SUPPLEMENTAL INFORMATION

Specialized representations of value in orbital and ventrolateral prefrontal cortex: desirability versus availability of outcomes

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SUPPLEMENTAL FIGURES

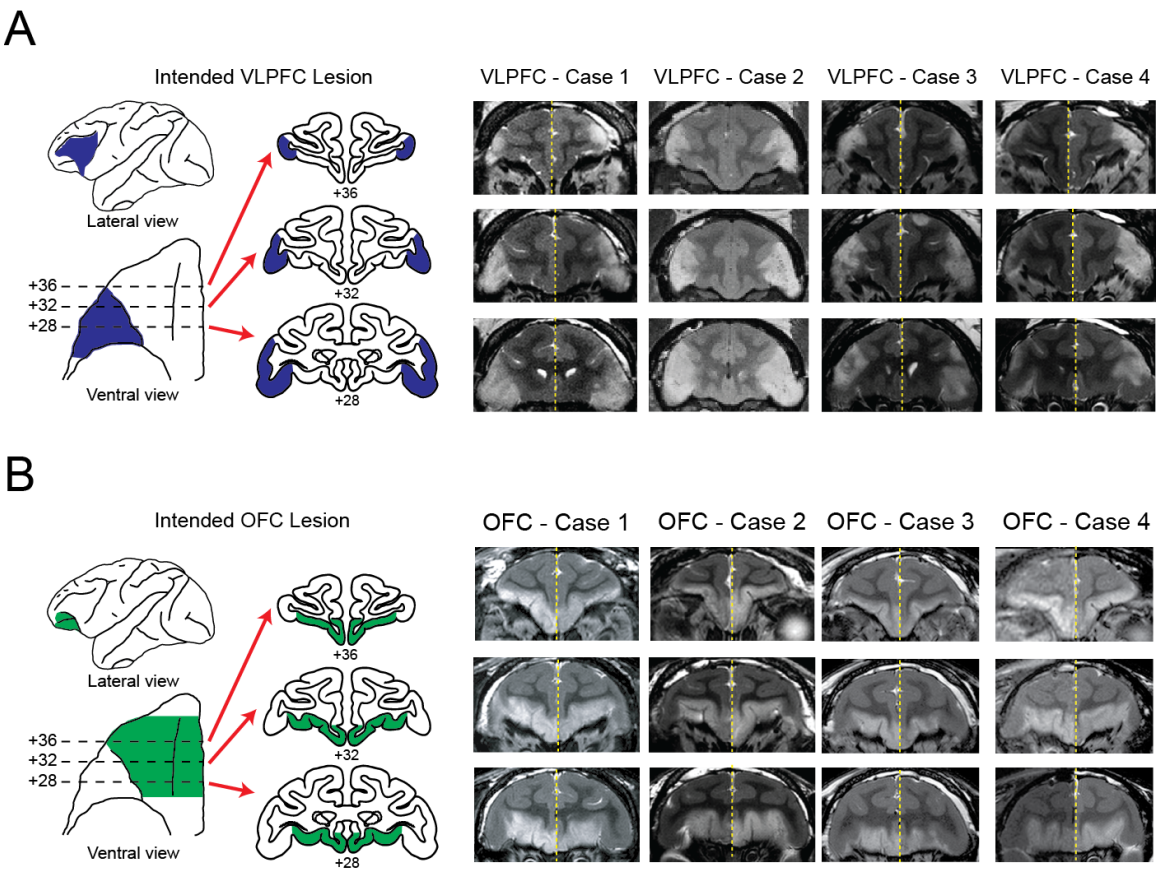

Figure S1. Related to Figure 1 and Table S1: Excitotoxic lesions of the VLPFC and OFC. A) The first column shows the extent of the intended VLPFC lesion (blue shading) on lateral and ventral views and on standard coronal sections through the frontal lobe of a macaque brain. The lesions correspond approximately to Walker's areas 12, 45, and ventral 46. The other columns show coronal images at corresponding levels taken from T_2-weighted MRI scans obtained within one week of surgery from all four VLPFC cases. B) The first column shows the extent of the intended OFC lesion (green shading) on lateral and ventral views and on standard coronal sections through the frontal lobe of a macaque brain. The lesions correspond approximately to Walker's areas 11, 13, 14 and medial 10. The other columns show coronal images at corresponding levels taken from T_2-weighted MRI scans obtained within one week of surgery from all four OFC cases. For both A and B, white hypersignal is associated with edema that follows injections of excitotoxins and indicates the presumed extent of the lesion. Except for VLPFC case 2, the only operated monkey that received a one-stage surgery, the left and right sides of the MR images are from different scans and have been placed together for ease in viewing. Yellow dashed lines indicate where images have been put together. Numerals indicate the distance in mm from the interaural plane.

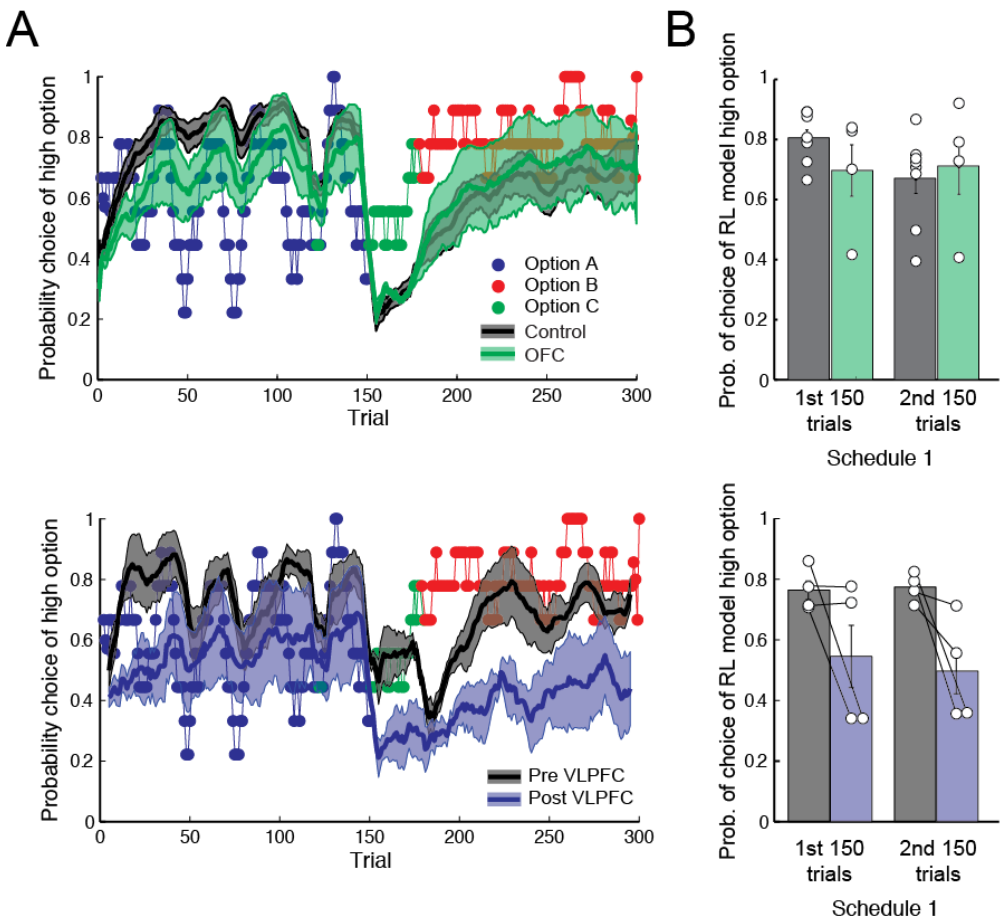

Figure S2. Related to Figures 2 and 3: Three-choice probabilistic learning task – Schedule 1 performance. A) Mean (±SEM) choice behavior of unoperated controls (gray, top row), monkeys with OFC lesions (green, top row), and monkeys before (gray) and after (blue) VLPFC lesions (bottom row) on schedule 1. Colored points represent the identity and probability of receiving a reward for selection of the high reward option. B) Mean (±SEM) probability of choosing the option associated with the highest probability of receiving a reward based on a reinforcement learning model fit to monkeys choices for the first 150 and second 150 trials for controls (gray) and monkeys with OFC lesions (green, top row) and monkeys before (gray) and after lesions (blue) of the VLPFC (bottom row). Symbols show scores of individual subjects.

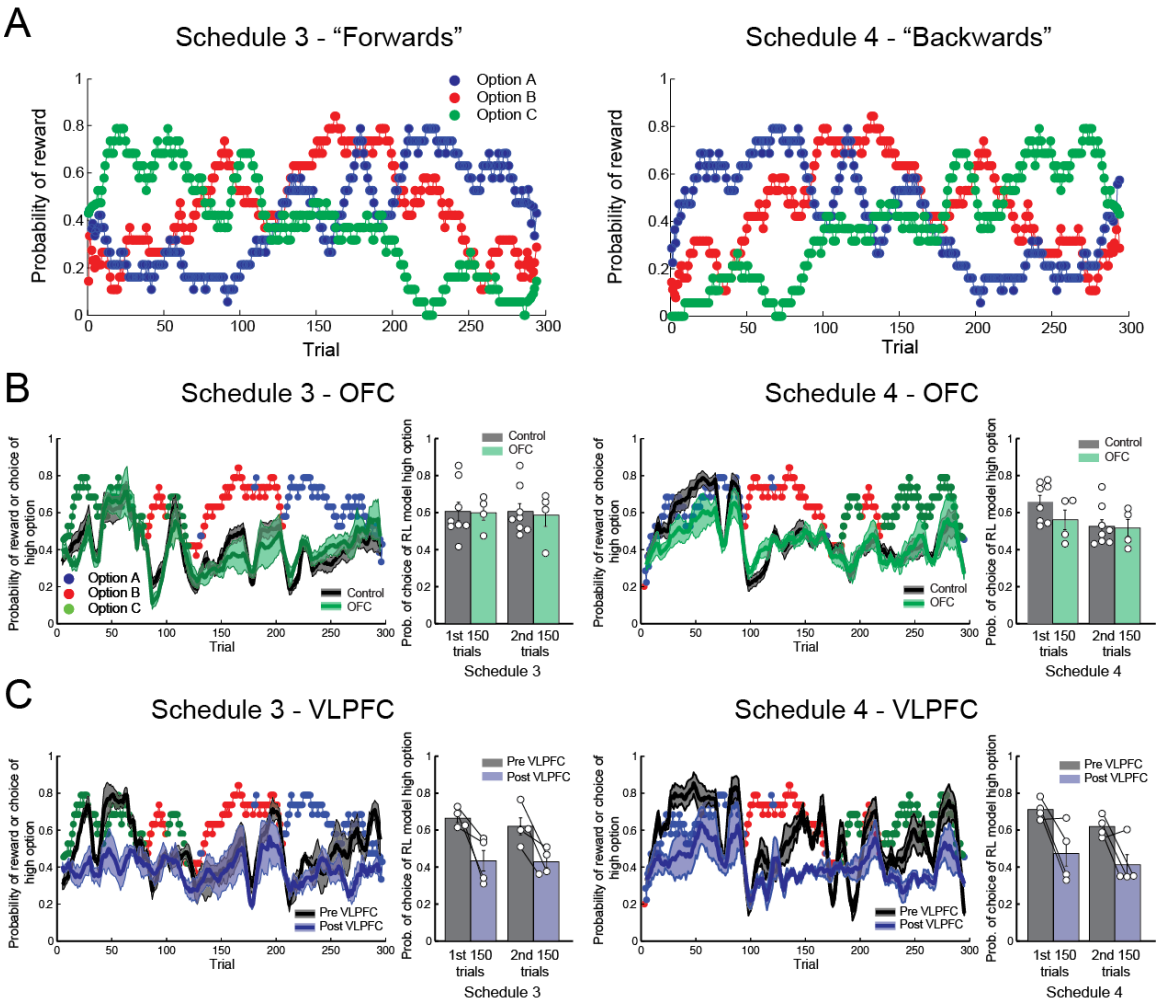

Figure S3. Related to Figures 1-3: Three-choice probabilistic learning task – Schedules 3 & 4 and associated performance. A) The plots show the probability of receiving a reward for choosing either options A (blue), B (red), or C (green) on each trial in the 300-trial test sessions for schedules 3 ('forwards') and 4 ('backwards'). B & C) Mean (±SEM) choice behavior of unoperated controls (gray), monkeys with OFC lesions (green, panel B), and monkeys before (gray) and after (blue) VLPFC lesions (panel C) on schedules 3 and 4. Note that in B, the gray curve and shading (Control) is largely obscured by the overlying green curve and shading (OFC), whereas in C, the gray and blue curves and shading overlap infrequently. Colored points represent the identity and probability of receiving a reward for selection of the high reward option. Bar plots associated with each schedule show the Mean (±SEM) probability of choosing the option associated with the highest probability of receiving a reward based on a reinforcement learning model fit to monkeys' choices for the first 150 and second 150 trials for controls (gray) and monkeys with OFC lesions (green) and monkeys before (gray) and after lesions (blue) of the VLPFC. Symbols show scores of individual subjects.

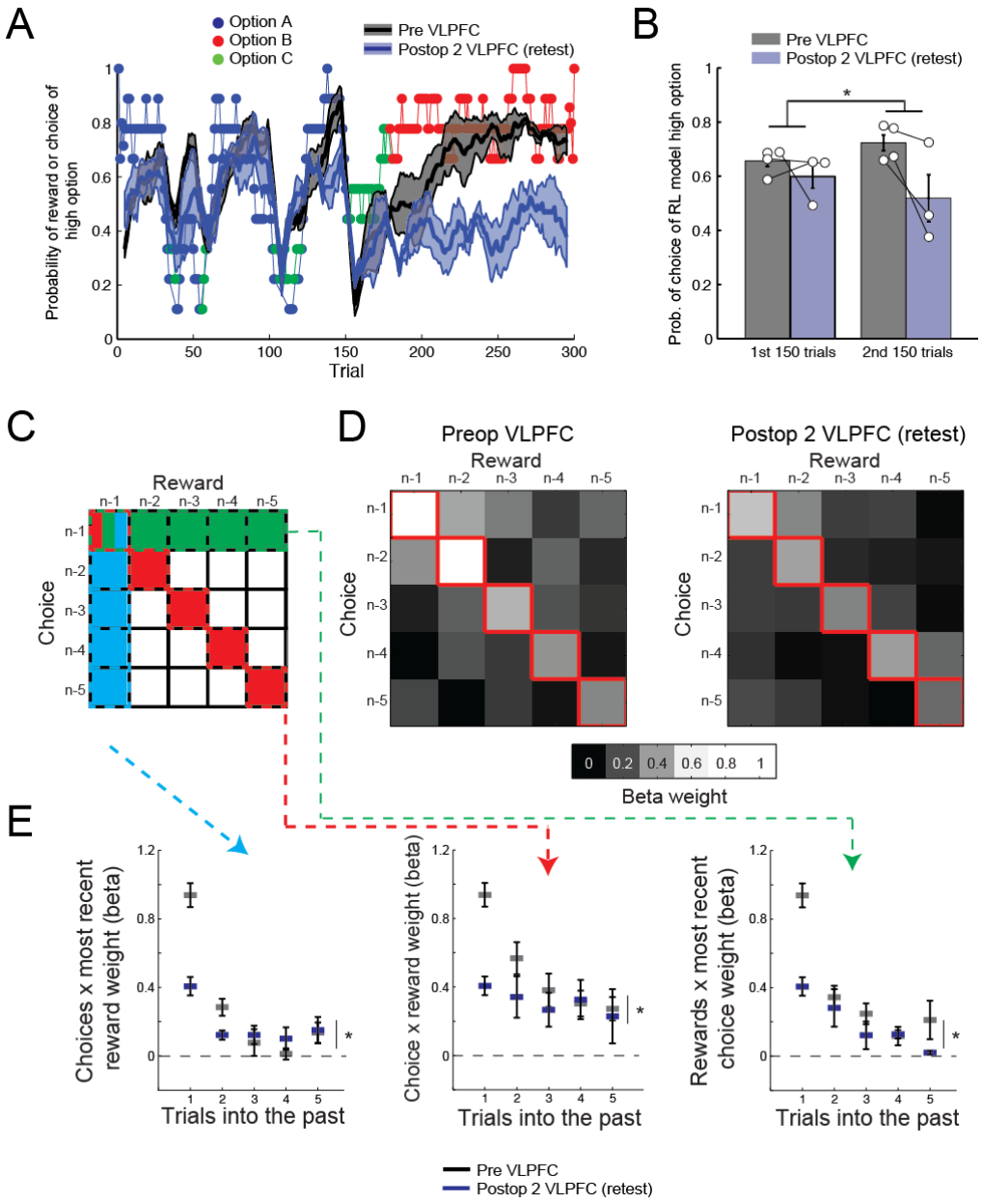

Figure S4. Related to Figure 4: VLPFC lesions still affect performance on the three-choice probabilistic learning task over 1 year after lesions. For the second postoperative test, which was conducted over a year after the monkeys sustained lesions of VLPFC, all subjects were tested on the 4 schedules in an identical manner to the test conducted immediately before lesions were made (preoperative). There was, however, one exception: for VLPFC case 1 only data from schedules 3 and 4 ("forwards" and "backwards") were included from the second postoperative test. This was because this subject was unable to complete testing on schedules 1 and 2 during the retest despite significant additional training. A) Mean (±SEM) preoperative (gray, n=4) and postoperative 2 (retest, blue, n=3) performance of monkeys with VLPFC lesions on schedule 2. Colored points represent the identity and probability of receiving a reward for selection of the high reward option. B) Mean (±SEM) preoperative (gray, n=4) and postoperative 2 (retest, blue, n=3) proportion of choices of the option associated with the highest probability of reward as determined by a reinforcement learning model fit to monkeys choices on schedule 2 [effect of surgery, $F(1,2)=23.75$, $p<0.05$; effect of phase or phase by surgery interaction, $F(1,2)<2$, $p>0.3$]. Symbols show scores of individual monkeys. C) Schematic of the full matrix of five previous

choices and corresponding rewards received for those choices. D) Matrix plots showing the influence (beta weightings from logistic regression) of all combinations of the five previous choices and rewards on subsequent choice for monkeys before (left, n=4) and a year after VLPFC lesions (right, n=4). Data from all four schedules are used. Lighter shading is associated with higher beta weights. E) Raw beta weights from the logistic regression matrix for monkeys before VLPFC lesions (gray) and over one year after VLPFC lesions (blue). [ANOVA of the influence of previous choices on most recent reward (left plot and blue cells in part C), trial by surgery, $F(5,15)=11.92$, $p<0.001$; influence of recent choices and contingent rewards (middle plot and red cells on diagonal in part C), trial by surgery interaction, $F(5,15)=9.4$, $p<0.001$; influence of past rewards on most recent choice (right plot and green cells in part C), trial by surgery interaction, $F(5,15)=11.81$, $p<0.001$). In all plots * denotes $p < 0.05$

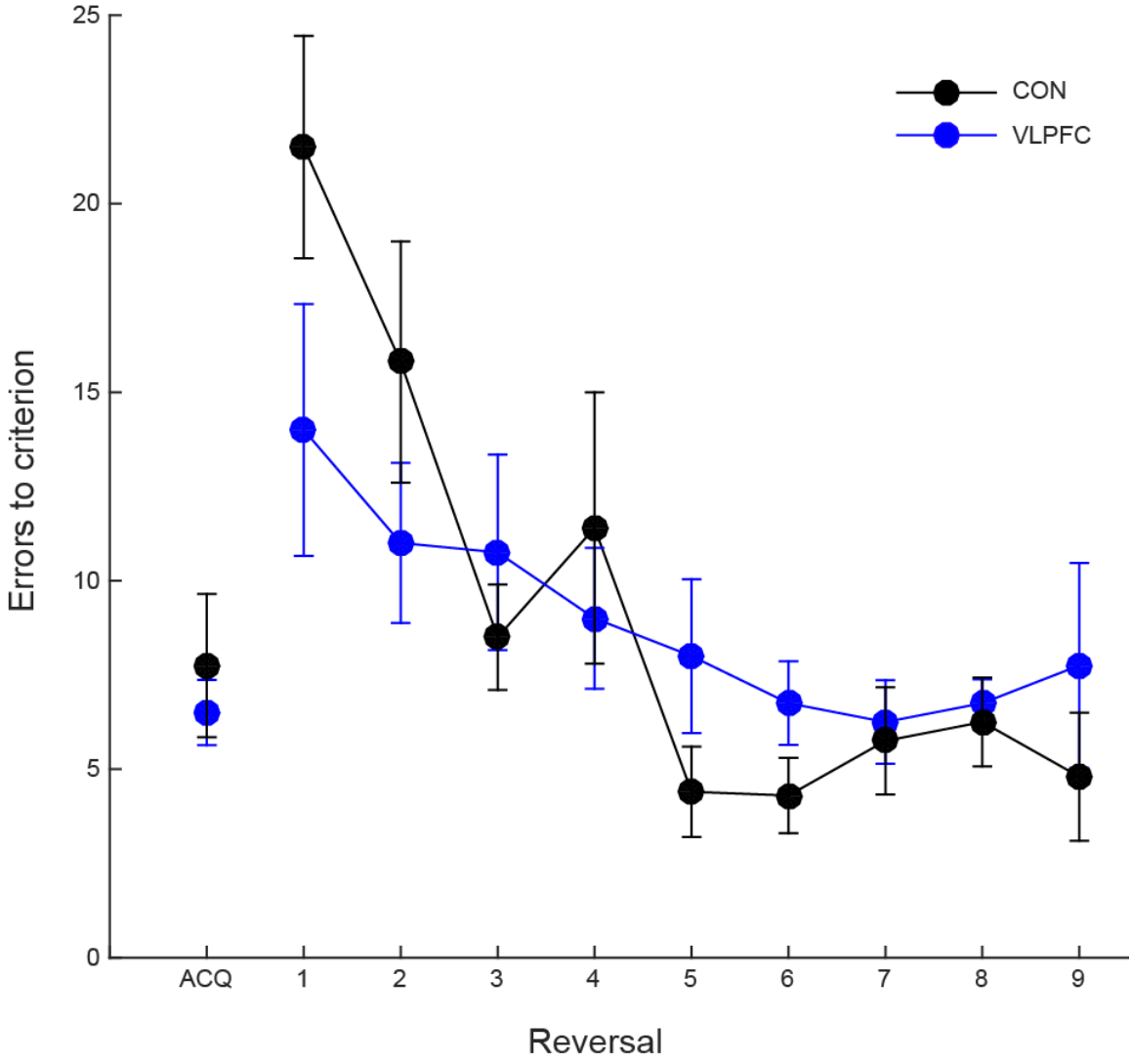

Figure S5. Related to Figures 4 and 6: The effect of VLPFC lesions on object reversal learning. Mean (±SEM) number of errors to criterion scored by monkeys during acquisition (ACQ) and the nine subsequent serial reversals (1-9) in the object reversal learning task. Testing methods were identical to those described in Rudebeck et al. (2013). Following lesions of the VLPFC (n=4), monkeys performed highly similarly to unoperated controls (n=8), both in the acquisition phase (effect of group, $F(1,10)=0.64$, $p>0.4$) and during the reversal phase (effect of group, $F(1,10)=0.06$, $p>0.8$; surgery by reversal interaction, $F(8,80)=1.56$, $p>0.2$).

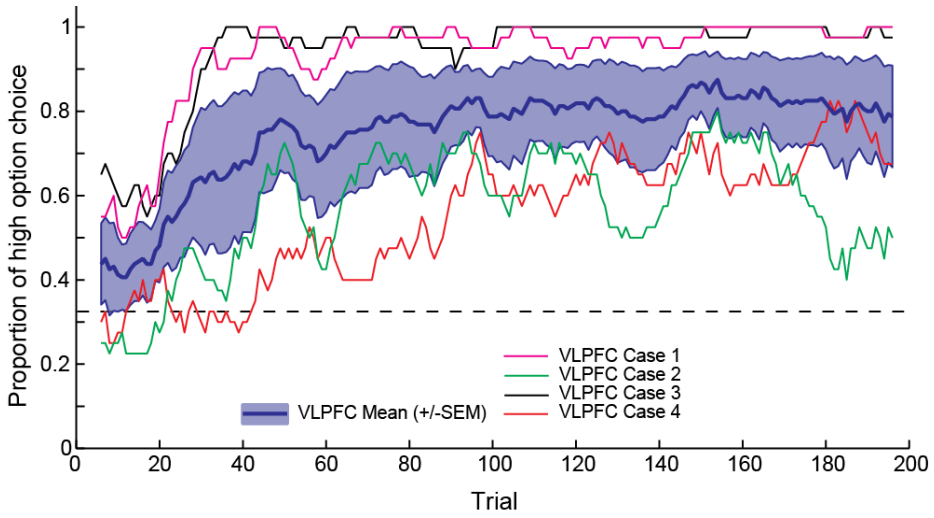

Figure S6. Related to Figure 4 and 6: Three-choice probabilistic learning task – 1.0/0.0/0.0 schedule. At the end of the first postoperative test monkeys with VLPFC lesions were tested under exactly the same conditions as used for the 4 schedules, but here the probabilities were stable across a 200-trial testing session and were fixed at 1.0/0/0. The plot shows mean (±SEM) proportion of high reward option choices for monkeys after they had received VLPFC lesions (blue). The mean performance of individual monkeys is shown as single colored lines. The mean for each monkey is based on four 200-trial sessions. Data from individual monkeys was smoothed with a 10-trial moving window. Dashed line represents chance performance (0.33). Mean performance for the group of monkeys with VLPFC lesions was greater than chance [one sample t-test, $t(3)=3.86$, $p<0.05$]. The difference between cases 2 and 4 versus cases 1 and 3 may be related to slight differences in training history. Cases 1 and 3 received additional training before VLPFC lesions were made compared to cases 2 and 4.

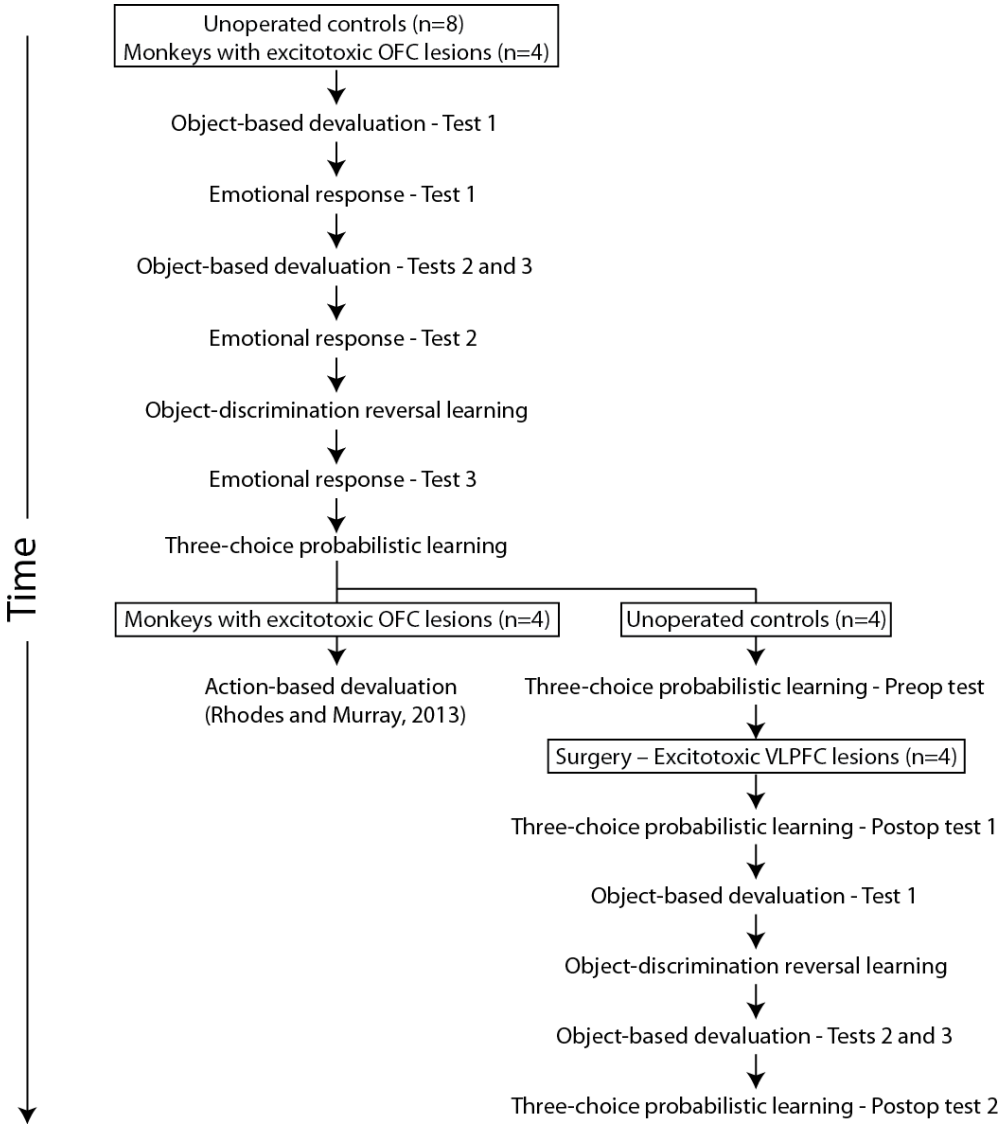

Figure S7, related to STAR Methods, *Subjects***:** Order of task administration for unoperated controls, monkeys with excitotoxic orbitofrontal cortex lesions and monkeys with excitotoxic lesions of the ventrolateral prefrontal cortex. Object-based devaluation test 3