Supplementary Tables

	WT *Shank3*$^{+/+}$		HET *Shank3*$^{fx/+}$		Total
	CreER+/-	CreER-/-	CreER+/-	CreER-/-	
Gavage - TMX	8	4	12	11	35
Gavage – control	10	6	8	5	29
mPFC - endoxifen	NA	NA	5	4	9
mPFC - control	NA	NA	2	2	4
Total	28		49		77

Supplementary Table 1. Animals, genotype and manipulations involved. The HET animals received TMX gavage to evaluate for the systemic effect of *Shank3* restoration. To further control for the potential independent effects of familiarity or time-progression, the HET animals also received no TMX but instead received corn oil (i.e., vehicle). Comparisons were made between the HET (*Shank3*$^{fx/+}$) mice and littermate-matched WT (*Shank3*$^{+/+}$) mice undergoing the same manipulations. HET mice receiving endoxifen injection in the mPFC were compared to HET mice receiving saline (i.e., vehicle) injection into the same area. Finally, to validate the selectivity of *Shank3* expression, we also compared *CreER*+/- to *CreER*-/- mice, the latter of which lacked the CreER recombinase gene.

	ANOVA		Linear decoder	
	WT	HET	WT	HET
Total neurons	188	180	188	180
Task modulated	112	131	102	120
Other-experience	33 (30%)	12 (9%)	37 (36%)	19 (15%)
Self-experience	29 (26%)	50 (38%)	31 (30%)	44 (37%)
post-TMX (> 5 wks)				
Task modulated	-	138	-	95
Other-experience	-	49 (36%)	-	29 (31%)
Self-experience	-	27 (20%)	-	18 (19%)
post-Endox. (> 5 wks)				
Task modulated	-	72	-	67
Other-experience	-	30 (42%)	-	26 (39%)
Self-experience	-	14 (19%)	-	14 (21%)

Supplementary Table 2. Evaluating the consistency of neuronal encoding using different statistical techniques. Proportions of neurons based on ANOVA ($p < 0.0125$) and linear decoding approaches ($p < 0.0125$). Overall, both statistical approaches were associated with a similar proportion of neurons that responded to self- and other-experience. Both approaches were also associated with a similar difference in encoding when comparing the WT to HET mice as well as when comparing the HET mice before vs. after TMX or endoxifen administration.

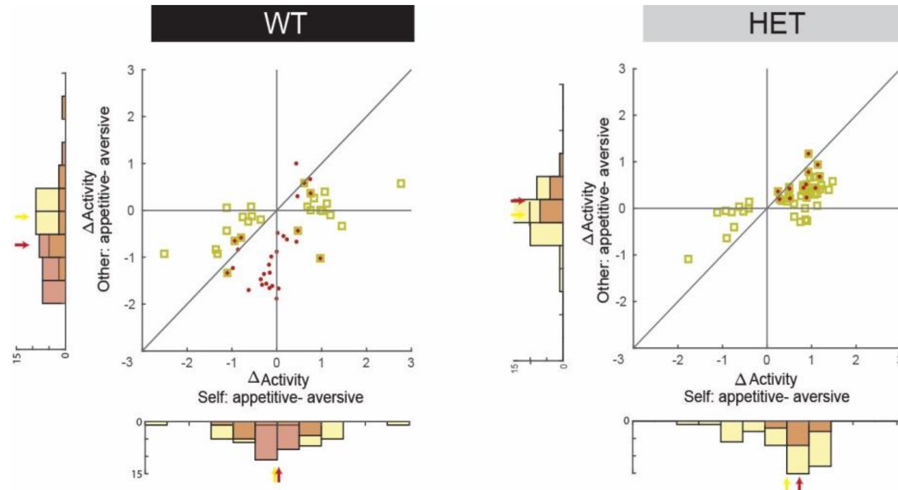
Overlap (WT)		Overlap (HET)	
Other (n=33)	Self (n=29)	Other (n=12)	Self (n = 50)
5	2	3	6

Supplementary Table 3. **Neurons that responded to physical engagement**. Overall, the proportion of neurons that were modulated by the recorded animal's physical engagement with the other as well as the other's specific experience were lower than expected by chance ($\chi 2$ test, $p < 0.05$).

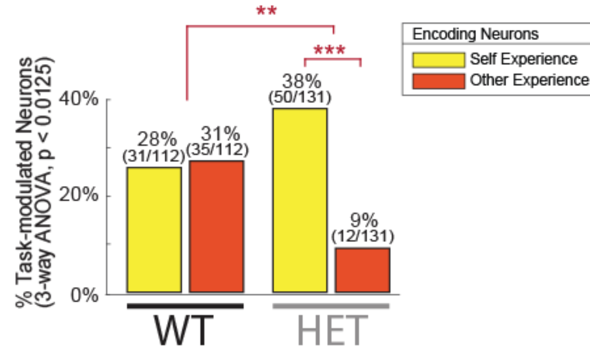
Overlap (WT)		Overlap (HET)	
Other (n=33)	Self (n=29)	Other (n=12)	Self (n = 50)
1	1	1	3

Supplementary Table 4. **Neurons that responded to physical movement**. We also examined the recorded animal's movements directly. We theorized that, if differences in movement during recordings may have contributed to our findings, then we should also see differences in activity when comparing periods of movement and rest (i.e., moving vs. not moving). Therefore, to test this, we divided neuronal data into time periods in which the recorded animals were moving and those in which they were not but find that only 4.3% (n = 8) of neurons in the WT mice displayed a difference in response. More importantly, we find that only 1 neuron that responded to other-experience and only 1 neuron that responded to self-experience also responded to differences in movement. Similar findings were also made for the HET mice. Additionally, to account for small differences in the position and orientation of the animals during recordings, the precise positions of all animals were tracked in a semi-automated fashion at millisecond resolution. As expected, we find that WT and HET mice were orientated (within < 20 degrees) towards their partner 50.7 +/- 5.0% and 40.2 +/-5.6% of the time respectively (i.e., the HET mice were slightly less likely to be oriented towards their partner). Therefore, to account for this small difference, we performed an additional control analysis in which we only selected neuronal data during the time points in which the animals were oriented towards their partners. This therefore accounted for the possibility that small differences in sensory 'viewing time' affected neuronal response. By matching these data, we find that largely identical results were obtained from the WT and HET mice as in our original analyses. Specifically, we find that the ratio of self:other valence 0.7:1 (4:3) and 3.2:1 (13:4) for the WT and HET mice and significantly similar to that observed when considering all the data recorded (chi-square test, $p < 0.05$).

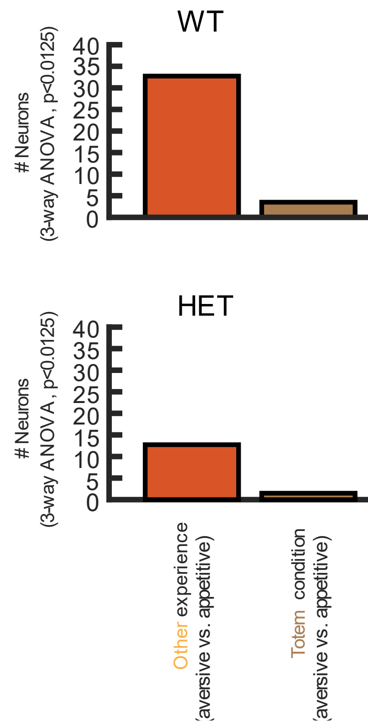
Supplementary Figures



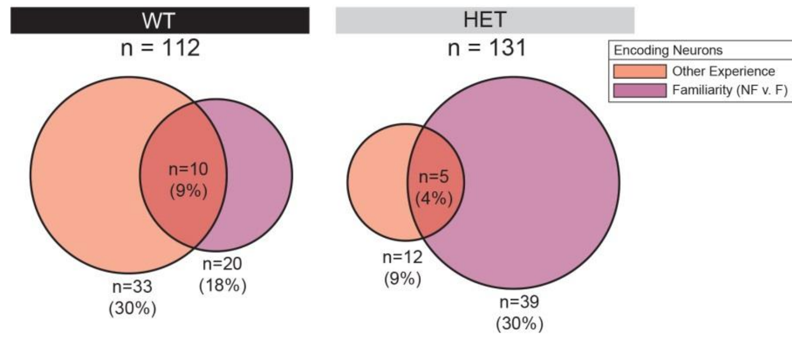
Supplementary Figure 1. Polarity of neuronal encoding and changes in firing activity. Scatter plots and histograms demonstrating the magnitude and polarity of change in neuronal response based on variations in agency and experience valence across cells. Here, each point indicates the difference in activity (z-score) *per* neuron on trials in which an appetitive (positive) experience was given minus trials in which an aversive (negative) experience was given. Here, the y-axis reflects differences in activity based on variations in the other's experiences and the x-axis reflects differences in activity based on variations in the animal's own experiences on a *per* cell basis. Plotted cells are those which displayed significant modulation (three-way ANOVA, $p<0.0125$) to self (yellow) and other (orange) experience. The histograms reflect the mean (arrow) and distribution of population responses.



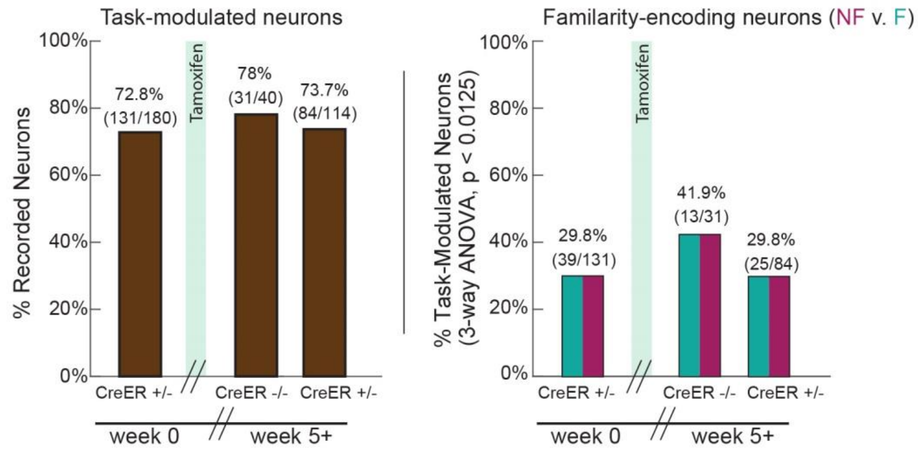
Supplementary Figure 2. Aligning neuronal activity to behavioral events. We considered other sensorimotor variables such as the time point at which the other animal first consumed reward. For these analyses, neural activities were aligned to the time at which the other animal first consumed food rather than the start of the trial. These reveal largely similar results to those displayed in **Figure 2a**. In this case, differences in encoding characteristics within and between the WT and HET mice were made by Chi-square tests (** $\chi^2(1) = 15.6$, $p < 7.82 \times 10^{-5}$, *** $\chi^2(1) = 30.51$, $p < 3.32 \times 10^{-8}$). By aligning neuronal activity to the time period in which the animals first consumed food reward, we find that 31% of the neurons in WT mice responded to the other's experience (compared to 30% when more simply aligned to trial onset). Additionally, Therefore, based on these analyses, neuronal responses in the WT mice were largely robust to these different alignments.



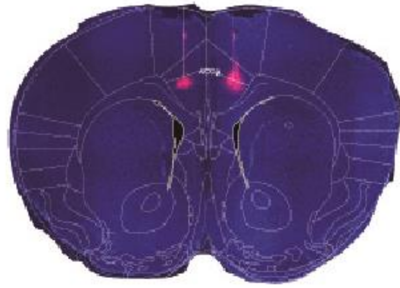
Supplementary Figure 3. Neuronal responses to the aversive vs. appetitive stimuli when paired with an inanimate totem. To evaluate whether neurons in the mPFC may respond to the aversive vs. appetitive stimuli themselves independently of another social agent, we tested their responses when paired with inanimate totems. Overall, we found that only 2 of the 131 task-modulated neurons recorded in the HET mice responded to the aversive vs. appetitive stimuli when in the setting of an inanimate totem (*Bottom*). Moreover, of these neurons, none overlapped with neurons that responded to the other's experience. For comparison, 4 of the 112 task-modulated neurons in the WT mice responded when in the setting of an inanimate totem (*Top*), together suggesting that neither neurons recorded from WT nor HET animals responded to inanimate totems.



Supplementary Figure 4. Overlap of other experience and familiarity-encoding neurons. The number of neurons encoding familiarity (NF v. F mice; purple) is shown for both WT and HET mice, as well as their overlap with other-experience encoding neurons (orange).



Supplementary Figure 5. Effect of *Shank3* expression on task modulation and encoding of familiarity. The proportion of task-modulated and familiarity-encoding neurons are displayed before and after TMX for the *Shank3*$^{fx/+}$*:CreER*$^{+/-}$ and *Shank3*$^{fx/+}$*:CreER*$^{-/-}$ mice.



Supplementary Figure 6. Confirming localization of muscimol injection sites. Histological localization was made after muscimol and saline (control) experiments were performed. This was used to demonstrate the center point of injection and to confirm that it corresponded with the same sites used for neuronal recordings (**Fig. 1B**).