Supplementary Information

Distinct Value Signals in Anterior and Posterior Ventromedial Prefrontal Cortex

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Supplemental Results

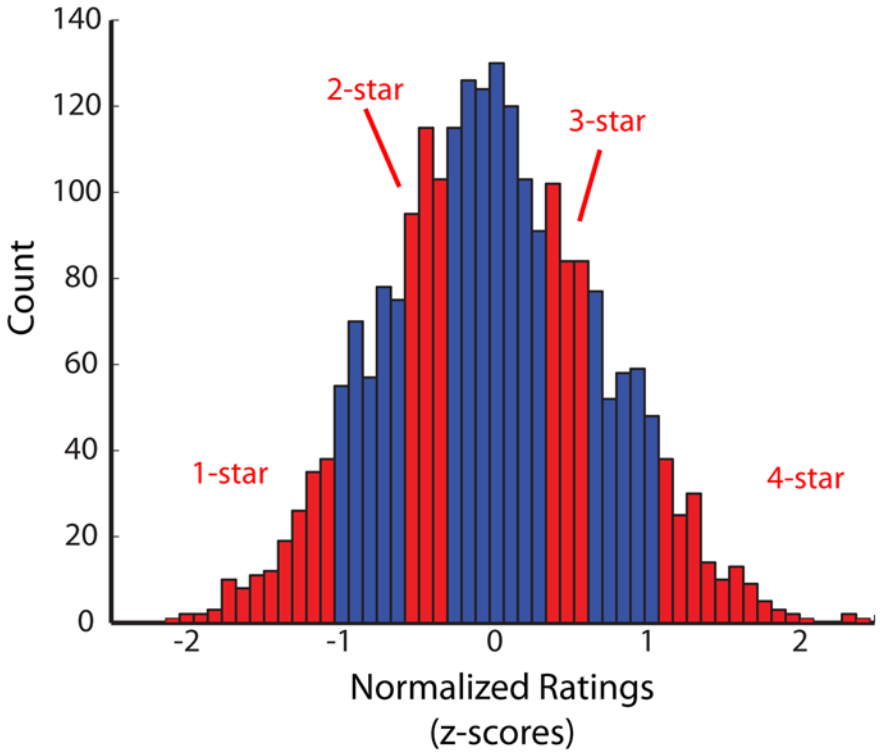

Figure S1: Attractiveness distribution

Before the current experiments, a group of male participants rated a large set of images of young-adult female faces (N > 2000) for attractiveness. Shown in blue is the distribution of normalized ratings (converted to averaged *z*-scores to minimize rater response bias) obtained from that independent behavioral study. From this distribution, we identified four attractiveness categories (shown in red) to be used in the multimodal reward and economic exchange tasks.

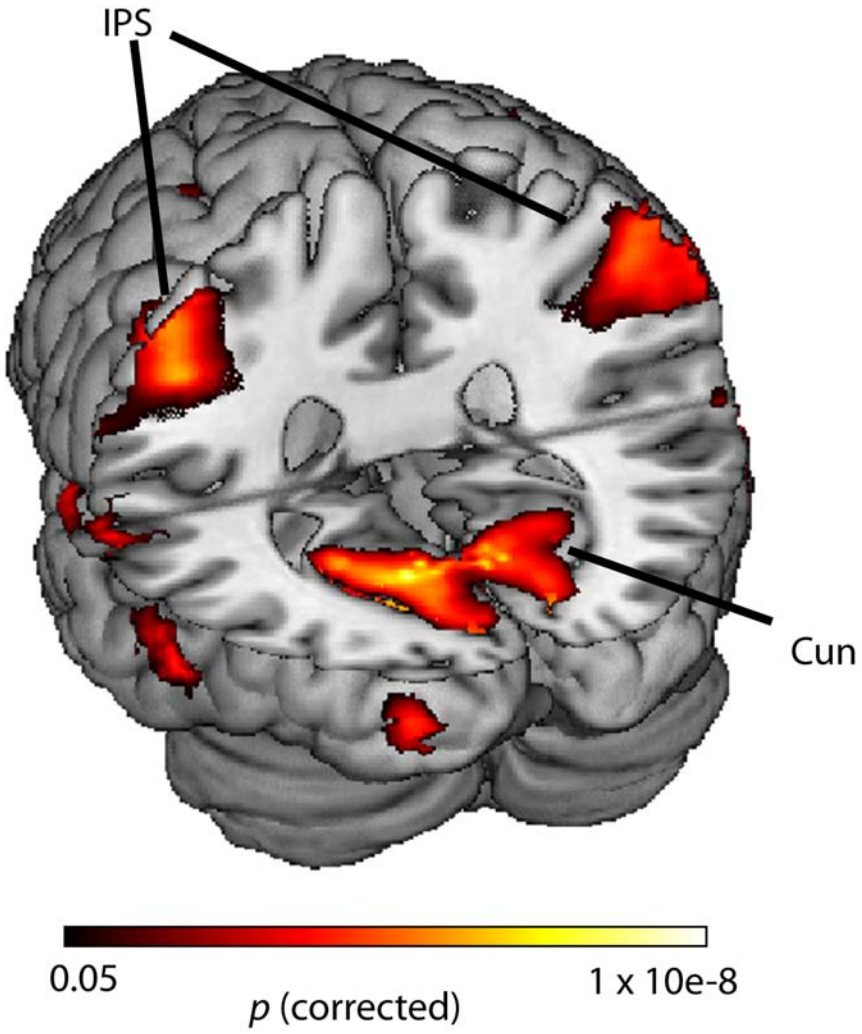

Figure S2: Main effect of monetary stimuli

Monetary stimuli, combined across all value levels, evoked greater activation in lateral and medial parietal regions than face stimuli. Highlighted here are areas of increased activation (money > faces) along the intraparietal sulcus (IPS) and cuneus (Cun). Areas of activation passed a cluster significance threshold of $z > 2.3$, with whole-brain cluster-correction at $p < 0.05$.

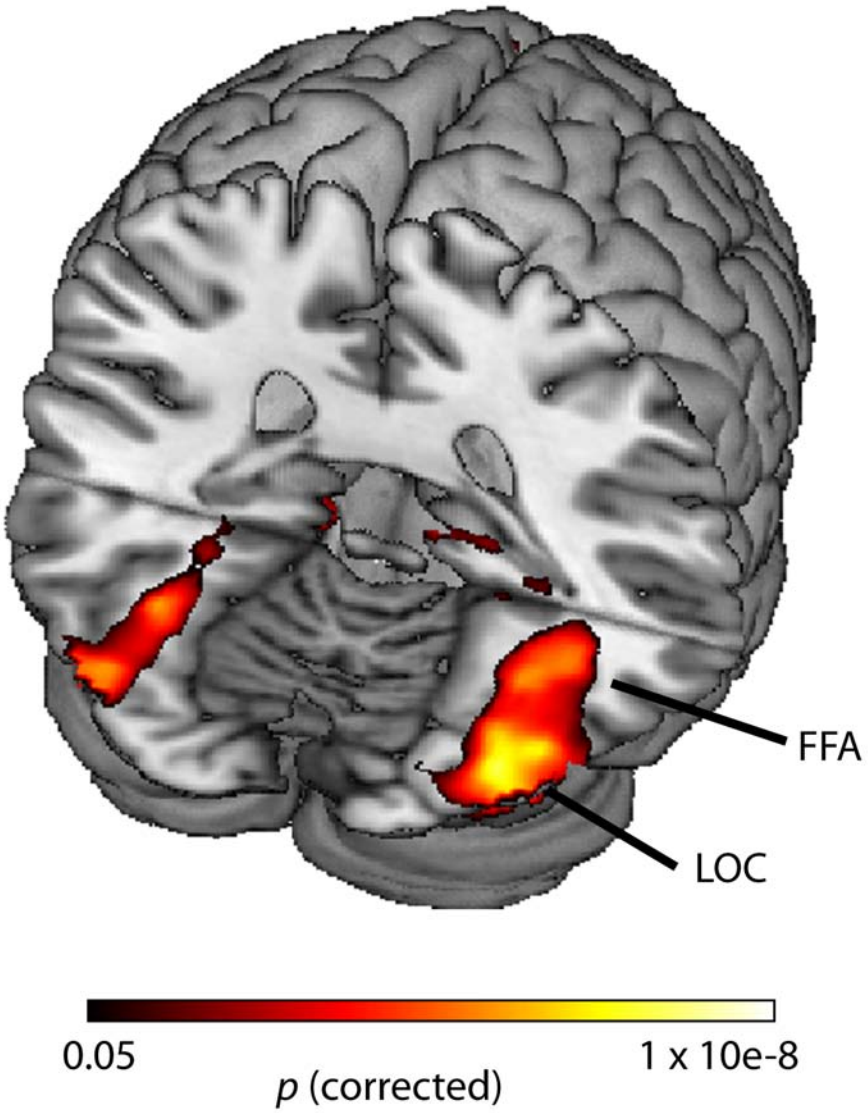

Figure S3: Main effect of face stimuli

Face stimuli, combined across all attractiveness levels, evoked greater activation in regions associated with object processing than monetary stimuli. Highlighted here are areas of increased activation (faces > money) in the fusiform face area (FFA) and lateral occipital cortex (LOC). Areas of activation passed a cluster significance threshold of $z > 2.3$, with whole-brain cluster-correction at $p < 0.05$.

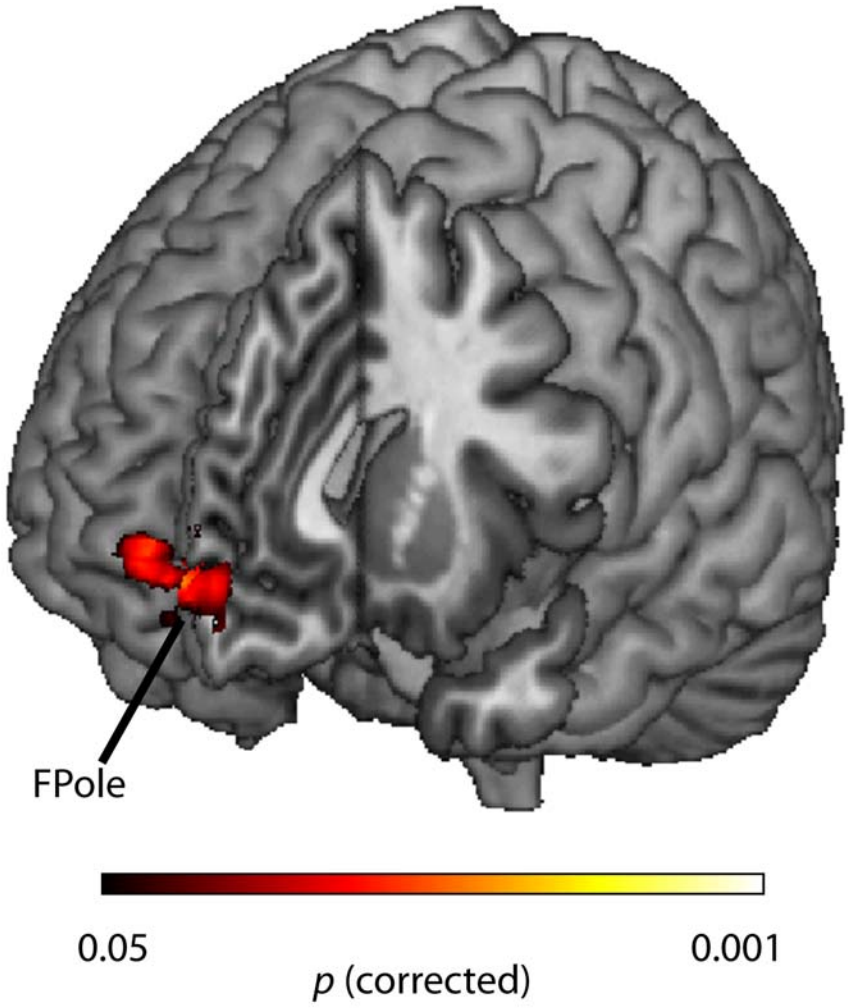

Figure S4: FPole activation scales with the size of monetary rewards

To confirm that FPole activation scaled as a function of the size of monetary rewards, we conducted a parametric analysis in which rewards were modeled as a single regressor with response levels dependent upon the size of the monetary reward. This analysis confirmed that FPole activation increases with increasing size of monetary rewards. Areas of activation passed a cluster significance threshold of $z > 2.3$, with whole-brain cluster-correction at $p < 0.05$.

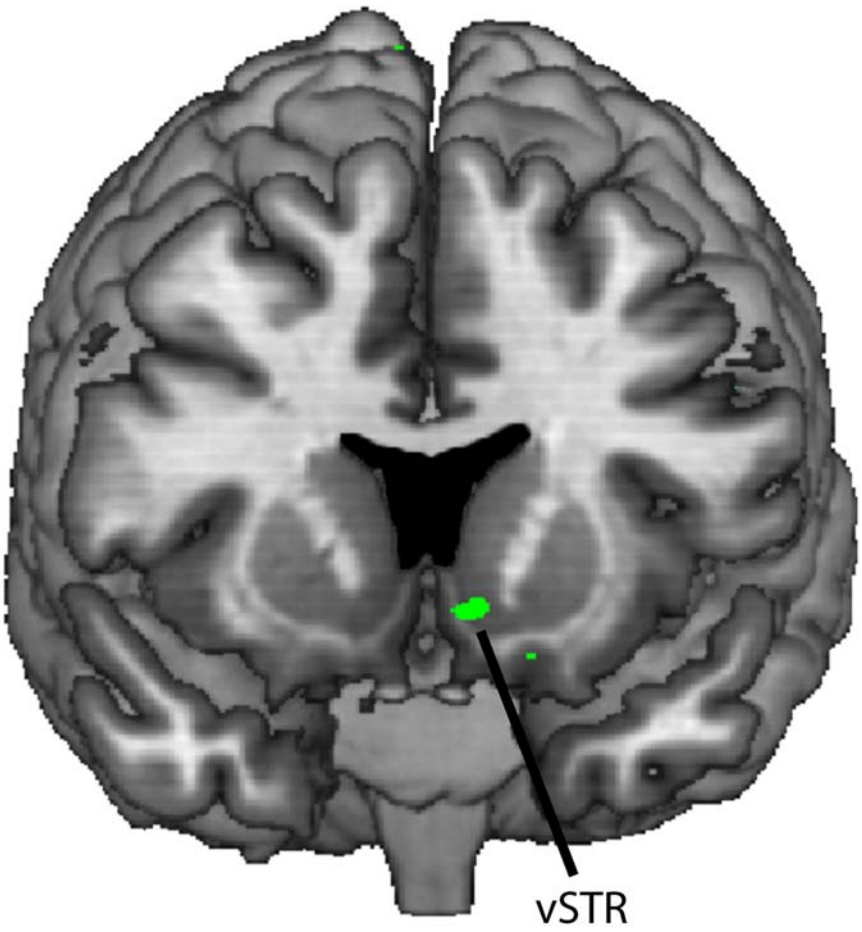

Figure S5: Monetary rewards evoke activation in vSTR

Our initial analysis found that monetary rewards activate regions of the vmPFC and frontopolar cortex, but did not find significant vSTR activation (cf. **Figure 2**). Given the small size of vSTR, it is possible that our conservative cluster-correction threshold could miss activation in this region. We therefore examined the contrast between large and small monetary rewards (+$5 & +$2 > -$5 & -$2) without a strict cluster criterion and using a lower, uncorrected threshold of $z > 2.5$. We found that this adjustment in statistical threshold revealed activation in vSTR (shown in green; image is not masked in any manner). Notably, this procedure bears similarity with other techniques that use small volume correction to examine activation in vSTR.

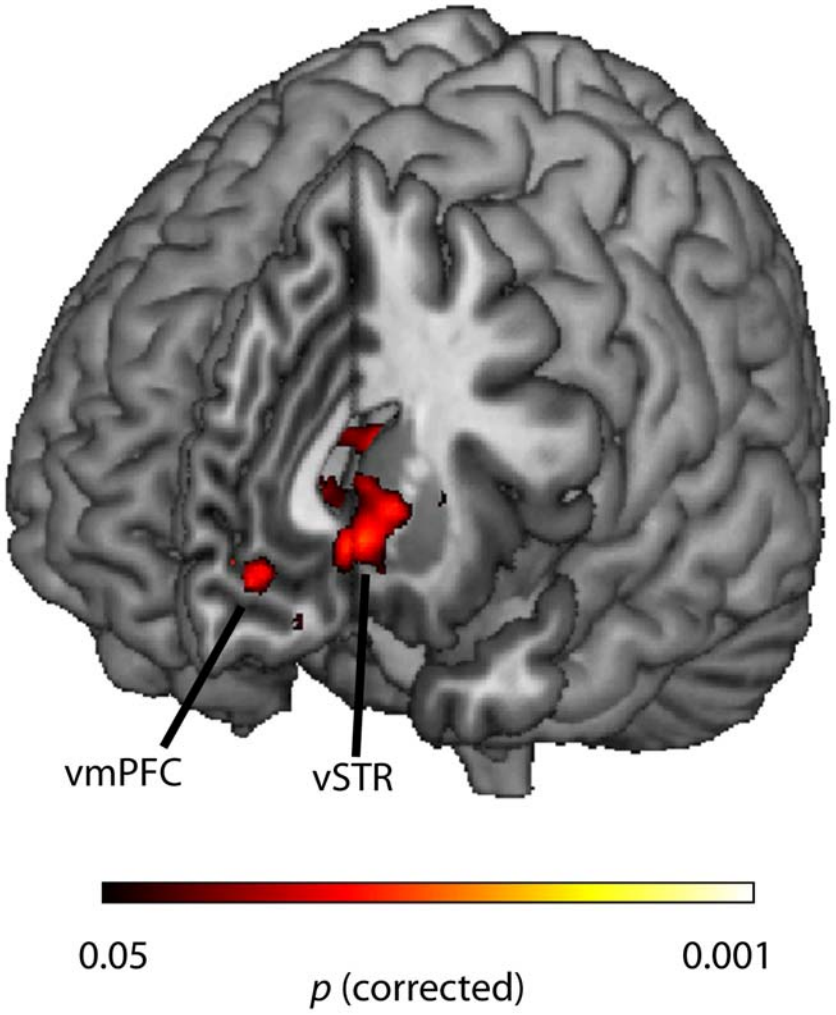

Figure S6: vmPFC and vSTR activation scales with the size of social rewards

To confirm that vmPFC and vSTR activation scaled as a function of the size of social rewards, we conducted a parametric analysis in which rewards were modeled as a single regressor with response levels dependent upon the size of the social reward. This analysis confirmed that vmPFC and vSTR activation increases with increasing size of social rewards. Areas of activation passed a cluster significance threshold of $z > 2.3$, with whole-brain cluster-correction at $p < 0.05$.

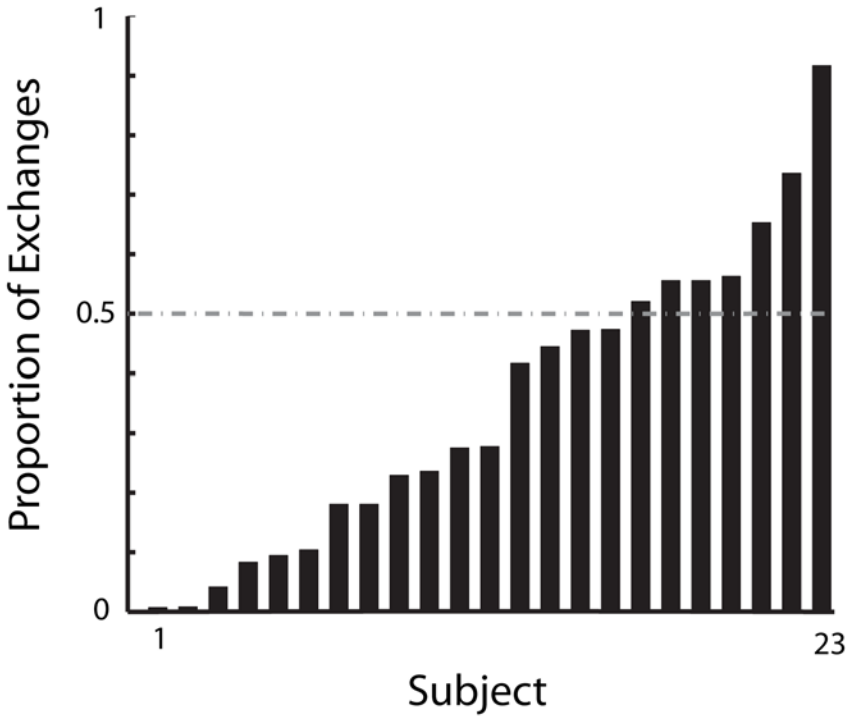

Figure S7: Individual differences in exchange rate

In our economic exchange task, participants had the opportunity to exchange small amounts of money for the opportunity to view a more attractive face. This task afforded an opportunity to examine each participant's relative economic valuation of social and monetary rewards. We observed substantial inter-individual differences in participants' willingness to make these exchanges; shown in the plot is a ranking of participants (N = 23) by the proportion of time they sacrificed a larger amount of money to purchase a more attractive face.

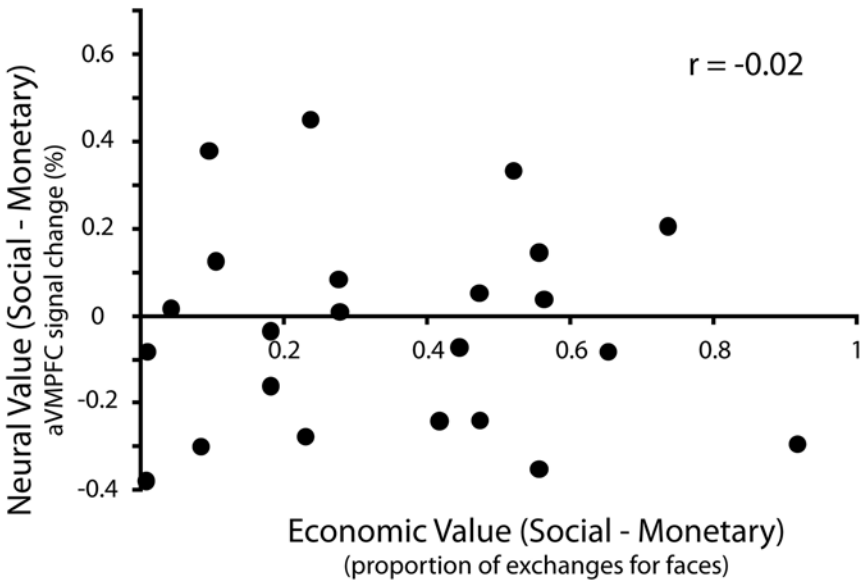

Figure S8: Neural value in aVMPFC does not predict economic value

Because aVMPFC responded to both social and monetary rewards, we reasoned that it may show some relationship to subsequent economic exchanges that was not revealed in our whole brain analysis. We therefore examined the relationship of neural value and economic value within aVMPFC. Each point represents the average neural value response within aVMPFC (Social > Money reward responses) for each participant. We did not find any relationship between neural value and each participant's exchange rate. This result supports a specialized role for pVMPFC in value computation.

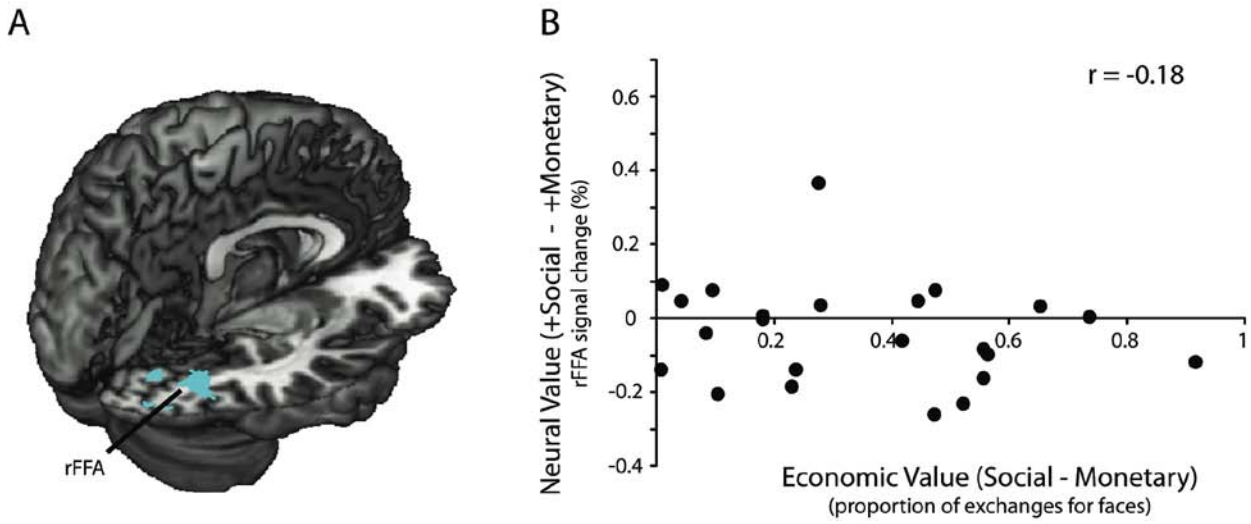

Figure S9: Neurometric value in rFFA does not predict economic value

We performed a *post hoc* analysis to examine effects of value when considering only the most-positive stimuli within our set. We constructed two contrasts: a parametric effect of monetary gains ($1, $2, $5) and a subtraction between 4-star faces and 3-star faces. (**A**) We first identified areas of activation from each contrast that passed a cluster significance threshold of $z > 2.3$, with whole-brain cluster-correction at $p < 0.05$, and then identified the intersection of these contrasts. The sole point of overlap was within right fusiform face area (rFFA; x30 y-70 z-10), which survived an additional cluster correction of 15 contiguous voxels. **(B)** Of note, the rFFA neurometric value over positive stimuli (i.e., the 4-star minus 3-star effect minus the parametric effect for monetary gains) was not predictive of participants' proportion of exchanges ($r_{(21)} = -0.18$, n.s.).

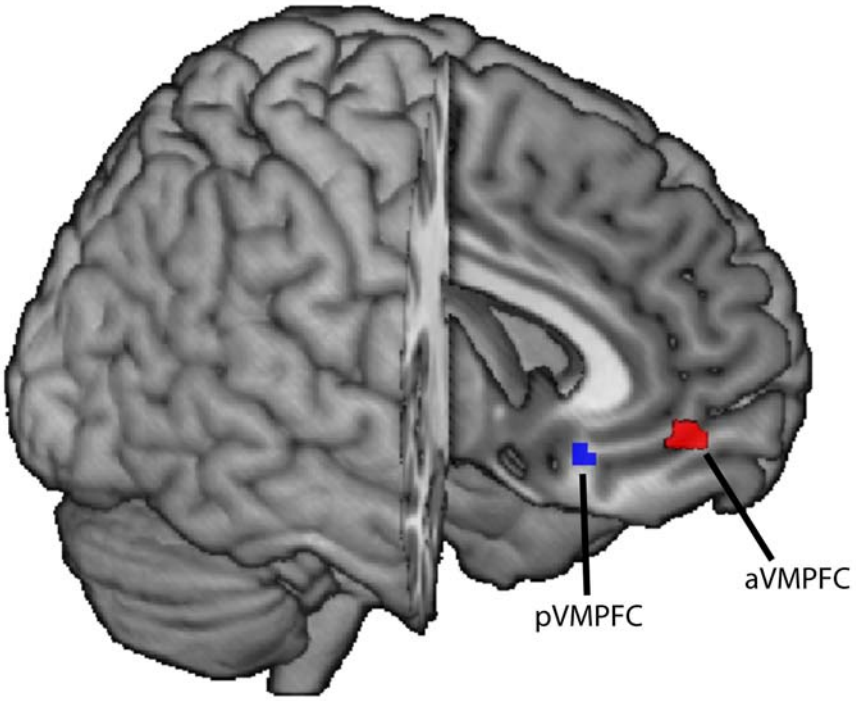

Figure S10: Regions identified as pVMPFC and aVMPFC

We identified two distinct subregions of VMPFC that responded to different forms of value. Shown in red is anterior VMPFC (aVMPFC; x0, y46, z-8). This region was the sole point of overlap for monetary and social value, indicating a role for processing experienced rewards. Shown in blue is posterior VMPFC (pVMPFC; x6, y26, z-14). This region was identified in a whole-brain analysis in which we regressed relative neural value (Social > Money reward responses) against relative economic value (Social > Money; proportion of exchanges for faces).

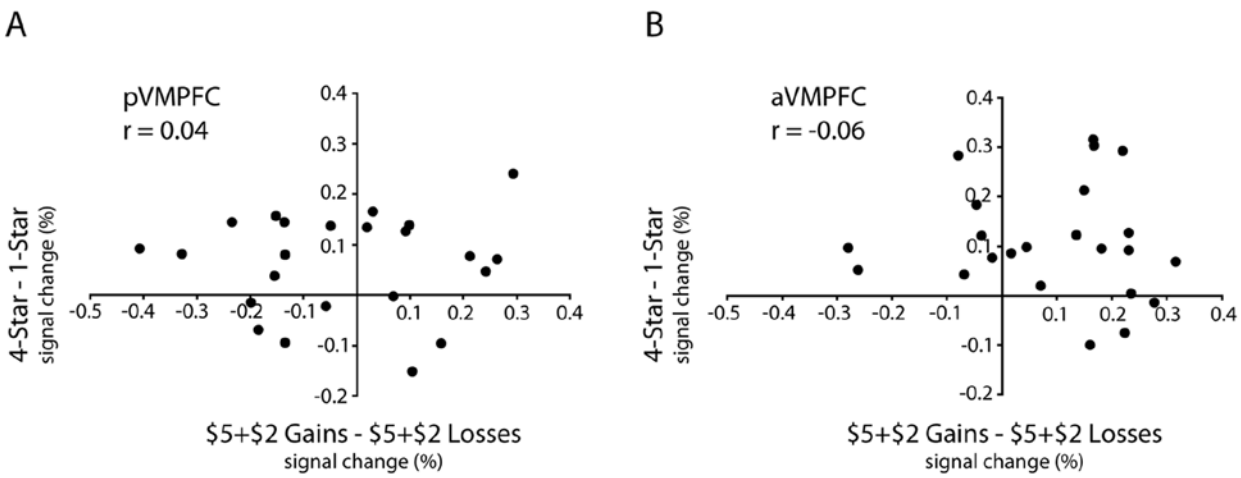

Figure S11: Activation in VMPFC is uncorrelated between reward modalities

We investigated whether VMPFC activation to one reward modality predicted activation to the other modality. To do this, we correlated the activation contrast [4-star minus 1-star images] to the contrast [large monetary gains minus large monetary losses], for each of anterior and posterior VMPFC, independently. No significant relationship was observed for either pVMPFC (**A**) or aVMPFC (**B**).

Supplemental Tables

Table S1
The attractiveness categories used in the present experiment. All are drawn from the distribution shown in Figure S1, with ratings here expressed as *z*-scores.

	Normalized Ratings				
	min	**max**	**mean**	***SD***	**N of photos**
1-star	-2.11	-1.05	-1.36	0.23	138
2-star	-0.68	-0.32	-0.47	0.06	174
3-star	0.34	0.69	0.48	0.07	157
4-star	1.02	2.48	1.43	0.28	130

Table S2
Regions exhibiting increased activation to monetary rewards, regardless of their value, compared to photographs of faces. Coordinates of cluster maxima are in MNI space.

x	**y**	**z**	**Region**	**Brodmann Area (BA)**	***Z*-stat**	**Cluster size (2 mm^3 voxels)**	**Cluster Index**
4	-72	34	Precuneus	BA 7	6.26	11072	1
40	-40	44	Inferior Parietal Lobule	BA 40	4.92	3306	2
32	4	64	Middle Frontal Gyrus	BA 6	4.95	3110	3
62	-46	-8	Middle Temporal Gyrus	BA 21	4.79	1570	4
-24	6	62	Superior Frontal Gyrus	BA 6	4.23	1562	5
-52	-56	-14	Middle Temporal Gyrus	BA 37	4.51	587	6

Table S3
Regions exhibiting increased activation to photographs of their faces, regardless of their attractiveness, compared to monetary rewards. Coordinates of cluster maxima are in MNI space.

x	**y**	**z**	**Region**	**Brodmann Area (BA)**	***Z*-stat**	**Cluster size (2 mm^3 voxels)**	**Cluster Index**
48	-62	6	Middle Temporal Gyrus	BA 39	6.40	6255	1
-42	-78	0	Middle Occipital Gyrus	BA 19	5.14	3640	2
6	40	-22	Rectal Gyrus	BA 11	4.33	1397	3

Table S4
Regions exhibiting sensitivity to monetary value, defined as increased activation to large gains (+$5 & +$2) compared to large losses (-$5 & -$2). Coordinates of local maxima within clusters of activation are in MNI space.

x	y	z	Region	Brodmann Area (BA)	*Z*-stat	Cluster size (2 mm^3 voxels)	Cluster Index
12	58	2	Medial Frontal Gyrus	BA 10	3.43	713	1
-2	68	-2	Medial Frontal Gyrus	BA 10	3.41	-	1
10	64	0	Medial Frontal Gyrus	BA 10	3.27	-	1
0	44	-10	Medial Frontal Gyrus	BA 11	3.22	-	1
-2	62	-2	Medial Frontal Gyrus	BA 10	3.08	-	1
-18	32	34	Medial Frontal Gyrus	BA 9	3.79	591	2
-14	40	6	Anterior Cingulate	BA 32	3.21	-	2
-26	20	44	Middle Frontal Gyrus	BA 8	3.12	-	2
-24	24	52	Superior Frontal Gyrus	BA 8	3.00	-	2
-18	46	10	Anterior Cingulate	BA 32	2.97	-	2

Table S5
Regions whose activation increases with increasing monetary reward size (see Supplemental Fig. 4). Coordinates of local maxima within clusters of activation are in MNI space.

x	y	z	Region	Brodmann Area (BA)	*Z*-stat	Cluster size (2 mm^3 voxels)	Cluster Index
0	68	-2	Medial Frontal Gyrus	BA 10	3.38	596	1
12	60	0	Medial Frontal Gyrus	BA 10	3.13	-	1
8	68	0	Superior Frontal Gyrus	BA 10	3.06	-	1
-6	72	-4	Medial Frontal Gyrus	BA 10	3.02	-	1
4	52	-10	Medial Frontal Gyrus	BA 10	2.94	-	1

Table S6
Regions exhibiting sensitivity to social value, defined as increased activation to attractive faces (those from the 4-star category) compared to unattractive faces (those from the 1-star category). Coordinates of local maxima within clusters of activation are in MNI space.

x	y	z	Region	Brodmann Area (BA)	*Z*-stat	Cluster size (2 mm^3 voxels)	Cluster Index
0	48	-8	Medial Frontal Gyrus	BA 10	3.31	1046	1
-8	18	-6	Caudate	Caudate Head	3.23	-	1
0	38	-12	Medial Frontal Gyrus	BA 11	3.19	-	1
0	42	-6	Anterior Cingulate	BA 32	3.04	-	1
-18	18	0	Caudate	Caudate Head	3.02	-	1
50	-76	-2	Middle Occipital Gyrus	BA 19	3.41	600	2
34	-92	-6	Middle Occipital Gyrus	BA 18	3.35	-	2
40	-82	8	Middle Occipital Gyrus	BA 19	3.32	-	2
54	-72	10	Middle Temporal Gyrus	BA 39	3.25	-	2
48	-74	6	Middle Occipital Gyrus	BA 19	3.23	-	2
40	-84	-2	Inferior Occipital Gyrus	BA 18	3.21	-	2

Table S7
Regions whose activation increases with increasing social reward size (see Supplemental Fig. 6). Coordinates of local maxima within clusters of activation are in MNI space.

x	y	z	Region	Brodmann area (BA)	*Z*-stat	Cluster size (2 mm^3 voxels)	Cluster Index
50	-76	-2	Middle Occipital Gyrus	BA 19	3.98	2856	1
36	-84	16	Middle Occipital Gyrus	BA 19	3.60	-	1
40	-82	6	Middle Occipital Gyrus	BA 19	3.58	-	1
4	-80	16	Cuneus	BA 18	3.56	-	1
12	-86	10	Cuneus	BA 18	3.53	-	1
34	28	-6	Inferior Frontal Gyrus	BA 47	3.60	1971	2
0	48	-8	Medial Frontal Gyrus	BA 10	3.36	-	2
-8	16	-6	Caudate	Caudate Head	3.20	-	2
14	-16	-2	Thalamus	*	3.19	-	2
-16	16	2	Caudate	Caudate Head	3.16	-	2
-18	-62	48	Precuneus	BA 7	3.57	640	3
-26	-50	48	Precuneus	BA 7	3.42	-	3
-10	-64	60	Precuneus	BA 7	3.24	-	3
-20	-54	34	Precuneus	BA 31	3.10	-	3
-20	-90	24	Cuneus	BA 18	3.68	620	4
-26	-82	36	Precuneus	BA 19	3.39	-	4
-26	-68	24	Precuneus	BA 7	3.16	-	4
-28	-70	20	Posterior Cingulate	BA 31	3.08	-	4
-34	-86	24	Superior Occipital Gyrus	BA 19	2.87	-	4