Supplemental figures for

McLaughlin & Redish

Optogenetic Disruption of the Prelimbic Cortex Alters Long-Term Decision Strategy but Not Valuation on a Spatial Delay Discounting Task

Neurobiology of Learning and Memory

This file generated on 2023-02-10 at 2:12pm.

Figure S1: Theta and Noise Session Comparisons

(a-c) Average metrics for control and active cohorts separating the experimental opto sessions by stimulation pattern type. On light delivery sessions (dark gray background) one of two light patterns were delivered: theta (T, a 7hz sine wave) or white noise (Noise). One third of experimental sessions were no opto (N.O.) sessions which were used as experimental controls. Boxplots show the session averages for each protocol (pre-training, no-opto, theta-stimulation, noise-stimulation), individual means for each rat are shown (dots), and the horizontal lines represent the group means. No significant differences were detected for (a) Final Delay: (ANOVA, effect of rat: p=.0013 [df = 11; F = 3.9]; no main effect of virus: p=0.36 [df=1; F=0.86]; no main effect of protocol: p=0.63 [df=1; F=0.58]; and no interaction: p=0.34 [df=1; F=1.2]). Only a main effect of virus was detected for (b) Final Delay Slope: (ANOVA, effect of rat: p=.0001 [df = 11; F = 5.1]; a significant main effect of virus: $p<10^{-10}$ [df=1; F=23.5]; no main effect of protocol: p=0.65 [df=1; F=0.56]; and no interaction: p=0.19 [df=1; F=1.7]) and (c) proportion of VTE on late-session adjustments: (ANOVA, effect of rat: p=0.05 [df = 10; F = 2.2]; a significant main effect of virus: p=.0008 [df=1; F=13.9]; no main effect of protocol: p=0.40 [df=1; F=1]; and no interaction: p=0.23 [df=1; F=1.5]). (d-e) Average proportion of adjustment laps separated by light stimulation type. (d) Control animals showed a reduction in late-session adjustment proportion in all three experimental conditions compared to their baseline (black line). This effect was not seen in (e) active animals, and neither group showed any apparent differences between stimulation type.

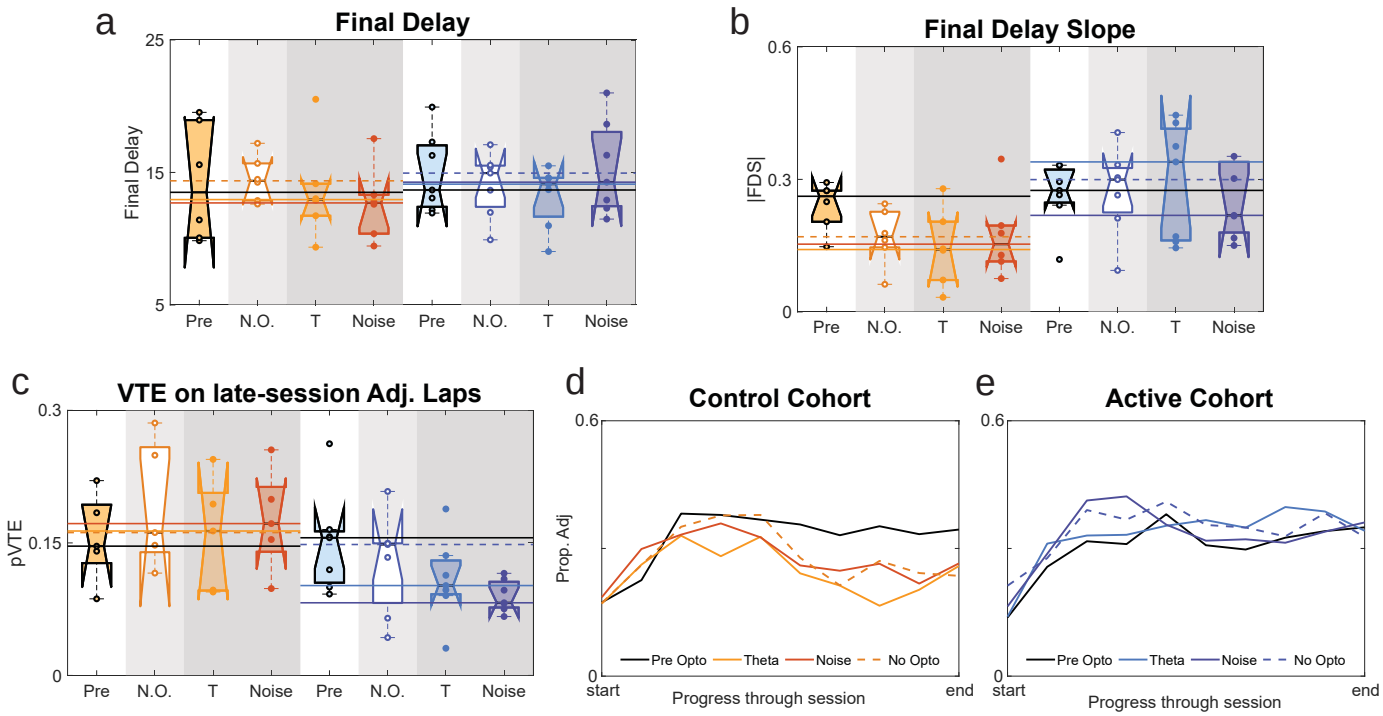

a
Final Delay
Final Delay
25
15
5
Pre
N.O.
T
Noise
Pre
N.O.
T
Noise
b
Final Delay Slope
|FDS|
0.6
0.3
0
Pre
N.O.
T
Noise
Pre
N.O.
T
Noise
c
VTE on late-session Adj. Laps
pVTE
0.3
0.15
0
Pre
N.O.
T
Noise
Pre
N.O.
T
Noise
d
Control Cohort
Prop. Adj
0.6
0
Pre Opto
Theta
Noise
No Opto
start
Progress through session
end
e
Active Cohort
0.6
0
Pre Opto
Theta
Noise
No Opto
start
Progress through session
end

Figure S2: Stim Lap vs Sham Lap comparisons

(a-c) Average lap metrics for experimental session types separated by laps in which light was delivered (stim) and those in which it wasn't (no-light, Ø) laps. (left) sessions grouped by stimulation type (no-opto 'N.O.', Theta, Noise) and (right) combined 'Opto' sessions (N.O. vs Opto). No significant lap differences were detected for (a) proportion delay side laps: (ANOVA, no main effect of lap: p=0.82 [df = 1; F = .06]; no interaction of lap and virus: p=0.53 [df=1; F=0.40]; no interaction of lap and stimulation type: p=0.59 [df=1; F=0.30]; and no interaction of lap, virus, and stimulation type: p=0.96 [df=1; F=0]), or (b) proportion of adjustment laps: (ANOVA, no main effect of lap: p=0.70 [df = 1; F =0.15]; no interaction of lap and virus: p=0.82 [df=1; F=.05]; no interaction of lap and stimulation type: p=0.83 [df=1; F=.05]; and no interaction of lap, virus, and group: p=0.73 [df=1; F=.12]). (c) There was an interaction effect between lap and session type on the proportion of VTE: (ANOVA, no main effect of lap: p= 0.15 [df =1; F = 2.2]; no interaction of lap and virus: p= 0.57 [df=1; F=0.32]; a significant interaction of lap and stimulation type: p=0.03 [df=1; F=5.43]; but no interaction of lap, virus, and stimulation type: p= 0.63 [df=1; F=0.23]). It appeared that VTE was higher for stimulation laps on opto sessions. But the absence of a virus effect or interaction suggests that the VTE increase occurs equally across control and active groups. We do not know the cause of this effect. Although we endeavored to minimize light escaping from the implant, the effect might have arisen from small amounts of light on these laps having an effect on the tracking used to calculate VTE or the external appearance of light affecting the animal's behavior during those laps.

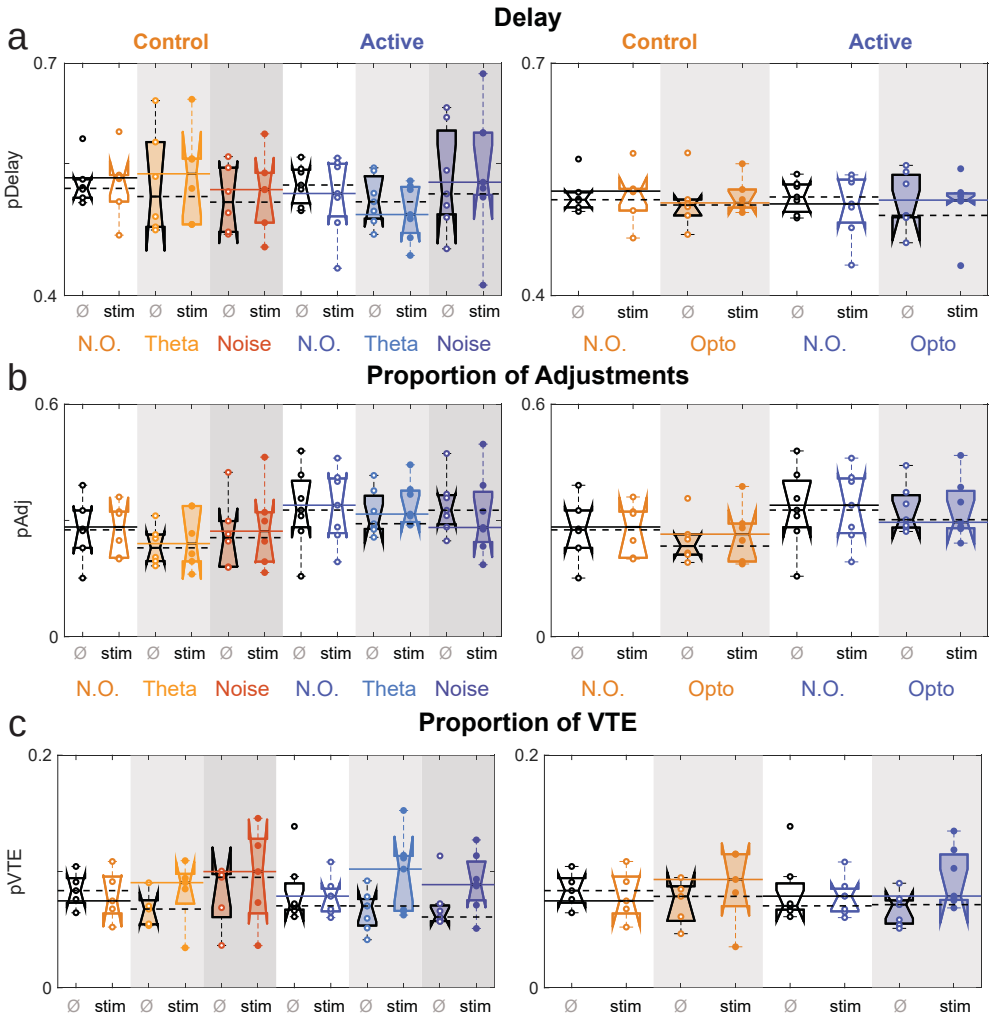

a
Delay
Control
Active
Control
Active
pDelay
0.7
0.4
Ø stim Ø stim Ø stim Ø stim Ø stim Ø stim
N.O. Theta Noise N.O. Theta Noise
Ø stim Ø stim Ø stim Ø stim
N.O. Opto N.O. Opto
b
Proportion of Adjustments
pAdj
0.6
0
N.O. Theta Noise N.O. Theta Noise
N.O. Opto N.O. Opto
c
Proportion of VTE
pVTE
0.2
0

Figure S3: Proportion of VTE on other lap types

(a-c) Proportion of VTE. No overall effect of VTE was seen when (a) all lap types were considered for each session (left): (ANOVA, effect of rat: p=.0013 [df = 10; F = 3.9]; no main effect of virus: p=0.36 [df=1; F=0.86]; no main effect of stimulation type: p=0.63 [df=1; F=0.58]; and no interaction: p=0.34 [df=1; F=1.2]) and for pre-post (right): (ANOVA, no effect of rat: p=.07 [df = 10; F = 2.6]; no main effect of virus: p=0.75 [df=1; F=0.1]; no main effect of pre vs post: p=0.22 [df=1; F=1.7]; and no interaction: p=0.91 [df=1; F=.01]). (b) There were no VTE effects seen on alternation laps between sessions: (ANOVA, effect of rat: p=.05 [df = 10; F = 2.4]; no main effect of virus: p=0.80 [df=1; F=.07]; no main effect of stimulation type: p=0.37 [df=1; F=1.0]; and no interaction: p=0.84 [df=1; F=0.17]) or from pre-post: (ANOVA, no effect of rat: p=0.10 [df = 10; F = 2.3]; no main effect of virus: p=0.64 [df=1; F=0.23]; no main effect of pre vs post: p=0.25 [df=1; F=1.5]; and no interaction: p=0.66 [df=1; F=0.2]). (c) There were no VTE effects seen on late-session alternation laps between sessions: (ANOVA, effect of rat: p=.01 [df = 10; F = 3.1]; no main effect of virus: p=0.29 [df=1; F=1.2]; no main effect of stimulation type: p=0.43 [df=1; F=0.9]; and no interaction: p=0.45 [df=1; F=0.84]) or from pre-post: (ANOVA, no effect of rat: p=0.09 [df = 10; F = 2.4]; no main effect of virus: p=0.26 [df=1; F=1.4]; no main effect of pre vs post: p=0.38 [df=1; F=84]; and no interaction: p=0.37 [df=1; F=0.9]).

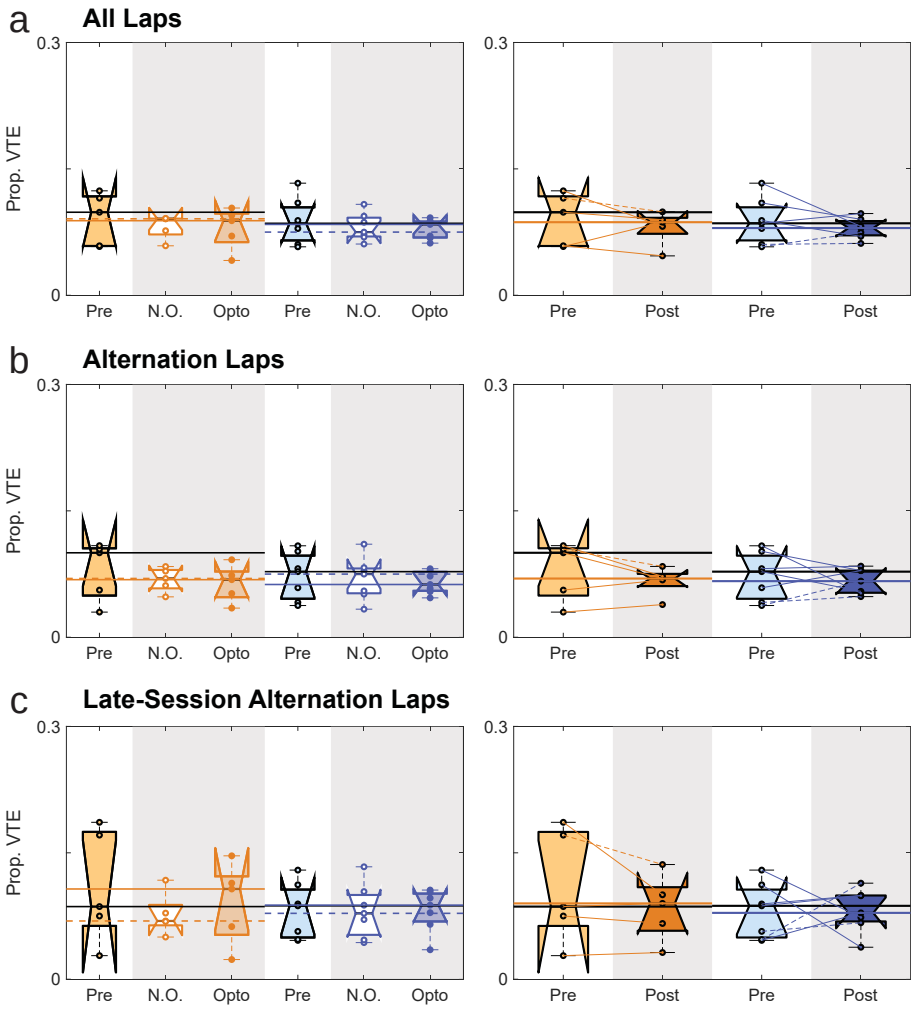
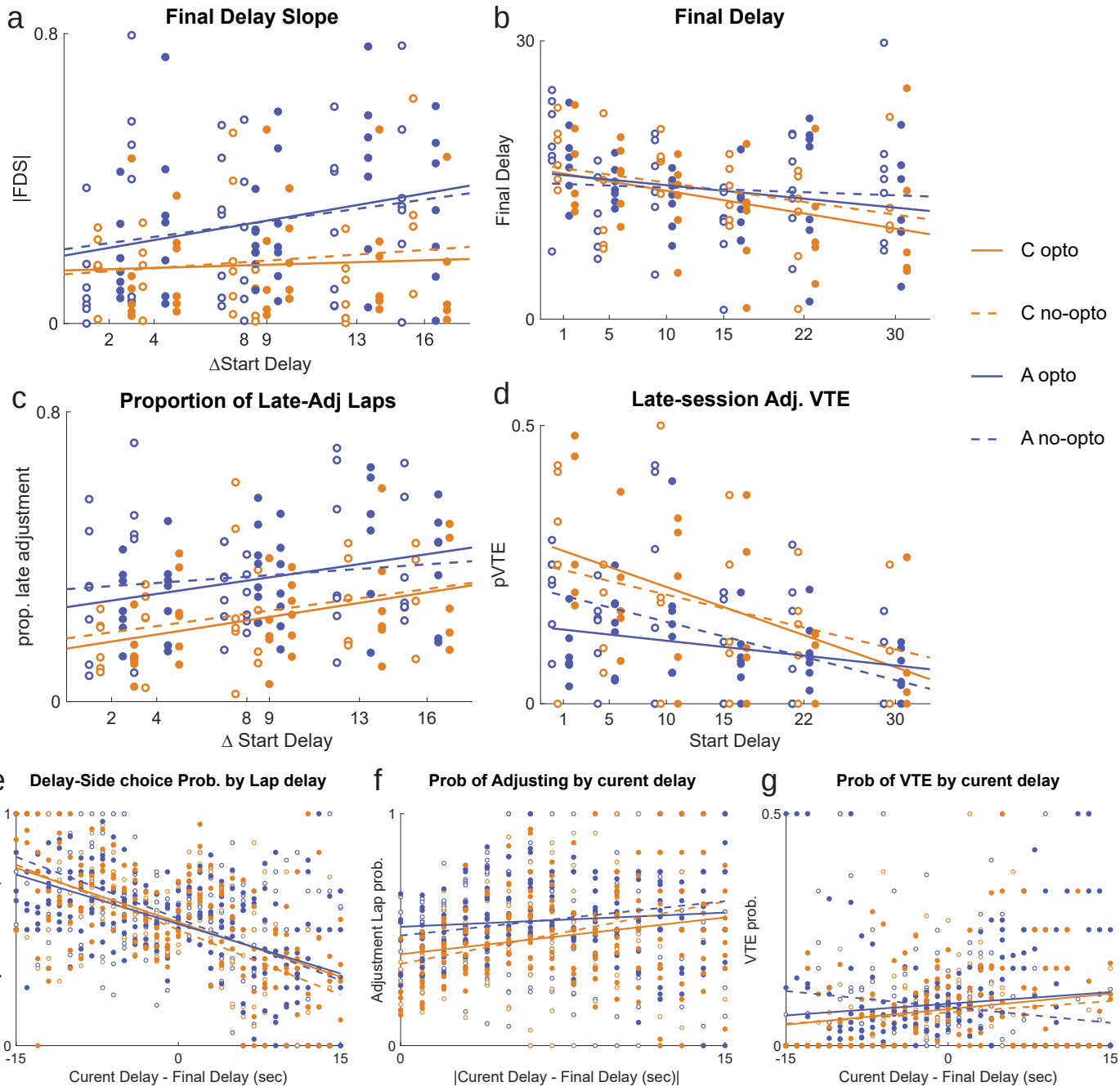

a
All Laps
b
Alternation Laps
c
Late-Session Alternation Laps
Prop. VTE
0.3
0
Pre
N.O.
Opto
Pre
N.O.
Opto
Pre
Post
Pre
Post

Figure S4: Initial delay correlations

(a-d) Main metric correlations with initial session delay. Experimental session averages for control and active animals grouped start delay. Start delays ranged from 1-30s with the mean being 14s. We correlated these data with start delay and with start distance from mean delay (|start delay-14|). Here we display the correlation using either the 'start delay' or distance from mean start delay '△ start delay' depending on what fit the data best. Least square lines fit the opto (solid line, filled circles) and no opto (dashed line, open circles) correlations for each cohort. In these analyses, we treated the virus and opto/not) as a single statistical group with four components. (a) Final Delay Slope was positively correlated with △ start delay. Group differences were detected, but unable to be correlated with △ start delay: (ANCOVA, effect of start delay: p=.016 [df=1; F=5.9]; a main effect of group: p=.0002 [df = 3; F = 6.8]; and no interaction: p=0.66 [df=3; F=0.53]). (b) Final Delay was inversely correlated with start delay, but no significant differences were detected between groups for these correlations: (ANCOVA, a significant effect of start delay: p=.0014 [df=1; F=10.4]; no main effect of group: p=0.77 [df = 3; F = 0.38]; and no interaction: p=0.49 [df=3; F=0.82]). (c) Proportion of late adjustment laps was positively correlated with △ start delay, and significant differences were detected between groups, but these group differences were not an effect of △ start delay: (ANCOVA, a significant effect of start delay: p=.0004 [df=1; F=13.2]; a main effect of group: p=.0001 [df = 3; F = 7.8]; and no interaction: p=0.83 [df=3; F=0.29]) (d) Proportion of VTE on late adjustment laps was inversely correlated with start delay, and significant differences were detected between groups. These group differences had a trend toward an interaction effect with start delay but was not significantly correlated: (ANCOVA, a significant effect of start delay: $p<10^{-10}$ [df=1; F=28.1]; a main effect of group: =.0004 [df=3; F=4.6]; and a trend toward interaction: p=.07 [df=3; F=2.3]). (e-g) Main lap metric correlations with current delay. We correlated these data with either the difference between current and final delay (D-FD), or with the absolute value of D-FD depending on what fit the data best. Least square lines fit the opto (solid line, filled circles) and no opto (dashed line, open circles) correlations for each cohort. (e) Probability of choosing the delay side was inversely correlated with D-FD. No group differences or interaction effects were detected: (ANCOVA, effect of current delay: $p<10^{-10}$ [df=1; F=360]; no main effect of group: p=0.21 [df = 3; F = 1.5]; and no interaction: p=0.25 [df=3; F=1.4]). (f) Probability of adjusting was correlated with |D-FD|, and significant differences were detected between groups. These group differences had a trend toward an interaction effect with current delay but was not significantly correlated: (ANCOVA, effect of current delay: $p<10^{-10}$ [df=1; F=31.9]; a main effect of group: p=.0007 [df = 3; F = 5.8]; and a trend toward interaction: p=.06 [df=3; F=2.5]). (g) Probability of VTE was inversely correlated with |D-FD|. No significant differences were detected between groups, but there was a trend toward a group interaction effect with current delay: (ANCOVA, effect of current delay: p=.0006 [df=1; F=11.8]; no main effect of group: p=0.44 [df = 3; F = 0.91]; and a trend toward interaction: p=.06 [df=3; F=2.5]).


a
Final Delay Slope
|FDS|
ΔStart Delay
b
Final Delay
Final Delay
c
Proportion of Late-Adj Laps
prop. late adjustment
Δ Start Delay
d
Late-session Adj. VTE
pVTE
Start Delay
C opto
C no-opto
A opto
A no-opto
e
Delay-Side choice Prob. by Lap delay
Delay side choice prob.
Curent Delay - Final Delay (sec)
f
Prob of Adjusting by curent delay
Adjustment Lap prob.
|Curent Delay - Final Delay (sec)|
g
Prob of VTE by curent delay
VTE prob.
Curent Delay - Final Delay (sec)