Neuron, volume 53

Supplemental Data

Neural Predictors of Purchases

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Supplement 1. SHOP product descriptions

Table S1.1. Descriptive statistics by product set

Mean(SD)	Screen Price	Preference	%WTP	Purchase Rate
Set 1	7.1 (4.1)	1.1 (0.7)	25.5 (10.2)	30.4 (12.5)
Set 2	7.3 (4.2)	1.0 (0.7)	24.7 (9.7)	28.8 (15.8)
Average	7.2 (4.1)	1.1 (0.7)	25.1 (9.9)	29.6 (14.2)

Table S1.2. Product set 1 characteristics

Product	Screen Price	Preference	%WTP	Purchase Rate
24 DVD Set: Season 1	11	0.9	17	30
256 MB MP3 Player	16	1.7	23.9	37
Big "S" Pillow	7	-0.1	11	17.3
Brita Aquaview System	9	1	23.9	11.4
Catch Phrase Game	5	0.8	25	35.4
CD Wallet (224-Disc Capacity)	4	0.9	28.1	33.3
Collateral DVD	4	0.9	20.8	20
Color Flow Lamp	4	-0.3	15	16
Curb Your Enthusiasm DVD	8	1	20	30
Digital Voice Recorder	13	1.3	22.1	33.3
Eternal Sunshine Of The Spotless Mind DVD	4	2	36.5	42.3
Fact or Crap Game	5	0.1	13.5	15.4
Freakonomics	4	1.3	34.5	35.7
Godiva Chocolate	7	2.4	29	36
Harry Potter Box Set	7	0.8	25	29.2
Jenga Truth or Dare	5	0.2	13.5	13.5

Key Ring Camera	15	1.7	24	30.8
LED Lamp	15	0.7	14.4	25
M.C. Escher 'Relativity" Art Print	3	1	29	24
Meet the Fockers DVD	5	0.8	17.3	15.4
Monet's Sunset in Venice Print	4	1.8	28	32.7
Napoleon Dynamite DVD	5	2	38.5	45.8
Packing Cubes	4	0.7	27.9	19.2
Portable Lap Desk	10	0.8	17.3	30.8
Rolled Fleece Blanket	9	1.1	21.9	26
Saturday Night Live Best of Will Ferrell DVD	4	1.5	29.8	44.2
Sex and the City DVD Set: Season 1	6	0.5	17.3	28.8
Sonic Power Toothbrush	15	2	31.8	40.9
Space-Saver Bags	5	0.5	17.3	19.2
Stanford Campus Throw Rug	16	-0.2	10	15.4
Stanford Martini Glasses	2	1.3	51	48.1
Stanford Nalgene Bottle	4	2.1	34.7	47.4
Star Wars - Episode II, Attack of the Clones DVD	3	-0.1	15	14
The Daily Show's "America (The Book)"	4	1.5	40	22.5
The Incredibles DVD	4	1.7	37.5	36.4
The O.C. DVD Box Set: Season 1	13	0.3	14	20
The Office DVD Set: Season 1	6	1.4	29	36
USB Flash Drive (128 MB)	5	2.4	52.4	71.4
van Gogh's Café Terrace at Night Art Print	4	2	34.4	40
Wireless Headphones	10	1.5	28	46

Table S1.3. Product set 2 characteristics

Product	Screen Price	Preference	%WTP	Purchase Rate
Anchorman DVD	4	1.3	39.6	50
Aqua Teen Hunger Force DVD Set: Volume 3	6	0.2	11.5	13.5
Bar Master, Electronic Drink Guide	7	0.8	23	28
Chappelle's Show DVD Set: Season 1	5	1.4	34	40
Color Changing Mood Clock	5	0.6	22	20
Colorsplash Camera	19	1	16.3	13.5
Crest Whitestrips Premium	7	1.2	26	16.7
Da Ali G Show DVD Set: Season 1	6	0.5	16.7	27.1
Dodgeball DVD	6	1.3	35.4	44.7
Eyeglass Cleaner	15	0	9.6	7.7
Family Guy DVD Set: Season 3	9	2	33.7	43.5
Free Association Game	5	0.2	13.5	7.7
Garden State DVD	6	1.7	28.8	34.6
Ice Cream Maker	7	1.5	28	30
Kandinsky's Farbstudie Quadrate Art Print	4	1	32	26
Kill Bill Vol. 1 DVD	4	0.8	30	26
Lighted Wine Charms	9	0.1	9	8
Malcolm Gladwell's "Blink"	4	0.9	19	14

Mini CCFL Desk Light	6	1.3	26	29.2
Monet's Venice Palazza Da Mula	3	1.2	30.8	30.8
Noise-Cancellation Headphones	12	2.4	36	62
Picasso Three Musicians Art Print	3	1.3	29.8	48.1
Picasso's The Dog Art Print	6	0.5	13.5	15.4
Portrait of a University Book	9	0	13.5	3.8
Reno 911 DVD Set: Season 1	5	0.6	20.2	23.1
Shrek 2 DVD	4	1.3	32	42
South Park DVD Set: Season 4	10	1.3	17.3	23.1
Stanford Banner	7	0.2	11	14
Stanford Bucket Hat	5	-0.7	8.7	5.8
Stanford Full Zip Hooded Sweatshirt	14	2.1	37	52
Stanford T-Shirt	4	1.4	41.2	50
Swiss Light Multi-Tool	6	1.8	39.1	45.7
Team America - World Police DVD	5	0.3	18.8	6.3
The Lord of the Rings Trilogy DVD Box Set	19	1.8	25	39.6
The Simpsons DVD Set: Season 5	8	2	30.8	36.5
The Sopranos DVD Box Set: Season 1	16	0.5	11.4	17.4
Trivial Pursuit Pop Culture Edition	7	0.8	21	20
van Gogh's Starry Night Over the Rhone Art Print	3	2	35	56
Waterproof Disposable Camera	2	1.2	31.7	42.3
Wireless Keyboard and Mouse	10	2	31.8	39.1

Supplement 2. Spiral In/Out Pulse sequence resolves signal to noise in artifact-prone areas

Background:

In the SHOP task, detection of signal in artifact-prone brain regions (e.g., orbitofrontal cortex, amygdala, nucleus accumbens) is critical. Here, we verified that the spiral in/out pulse sequence provided adequate signal to noise ratio (SNR) in these areas.

Method:

As described previously, all scans were acquired on a General Electric 1.5 T Signa magnet utilizing a spiral in/out pulse sequence, and spiral in and out images were combined with weighted averaging. After preprocessing, but prior to high pass filtering, functional data was averaged over the first run for each subject and then averaged across all subjects (n=26). An estimate of noise was drawn from a representative voxel outside the cranium (=70 intensity units). The average value of voxels in regions of interest were divided by the noise estimate to obtain a measure of signal to noise ratio (SNR). Signal maximum was approximately 3000 intensity units. Percentage maximum was thresholded at 10%, and overlaid on a representative structural scan, with each change in color representing an additional 10% increase, up to 100% maximum. Percentage maximum maps are superimposed on representative slices from the 24-slice axial montage (see Fig S2.1).

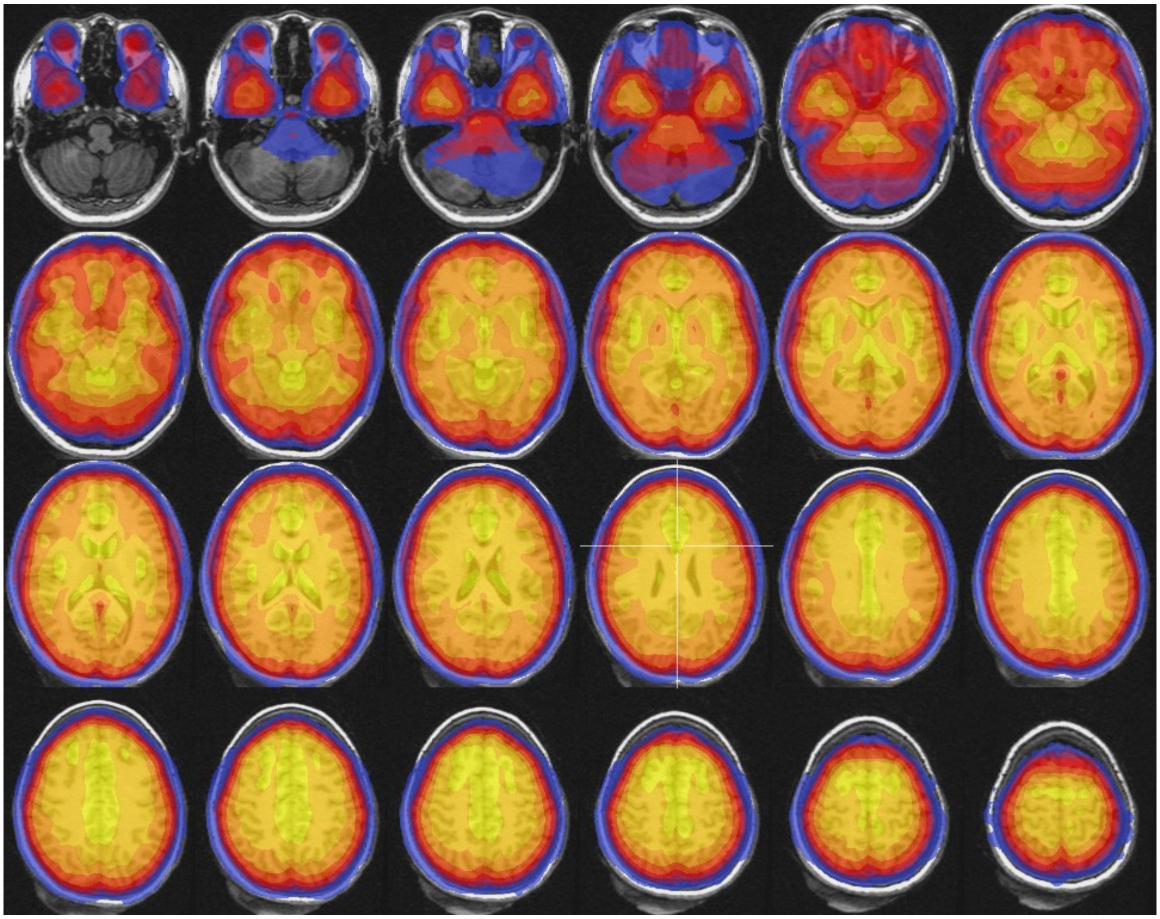
Results:

Even in the most artifact-prone regions, signal was > 65% of maximum, and SNR was > 35 (see Table S2.1 and Figure S2.1). The only regions that fell outside of the scanning range were the cerebellum and top of the cranium (not depicted).

Table S2.1. Percent SNR by region.

Region	**% Max.**	**SNR**
OFC	67	35
MPFC	**80**	**42**
ACing	96	50
MCing	98	51
PCing	90	47
NAcc	**82**	**43**
Amygdala	78	41
VTA / midbrain	80	42
Insula	**90**	**47**
Sup. Parietal	75	39

Figure S2.1. Average signal to noise maps across 26 subjects (warmer colors indicate 10% increase in SNR).



Summary:

SNR maps superimposed on artifact-prone regions revealed SNR > 35 and maximum signal > 65%. Thus, use of the spiral in/out pulse sequence minimized dropout in artifact-prone regions, providing acceptable levels of SNR over all brain regions of interest.

Supplement 3. Volume of interest (VOI) specifications

For verification and prediction analyses, spheres 8 mm in diameter were placed bilaterally in predicted regions of interest, ensuring sampling of equal volumes of tissue in each location (NAcc: ±12, 10, -2; MPFC: ±4, 53,-6; Insula: ±32, 9, 9). VOIs were then superimposed over structural scans of each individual subject and moved to ensure that they included only gray matter. NAcc VOIs required no adjustment in any subject.

MPFC VOIs, however, required some individual adjustment to correct for gyral variability in a subset of subjects (n=18). Specifically, each subject's MPFC VOIs were placed on the third gyrus superior to the rectal gyrus (viewed in the coronal plane), with anterior-posterior placement depending upon the extent of the cingulate gyrus, such that subject's VOIs were then moved anterior until the cingulate gyrus no longer intruded into the VOI. Thus, right-left orientation was fixed, while anterior-posterior orientation changed no more than 4 mm, and superior-inferior orientation changed no more than 4 mm.

Insula VOIs also required individual adjustment in a subset of subjects (n=10). VOIs were moved right-left and superior-inferior until the sphere included gray matter of the insula at the superior junction between the insular cortex and the inferior frontal gyrus. Thus, right-left orientation changed no more than 4 mm, anterior-posterior orientation was fixed, and superior-inferior changed no more than 4 mm.

Activation time course data from VOIs that were not adjusted according to individual anatomy yielded similar results in verification and prediction analyses, but with slightly higher variance.

Supplement 4. Brain activation in other regions does not predict purchasing

Background:

While NAcc activation was correlated with preference during product presentation, and while MPFC activation was correlated with price differential during price presentation as hypothesized, other brain regions also correlated with these variables during these periods. Here, we examined whether adding activation from other regions identified in localization analyses to logit models would strengthen prediction of purchasing.

Method:

Activation was extracted from 8 mm spherical volumes of interest centered on foci which were most significantly correlated with preference or price differential in localization analyses (Tables 1-3). To increase the stability of estimates, bilateral VOIs were selected in regions in which activation was significant or approximately significant in corresponding points in both hemispheres. Activation during the product period (lag=4 s) was extracted for the preference-correlated regions, and activation during the price period (lag=4 s) was extracted for the price-differential-correlated regions (Table S4.1). These activation values were then added to the standard logit regression prediction model (Table 4), and the significance of individual coefficients, as well as variance accounted for (R^2) and fit (AIC), were compared.

Table S4.1. Talairach coordinates of additional foci correlated with preference and price differential

Preference	**R,A,S**
Anterior cingulate	±10, 37, -6
Medial frontal gyrus	±4, 31, 30
Dorsolateral prefrontal cortex	±39, 35, 11
Anterior insula	±28, 21, -2
Posterior cingulate	±4, -34, 31
Price differential	
Frontopolar cortex (R)	30, 60, -4
Frontopolar cortex (L)	-13, 68, -2
Parahippocampal gyrus (R)	-9, -47, 5

Results:

Activation from other regions that were strongly associated with preference and price differential did not significantly contribute to prediction of purchasing (with the possible exception of the anterior cingulate VOI). Additionally, relative to the canonical model, the extended model did not account for more variance overall, and had a worse fit to the data (Table S4.2).

Table S4.2. Extended logistic regression predicting decisions to purchase (n=26)

	Combined
Constant	-16.05 *** 6.12 (0.381)
Preference	18.80 *** 1.20 (0.064)
Price differential	11.89 *** 0.13 (0.011)
NAcc (Bilateral)	2.75 ** 0.62 (0.225)
MPFC (Bilateral)	3.49 *** 0.54 (0.154)
Insula (Right)	-2.45 * -.059 (0.241)
Anterior cingulate (Bilateral)	0.46 0.10 (0.221)
Medial frontal gyrus (Bilateral)	-2.20 * 0.50 (0.230)
Dorsolateral PF cortex (Bilateral)	0.42 0.09 (0.223)
Anterior insula (Bilateral)	0.30 0.08 (0.277)
Posterior cingulate (Bilateral)	0.84 0.17 (0.203)
Frontal pole (Left)	1.40 0.14 (0.096)
Frontal pole (Right)	-1.48 -.017 (0.112)
Parahippocampus (Left)	0.19 0.02 (0.111)

N. Obs.	3,909
Pseudo-R^2	0.535
AIC	2266.5

Notes: Regression includes subject fixed effects,
Z-scores above coefficients with standard errors in parentheses
Significance: *: <.05; **<.01; ***<.001

Summary:

Activation in additional brain regions highlighted by localization analyses did not significantly add to the prediction of NAcc activation during product presentation, MPFC activation during price presentation, and right insula activation during price presentation. These findings suggest that the hypothesized regions under study ultimately predict purchasing more robustly than other regions highlighted by localization analyses.

Supplement 5. Familiarity does not account for preference findings

Background:

In the SHOP task, NAcc activation during the product and price periods correlates with product preference. However, familiarity may correlate with preference, which may introduce a confound. For instance, subjects might be more familiar with a specific product brand and thus prefer it more. Thus, familiarity might account for the correlation of preference with NAcc activation as subjects view products. Here, we examined whether NAcc activation would remain correlated with preference, even when familiarity was added to the same model.

Method:

A subset (n=20) of the subjects who completed the SHOP task were called back to rate their familiarity with each of the products they saw during the task on 7 point Likert scales in a separate survey. Data from each product set was analyzed separately and resulting statistical maps were conjoined at a liberal threshold of $p<.01$ (uncorrected).

In localization analyses, the association of NAcc activation with preference alone versus preference and familiarity combined was examined by comparing both models. In the first model, preference was modeled for 8 s during product and price periods, price differential for 4 s during the price period, and choice for the 4 s of choice period, as in the primary analysis. The second model was the identical, except familiarity was also included during product and price periods, in parallel with preference. Further, paired t-tests were conducted between the preference coefficients in both models above to quantify significant differences in preference-correlated NAcc activation in both models. Finally, in additional prediction analyses, familiarity was included in logistic regressions to determine whether it decreased the ability of preference or NAcc activation to predict purchasing.

Results:

Both preference alone and preference in the model including familiarity were strongly correlated with bilateral NAcc activation. Preference activation peaks in bilateral NAcc foci were only slightly weaker in the model including familiarity (Fig S5.1). However, familiarity was not significantly correlated with NAcc activation (Table S5.1). Paired t-tests comparing preference coefficients for the two models also did not reveal significant differences anywhere in the brain (conjunctions, threshold at $p<.01$, uncorrected).

Fig S5.1. Preference-correlated conjoined activations in a model with (left) and without (right) familiarity (p's<0.05 uncorrected).

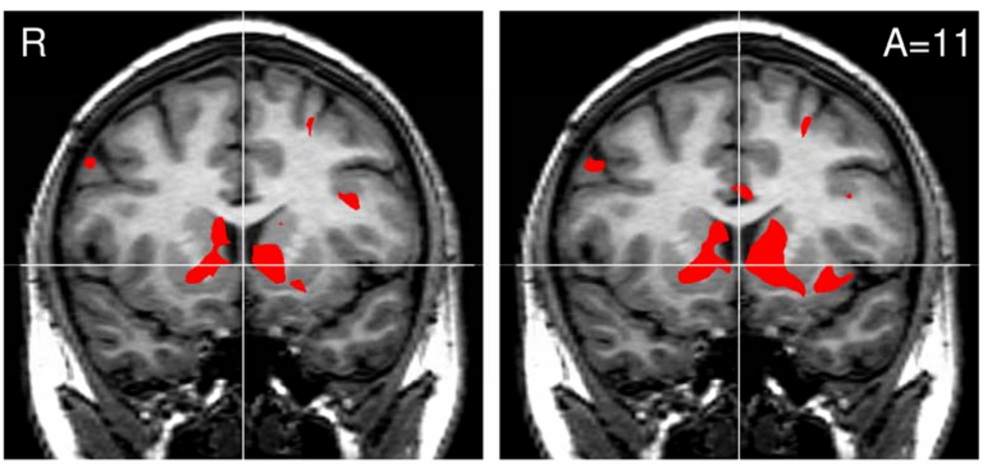


Table S5.1. Brain regions significantly correlated with familiarity. Conjoined regions significant at p<.001, 3 voxels

Familiarity	**Set 1 Z**	R	A	S	**Set 2 Z**	**R**	A	S
MPFC	3.94	-2	53	-3	3.32	0	41	0
L Posterior Cingulate	4.03	-3	-41	24	3.41	-7	-41	27
R Inferior Parietal Lobule	3.53	30	-55	46	3.79	30	-68	46

In prediction models that included familiarity alone, familiarity significantly predicted purchasing. However, after adding preference to the model, familiarity no longer significantly predicted purchasing. Further, preference and NAcc activation remained significant predictors of purchasing even when familiarity was included in the model. Therefore, familiarity did not add to existing prediction models (Table S5.3).

Table S5.2. Correlations between familiarity and variables of interest (n=2979).

	Familiarity
Purchase	0.285***
Preference	0.415***
Price Diff	0.381***
NAcc	0.047**
MPFC	0.062**
Insula	-0.008

***p<.0001, **p<.001,*p<.01

Table S5.3. Logistic regressions predicting decisions to purchase versus not, including familiarity (n=20)

	Familiarity	Self Report	Brain Activation	Combined
Constant	-11.07 *** -2.56 (0.232)	-14.46 *** -6.20 (0.429)	-10.94 *** -2.57 (0.235)	-14.36 *** -6.19 (0.431)
Preference		16.11 *** 1.197 (0.074)		16.07 *** 1.198 (0.075)
Price differential		11.00 *** 0.142 (0.013)		10.63 *** 0.137 (0.013)
Familiarity	15.17 *** 0.433 (0.029)	0.55 0.022 (0.039)	14.80 *** 0.427 (0.029)	0.37 0.015 (0.040)
NAcc			4.41 *** 0.865 (0.196)	2.08 * 0.549 (0.264)
MPFC			4.72 *** 0.626 (0.133)	2.92 ** 0.510 (0.175)
Insula (R)			-3.98 *** -0.854 (0.214)	-1.64 [p<.10] -0.481 (0.293)
N. Obs.	2969	2969	2969	2969
Pseudo-R^2	0.158	0.516	0.175	0.520
AIC	3014.6	1755.6	2959.6	1745.2 [w/o Fam., = 1744.6]

Notes: Regression includes subject fixed effects, Z-scores above coefficients with standard errors in parentheses
Significance: ***p<.001; **p<.01; *p<.05

Summary:

In localization analyses, NAcc activation correlated with preference but not familiarity. Inclusion of familiarity in regression models did not significantly diminish the correlation of preference with NAcc activation. In prediction analyses, when added to a model including preference, familiarity did not significantly predict purchasing, and did not reduce the ability of preference or NAcc activation to predict purchasing. Therefore, preference rather than familiarity appears to correlate with NAcc activation during product and price periods and to predict purchasing. By extension, the familiarity component of brand information cannot account for the effects observed in localization or prediction analyses.

Supplement 6. Price does not account for price differential findings

Background:

In the SHOP task, MPFC activation during the price period correlates with price differential. However, price itself may be a stronger correlate of MPFC activation, obviating the need to compute price differential (which indexes the subjective reaction to price rather than price itself). Here, we examined whether MPFC activation would remain correlated with price differential, even after adding price to the same model.

Method:

In localization analyses, data from each product set was analyzed separately and resulting statistical maps were conjoined at a liberal threshold of $p<.01$ (uncorrected). In prediction analyses, price was included in logistic regressions to determine whether it decreased the ability of price differential or MPFC activation to predict purchases.

Results:

Price differential was correlated with MPFC activation, even after price was included in the model (Fig S6.2). Paired t-tests comparing preference coefficients for the two models also revealed no significant differences anywhere in the brain (conjunctions, threshold at $p<.01$, uncorrected).

Figure S6.1. Price differential-correlated conjoined activations in models with price (left) and without price (right) included (ps < 0.05 uncorrected)

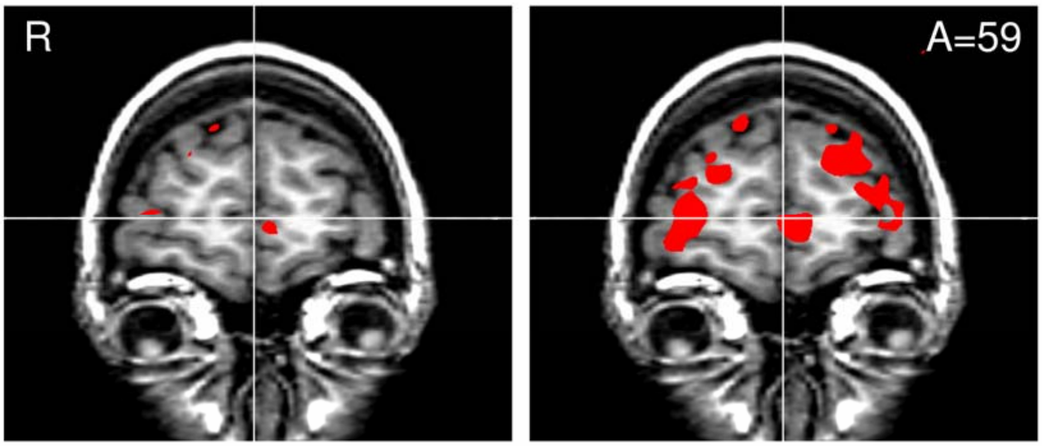


Table S6.1. Correlations between price and variables of interest (n=3909).

	Price
Purchase	-0.032
Preference	0.017
Price Diff	-0.174***
NAcc	-0.012
MPFC	-0.015
Insula	-0.048*

***p<.0001, **p<.001,*p<.01

In prediction models, price alone significantly negatively predicted purchasing. However, price differential continued to predict purchasing after adding price to the prediction model, and did so three times as robustly. Further, price differential and MPFC activation remained significant predictors of purchasing even with price included in the model. Thus, price could not account for the more robust effects of price differential in predicting purchasing (Table S6.2).

Table S6.2. Logistic regressions predicting decisions to purchase or not (n=26)

	Price	Self Report	Brain Activation	Combined
Constant	-0.76 -0.14 (0.180)	-14.94 *** -5.76 (0.385)	-0.90 -0.17 (0.183)	-14.86 *** -5.76 (0.387)
Preference		19.14 *** 1.22 (0.064)		18.98 *** 1.216 (0.064)
Price differential		12.36 *** 0.14 (0.011)		11.99 *** 0.135 (0.011)
Price	-1.92 -0.018 (0.010)	-4.51 *** -0.067 (0.015)	-1.94 * -0.018 (0.009)	-4.53 ** -0.068 (0.015)
NAcc (Bilateral)			5.56 *** 0.841 (0.153)	2.65 ** 0.577 (0.218)
MPFC (Bilateral)			7.25 *** 0.775 (0.107)	3.48 *** 0.522 (0.150)
Insula (Right)			-5.39 *** -0.861 (0.160)	-2.67 ** -0.642 (0.241)
N. Obs.	3909	3909	3909	3909
Pseudo-R^2	0.081	0.532	0.106	0.538
AIC	4381.9	2260.7	4270.0	2240.5 [w/o Price 2259.7]

Notes: Regression includes subject fixed effects, Z-scores above coefficients with standard errors in parentheses
Significance: ***p<.001; **p<.01; *p<.05

Summary:

In localization analyses, price did not correlate with MPFC activation, and did not significantly reduce the correlation between price differential and MPFC activation. In prediction analyses, price alone slightly predicted purchasing, but when price differential and MFPC activation were added to the model, both predicted purchasing more strongly than price. Therefore, price differential rather than price best correlated with MPFC activation during price presentation and more robustly predicted purchasing.

Supplement 7. Lagged activation does not account for price differential findings

Background:

In the SHOP Task, MPFC activation correlated with price differential, putatively computed when price information is revealed. However, this correlated activation may have resulted from lagged activation that began earlier during the product period and continued into the price period. To establish that MPFC activation coincided with the onset of price information, we lagged price differential forward to the product period in the model (before price was revealed) to examine whether it would still correlate with MPFC activation.

Method:

A “standard” model including preference during the product and price periods (8 s), price differential during the price period (4 s), and choice during the purchase period (4 s), was compared with an “early” model including preference during the product and price periods (8 s), price differential during the product period (4 s), and choice during the purchase period (4 s), essentially moving price differential forward by 4 s. Z-scores of correlated MPFC activation were compared between models for both stimulus sets.

Results:

Results indicated that while price differential correlates with MPFC activation during the price period, it did not correlate with MPFC activation during the preceding product period (Table S7.1). Therefore, the correlation of price differential with MPFC activation apparently depended upon delivery of price information.

Table S7.1. Activation foci for alternative price differential models (Early version models price differential information during the product period; Z=2.57; p<.01)

Standard PD Model	**Set 1 Z**	**R**	**A**	**S**	**Set 2 Z**	**R**	**A**	**S**
R MPFC	3.85	4	46	-6	3.12	4	46	-6
L MPFC	3.61	-4	59	-3	3.35	-4	59	-3
Early PD Model								
R MPFC	0.68	4	46	-6	0.67	4	46	-6
L MPFC	1.52	-4	59	-3	0.01	-4	59	-3

Summary:

Price differential correlated with MFPC activation during the price period but not during the earlier product period. This implies that price differential is not just a function of preference or willingness to pay (which might be computed during product presentation), but rather a computation that depends on the revelation of price information. This finding suggests that computation of a difference between price and willingness to pay (i.e., price differential) is critical for eliciting correlated MPFC activation.

Supplement 8. Lagging price presentation similarly lags price differential findings*

Background:

In the SHOP task, price appears 4 s after presentation of the product. The standard analysis, which models preference during the product and price periods, as well as price differential during the price period, indicated that NAcc activation correlated with preference while MPFC activation correlated with price differential. These findings imply that MPFC activation depends upon the revelation of price information. However, the peak of MPFC activation might have lagged behind NAcc activation, thus only appearing to co-occur with the subsequent appearance of price information (though preference and price differential were modeled simultaneously, essentially covarying for each other). To establish that MPFC activation depended on the appearance of price information, we conducted a second experiment on an independent sample of 8 males, in which the product appeared for a longer period (8 rather than 4 s), after which price appeared for the same amount of time (4 s), after which subjects chose whether to purchase the item or not (4 s).

Method:

Eight male subjects completed a lagged version of the SHOP task in which a product appeared for 8 s, followed by the price for 4 s, followed by choice to purchase the item (yes/no, counterbalanced by side) for 4 s, followed by a fixation cross for 2 sec. Subjects saw all 80 products in one scanning session for one presentation per product. For localization analyses, brain activation was modeled using the similar individualized regressors as implemented in the model of the primary dataset (preference, price differential, choice, reaction time, and nuisance motion regressors), with preference modeled from product onset until choice (12 s) and price differential modeled from the price onset until choice (4 s). Additional models in which price differential was inserted earlier at product onset and 4 s into product onset were compared with activation in the standard model using paired t-tests as a means of further examining the dependence of MPFC and insula activation on the onset of price information. For prediction analyses, logistic regressions examined whether the original findings could be replicated with this different temporal onset of price information.

Results:

Subjects' average purchasing rate was similar to that observed in the primary SHOP task (28%±3.2%). Volumes of interest (VOIs) were based on those identified in the primary SHOP task. For localization analyses, activation foci were thresholded at $p<.01$ (uncorrected) and a cluster criterion of 3 voxels, due to specificity of prior hypotheses and reduction of sample size by a third. Foci for the lagged SHOP task replicated the pattern of findings observed in the primary SHOP task. First, preference during the product period robustly correlated with ventral striatal activation (though moreso in the caudate and putamen than the NAcc, possibly due to the extended length of the product period). Second, price differential during the price period correlated with MPFC activation and insula deactivation. Third, the decision to purchase during the choice period correlated with insula deactivation (Table S8.1).

Table S8.1. Price-lagged SHOP activation foci (Z=3.2; p<.001, 3 voxels; a priori regions reported at p<.01)

Preference	**Z-Score**	**R**	**A**	**S**
R DLPFC*	3.69	33	53	4
R Middle Frontal Gyrus*	3.95	45	30	30
L Caudate	**3.11**	**-7**	**9**	**5**
	3.26	**-15**	**18**	**9**
R Caudate	**3.20**	**14**	**14**	**15**
	2.90	**8**	**8**	**12**
L Putamen*	**3.87**	**-12**	**1**	**5**
	3.55	**-8**	**5**	**-10**
R Middle Insula	-3.37	33	-2	4
L Middle Insula	-3.04	-31	-2	7
L Parahippocampal Gyrus*	3.95	-15	-27	-3
L Inferior Parietal Lobe*	4.52	-49	-56	49
Precuneus*	3.86	0	-61	49

Price Differential	**Z-Score**	**R**	**A**	**S**
R MPFC	**2.65**	**6**	**46**	**-9**
R Anterior Cingulate*	3.87	6	32	27
R Caudate	2.92	11	10	0
R Putamen	3.11	18	1	-3
L Putamen	3.28	-22	6	-3
R Middle Insula	**-3.51**	36	-12	23
L Middle Insula	**-3.28**	-42	2	-4
R Cingulate*	-3.90	1	-11	54

Choice	**Z-Score**	**R**	**A**	**S**
R VMPFC*	3.79	3	33	-10
L VMPFC*	3.53	-4	33	-7
L Middle Insula	**-2.91**	**-34**	**-11**	**8**

*p<.001

Within-subjects t-tests of coefficients for this model versus alternative models in which price differential was lagged forward 8 s (at product presentation) or 4 s (4 s into product presentation) indicate that activation at the predicted lag (i.e., at price presentation) best correlated with MFPC activation (Table S8.2).

Table S8.2. Contrast of MPFC correlation with price differential during the price period versus lagged 4 or 8 sec forward (into the product period)

	Z-Score	R	A	S
PD at price vs. PD at product (8 s prior)				
R MPFC	2.22*	-1	56	-3
PD at price vs. PD 4 s into product (4 s prior)				
R MPFC	2.85**	6	53	-10
	2.60*	3	64	-5

**p<.005, *p<.05,

Table S8.3. Zero-order correlations

	Purchase	Preference	Price Diff	NAcc	MPFC	Insula
Purchase	--					
Preference	0.553***	--				
Price Diff	0.547***	0.659***	--			
NAcc	0.233**	0.156**	0.184	--		
MPFC	0.137*	0.054	0.056	0.044	--	
Insula	-0.041	-0.106	-0.032	-0.012	0.124	--

***p<.0001, **p<.001, *p<.05

Prediction analyses replicated most findings from the original study. Specifically, NAcc and MPFC activation predicted subsequent purchases, even after controlling for self-reported product preference and price differential. However, insula activation no longer significantly predicted subsequent purchases (Table S8.4). Addition of product familiarity or price to the model did not alter these findings. NAcc activation most robustly predicted purchasing during the initial appearance of the product (i.e., TRs 3 and 4), while MPFC activation most robustly predicted purchasing at the same time as the lagged revelation of price information (i.e., TRs 7 and 8).

Table S8.4. Logistic regression models predicting decisions to purchase or not in the price-lagged SHOP experiment (n=8).

	Self Report	Brain Activation	Combined
Constant	-4.86*** 0.51 (0.508)	-1.80 -0.45 (0.252)	-6.60*** -3.35 (0.508)
Preference	5.96*** 0.68 (0.097)		5.83*** 0.59 (0.101)
Price differential	6.03*** 0.13 (0.022)		5.58*** 0.12 (0.023)
NAcc		5.20*** 2.13 (0.409)	3.38*** 1.80 (0.533)
MPFC		3.76*** 0.94 (0.249)	2.67** 0.90 (0.337)
Insula (R)		-0.78 -0.28 (0.359)	0.18 0.08 (0.466)
Number of observations	589	589	589
Pseudo-R^2	0.395	0.111	0.425
AIC	437.9	636.5	423.3
Notes: Subjects with significant fixed effects (out of 26; p<.01)	4	3	4

Regression includes subject fixed effects, Z-scores above coefficients with standard errors in parentheses
Significance: ***p<.001; **p<.01; *p<.05

Summary:

Overall, these findings indicate that when price information was lagged by 4 sec, correlation of MPFC and insula activation with price differential also lagged by 4 sec, supporting the notion that activation in these regions correlated with price differential depended upon the onset of price information. However, NAcc activation continued to correlate with preference at product onset. In prediction analyses, NAcc continued to predict purchasing at product onset, and MPFC activation continued to predict purchasing at price onset. Thus, these findings verify that lagging price information also lags the correlation of MFPC and insula activation with price differential, as well as MPFC activation's ability to predict purchasing.

Supplement 9. Lagging choice presentation does not lag price differential findings*

Background:

In the SHOP task, an opportunity to choose to purchase the displayed product appears 4 s after presentation of the product's price. The standard analysis, which models preference during the product and price periods, as well as price differential during the price period, indicated that NAcc activation correlated with preference while MPFC activation correlated with price differential. Insula activation correlated with the decision not to purchase during the purchase period. However, insula activation also predicted purchasing during the price period. These findings raise the question of whether insula activation does correlate (negatively) with price differential, but perhaps over a longer timescale. To examine whether insula activation responded to the appearance of price information (as opposed to the purchase choice), we conducted a third experiment on an independent sample of 8 males, in which the product appeared for the same amount of time (4 s), after which price appeared for a longer time (8 s), after which subjects chose whether to purchase the item or not (4 s).

Method:

Eight male subjects completed a lagged version of the SHOP task in which a product appeared for 4 s, followed by the price for 8 s, followed by choice to purchase the item (yes/no, counterbalanced by side) for 4 s, followed by a fixation cross for 2 sec. Subjects saw all 80 products in one scanning session for one presentation per product. For localization analyses, brain activation was modeled using the similar individualized regressors as implemented in the model of the primary dataset (preference, price differential, choice, reaction time, and nuisance motion regressors), with preference modeled from product onset through the price period (8 s) and price differential modeled for the onset of the price period (4 s). For prediction analyses, logistic regressions examined whether the original findings could be replicated with this different temporal onset of choice information.

Results:

Subjects' average purchasing rate was similar to that observed in the primary SHOP task (32.0%±14.5%). Volumes of interest (VOIs) were based on those identified in the primary SHOP task. For localization analyses, activation foci were thresholded at p<.01 (uncorrected) and a cluster criterion of 3 voxels, due to the specificity of the prior hypotheses and reduction of sample size by a third. Foci for the lagged SHOP task replicated the pattern of findings observed in the primary SHOP task. First, preference during the product period robustly correlated with NAcc activation. Second, price differential during the price period correlated with MPFC activation as well as insula deactivation. Third, the decision to purchase during the choice period correlated with insula deactivation (Table S9.1).

Table S9.1. Price-lagged SHOP activation foci (Z=3.2; p<.001, 3 voxels; a priori regions reported at p<.01)

Preference	**Z-Score**	**R**	**A**	**S**
L Medial Frontal Gyrus*	4.23	0	60	4
R Inferior Frontal Gyrus*	3.95	41	56	1
R Middle Frontal Gyrus*	4.01	37	41	19
	3.65	37	30	38
L Middle Frontal Gyrus*	3.83	-41	26	31
	4.40	-3	26	34
R Anterior Insula*	3.79	30	19	-3
R NAcc*	**4.01**	**11**	**15**	**0**
L NAcc*	**4.04**	**-11**	**11**	**0**

R Midbrain*	3.78	4	-22	-14
L Posterior Cingulate*	3.63	-4	-34	27
L Inferior Parietal Lobe*	4.21	-38	-45	49
	4.07	-41	-52	46
L Precuneus*	4.17	-15	-60	27
	4.70	0	-67	46
R Cuneus*	3.37	22	-67	12

Price Differential	**Z-Score**	**R**	**A**	**S**
R MPFC	**2.68**	**4**	**44**	**7**
R Middle Insula	**-2.70**	**31**	**11**	**11**
L Middle Insula	**-3.26**	**-34**	**6**	**4**
R Middle Insula	**-2.61**	**40**	**1**	**4**
L Middle Insula	**-2.95**	**-37**	**-4**	**-7**
R Posterior Insula	**-2.95**	**37**	**-13**	**3**
L Posterior Insula	**-3.38**	**-40**	**-16**	**-2**

Choice	**Z-Score**	**R**	**A**	**S**
R Middle Frontal Gyrus*	3.66	52	26	23
R Anterior Insula	**-2.89**	**33**	**15**	**8**
L Middle Insula	**-2.72**	**-30**	**7**	**11**
R Parahipp Gyrus*	4.39	30	-37	-7
L Parahipp Gyrus*	4.03	-26	-30	-7
	3.93	-26	-49	-3
Posterior Cingulate*	3.86	0	-52	23

*p<.001

Table S9.2. Zero-order correlations

	Purchase	Preference	Price Diff	NAcc	MPFC	Insula
Purchase	--					
Preference	0.613***	--				
Price Diff	0.582***	0.499***	--			
NAcc	0.147**	0.175**	0.111**	--		
MPFC	0.126*	0.095*	0.088*	0.147***	--	
Insula	-0.050	-0.040	-0.055	-0.058	0.286***	--

***p<.0001, **p<.001, *p<.05

Prediction analyses replicated most findings from the original study. Specifically, NAcc, MPFC, and insula activation predicted subsequent purchases (Table S9.3). However, unlike the other experiments, when self-report variables were added to the logit model, brain activation variables no longer significantly added to the prediction of purchasing, probably due to the higher correlation between self-report and brain variables in this dataset (Table S9.2). Addition of product familiarity or price to the model did not alter these findings. NAcc activation most robustly predicted purchasing during the initial appearance of the product (i.e., TRs 3 and 4), while MPFC and insula activation most robustly predicted purchasing at the same time as the lagged revelation of price information (i.e., TRs 5 and 6).

Table S9.3. Logistic regression models predicting decisions to purchase or not in the choice-lagged SHOP experiment (n=8).

	Self Report	Brain Activation	Combined
Constant	-8.03*** -0.47 (0.556)	-5.76*** -0.79 (0.310)	-7.94*** -4.53 (0.568)
Preference	8.15*** 0.82 (0.101)		7.99*** 0.82 (0.103)
Price differential	7.78*** 0.22 (0.029)		7.57*** 0.22 (0.029)
NAcc		3.44*** 1.27 (0.368)	0.45 0.23 (0.510)
MPFC		3.09** 0.72 (0.233)	1.59 0.53 (0.332)
Insula (R)		-2.84** -1.00 (0.354)	-0.76 -0.40 (0.524)
Number of observations	614	614	614
Pseudo-R^2	0.531	0.116	0.534
AIC	387.1	713.5	390.0
Notes: Subjects with significant	4	3	4

fixed effects (out of 26; p<.01)
Regression includes subject fixed effects, Z-scores above coefficients with standard errors in parentheses
Significance: ***p<.001; **p<.01; *p<.05

Summary:

Overall, these findings indicate that when choice information was lagged by 4 sec, the correlation of MPFC and insula activation with price differential did not lag, supporting the notion that the correlation of activation in these regions with price differential depended upon the onset of price, not choice, information. As in other experiments, NAcc activation continued to correlate with preference at product onset. In prediction analyses, NAcc continued to predict purchasing at product onset, and MPFC and insula activation continued to predict purchasing at price onset. Overall, these findings verify that lagging choice information neither influences the correlation of MFPC and insula activation with price differential, nor does it influence the ability of MPFC and insula activation to predict purchasing. Thus, MFPC and insula appear to respond to price rather than choice information.

Supplement 10. Zero-order correlations between predictor and outcome variables

Table S10.1. Correlations between predictor and outcome variables.

	Purchase	Preference	Price Diff	NAcc	MPFC	Insula
Purchase	--					
Preference	0.594**	--				
Price Diff	0.564**	0.649**	--			
NAcc	0.118**	0.093**	0.088**	--		
MPFC	0.122**	0.097**	0.107**	0.132**	--	
Insula	-0.068*	-0.067*	-0.048*	-0.039	0.180*	--

**p<.0001; *p<.05

Supplement 11. Prediction models incorporating averaged (rather than individualized) self-report variables

Table S11.1. Logistic regression models predicting decisions to purchase or not using averaged self-report variables (n=26).

	Self Report	Brain Activation	Combined
Constant	-5.11 *** -1.05 (0.206)	-1.74 -0.30 (.170)	-5.12 *** -1.05 (0.207)
Preference	8.85 *** 0.78 (0.088)		8.49 *** 0.75 (0.089)
Price differential	3.72 *** 0.08 (0.021)		3.34 *** 0.07 (0.021)
NAcc (Bilateral)		5.55 *** 0.85 (.153)	4.76 ** 0.76 (0.160)
MPFC (Bilateral)		7.26 *** 0.78 (.107)	5.57 *** 0.63 (0.113)
Insula (Right)		-5.27 *** -0.84 (.160)	-4.41 *** -0.74 (0.168)
Number of observations	3,909	3,909	3,909
Pseudo-R^2	0.153	0.105	0.169
AIC	4042.4	4267.6	3972.1
Notes: Subjects with significant fixed effects (out of 26; p<.01)	18	16	17

Regression includes subject fixed effects,
Z-scores above coefficients with standard errors in parentheses
Significance: ***p<.001; **p<.01; *p<.05