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Price is a key factor in most purchases, but it can be presented at different stages of decision making. The authors examine the sequence-dependent effects of price and product information on the decision-making process at both neural and behavioral levels. During functional magnetic resonance imaging, the price of a product was shown to participants either before or after the product itself was presented. Early exposure to price, or “price primacy,” altered the process of valuation, as observed in altered patterns of activity in the medial prefrontal cortex immediately before making a purchase decision. Specifically, whereas viewing products first resulted in evaluations strongly related to products’ attractiveness or desirability, viewing prices first appeared to promote overall evaluations related to products’ monetary worth. Consistent with this framework, the authors show that price primacy can increase purchase of bargain-priced products when their worth is easily recognized. Together, these results suggest that price primacy highlights considerations of product worth and can thereby influence purchasing.

Keywords: consumer behavior, price, functional magnetic resonance imaging, value, purchase decisions

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Cost Conscious? The Neural and Behavioral Impact of Price Primacy on Decision Making

Imagine walking into a department store. Suppose the first thing you see is a display with a sweater that catches your eye. When you walk over to it, you look at the tag to find a price of \$49.99. Next, suppose that when you enter the store, you first approach a rack of clothes labeled with a “\$49.99” sign. With this price in mind, you browse through the options and find a sweater that fits your taste. In both scenarios, you have the same information before deciding

whether to head to the register. But are you going to be making the same kind of choice?

It would be reasonable to assume that information plays a fixed role in the computation of value and should be factored into a decision the same way regardless of when it is encountered. However, early exposure to certain facts or attributes could also set a context for processing subsequent information, shaping product perceptions and choice behavior. When consumers attend to a product first, they are engaged affectively, and this liking (or disliking) reaction largely influences their perceptions of value and purchase decisions. Herein, we propose that attending to price first, or “price primacy,” focuses consumers on whether a product is worth a given price.

Disentangling constructs such as liking and value can be difficult with behavioral measures alone, because explicit tests of attribute perceptions may introduce additional biases in attitudes and behavioral intentions (Feldman and

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Lynch 1988). Functional magnetic resonance imaging (fMRI) can provide a unique and useful tool for addressing some of these challenges because it can be used to track the neural correlates of key decision components before choice without disrupting the decision-making process. Thus, we combine behavioral measures with neuroimaging to explore predictions related to price primacy.

THEORETICAL BACKGROUND

Primacy and Sequencing Effects

Research on sequential presentation of information has shown that changing the order of information can influence a broad range of evaluative processes. “Primacy” of information (i.e., presenting it first) can increase its salience, command greater attention, improve encoding in memory, and facilitate retrieval of related information (Anderson 1973; Asch 1946; Page and Norris 1998; Wyer and Srull 1986).

In the context of decision making, studies on multi-option choice sets have shown that initial items in a series can dominate later items in part due to their relative advantage in being remembered (Bruine de Bruin 2005; Mantonakis et al. 2009). In addition to memory-related effects, early options can set standards, expectations, or reference points by which all later options are then benchmarked (e.g., Bruine de Bruin and Keren 2003).

Order effects can also influence how information or certain attributes contribute to making a choice. Early consideration of an attribute can amplify its impact on subsequent judgment and decision making (Feldman and Lynch 1988; Johnson, Häubl, and Keinan 2007; Tavassoli and Lee 2004; Weber et al. 2007). Furthermore, when determining product preferences, initial attributes can bias the interpretation of, or even the consideration given to, the information presented afterward (Russo, Meloy, and Medvec 1998; Yeung and Wyer 2004).

Across this literature, it is clear that order effects can influence the way a decision unfolds. Initial information can be overweighted, dominating the rest of the choice process, or it can engage a particular strategy (or perspective) that frames later evaluations. Building on this notion, we propose that changing the sequence in which price and product information are encountered will change the decision-making process. To better understand how this might occur, we turn our attention to how product and price information contribute to preference formation and value estimates.

Product Preference Formation

Extensive research has demonstrated that exposure to a stimulus (or product) results in immediate affective preference formation (e.g., Zajonc 1980). Furthermore, evidence has indicated that both previously established preferences and novel evaluations arise automatically, suggesting that it may not be possible for a consumer to avoid experiencing positive or negative affect when they see a product (Bargh et al. 1992; Duckworth et al. 2002; Fazio et al. 1986). Consistent with this finding, fMRI studies of yes/no purchase decisions in which products are shown before prices have revealed that a product’s evaluation is dominated by its initially evoked desirability, or how much it is liked or disliked when it is first encountered (Knutson et al. 2007).

Price, Preference, and Estimating Value

How could early exposure to price information differentially influence this process? Despite (or perhaps because of) its quantitative nature, a price alone is difficult to evaluate without points of reference (Hsee, Rottenstreich, and Xiao 2005; Hsee et al. 2003). Indeed, consumers typically draw from a range of additional information when called on to interpret prices (e.g., Ariely, Lowenstein, and Prelec 2003; Simonson and Drolet 2004). These findings might imply that price information will be integrated with product information in the same way regardless of their order, and so price primacy should have minimal effects on valuation and choice.

Even when presented alone, however, price represents what the consumer will lose in a transaction. Anticipating or incurring this cost may even elicit a physical “pain of paying” (Knutson et al. 2007; Prelec and Loewenstein 1998; Rick, Cryder, and Loewenstein 2008). According to this account, price primacy might initialize a transaction with a negative valuation or loss frame. By this reasoning, early exposure to price would overweight potential costs associated with a product. This “loss frame” hypothesis further predicts that price primacy could reduce perceptions of product value and/or attractiveness, potentially resulting in decreased purchase rates.

In general, the price literature reviewed previously implies that price primacy should only exert a quantitative influence on the weighting (or saliency) of price within a constant calculation of value. Yet we can also explore the possibility that it has qualitative effects on the value calculation (or purchase criteria) itself. Beyond conveying costs, price information can invoke considerations of the utility, benefit–cost balance, or overall worth of a product (e.g., Thaler 1999). Indeed, people commonly associate price and worth so strongly that prices can not only establish expectations of an item’s value (Rao and Monroe 1989) but also influence an item’s experienced quality or functionality during its consumption (Plassmann et al. 2008; Shiv, Carmon, and Ariely 2005; Waber et al. 2008). Thus, whereas product primacy initializes the decision with the affective attractiveness of a product, price primacy could initialize it with considerations of whether the product will be worth its price.

A price tag presented in advance of an associated product may not be sufficient to set specific value expectations on its own. More broadly, though, it could focus the evaluation process on a product’s utility, potentially resulting in a different scale or criterion for determining value. Thus, we predict that price primacy may influence not how much people desire a subsequently presented item but, rather, the way they integrate that product’s desirability with price information to form a comprehensive estimate of its worth. Such a shift goes beyond simple predictions of order effects, in which price might be weighted more heavily as an independent factor in the calculation of value. Instead, it is in line with research indicating that early information can determine the evaluative criteria used in decision contexts (e.g., Bruine de Bruin and Keren 2003; Russo, Meloy, and Medvec 1998; Yeung and Wyer 2004).

In summary, we approach the question of whether the order of product and price information can influence the mechanisms underlying the choice process and, ultimately,

purchasing decisions themselves. We propose the following hypotheses:

- H₁: Changing the sequence in which price and product information are encountered changes the decision-making process.
- H₂: In contrast to product primacy, price primacy causes a qualitative shift in how product value is determined, increasing considerations of an item's (monetary) worth.

Testing these hypotheses presents some challenges because we are positing a change in the ways that value-related mechanisms operate as information is encountered over time. Although behavioral measures can provide some insight regarding general trends in preferences, some mechanistic changes may not be consciously accessible, particularly at different stages of the decision process. We thus turn to fMRI because of its ability to record signals simultaneously from multiple neural loci that represent different facets of value while a choice is under way.

Neural Correlates of Value and Preferences

Recent research in decision neuroscience enables us to focus on at least two brain areas whose activity correlates with an item's desirability and its value, respectively. This suggests that fMRI has the potential to test our hypotheses and to address the alternatives (e.g., no change, loss framing, differential weighting of value).

Most central to our hypotheses are the mechanisms involved in the monetary value of an item. Willingness to pay (WTP) has been correlated with levels of activity in overlapping regions of the medial orbitofrontal and prefrontal cortex (Plassmann, O'Doherty, and Rangel 2007, 2010). Knutson et al. (2007) find that the degree to which people perceived product offers to be a bargain (or overly expensive) correlated specifically with activity in the medial prefrontal cortex (MPFC). This is consistent with a broader set of findings in which the MPFC and neighboring regions appear to integrate information, including product attributes or choice set composition, to reflect the overall value of one or more items (Hare, Camerer, and Rangel 2009; Hare et al. 2008; Knutson et al. 2001, 2007; Levy and Glimcher 2012; Smith et al. 2010).

Drawing on these findings, we selected the MPFC as a region of interest (ROI) for our analysis and suggest that activity patterns correlated with perceived value in this brain area will differ on the basis of price versus product primacy. Although this could be expressed as an overall decrease or increase in MPFC signal during the decision process, our hypotheses suggest a more qualitative change. Thus, the average response across items that yield distinct decision outcomes (e.g., evoke low vs. high values) may not be sufficiently informative.¹ To understand the full range of potential changes to evaluative mechanisms within the context of choice, we investigate how price primacy influences

the value signal for items that are purchased compared with those that are not purchased.

Though we make direct predictions about overall value, price primacy might also influence the automatic affective response to the product itself. Thus, a second ROI is the nucleus accumbens (NAcc), whose activity has been shown to correlate with the attractiveness or expressed preference for an item. In particular, the NAcc appears to represent the anticipated reward value of monetary gains, prizes, and various products (e.g., Erk et al. 2002; Knutson et al. 2001, 2007, 2008; see also Hare et al. 2008). Our hypotheses (H₁ and H₂) do not address how price primacy might change the perceived attractiveness of a product or, by extension, activity in the NAcc. However, it is also our goal to rule out competing predictions such as those generated by loss framing and/or price evoking pain associated with the transaction, which suggest that early attention to price might decrease product value or desirability. Thus, we predict that early exposure to price will not decrease the MPFC or NAcc response to the offered products.

In summary, to examine the effects of price primacy on decision making, we chose to analyze two specific ROIs correlated with product value and product attractiveness. In support of our psychological predictions, we make the following neural predictions:

- H_{3a}: Activity patterns correlated with perceived monetary value in the MPFC for purchased and unpurchased products differ on the basis of price versus product primacy.
- H_{3b}: Price primacy does not decrease overall activity correlated with product value in the MPFC and preference (liking) in the NAcc.

The results of this research are important from not only a theoretical perspective but also a managerial one. The availability and timing of price information during purchase decisions is increasingly under a firm's control, such as in promotional displays, store design, and particularly online (e.g., e-commerce websites). Thus, the effects of price versus product primacy are relevant considerations for marketers in the design of nearly any retail experience.

With this in mind, we designed a follow-up study connecting the process-related findings of the fMRI experiment more directly to their potential impact on consumer purchasing behavior. Previous research has suggested that congruence between the features of a message and important attributes of a product can facilitate purchasing (Wright and Lynch 1995). If, as we hypothesize, price evokes considerations of utility and worth, price primacy might facilitate purchases whose worth is easily established. We chose to test this possibility directly using utilitarian products because their value is defined by their utility, practicality, and, indeed, their worth (Dhar and Wertenbroch 2000; Okada 2005; Strahilevitz and Myers 1998).

- H₄: Price primacy increases the likelihood of purchasing products that are perceived (recognized) as utilitarian.

We use these findings to better validate the marketing implications of the fMRI work and to support an overall psychological account of price primacy.

¹As an example, suppose that focusing attention on worth had an amplifying (multiplicative) response. This could magnify increases in signal correlated with high value and decreases in signal correlated with low value compared with product primacy. However, the average signal in both cases might be the same. Thus, it is important to examine not only the overall response but also the response to two meaningfully distinct decision categories.

EXPERIMENTAL METHODS

Participants

Twenty-four participants completed the scanning task, 17 of whom (aged 19–27 years; 9 women) were included in the final fMRI analysis. We excluded 6 participants because they purchased fewer than four items per condition and therefore failed to provide sufficient data to model. As is the norm in fMRI studies, one participant was excluded due to excessive head motion (i.e., more than 2 mm from one whole brain acquisition to the next during or between runs).

Procedure

Before entering the scanner, participants received instructions about the task and were tested for task comprehension in two practice trials. Participants were provided with compensation of \$40 in cash to put in their pocket before entering the scanner; these funds were at their disposal to spend on products during the experiment. After entering the scanner, participants engaged in two sessions of the task, each consisting of 40 trials, reflecting a total of 80 offered products. During price primacy trials, participants viewed a price (period 1), followed by a product and the price together (period 2), and then made their decisions by pressing buttons indicating yes or no (period 3) (see Figure 1). In product primacy trials, the product was presented alone during period 1, followed by a product and the price together (period 2) and a decision period (period 3). Each period lasted four seconds, and a fixation cross was presented for two seconds between each trial, building on a previous neuroimaging study of single-item purchasing (Knutson et al. 2007). Using an event-based design, both trial types were pseudo-randomly mixed within sessions. Session order and

assignment of a particular product to the price or product primacy condition were counterbalanced across participants, resulting in four possible pseudo-random trial sequences to which participants were randomly assigned. We found no behavioral or neural differences between sequences; thus, we pooled data from all participants.

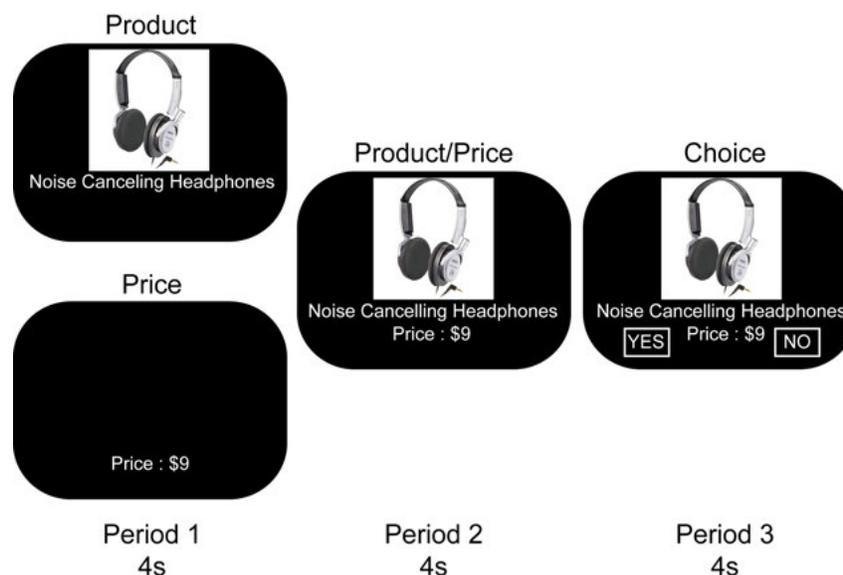
The experiment was incentive compatible to ensure that price information was meaningful and relevant. Two trials (one per session) were selected at random to count “for real” at the end of the session. Participants who chose to purchase the products that they viewed during those selected trials paid the offered price from their endowment and received their products by mail. Those who chose not to make purchases retained all of their funds. Products ranged in retail price from \$8 to \$80, but to encourage purchasing, prices were discounted by up to 80%. Participants were aware that the prices were discounted but did not know by how much.

After exiting the scanner, participants completed a survey in which they viewed the images and descriptions of each product that had been used in the main experiment (without price information) one at a time and rated their liking for each on a scale from 1 (“do not like”) to 7 (“like very much”). In a separate survey, participants viewed the images and descriptions of each product together with their true retail prices (one at a time) and rated their WTP for each item as a percentage of its associated retail price. The WTP rating process after scanning was not separately incentivized.

fMRI Acquisition and Analysis

All participants were right-handed and fluent in English, with no history of neurological disorders. Participants were screened for any metal or magnetically reactive substances present in or on the body before scanning. Images were

Figure 1
fMRI SHOPPING TASK



Notes: In the product primacy condition, participants viewed the labeled product first (period 1, four seconds), followed by the product together with its price (period 2, four seconds) and then were prompted to choose (period 3, four seconds). In the price primacy condition, participants viewed price first (period 1, four seconds); trials then proceeded as in the product primacy condition.

acquired with a 1.5-T General Electric MRI scanner, with whole-brain volumes acquired every two seconds (2s TR). (For a full description of the scanning parameters, see the Web Appendix.) We conducted analyses using Analysis of Functional NeuroImages software (Cox 1996).

For the whole-brain analyses, we used linear regression models to analyze the blood oxygenation level–dependent response (referred to as “activation” or “activity” hereinafter). We modeled whole-brain fMRI data recorded across the duration of the experiment with the following regressors of interest: (1) trial condition (price vs. product primacy), (2) individualized liking regressors derived from postscan ratings (converting responses from the 1–7 Likert scale to a –3 to +3 scale), and (3) individualized price differential or “worth” regressors, calculated by subtracting each item’s offered price from the participant’s WTP, all expressed as a percentage of retail price. We modeled liking and price differential simultaneously during period 2 to ensure that each regressor would account for unique variance in brain activity over the same time frame, allowing for separate examination of each factor. In addition, the model included the following regressors of “noninterest”: purchase decision, reaction time, interactions between trial condition and the other preceding variables, temporal periods, and six motion regressors.

Whole-brain maps were thresholded at $p < .001$ (uncorrected) to identify significant spatial areas of activation, with a four-voxel-cluster threshold (of 4 mm cubic voxels, alpha level of .001). For MPFC activity, we used small volume correction to confirm activation on the basis of functionally selected activity peaks (maximum beta; for further details, see the Web Appendix). These analyses enabled us to identify and confirm that activity in specific brain areas was correlated with specific decision components (e.g., liking, price differential).

A separate set of analyses directly examined the activity in our hypothesized (preidentified) ROIs. For each participant, we examined the signal taken from 8 mm spherical regions centered on the NAcc and MPFC at the following a priori designated coordinates: NAcc: $\pm 12, 10, -2$; and MPFC: $\pm 4, 53, -6$ (Knutson et al. 2007). From this, we averaged the percent signal change over time over purchase and nonpurchase product and price primacy trials within subject, which yielded four averaged time courses. Activity time courses were lagged by four seconds to compensate for the lag in hemodynamic response and compared across participants at predicted peak activation time points with paired t-tests.

We further tested for differences in differences between activity evoked by purchased and unpurchased products in the NAcc and MPFC ROIs for period 2 (when both product and price were visible to the participant). Average activity (in units of percent signal change) for all trials for all participants was regressed on condition (price/product primacy), purchase (yes/no), their interaction, and subject fixed effects.

RESULTS

Behavior

On average, participants chose to purchase 27% of the 80 products offered ($M = 21.29$, $SD = 11.56$). As a measure of perceived value, we calculated price differential or consumer surplus by subtracting participants’ WTP rating (as a percentage of retail) from each product’s price offered dur-

ing the scan (also as a percentage of retail). Thus, a positive price differential percentage meant that participants perceived a product to be a good value (or bargain), while a negative price differential meant that participants perceived a product to be expensive. Indeed, price differential was, on average, positive for purchased items ($M = 27.8\%$, $SD = 18.2$) and negative for unpurchased items ($M = -2.1\%$, $SD = 12.8$; $p < .001$). Notably, price differential for purchased items was significantly lower in price primacy trials ($M = 25.9\%$, $SD = 18.59$) compared with product primacy trials ($M = 29.7\%$, $SD = 18.32$, $p < .02$) but still positive in both cases. This result suggests that participants perceived their purchased items as a bargain in both conditions, but more so in the product primacy condition.

Despite this decrease in magnitude, the average number of items with a price differential of zero (accepted price) or higher (bargain) was identical between conditions ($M_{\text{price}} = 20.94$, $SD = 1.97$; $M_{\text{prod}} = 20.94$, $SD = 1.99$; $p = 1$). For the products with positive price differentials (≥ 0), we also examined “conversion rates,” or the percentage that were purchased, and found no significant differences ($M_{\text{price}} = 46\%$, $SD = .196$; $M_{\text{prod}} = 42\%$, $SD = .21$; $p = .25$, paired t-test).

Similarly, the number of products purchased did not significantly differ as a function of presentation order ($M_{\text{price}} = 11.06$, $SD = 5.38$; $M_{\text{prod}} = 10.23$, $SD = 6.63$; $p = .34$), nor did the average price of purchased products ($M_{\text{price}\$} = 8.58$, $SD = 1.24$; $M_{\text{prod}\$} = 8.47$, $SD = 1.58$; $p = .76$). As we expected, liking ratings were higher for purchased ($M = 5.79$, $SD = .71$) than unpurchased ($M = 3.37$, $SD = .61$; $p < .001$) products. However, liking for purchased products did not differ between product and price primacy ($M_{\text{prodlke}} = 5.85$, $SD = .75$; $M_{\text{pricelike}} = 5.72$, $SD = .80$; $p = .35$). Overall, these findings suggest that although participants may have changed their valuation process to be more critical or conservative under price primacy, doing so did not decrease their liking for products or their likelihood of purchase.

Neural Activity: Product Value

As a “neural manipulation check,” we conducted whole-brain analyses to confirm that we observed meaningful areas of brain activity correlated with monetary value. To do so, price differential ratings were modeled while both product and price information were presented (period 2). Focusing on this part of the trial allowed for direct comparisons between conditions and avoided contamination from postchoice effects. The whole-brain analysis revealed correlated activity localized in the prefrontal cortex (Table 1) as well as significant activation of the MPFC, as we predicted (Figure 2, Panel A). These findings suggest that the MPFC tracked price differential when participants viewed price and product information together on the screen. It also replicates previous work demonstrating the role of the MPFC in integrating price and product information (e.g., Hare et al. 2008; Knutson et al. 2007, 2008; Plassmann, O’Doherty, and Rangel 2007).

Given this validation, we used an anatomically defined a priori ROI analysis on the raw data (see the “Experimental Methods” section) to independently test the condition-dependent activity in the MPFC. There was no difference in the average time courses for price primacy trials compared with product primacy trials at any point in the trial, countering the possibility of a quantitative main effect or decrease

Table 1
WHOLE-BRAIN ACTIVITY PATTERNS FOR PRICE DIFFERENTIAL AND PREFERENCE

	Talairach Coordinates				
	Peak Z	Cluster Size (Voxels)	Right (x)	Anterior (y)	Superior (z)
<i>Price Differential</i>					
<i>MPFC</i>	4.49 (SVC)	(3)	±2	-49	0
Frontal gyrus	4.16	5	4	-68	1
<i>Preference</i>					
Left middle occipital gyrus	3.98	4	-34	75	12
Right caudate and NAcc	4.67	16	8	-8	4
Left caudate and NAcc	4.34	7	-11	-11	12
Right middle frontal gyrus	3.54	4	30	-22	46
Bilateral medial frontal gyrus, including anterior cingulate	4.63	27	0	-26	38
Left middle frontal gyrus	3.68	4	-22	-30	42
Left medial frontal gyrus	3.63	4	0	-38	42
Right ventrolateral prefrontal cortex	3.97	5	34	-41	-7

Notes: Predicted areas appear in italics. SVC = small volume correction.

in value due to overweighting costs (H_{3b} ; see Figure 2, Panel B). To examine whether price primacy might be altering the evaluation process as it relates to choice, we examined the conditions by response to purchased and unpurchased products. The time courses in Figure 2, Panel C, show that the MPFC responded differently depending on the order of information presented. In product primacy trials, neural activity increased significantly more in the MPFC for products that were eventually purchased compared with those that were not purchased when product and price information were both on the screen (period 2), as the left graph of Figure 2, Panel C, indicates ($p < .05$, paired t -tests). However, this finding no longer held in price primacy trials. Despite a moderate increase in MPFC activity for purchased items during the trial (Figure 2, Panel C), the difference in activity for eventually purchased and unpurchased items in period 2 did not reach significance.

Regression analysis of the average peak MPFC activity for the four seconds when price and product information were visible before choice (period 2) formally tested these effects for a difference in differences between product and price primacy (Table 2). The significance of the condition-by-purchase interaction coefficient ($p < .05$) suggests a qualitative difference between conditions. Furthermore, examination of the neural response to items that were not purchased revealed that MPFC activity decreased during period 2 in the product primacy condition but remained close to baseline in the price primacy condition (Figure 2, Panel D, $p < .05$, paired t -test). Notably, this finding also argues against loss or cost amplification predictions by showing that value for unwanted items is actually "less negative" under price primacy.

Neural Activity: Product Desirability

We again used whole-brain analyses to confirm that activity in NAcc correlated with product desirability by modeling preference (liking) ratings when the product and price were presented together. This analysis indeed revealed that NAcc activity scaled with product liking (Figure 3, Panel A), consistent with previous evidence that NAcc activity tracks anticipated reward and product preference (Erk et al. 2002; Knutson et al. 2001, 2007, 2008). We also found that neural activity correlated with liking in the adja-

cent caudate (Table 1), which has been linked to reward-motivated behavior (Balleine, Delgado, and Hikosaka 2007), and in the anterior cingulate cortex, believed to be involved in conflict monitoring and decision difficulty (Bush, Luu, and Posner 2000; Pochon et al. 2008), among other processes.

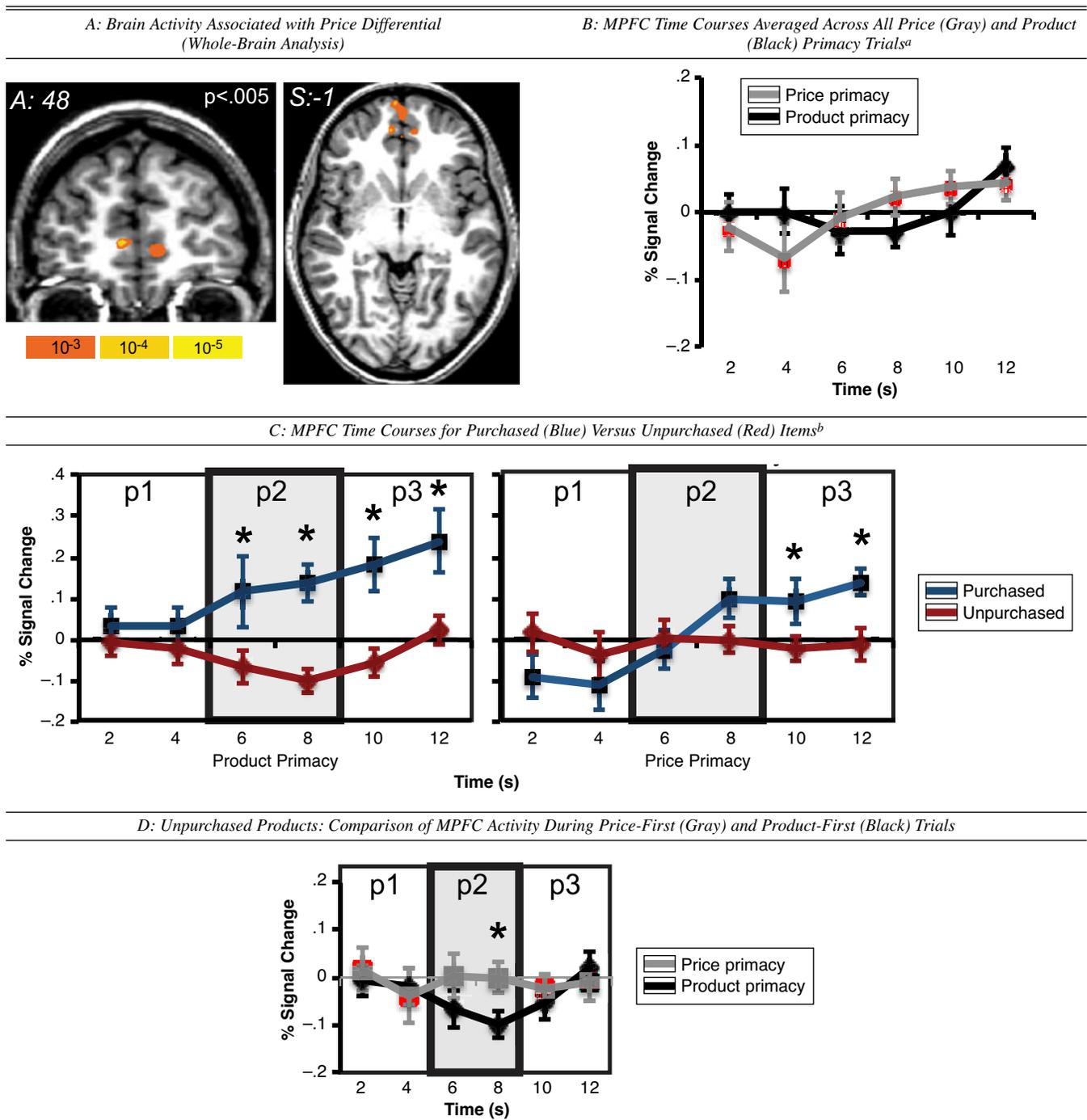
Analysis of independently specified a priori ROI data across all products for the entire trial demonstrated that price primacy did not decrease the signal in NAcc (H_{3b} ; see Figure 3, Panel B). Indeed, at one of the time points when price and product information were visible, activity in price primacy trials was significantly greater than product primacy. To better understand how this could occur, we examined activity related to purchase outcomes. In product primacy trials, NAcc activity increased for items that were eventually purchased and decreased for products that were eventually not purchased (left chart, Figure 3, Panel C). This difference arose when products first appeared (period 1). In price primacy trials, a comparable pattern of activity occurred in response to later product presentation in period 2 (right chart, Figure 3, Panel C). It is notable that in both cases, the onset of the NAcc response was locked to the first appearance of the product, suggesting that NAcc activity responded specifically to the item under consideration rather than to other, more general decision biases or action plans.

Regression analysis of period 2 (Table 2) confirms that the coefficient of the interaction term for condition by purchase was not significant ($p = .652$), suggesting that NAcc similarly differentiated between eventually purchased and unpurchased items at this time, regardless of trial type. However, examination of the responses to unpurchased items indicated a slightly lesser decrease during price primacy trials (Figure 3, Panel D, $p < .05$). This result implies that seeing prices first may have caused participants to have a more neutral affective response to products they eventually did not choose.

DISCUSSION

Our findings demonstrate that the ordering of price and product information can alter the product evaluation process (H_1). Behaviorally, price primacy could have simply reduced items' perceived attractiveness or value because purchased products elicited lower (though still positive) price differentials. However, participants bought the same

Figure 2
MPFC ACTIVITY CORRELATED WITH PRICE DIFFERENTIAL



* $p < .05$.
^aOnsets lagged by four seconds to accommodate hemodynamic response.
^bDuring period 1 (p1), participants viewed the product alone for product-first trials and the price alone for the price-first trials. During period 2 (p2), participants viewed product and price together. During period 3 (p3), they were prompted to decide whether to purchase. The first time point in period 1 indicates the onset of the trial.

number of items and had similar liking ratings (reflecting similar product desirability) across conditions. Thus, it is possible that participants found products similarly attractive in both situations but were more critical of their value under price primacy (consistent with H_2). Importantly, these findings

also support the assumption that liking and monetary value are meaningfully distinguishable during the decision process. To gain a more nuanced understanding of price primacy's effects, we turn to the neural data and related hypotheses. In support of H_{3b} , price primacy did not cause a "main effect"

Table 2
DIFFERENCE-IN-DIFFERENCES REGRESSIONS FOR MPFC
AND NAcc ACTIVITY DURING PERIOD 2

	<i>B</i>	<i>SE</i>	<i>Z</i>	<i>p-Value</i>
<i>MPFC Activity (Observations = 1,360)</i>				
Constant	.059	.051	1.15	.249
Condition (product or price primacy)	-.50	.027	-1.79	.074
Purchase (yes/no)	.009	.037	.22	.822
Interaction (Condition × Purchase)	.11	.053	2.10	.036
Participants with significant fixed effects (out of 17) = 5 ($p < .05$)				
<i>NAcc Activity (Observations = 1,360)</i>				
Constant	.0286	.032	.90	.386
Condition (product or price primacy)	-.044	.017	-2.55	.01
Purchase (yes/no)	.0899	.23	3.83	<.001
Interaction (Condition × Purchase)	.014	.032	.45	.652
Participants with significant fixed effects (out of 17) = 2 ($p < .05$)				

decrease in activity in the MPFC or NAcc during any part of the trial, suggesting that price did not simply shift these value signals down (or up) quantitatively. Instead, as we predicted, the strongest sequence-dependent effects occurred in the MPFC, a region whose activity correlates with perceived product worth (H_{3a}). In product primacy trials, consideration of items that were eventually purchased increased MPFC activity, whereas eventually unpurchased items decreased it. This pattern of responses could be interpreted as a general value integration process that utilizes a scale ranging from positive (increased value) to negative (decreased value) endpoints. In price primacy trials, however, activity increased moderately for purchased items but did not decrease for unpurchased items. This result suggests a modification of the general value scale, which ranges from positive (increased value) to zero (no value or no interest). In this case, we surmise that items that surpassed some “sufficient” level of worth were then purchased, while those that were not valued were not purchased. Indeed, given that NAcc activity for unpurchased items also decreased less in price primacy trials, one possibility is that people simply ignored those products rather than actively rejecting them. Furthermore, truncation of the general valuation scale under price primacy (e.g., from “liked” to “sufficient”) is in accordance with the observed decreased price differential even in the face of unchanged liking ratings.

These findings suggest a novel account of price primacy surpassing the conclusions that could be drawn from behavior alone. Price primacy seems to encourage people to critically evaluate whether a product is worth its attendant price rather than merely evaluate the product on the basis of its attractiveness (H_2). However, we are mindful that care must be taken when inferring behavioral function from brain data (e.g., Poldrack and Wagner 2004). In addition, for marketers’ purposes, it is useful to understand whether and how such mechanistic changes influence purchase behavior when information is presented in different sequences to consumers, and these behavioral results are often examined in larger sample sizes. Given these considerations, we conducted a “validation” study to examine some of the more nuanced predictions made by the fMRI findings.

PRICE PRIMACY AND UTILITARIAN PURCHASES

Because product and price primacy lead to different types of evaluation, their influence on purchase may depend on

the nature of the products under consideration. Utilitarian products are commonly defined as having practical or functional uses (e.g., Strahilevitz and Myers 1998), which provides them an evident and easily justified worth (Dhar and Wertenbroch 2000; Okada 2005). Our framework suggests that under price primacy, consumers make their purchasing decisions by evaluating whether a product is sufficiently worth its price. We therefore predict that price primacy could increase purchases of utilitarian products compared with product primacy because its evaluation criteria align better with these products’ merits (see H_4). The following experiment tests this possibility directly.

Methods

Eighty-three participants from a national sample (aged 18–79 years; 56 women) took part in an Internet study compensated by lottery drawings for gift certificates to an online retailer. Respondents were randomly assigned to either the product primacy or price primacy condition in a between-subjects experimental design. Similar to the fMRI study, participants assumed an endowment of \$15 for each decision and were offered four utilitarian products at discounted prices. Participants viewed only a price or only a product (image and product name) for eight seconds and then a decision screen displaying both price and product. Using a slider on a scale from 0 (“do not want to buy”) to 100 (“definitely want to buy”), participants indicated whether they did (≥ 50) or did not (< 50) want to buy the item. After this purchase process, participants viewed the names of the four items (without pictures) and reported their WTP for each one by typing in a dollar amount. This procedure differed from the “percentage of retail” process used in the fMRI experiment to allow participants to generate their own values without using an explicit reference point.

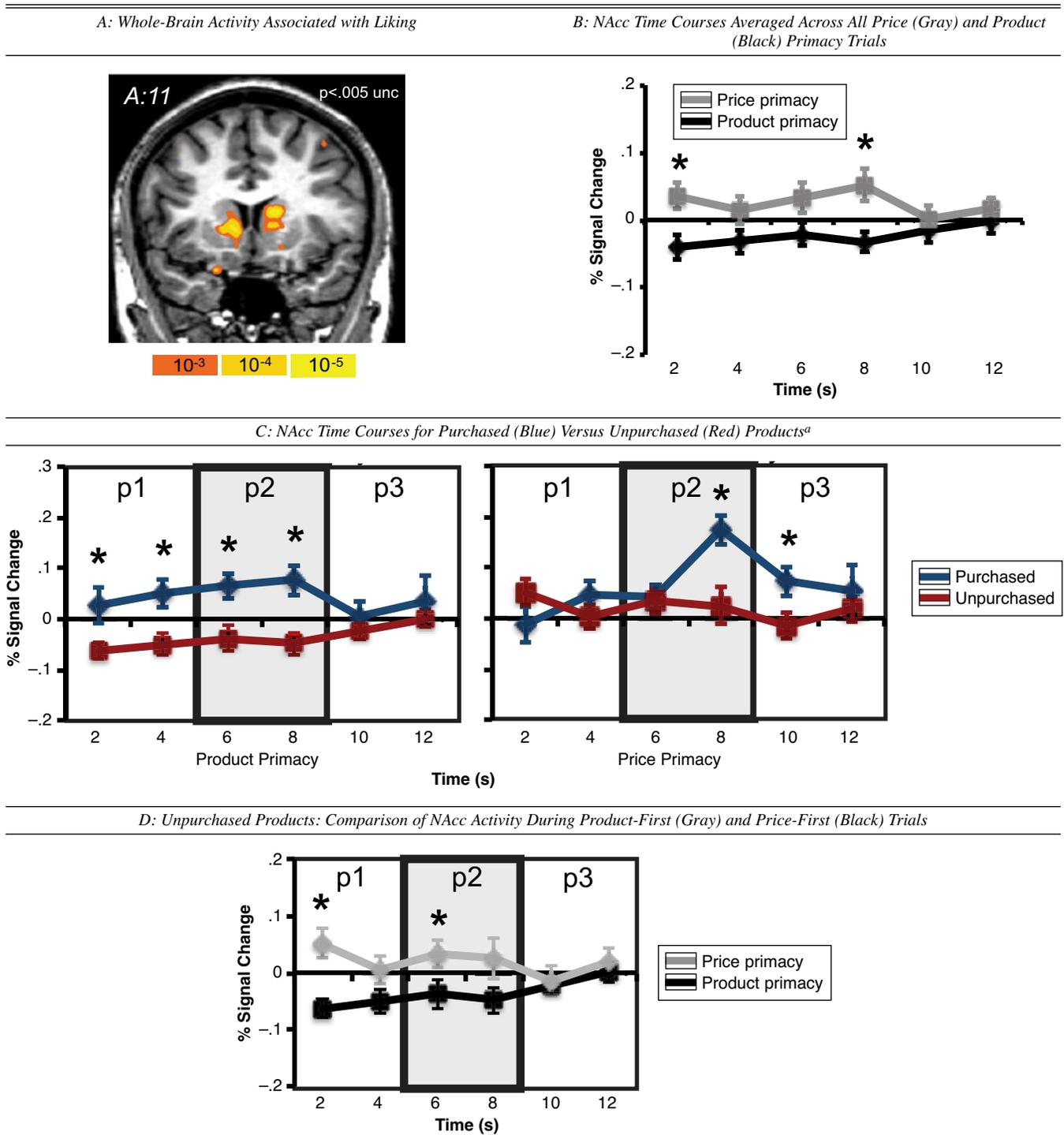
Participants were informed that their decisions potentially had real consequences at the beginning of the experiment. To implement incentive compatibility, four people were randomly selected, independent of the compensation lottery, to have one of their choices realized (as in the fMRI study). If they had chosen to purchase the product, it was delivered by mail, and they received the remaining amount of the endowment (minus the item’s price) as credit to a popular online retailer. Participants who had chosen not to purchase received the entire \$15 endowment credit. Finally, participants read definitions for frivolous (hedonic) or practical (utilitarian) products adapted from Strahilevitz and Myers (1998):

Frivolous Products: Bought for pleasure-oriented use. Something fun, experiential, and perhaps even decadent. Purchasing these goods or these kinds of services might be seen as a guilty pleasure. One example might be a bottle of champagne.

Practical Products: Bought for goal-oriented use. Something that you ordinarily buy to carry out a necessary function or task in your life. Buying these doesn’t cause any guilt because they are things you need. One example might be toilet paper.

Participants were asked to categorize each product as frivolous, practical, both frivolous and practical, or neither frivolous nor practical.

Figure 3
NAcc ACTIVITY CORRELATED WITH LIKING



^a*p* < .05.

During period 1 (p1), participants viewed the product alone for product-first trials and the price alone for price-first trials. During period 2 (p2), participants viewed the product and price together. During period 3 (p3), they were prompted to decide whether to purchase. The first time point in period 1 indicates the onset of the trial.

Results

Products were selected to be explicitly utilitarian in nature and included a water filtration pitcher, AA batteries, a USB drive, and a flashlight. For any individual product, price versus product primacy had no effect on the frivolous/practical item categorization measure (Table 3). Thus, to

ensure that participants' perceptions of the products were consistently utilitarian, only people who rated all four items as "practical" or "frivolous and practical" were included in further analyses (*n* = 61; aged 18–79 years; 41 women). Examining the total number of purchased items (purchase intention scores ≥ 50) showed that purchase rates were sig-

Table 3
PRACTICAL/FRIVOLOUS CATEGORIZATION OF UTILITARIAN PRODUCTS

	Product Primacy	Price Primacy
Water filtration pitcher	90%	90%
AA batteries	95%	100%
8 GB USB drive	93%	90%
Mini flashlight	95%	93%

Notes: This table shows the percentage of respondents who rated the item as either practical or practical and frivolous.

nificantly higher in the price primacy condition ($M = 2.61$, $SD = 1.05$) compared with the product primacy condition ($M = 1.83$, $SD = 1.17$; $p < .01$, student's t-test), as predicted in H_4 (see Figure 4, Panel A).

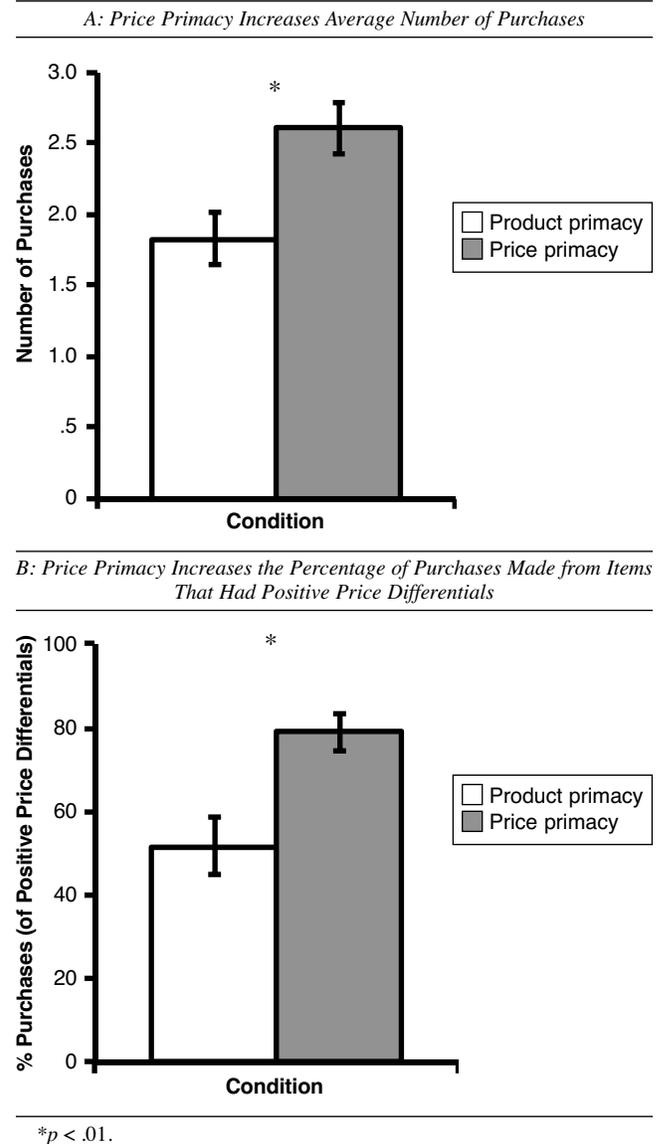
We calculated price differential as the simple difference between the elicited WTP and the listed price in the offer. Price differential across products did not show a significant difference, though directionally, the average was lower for price primacy, as the fMRI results show ($M_{\text{price}} = \$2.70$; $SD = 3.30$; $M_{\text{prod}} = \$4.48$, $SD = 5.39$; $p = .126$). In addition, the average number of products with a price differential of zero or greater did not differ between conditions ($M_{\text{price}} = 2.74$, $SD = 1.24$; $M_{\text{prod}} = 2.97$, $SD = 1.19$; $p = .473$). However, as we illustrate in Figure 4, Panel B, examining the relationship between price differential and purchase in this study showed that under price primacy, participants were more likely to have purchased items for which they had a price differential greater than or equal to zero ($M_{\text{price}} = 79\%$; $M_{\text{prod}} = 52\%$; $p < .002$).² Notably, this result provides strong support for our framework because it demonstrates that under price primacy, estimates of value more accurately correlate with purchase decisions, suggesting that the worth of the product indeed plays a larger part in the decision than under product primacy.

GENERAL DISCUSSION

As a whole, these findings demonstrate that the sequence of information during a purchasing decision can alter the mechanisms underlying product evaluation and can also influence choice behavior. In a neuroimaging experiment, price primacy altered patterns of activity in the MPFC in a manner suggesting that products were being evaluated on the basis of whether they were sufficiently worth their price rather than how much they were liked (or disliked). This apparent focus on worth was consistent with the overall behavioral results indicating that participants had somewhat more critical estimates of purchased products' value under price primacy even though their liking for the products did not decrease. As independent validation for this relationship between justifiable, or sufficient, worth and purchasing, we found that price primacy could increase purchase rates for products with recognized utility. Indeed, we found that the relationship between purchasing and self-reported estimates of positive worth was more tightly correlated under price primacy than product primacy. Colloquially, our findings

²This analysis excludes three participants whose price differentials were negative for all four offered products.

Figure 4
PRICE PRIMACY AND UTILITARIAN PURCHASES



suggest that price primacy shifted participants' purchasing question from "Do I like it?" toward "Is it worth it?"

Critical to our framework, price primacy had a distinct effect from product primacy on the valuation of products that were eventually not purchased. Under product primacy, neural activity in the MPFC and NAcc decreased for items that were eventually not purchased, consistent with assigning decreased value to those products. However, under price primacy, neither brain region showed diminished activity for items that were eventually not purchased. This finding suggests that price primacy may simply cause people to exclude less desirable items from consideration rather than actively devalue them. The data and our interpretation differ from a case in which price primacy increases the salience or weighting of losses or decreased value due to increased painfulness of paying because that would be expected to decrease MPFC and/or NAcc activity (e.g., Tom et al. 2007). Furthermore, neither product liking nor purchasing

decreased under price primacy in the neuroimaging study, as might occur under a loss frame.

In addition to merely representing costs or loss in a rational sense, the “pain of paying” theory argues that price can elicit an aversive response akin to physical pain (Prelec and Loewenstein 1998, Rick, Cryder, and Loewenstein 2008). The results for the NAcc and MPFC indicate that even if price primacy evoked pain early in the decision process, that pain did not systematically lower estimates of product value or prevent or decrease purchases. We can also examine whether there is evidence for price-evoked pain elsewhere in the brain. Prior neural research consistent with pain of paying has suggested that the anterior insula, a region involved in processing pain and negative emotions (Calder, Lawrence and Young 2001; Coghill et al. 1994, 1999), shows increased activity in anticipation of not purchasing products (Knutson et al. 2007). Despite using identical discounts and replicating the design of that study in the product primacy trials, we did not find evidence linking increased insula activity directly to unpurchased products, nor did insula correlate with price differential (see the Appendix). Although we do not find a significant role of this theory in the current study, questions of how and when price information may induce pain (or the anticipation of pain) and how such pain might influence perceived value remain important domains for further investigation.

Our hypotheses build on the theory that price can be representative of value or utility in a broader sense than costs (Thaler 1999) and that price sets expectations of product worth (e.g., Rao and Monroe 1989). Indeed, for products such as wine or medicine, whose “utility” is difficult for nonexperts to evaluate objectively,³ price information directly influences the perceived quality of the consumption experience (Plassman et al. 2008; Shiv, Carmon, and Ariely 2005; Waber et al. 2008). Our results complement these studies, demonstrating that price can evoke general considerations of worth, even before the specific product is known. Furthermore, they show that these considerations can dominate the decision process before consumption ever happens. Future directions for this work would be to concretely tie these findings together by examining the effects of price primacy on postchoice consumption experiences and satisfaction, particularly in situations in which the price-implied quality is noticeably different from the experienced quality.

We would expect the observed shift in evaluation mechanism, from liking to worth, to generalize to other price ranges or categories of goods. However, the specific downstream influence of price primacy on purchasing *behavior* may depend on certain boundary conditions. Across studies, participants were aware that prices had been discounted. In the behavioral experiment, when participants were able to freely enter their WTP, their average price differential was positive ($M = \$3.58$), suggesting that they perceived the products to be good values. Thus, the present findings may rely on initial perceptions of prices as reasonable, “good,” or even bargain prices. Still, our experiments were incentive

compatible, and price differential values for unpurchased items in the neuroimaging experiment were negative, suggesting that participants did not dismiss the price information and indeed considered some prices excessive. Participants also clearly attended to potential costs, expressing reluctance to give up their endowment during debriefing, even to obtain highly desirable products.

Given the limitations of the current study, further research would benefit from examining the influence of price primacy on purchasing in different types of value contexts, particularly ones in which the expectation is that prices are expensive. For example, if consumers are aware that they are paying full retail prices in a brick-and-mortar store, an increased focus on worth might be predicted to decrease purchasing because consumers might have difficulty justifying not searching for a better value. This could be contrasted with situations in which base prices are known to be (unavoidably) high. In this situation, our framework suggests that a focus on worth might decrease the consideration set (reducing the number of items with positive price differential) but increase purchase likelihood for the items that were recognized as sufficiently worthy.

Overall, these findings demonstrate that the assessment of value from product and price information partly depends on the order of their presentation. In a similar vein, “query theory” research proposes that the sequence of processing options can determine different choice outcomes. In query theory, decisions can be broken down into a series of internal memory queries, and the ordering of these queries can alter preferences or value estimates (Johnson, Häubl, and Keinan 2007; Weber et al. 2007). This framework has primarily been applied when sequential information relates to the comparison of two distinct options, rather than decisions about different attributes of single items. Unlike the current account, query theory assumes that the basic evaluation process remains constant regardless of order. Differences in estimated value instead arise because the initial query interferes with the impact of subsequent queries. In addition, explicit memory and retrieval play a crucial role in query theory; in contrast, the current study’s decision scenarios do not require access of explicit memories (because all relevant information is provided on the screen). Accordingly, our participants did not show significant recruitment of regions commonly implicated in memory retrieval such as the hippocampus or parahippocampus (Squire 1992). Thus, although query theory’s order effects appear similar to the present findings on some dimensions, the underlying neural mechanisms and behavioral consequences likely diverge. This further suggests that additional study is needed in understanding how the timing of different kinds of information, such as attributes or options, influence choice.

The use of time resolved neuroimaging (e.g., fMRI) uniquely afforded visualization of participants’ reactions to different decision elements as well as exploration of the impact of these elements on purchasing. In typical studies of economic decision making, liking and price differential (or WTP) can be considered inseparable and are assumed to reflect a common underlying dimension of preference. Here, although relative desirability of the items was represented faithfully in the NAcc regardless of the ordering of information, the estimated monetary value of these items

³These goods could be considered a combination of experience and credence goods in that their evaluation is often dependent on both the user’s experience and information/assurances provided by outside sources.

and correlated MPFC activation changed as a function of price primacy. By extension, NAcc activity might represent a context-independent element of preference that can be distinguished from the more context-dependent overall value of an item represented in the MPFC. Because purchasing of the same item can take place in numerous and varied situations, it is important that future work examine the degree to which the stable element in the NAcc response might facilitate prediction of a decontextualized demand for products (e.g., Berns and Moore 2011), allowing for more strategic product-related decisions on the part of the firm.

From a marketer's perspective, the effects of price and product primacy are of particular importance in shopping contexts in which the flow of information is largely determined for the consumer, such as online retailing and e-commerce. If firms can offer good or bargain prices for utilitarian products, these findings suggest distinct sales benefits to making price salient early on. Conversely, when consumers will be seeing prices first, highlighting products' functionality may also increase purchases. However, the findings also suggest a caveat: because price primacy may decrease WTP and may generally increase critical evaluations of worth, its benefits might be nullified by minor or misleading promotions.

In conclusion, we show that simply changing the order of price versus product information can exert meaningful effects on overall product valuation as well as purchase decisions by shifting the basis for product evaluation. These insights not only clarify how consumers make daily decisions but also help predict how they might choose in novel situations involving different product categories.

APPENDIX: PRICE PRIMACY, INSULA, AND THE PAIN OF PAYING

Previous research on shopping decisions has found that activity in the insula—a brain area associated with anticipation of pain (e.g., Coghill et al. 1994, 1999) and negative emotions such as disgust (Calder, Lawrence, and Young 2001) and monetary loss (Paulus and Stein 2006)—is negatively correlated with purchasing behavior (Knutson et al. 2007). In particular, the Knutson et al. (2007) study shows that insula activity increased when people rejected an item for purchase and when they perceived prices to be excessive. This has been interpreted as support for a pain-of-paying account in which prices, as representations of loss, have an impact similar or equal to physical pain (Prelec and Loewenstein 1998; Rick, Cryder, and Loewenstein 2008). Such findings might suggest that being exposed to potential costs or excessive prices in the current study should evoke an insula response as well. However, the whole-brain analysis examining activations correlated with price differential revealed no significantly correlated activity in the insula (confirmed with exploratory analyses that allowed a statistical threshold as lenient as $p < .01$, uncorrected). We averaged and extracted activation time courses to further examine insula activity from focal volumes of interest (Talairach coordinates: $\pm 32, 9, 9$) under price and product primacy conditions to allow for direct comparisons with earlier findings (Knutson et al. 2007). These analyses indicated that insula activity did not significantly discriminate between

purchased and unpurchased items at any point during the trials for either condition (Figure A1, Panel A).

Given that we were not able to replicate this particular insula finding of Knutson et al. (2007) despite using an identical paradigm and the same incentives, it is useful to consider the possibility that the design of the primary analysis model did not capture the relevant insula activity. This could have been because variance related to price was entirely modeled as part of the price differential regressor. Instead, one could include price in the model as a parametric representation of the specific prices that participants viewed during each trial of the experiment. Thus, we constructed two variants of the original model. In the period 2 model, a regressor representing the mean-centered price of the item offered on each trial replaced the price differential regressor from the primary analysis. As the label suggests, brain activity was still modeled during period 2, when both price and product information were visible on the screen in all trials. A second "First 4" model also used a mean-centered offered price regressor, but price was modeled during the first four seconds that it appeared on a trial-by-trial basis. Thus, in price primacy trials, price was modeled during period 1, but in product primacy trials, it was modeled during period 2.

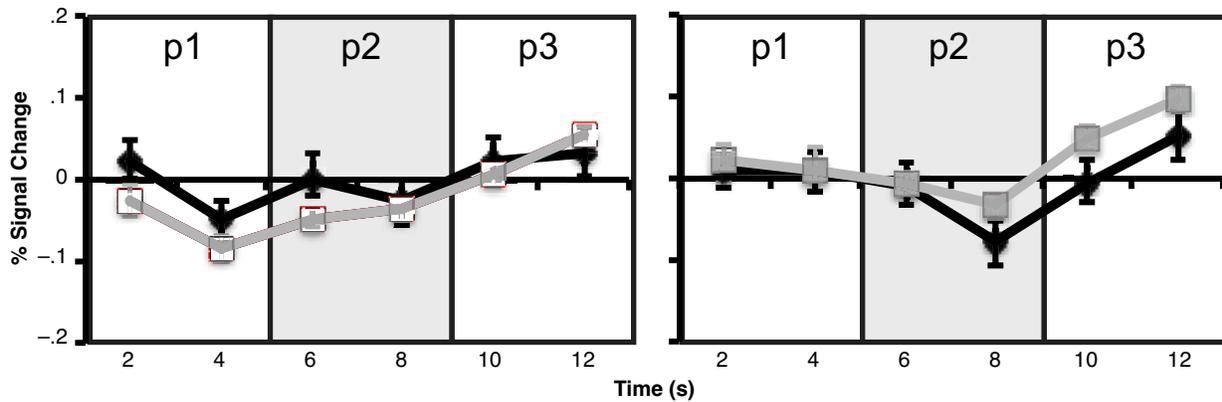
Areas of activation correlating with price were qualitatively similar between models, as Figure A1, Panel B, shows. In both cases, we saw activation in the right anterior insula and dorsolateral prefrontal cortex (for a complete list of activations from the period 2 model, see Table A1). Although insula activity is commonly interpreted as relating to pain or negative emotions, activity in the anterior portion of the insula has also been shown to correlate with general arousal and salience (Bartra, McGuire, and Kable 2013; Critchley et al. 2000; Knutson and Greer 2008). Thus, one cannot infer whether increases in activity at the observed location are specifically due to increased feelings of anticipated loss or more generally due to increased feelings of arousal (good or bad) in response to high prices. Furthermore, it may be relevant that the activations revealed by these models are significantly more anterior from the loss-related regions previously identified (Knutson et al. 2007). Overall, the current data cannot provide conclusive evidence one way or the other to speak to the role of insula activity in pain of paying in this version of the purchasing task.

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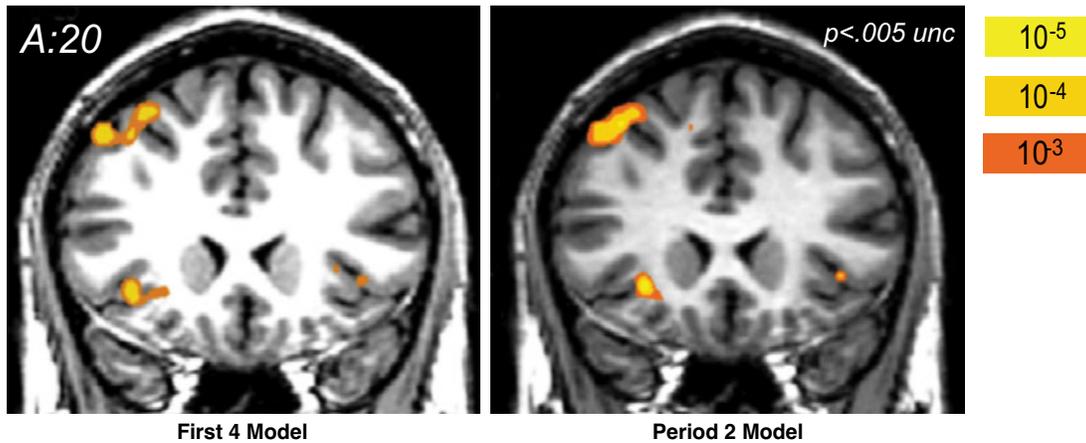
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Figure A1
INSULA MODELS AND ANALYSIS

A: Activity in Insula ROI for Unpurchased (Gray) and Purchased (Black) Items^a



B: Whole-Brain Activation Maps for First 4 and Period 2 Models



^aEvent onsets lagged by four seconds.

Table A1
ACTIVATION FOCI FOR PERIOD 2 (PRICE) MODEL

	Talairach Coordinates			
	Peak Z	Right (x)	Anterior (y)	Superior (z)
<i>Price (Orthogonalized)</i>				
Left cuneus	3.70	-11	86	19
Right cuneus	3.44	8	82	8
Right precuneus	3.71	34	79	34
Right superior parietal lobule	3.78	30	68	53
Left middle occipital gyrus	3.60	-38	56	42
Bilateral parahippocampal gyrus ^a	4.65 (3.86)	±30	49 (45)	-3 (1)
Right inferior parietal lobule	3.44	52	45	4
Right posterior cingulate cortex	3.748	4	34	42
<i>Right insula</i>	5.22 (SVC)	-25	23	3
Right middle temporal gyrus	3.67	56	22	-7
Right dorsolateral prefrontal cortex	3.94	34	-19	46
Right superior frontal gyrus	3.98	15	-49	38

^aNumbers followed by numbers in parentheses indicate respective values from each side of the brain.

Notes: The hypothesized ROI appears in italics.

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