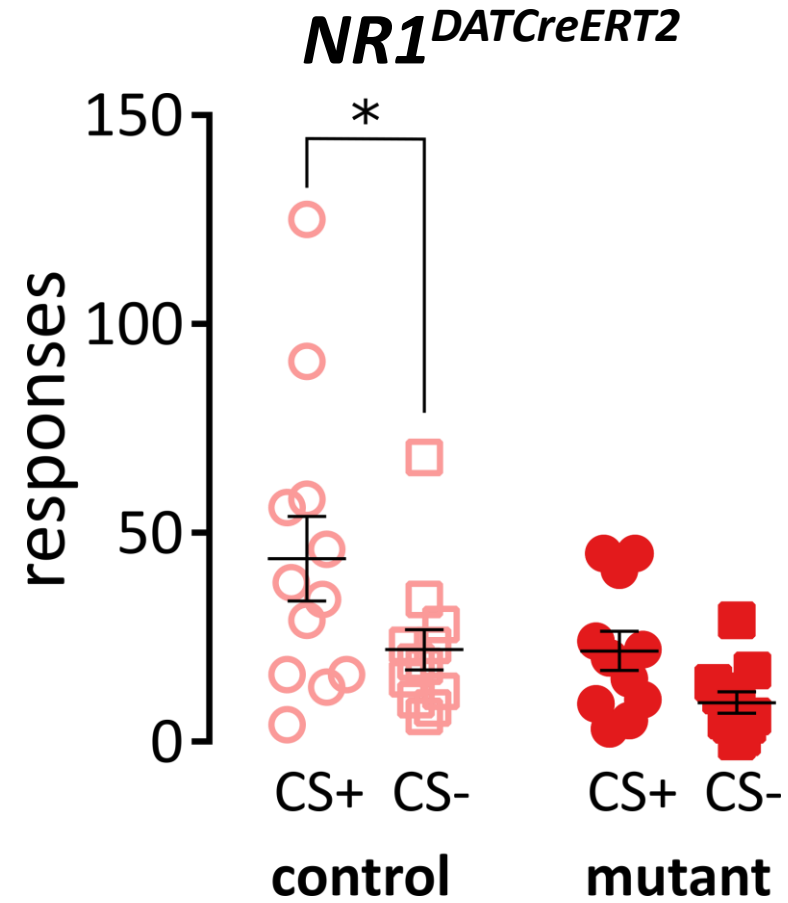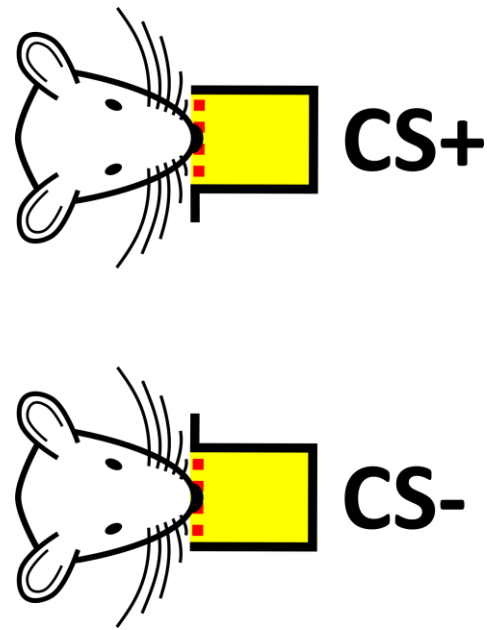* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
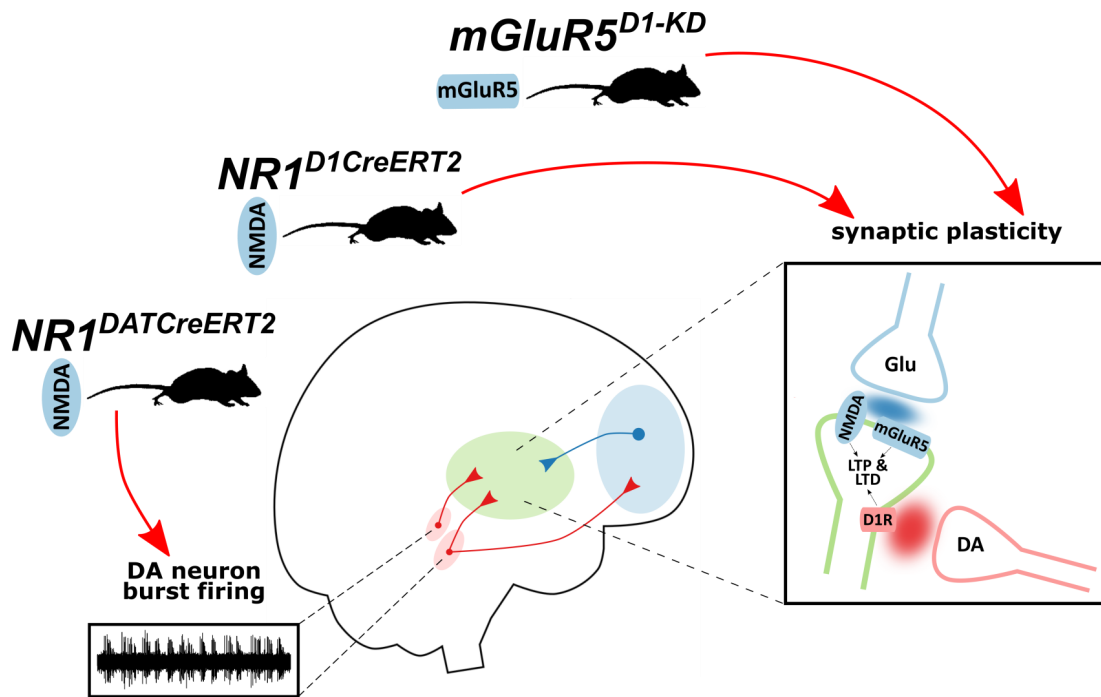
Predictive value of reward paired stimulus

Schultz et al., 1997

Predictive value of reward paired stimulus

Incentive value of reward paired stimulus

$NR1^{DATCreERT2}$

CS+

CS-

responses

150
100
50
0

*

CS+ CS-
control

CS+ CS-
mutant

* $p < 0.05$

Consequences of disrupted reinforcement learning - summary

- Decreased probability of selecting the more often rewarded alternative
- Decreased likelihood of repeating previously rewarded choice
- Slower action selection
- Impaired attribution of incentive value to reward-paired stimuli

Jan Rodriguez Parkitna
Łukasz Szumiec

cieslak@if-pan.krakow.pl

Thank You!