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Consumers' judgments of the magnitude of numerical differences are influenced by the ease of mental computations. The results from a set of experiments show that ease of computation can affect judgments of the magnitude of price differences, discount magnitudes, and brand choices. Participants seem to believe that it is easier to judge the size of a larger difference than that of a smaller difference. In the absence of appropriate corrective steps, this naive belief can lead to systematic biases in judgments. For example, when presented with two pairs of numbers, participants incorrectly judged the magnitude of the difference to be smaller for pairs with difficult computations (e.g., 4.97 – 3.96, an arithmetic difference of 1.01) than for pairs with easy computations (e.g., 5.00 – 4.00, an arithmetic difference of 1.00). The effect does not manifest when judgments do not entail mental computations or when participants are made aware that the ease or difficulty is caused by computational complexity. Furthermore, this effect is mitigated when participants' prior experience is manipulated in a learning phase of the experiment. The results have implications for buyers and sellers and for understanding the role of metacognitive experiences in numerical judgments.

Keywords: fluency, cognitive ease, behavioral pricing, numerical difference

The Ease-of-Computation Effect: The Interplay of Metacognitive Experiences and Naive Theories in Judgments of Price Differences

Numerical judgments often entail mental computations of an arithmetic difference. For example, consumers sometimes choose between two brands on the basis of the magnitude of their price difference. Similarly, consumers evaluate the attractiveness of a discount by judging the magnitude of the difference between the regular and the sale prices. Some of these mental computations are more difficult than others. This research examines the effect of ease of computations on subjective judgments of the magnitude of numerical differences. The following example illustrates the question under investigation: Suppose consumers are presented with prices of two brands of comparable products: Brand A at $5.00 and Brand B at $4.00. Consumers would presumably mentally compute the arithmetic difference (in either absolute or percentage terms) between the two prices and base their choices on the result of their mental computations. Now, suppose that instead of $5.00 and $4.00, the judgment entailed a relatively more complex computation, such as $4.97 and $3.96. We investigate whether this computational complexity will increase or decrease the perceived magnitude of the price difference.

Ease or fluency of information processing can affect judgments of probability (Tversky and Kahneman 1973), assertiveness (Schwarz et al. 1991), health risk (Raghubir and Menon 1998), and truth (e.g., McGlone and Tofighbakhsh 2000; Reber and Schwarz 1999); evaluations of products (Lee and Labroo 2004; Menon and Raghubir

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2003; Wanke, Bohner, and Jurowitsch 1997); and preference for brand logos (Janiszewski and Meyvis 2001). Furthermore, it has been shown that people interpret their fluency experiences using naive theories about the relationship between fluency and the judgment variable (Schwarz 2004; Whittlesea and Williams 2001). However, little is known about the naive theories that people have about the fluency of numerical judgments. A key objective of this research is to unearth a naive theory people hold about the relationship between the ease of computing a numerical difference and the magnitude of the difference: Is greater fluency associated with smaller or larger differences?

We report a set of experiments that examine the role of metacognition in numerical judgments in general and price judgments in particular. This article not only uncovers a novel psychological phenomenon that is of practical importance to buyers and sellers but also demonstrates how heuristic inferences from metacognition and analytic inferences drawn from arithmetic operations combine to shape magnitude judgments. While one part of the human mind performs the arithmetic operations to judge the size of the numerical difference, another part monitors the ease or difficulty of these mental operations. Under certain specifiable conditions, both the output of the arithmetic operations and the output from the heuristic processing of fluency experiences can affect the final magnitude judgment. However, the mechanisms that underlie heuristic processing of fluency are vastly different from those that underlie the analytic processes. In what follows, we first review the germane literature and then report the experiments.

THE ASSOCIATION BETWEEN COGNITIVE EASE AND NUMERICAL DIFFERENCE

The influence of metacognitive experiences on judgments is not random; it is guided by implicit or explicit naive theories about the relationship between fluency and a judgment variable (Schwarz 2004; Whittlesea 1993; Whittlesea and Williams 2001). For example, processing fluency variation induced by color (i.e., an easy- or difficult-to-read color) has been shown to influence judgments of truth (Reber and Schwarz 1999), and fluency variation induced by the use of rhyming (versus nonrhyming) words has been shown to affect judgments of descriptive accuracy (McGlone and Tofighbakhsh 2000). Such misattributions occur because people believe that familiar statements are more likely to be truthful than statements they have never heard before, and familiar statements usually are more fluent (McGlone and Tofighbakhsh 2000; Reber and Schwarz 1999). Similarly, processing fluency variation induced by a visual clarity manipulation (e.g., a word shown with or without a mask) has been shown to influence judgments of whether words have been seen previously (Whittlesea, Jacoby, and Girard 1990) because such words are usually easier to process than novel words. This discussion suggests that to predict the effects of computational complexity or ease on numerical judgments, it is important to understand people's naive theories about processing fluency experiences in numerical judgments.

We suggest that people rely on the following naive theory when making numerical judgments: The closer the representations of two stimuli on an internal analog scale, the greater is the processing difficulty. Usually, it is more difficult to discriminate between two bulbs of 70 and 80 watts of power than to discriminate between bulbs of 30 and 120 watts of power. Likewise, it is more difficult to discriminate between two weights or two sound pitches that are similar to each other than two that are relatively far apart on an internal analog scale. Research in numerical cognition has revealed that such an association between analog distance and processing fluency also manifests with numerical stimuli. Numerical stimuli are represented and processed not only as arithmetic symbols but also as analog magnitudes (Dehaene 1997; Moyer and Landauer 1967).[1] Just as with light and weight, comparing two numbers that are closer to each other is relatively more difficult than comparing two numbers that are farther apart (Dehaene 1997; McCloskey and Macaruso 1995). The ubiquity and the robustness of the relationship between analog distance and processing fluency suggest that people instinctively interpret processing fluency as a cue for magnitude differences.

PRETEST AND HYPOTHESIS DEVELOPMENT

Because our hypotheses and experimental designs are based on our assumption about people's naive theories about the relationship between fluency and the magnitude of numerical differences, we first empirically test this assumption. Fifty-six undergraduate students from a large university responded to the following question:

> The price difference between X and Y is very small.
> The price difference between M and N is very large.
> Which of the two judgments will be *easier* for you?

1. Judging whether the price difference between X and Y is small or large, or
2. Judging whether the price difference between M and N is small or large.

When presented as a forced-choice question, a vast majority of participants (77%; $p < .05$ that this percentage is higher than chance or 50%) stated that the judgment would be easier when the numbers are far apart from each other. These data suggest the existence of a salient belief that easier judgments are associated with larger differences.

A pertinent question is whether this belief is applicable in all situations. Discriminability of the analog magnitudes is not the only factor that affects the fluency of processing numerical information. Several other aspects of mental computations also affect the fluency of processing numerical information. For example, mental computations are faster when solutions are based on arithmetic facts retrieved from long-term memory than when they are based on online computations (Ashcraft and Battaglia 1978). Furthermore, in simple addition and subtraction tasks, problems that have smaller solutions (e.g., 2 + 3) are easier to solve than problems that have larger solutions (e.g., 9 + 7; Zbrodoff 1995). However, the results of several studies indicate that even though the human mind may notice the variations in fluency experiences caused by these and other factors, it may not be able to identify correctly the reasons

[1]The analog (or analogue) model refers to the mode of numerical information processing in which responses to stimuli are based only on quantity representations mapped on a continuous scale; symbolic representations (i.e., the visual Arabic form) and the concomitant mental arithmetic are ignored (Barth et al. 2006).

for the variation. As we discussed previously, variations in perceived fluency of information processing are often mistakenly attributed to factors rendered most salient by naive theories. We suggest that the notion that larger differences are easier to judge is one such salient heuristic used in fluency attributions of numerical judgments. Because the relationship between discriminability and ease of processing manifests not only with numbers but also with all forms of psychophysical stimuli, it is acquired at an early age and is reinforced almost on a daily basis. Therefore, we hypothesize that people rely on the heuristic that larger differences are easier, even when it may not be applicable. Even variations in processing fluency induced by unrelated factors, such as computational complexity, might be mistakenly attributed to numerical differences. At first glance, the difference between 4.97 and 3.96 might seem smaller than that between 5.00 and 4.00, though a slightly more careful scrutiny of the two pairs reveals the disingenuousness of this feeling. We argue that this initial feeling is at least partly due to the misattribution of computational complexity to numerical difference. Formally,

> H_1: Computationally easier differences (e.g., 5.00 – 4.00) will be judged to be larger than computationally difficult differences (e.g., 4.97 – 3.96), even when the arithmetic differences are similar.

We designed Experiments 1a, 1b, and 1c to test the practical relevance of the hypothesized effect. Experiments 1a and 1b examine whether the ease of computations influences discount and price evaluations, respectively. Experiment 1c examines the effect of ease of computations on brand choice. We designed Experiments 2 and 3 to investigate the underlying psychological processes for the effect.

EXPERIMENT 1A: DISCOUNT MAGNITUDES

We designed Experiment 1a to test whether computational ease affects judgments of discount magnitudes. Participants were shown pairs of prices; each pair comprised a regular price and a sale price. Participants evaluated the magnitude of the discount—that is, the difference between the regular and the sale price. The prices used as stimuli differed from each other in computational ease; some discounts were easy to compute, and other computations were relatively difficult. The prices also differed in discount magnitudes; some discounts were larger than others.

Method

Design and procedure. Sixty-two undergraduate students from a large northeastern university participated in this computer-administered experiment for partial course credit. Participants were told that to study how consumers evaluate discounts, the experimenters randomly selected prices of 24 products that were on sale at a large retail store. Participants saw each pair of prices, the regular price and the sale price, one at a time on the computer screen. The prices were presented with the regular price above the sale price, at the center of the computer screen, with their digits aligned. Participants evaluated the magnitude of the difference between the two prices on a semantic differential scale shown immediately below each pair of stimuli.

Ease of computations was tracked by measuring response times. To minimize random errors in response times, participants were encouraged to respond as quickly as possible. After each pair of stimuli, participants moved to the next price pair by clicking a button labeled “I Am Ready.” Clicking on this button brought the mouse to the center of the screen after each trial. The stimuli were 24 randomly ordered pairs of prices listed in Table 1. The computer was programmed to randomize the presentation order for each participant. Before judging the discount magnitudes for the stimuli, all participants made two trial judgments to familiarize themselves with the procedure.

The 24 pairs of prices were chosen such that they varied both in terms of computational ease and in the levels of discount magnitude. Specifically, across the 24 pairs of prices listed in Table 1, the difference between the regular price and the sale price (i.e., the discount magnitude) constitutes one of two approximate values: either approximately $1 or approximately $3. Furthermore, these prices can be categorized into three types: easy, difficult–higher, and difficult–lower. The easy prices (e.g., regular price $4.00 – sale price $3.00 = discount $1.00) use single-digit formats, and the discount computations are relatively easy. The difficult–higher prices (e.g., regular price $4.97 – sale price $3.96 = discount $1.01) have nominally larger discount magnitudes than the corresponding level in the easy condition, and the discount computations are relatively difficult. Our primary interest was in comparing the easy and the difficult–higher conditions; we predicted that participants would incorrectly perceive the numerical differences as larger in the easy condition than in the difficult–higher condition as a result of the ease-of-computation effect. Computations are also relatively difficult for the difficult–lower prices (e.g., regular price $4.96 – sale price $3.97 = discount $.99); however, these prices have nominally smaller discount magnitudes than the corresponding level in the easy condition. Although our primary interest was in comparing the easy and difficult–higher conditions, we believed that it was necessary to include difficult–lower prices to ensure that a difficult price had the same probability of being lower or higher than an easy price.[2] In the interest of generalizability, each of these six conditions had four replicates, and the

[2]If the set of stimuli contained only “difficult–higher” prices, after a few trials, participants in a repeated measures experiment might notice that all difficult prices have nominally higher discounts than easy prices.

Table 1

STIMULI USED IN EXPERIMENTS

Magnitude of Difference	*Difficult–Lower Condition*	*Easy Condition*	*Difficult–Higher Condition*
Approximately 1 (.99, 1.00, or 1.01)	4.96 – 3.97	4.00 – 3.00	4.97 – 3.96
	5.96 – 4.97	5.00 – 4.00	5.97 – 4.96
	8.96 – 7.97	8.00 – 7.00	8.97 – 7.96
	9.96 – 8.97	9.00 – 8.00	9.97 – 8.96
Approximately 3 (2.99, 3.00, or 3.01)	4.75 – 1.76	4.00 – 1.00	4.50 – 1.49
	5.75 – 2.76	5.00 – 2.00	5.50 – 2.49
	8.75 – 5.76	8.00 – 5.00	8.50 – 5.49
	9.75 – 5.76	9.00 – 5.00	9.50 – 5.49

Notes: Numbers in the difficult–lower condition were computationally more difficult and the differences were nominally smaller (.99 or 2.99) than those in the easy condition (1.00 or 3.00). Numbers in the difficult–higher condition were computationally more difficult and the differences were nominally larger (1.01 or 3.01) than those in the easy condition.

magnitudes of the minuends and subtrahends varied across these four replicates. Thus, the experiment used a 3 × 2 × 4 within-subjects design with computational ease (difficult–lower versus easy versus difficult–higher), discount magnitude (approximately \$1 versus approximately \$3), and replicate (four levels) as the three factors.

Dependent variables. For each participant, we recorded two sets of dependent variables—the perceived magnitudes of the differences between the regular and the sale prices and the response times for evaluating the differences. We measured the perceived magnitude of the difference on an 11-point semantic differential scale anchored by "small" (1) and "large" (11). The computer unobtrusively recorded the response times for evaluating each of the 24 pairs of prices.

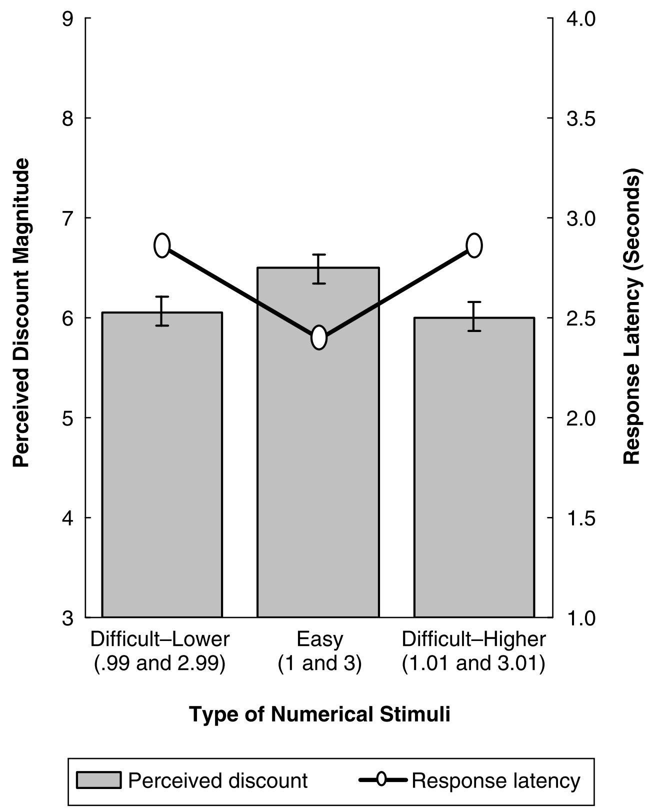
Manipulation check. To test whether the prices in the easy condition were actually perceived as easier than those in the difficult–lower and difficult–higher conditions, 44 undergraduate students who did not participate in the main experiment were presented with three different sets of subtraction problems and were asked to choose the set that was easiest and required the least time and the least effort to solve. Problem Set 1 used the eight pairs of numbers in the difficult–lower condition (left column in Table 1), Problem Set 2 used numbers in the easy condition (middle column), and Problem Set 3 used numbers in the difficult–higher condition (right column). Almost all participants chose Problem Set 2 as the easiest (100%) and as requiring the least time (93%) and the least effort (96%) to solve.

Results

Magnitude judgments. A 3 × 2 × 4 repeated measures analysis of variance (ANOVA) with computational ease (difficult–lower, easy, and difficult–higher), discount magnitude (approximately \$1 versus approximately \$3), and replicate (four levels) revealed a main effect of computational ease on judgments of discount magnitudes ($F(2, 122) = 16.63$, $p < .01$). Discounts were perceived as larger when the computations were easy ($M_{easy} = 6.49$) than when they were of the difficult–lower type ($M_{diff\text{-}lo} = 6.06$; $F(1, 122) = 22.23$, $p < .01$) or of the difficult–higher type ($M_{diff\text{-}hi} = 6.01$; $F(1, 122) = 27.40$, $p < .01$). This pattern suggests that participants misattributed the subjective ease induced by computation complexity to the analog distance between the prices (see Figure 1). Not surprisingly, the effect of discount magnitude was also significant. Discounts were perceived as larger when the numerical difference between the regular and the sale prices was larger than when it was smaller ($M_{\$3} = 8.37$ versus $M_{\$1} = 4.01$; $F(1, 61) = 455.89$, $p < .01$). However, the interaction between discount magnitude and computational ease was not significant ($F < 1$), suggesting that the ease-of-computation effect manifested for both levels of discount magnitudes.[3]

Figure 1

EXPERIMENT 1A: THE EFFECT OF EASE OF COMPUTATION ON THE PERCEIVED MAGNITUDE OF THE NUMERICAL DIFFERENCE



Response time. We submitted logarithmic transforms of the response time data to the same 3 × 2 × 4 repeated measures ANOVA. (However, for ease of interpretation, throughout this article, we report the means of the untransformed response times.) A main effect of computational ease ($F(2, 122) = 21.45$, $p < .01$) and subsequent simple contrasts confirmed that participants found it easier to judge the magnitude of the discount (i.e., they responded more quickly) when the computations were easy ($M_{easy} = 2089$ milliseconds) than when they were of the difficult–lower type ($M_{diff\text{-}lo} = 2505$ milliseconds; $F(1, 122) = 26.63$, $p < .01$) or of the difficult–higher type ($M_{diff\text{-}hi} = 2560$ milliseconds; $F(1, 122) = 36.90$, $p < .01$). The interaction between discount magnitude and computational ease was not significant ($F < 1$), suggesting that this ease-of-computation effect manifested for both levels of discount magnitudes.

Mediation analyses. We investigated whether response time mediated the effect of computational complexity on magnitude judgments. Following Kenny, Kashy, and Bolger's (1998) suggestions regarding multilevel modeling, we used the 24 pairs of numbers (in Table 1) as the unit of analysis. Specifically, to control for the effect of individual differences, we averaged the judgments and the response times for each of the 24 pairs of numbers across all participants. We tested four different regression models with the

[3]In all the experiments reported in this article, differences were judged to be larger when the arithmetic difference was larger. However, we do not discuss the statistical details of this effect, because this factor never interacted with computation complexity. The effect of computational complexity consistently manifested for small and large differences, suggesting that participants' judgments were influenced by the magnitude of the difference and the ease of computation.

resultant data.[4] First, we tested a regression model with the judged discount magnitude as the criterion variable and computational complexity (with easy pairs coded as 1 and difficult pairs coded as –1) as the predicting variable. As we expected, computational complexity was a significant predictor of judged discount magnitude ($\beta = .22$, $p = .02$). The second regression model revealed that computational complexity also significantly affected response latencies ($\beta = -.22$, $p < .01$). The third model showed that response latency is a significant predictor of judged discount magnitude ($\beta = -1.10$, $p < .01$). The negative value of the response latency coefficient suggests that faster responses (i.e., shorter response times) are associated with larger discount magnitude judgments. Finally, when we entered both computational complexity and response latency as predicting variables in the same model, the effect of latency was again significant ($\beta = -1.29$, $p = .05$), but computational complexity was no longer a significant predictor of magnitude judgments ($\beta = -.06$, $p = .72$). A Sobel test for mediation was also significant ($t = 2.02$, $p = .04$).

EXPERIMENT 1B: PRICE DIFFERENCE

Judgments of numerical differences occur not only in the context of discount evaluations but also in the context of price differences between competing stores or brands. It could be argued that from a practical point of view, the latter context is more relevant for testing the ease-of-computation hypothesis. Our hypothesis predicts that consumers might incorrectly judge the price difference between two brands to be smaller when retailers use computationally complex prices. To examine the generalizability of the ease-of-computation effect, we introduced a between-subjects manipulation of the judgment context: discount versus price difference. The stimuli and the procedure were identical to those in the preceding experiment, with one exception: Half the participants were told that their task was to judge discount magnitudes, and the other half were told that their task was to judge price differences between pairs of competing brands. One hundred eighty-eight students participated in this experiment and were randomly assigned to one of the two between-subjects conditions.

We submitted difference judgments to a $3 \times 2 \times 4 \times 2$ mixed factorial ANOVA with the same within-subjects factors as in the previous experiment and judgment context (discount versus price difference) as an additional between-subjects factor. The analyses revealed a main effect of computational ease ($F(2, 372) = 27.74$, $p < .01$). Discounts and price differences were perceived as larger when the computations were easy ($M_{easy} = 6.72$) than when they were of the difficult–lower type ($M_{diff\text{-}lo} = 6.38$; $F(1, 372) = 50.35$, $p < .01$) or of the difficult–higher type ($M_{diff\text{-}hi} = 6.46$; $F(1, 372) = 30.28$, $p < .01$). This result was not moderated by judgment context ($F < 1$), suggesting that the ease-of-computation effect manifests for discount magnitudes and for price differences between competing brands. The response latency patterns were the same as in the previous experiment. Specifically, response latencies were shorter when the computations were easy ($M_{easy} = 2110$ milliseconds) than when they were of the difficult–lower type ($M_{diff\text{-}lo} = 2661$ milliseconds; $F(1, 186) = 188.32$, $p < .01$) or of the difficult–higher type ($M_{diff\text{-}hi} = 2757$ milliseconds; $F(1, 186) = 247.50$, $p < .01$).[5]

EXPERIMENT 1C: BRAND CHOICE

The results from the previous experiment raise an intriguing question: Can difficult computations make consumers more likely to buy expensive brands? We designed this experiment to examine whether ease of computations affects consumers' brand choices. Participants were presented with two brands and were told that the objective of this study was to assess the premium they were willing to pay for their preferred brand. Their preferred brand was priced higher (at test prices) than the competing brand (always priced at $34.99). Test prices varied from $41 to $51, and at each price level, participants needed to choose between one of the two brands. We manipulated computational complexity by using two sets of test prices. Participants assigned to the difficult condition saw test prices that made computations of price differences between competing brands relatively complex (e.g., $41.56, $43.61). Participants assigned to the easy condition saw test prices that made computations relatively easy (e.g., $41, $43). Although the computationally difficult test prices were marginally higher than the easy ones, we predicted that participants would judge the price differences between the two brands to be smaller and consequently would evaluate the difficult test prices more favorably.

Method

Design and procedure. One hundred forty-seven undergraduate students from a large northeastern university participated in this experiment. They were paid a small monetary compensation for participating in this and some unrelated studies conducted by other experimenters. The experiment was administered on computers. Participants were randomly assigned to one of two between-subjects conditions: "difficult" versus "easy" computations.

Before the choice task, we assessed each participant's innate brand preference without any information on prices. Participants in both conditions were told about two brands of memory sticks—Sony and Lexar—and were asked to choose the brand they preferred (without any information on prices). We did this so that the computer could unobtrusively assign the test prices, which were higher than the competing brand's price, to the more preferred brand for each participant.[6] After participants indicated their brand choice, they were given information about the prices of the two brands. They were told that managers were considering six different test prices for the more preferred brand and

[4]We entered the actual discount magnitude as a covariate in all the mediation models we report in this article.

[5]Mediation analysis with the four regression models replicated the results reported in Experiment 1a. Furthermore, a Sobel test for mediation was also significant ($t = 2.55$, $p = .01$).

[6]Such a dynamic assignment of prices was necessary because of heterogeneity in brand preference. If the higher prices were assigned to the same brand for all participants, for some participants, it would have resulted in their preferred brand being priced lower, a scenario that is inconsistent with the ostensible experimental objective of assessing the premium they are willing to pay for their preferred brand.

that they were interested in consumers' brand choices at the different test prices. The computer was programmed such that, based on information on each participant's initial brand preference, the price of the less preferred brand was set at $34.99. All participants saw six different test prices for their preferred brand, one at a time in a random order, and they indicated their brand choice at each price level. On each screen, they saw prices of both the brands—the preferred brand at one of the six test prices and the competing brand, which was always priced at $34.99. Participants assigned to the difficult-computation condition saw the following test prices for the preferred brand in a random order: $41.56, $43.61, $45.87, $47.63, $49.77, and $51.94. Participants assigned to the easy-computation condition saw the following test prices for the preferred brand in a random order: $41, $43, $45, $47, $49, and $51. Thus, each participant made six choices. We wanted to examine whether participants' brand choices would be affected by the manipulation of the ease of computing the price difference between the competing brands.

Manipulation check. As in Experiment 1a, a separate group of 25 undergraduate students who did not participate in the main experiment were presented with two sets of subtraction problems and were asked to choose the set that was easier and required less time and less effort to solve. Problem Set 1 used the six pairs of numbers in the difficult condition (e.g., 41.56 – 34.99, 43.61 – 34.99), and Problem Set 2 used the six pairs of numbers in the easier condition (e.g., 41 – 34.99, 43 – 34.99). All participants chose Problem Set 2 as easier and requiring less time and less effort to solve.

Results

We analyzed the effect of computational complexity on participants' binary responses using clustered logistic regression. Specifically, we regressed the binary responses using PROC GENMOD in SAS with computational ease (with the easy condition coded as 1 and the difficult condition coded as –1) and price as independent variables; we also included the order of price presentation and initial brand preference in the model to control for individual differences. There was a significant effect of computational ease ($\beta = -.29$, $p = .05$) on brand choice. Because we coded participants' binary responses as 0 or 1, such that the higher number indicated choosing the higher-priced brand, the negative coefficient indicates that participants were less likely to choose the higher-priced brand when the computations of price difference were easier. Not surprisingly, price was also a significant predictor of brand choice ($\beta = -.26$, $p < .01$), the negative coefficient indicating that higher price levels reduced participants' propensity to choose the higher-priced brand. This result replicates the finding in Experiments 1a and 1b that participants' responses are influenced by the output of the arithmetic operations and the output from the heuristic processing of fluency experiences. Furthermore, this result suggests that it is unlikely that the participants were ignoring the price magnitude when making the brand choice.[7]

Discussion

The results of Experiments 1a and 1b support the hypothesis that subjective judgments of numerical differences are sensitive to the ease or difficulty of computations. Participants took more time to evaluate the difficult- than the easy-to-compute price differences, and this variation in processing fluency affected their magnitude judgments. Participants incorrectly judged the difference to be smaller for pairs with difficult computations than for pairs with easy computations. They seemed to have misattributed the processing fluency variations to the numerical difference between the price pairs, even though it was actually induced by computational complexity. Experiment 1c examined whether ease of computations can affect brand choice, and the results suggest that it can. When computations were easier, participants were less likely to choose the higher-priced product, suggesting that they perceived the price differences as larger in this condition.

The ease-of-computation hypothesis is based on the premise that the subjective experience of ease or difficulty of mental computations causes this effect. However, could the observed effects be caused by some other aspect of these numerical stimuli rather than by subjective experiences? We designed Experiment 2 to delineate the role of subjective experiences in judgments of numerical difference.

EXPERIMENT 2: MISATTRIBUTION OF COMPUTATIONAL COMPLEXITY

In this experiment, we used the same numerical judgment task as in Experiment 1a, but to confirm the causal role of mental computations in the observed effects, we also manipulated mental computations through problem-solution availability. Half of the participants were assigned to the compute-difference condition, in which they mentally computed the difference between the two prices before judging the magnitude of the discount, as in Experiment 1a. The other half were assigned to the difference-given condition, in which they were given the solution to the subtraction problem. Thus, participants in the latter condition did not need to compute the difference between the regular price and the sale price; they just needed to judge the magnitude of the discount. We predict that it is not the availability of the solution but rather the process of generating the solution that induces the experience of fluency. We believe that providing the solution will foil this experience of fluency and the concomitant attribution process. On the basis of this reasoning, we hypothesize the following:

> H_2: Computationally easier differences will be judged to be larger than computationally difficult differences of similar magnitude only when the judgments entail mental computations. When the solution to the subtraction problem does not need to be mentally computed, ease of computation will have no effect on magnitude judgments.

[7]We also tested for the mediating effect of reaction times, as we did in Experiments 1a and 1b, but the results were not significant for this study. This may have occurred because, in contrast to all the other studies in this article, in this study we manipulated computational complexity using a between-subjects design, and therefore individual responses in reaction times might have been swamped by the effects of computational complexity. However, the self-reported measures of computational ease recorded in the manipulation check phase of the study support our conjecture that the observed effect was indeed due to computational complexity.

If the observed effects are due to the ease or difficulty of mental computations of the solution, we do not expect the effect to manifest when the solution is provided. In contrast, if the observed effects are due to some other characteristics of the numerical information, the effect should manifest in both conditions because the subtrahends and the minuends remained unchanged across the conditions.

Method

Fifty-eight students participated in this experiment for partial course credit. Participants were randomly assigned to one of two between-subjects conditions: compute difference versus difference given. In the difference-given condition, participants saw the regular price, the sale price, and the difference between the two prices. The three numbers were presented at the center of the screen as follows:

Regular:	$5.00
Sale:	$4.00
Difference:	$1.00

Participants in the compute-difference condition just saw the two prices without the difference, as in Experiment 1a, so they needed to compute the difference between the two prices. The instructions to the participants, the dependent measures, and the prices used in both the conditions (see Table 1) were the same as in Experiment 1a. Before judging the 24 stimuli prices, all participants made four trial judgments to familiarize themselves with the task.

Results

Magnitude judgments. Discount magnitude judgments were submitted to a 3 × 2 × 4 × 2 mixed factorial ANOVA, with computational ease (difficult–lower, easy, difficult–higher), discount magnitude (approximately $1 versus approximately $3), and replicates (four levels) as the within-subjects factors and problem-solution availability (compute difference versus difference given) as the between-subjects factor. The analyses revealed that the main effect of computational ease on judgments of discount magnitudes ($F(2, 112) = 30.42$, $p < .01$) was qualified by an interaction with problem-solution availability ($F(2, 112) = 12.93$, $p < .01$). The ease of computation affected numerical judgments only when participants needed to compute the difference. For participants assigned to the compute-difference condition, discounts were perceived as larger when the computations were easy ($M_{easy} = 6.69$) than when they were of the difficult–lower type ($M_{diff\text{-}lo} = 6.23$; $F(1, 112) = 21.48$, $p < .01$) or of the difficult–higher type ($M_{diff\text{-}hi} = 6.35$; $F(1, 112) = 11.94$, $p < .01$). However, for participants assigned to the difference-given condition, ease of computation had no affect on their judgments. Instead, their judgments were based only on the magnitudes of the numerical differences presented on the screens. Recall that the computationally easy discounts were a cent higher than the difficult–lower type discounts but a cent lower than the difficult–higher type discounts. Accordingly, the computational easy discounts were perceived as larger ($M_{easy} = 6.33$) than the difficult–lower type ($M_{diff\text{-}lo} = 5.78$; $F(1, 112) = 29.25$, $p < .01$) and smaller than the difficult–higher type ($M_{diff\text{-}hi} = 6.57$; $F(1, 112) = 5.14$, $p = .03$). This pattern of means supports our proposition that the effect of computational complexity on judgments is due to the subjective experiences generated by the mental computations (see Figure 2).

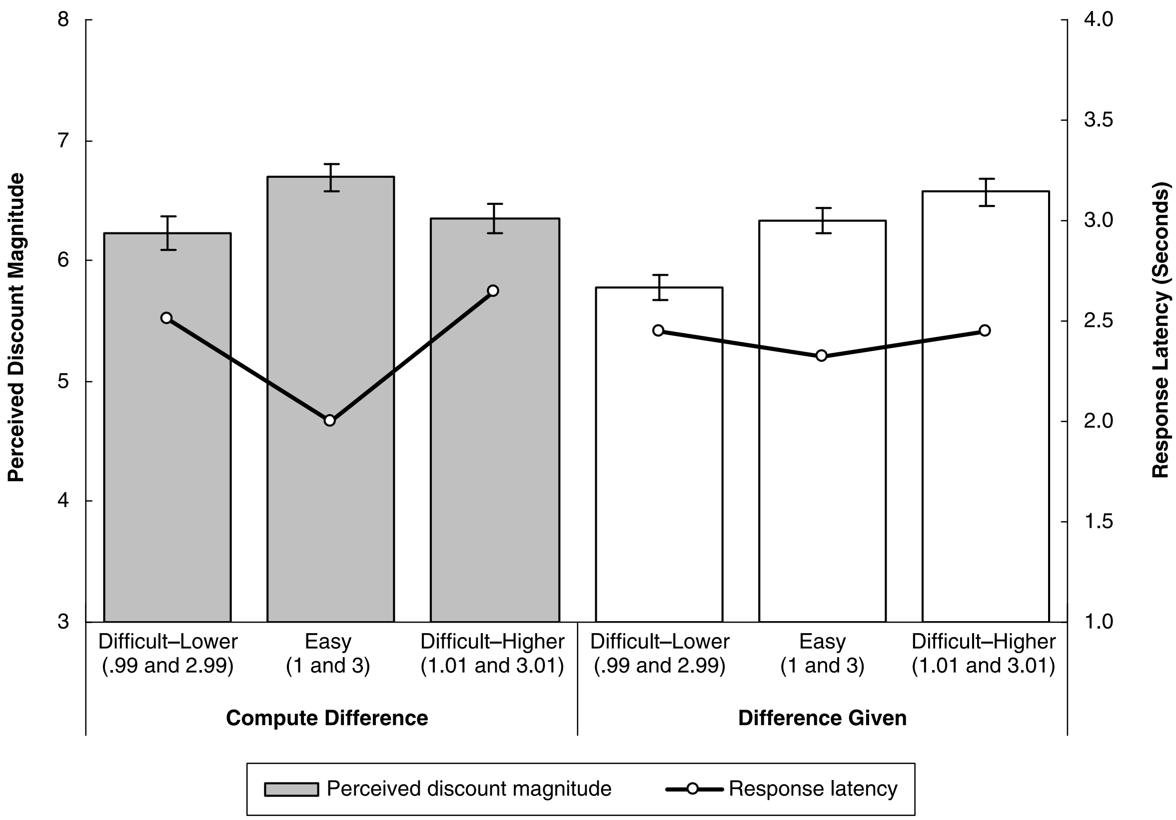
Response time. Giving the numerical difference versus making participants compute it also affected response times. The main effect of computational ease on the logarithmic transforms of response time ($F(2, 112) = 21.60$, $p < .01$) was moderated by problem-solution availability ($F(2, 112) = 10.43$, $p < .01$). The ease of computation affected response latencies only when participants needed to compute the difference (see Figure 2). For participants assigned to the compute-difference condition, response latencies were shorter when the computations were easy ($M_{easy} = 2009$ milliseconds) than when they were of the difficult–lower type ($M_{diff\text{-}lo} = 2512$; $F(1, 112) = 34.70$, $p < .01$) or of the difficult–higher type ($M_{diff\text{-}hi} = 2659$; $F(1, 112) = 58.34$, $p < .01$). However, for participants assigned to the difference-given condition, the ease of computations had no affect on their response latencies. The time taken for computationally easy discounts was not significantly different ($M_{easy} = 2321$ milliseconds) from that for the difficult–lower type ($M_{diff\text{-}lo} = 2450$; $p = .21$) or the difficult–higher type ($M_{diff\text{-}hi} = 2457$; $p = .22$). This suggests that because participants did not need to compute the difference, the computationally easy numbers were not perceived as any more fluent than the other numbers.

Mediation analyses. Mediation analyses revealed that response time mediated the effect of computational complexity on judgments in the compute-difference condition but not in the difference-given condition. As in Experiments 1a and 1b, we averaged the judgments and the response times for each of the 24 pairs of numbers across participants, and we tested four different regression models with the resultant data separately for the compute-difference and the difference-given conditions. In the former condition, computational complexity was a significant predictor of judged discount magnitude ($\beta = .20$, $p = .03$) and response latencies ($\beta = -.28$, $p < .01$). Furthermore, response latency by itself was a significant predictor of judged discount magnitude ($\beta = -.61$, $p < .01$). When we entered both computational complexity and response latency as predicting variables in the same model, the effect of latency was again significant ($\beta = -.53$, $p = .05$), but computational complexity was no longer a significant predictor of magnitude judgments ($\beta = .04$, $p = .69$). In contrast, in the difference-given condition, latency was not a significant predictor of magnitude judgments. Furthermore, a Sobel test for mediation was marginally significant ($t = 1.85$, $p = .07$) in the compute-difference condition but not in the difference-given condition ($p = .89$).

Discussion

The results of this experiment support the notion that the ease-of-computation effect is related to the subjective experiences generated by mental computations. When solutions to the numerical problems were readily available, participants did not need to do mental computations to arrive at their judgments. In this condition, ease of computation had no affect on response time, and consequently the metacognitive experience was not perceived as a diagnostic indicator of the magnitude of the numerical difference. In contrast, when solutions to the numerical differences were not available and participants needed to rely on mental compu-

Figure 2
EXPERIMENT 2: THE ROLE OF MENTAL COMPUTATIONS



tations to arrive at their judgments, ease of computation had a significant effect on judgments.

Notably, we found that responses for easy pairs of numbers were faster when the solutions were not provided (2009 milliseconds) than when the solutions were provided (2321 milliseconds). This result, though counterintuitive, is consistent with other researchers' observation that judgments based on retrieval processes are faster than those that entail online processes. Kelley and Jacoby (1987) report an experiment in which participants were asked to judge the difficulty of anagrams under different conditions. Either the solution to the anagram had been read in an earlier phase of the experiment or, in another condition, the solution word was presented with the anagram that was to be solved, such as *scarf fscar*. Providing the solution with the anagram increased the response latency for judgments. Participants took 2.6 seconds when the anagrams were old and 3.5 seconds when the solution word was presented with the anagrams. These results indicate that in our experiments, responses for easy pairs of numbers may be largely based on retrieval of arithmetic facts when solutions are not provided.

We performed a follow-up experiment on the effect of awareness. Our proposed explanation for the ease-of-computation effect is based on the assumption that people tend to misattribute their metacognitive experiences because they are not aware of the actual cause of the fluency variation. Specifically, we argue that participants in our experiments did not know that the variations in fluency are due to computational complexity. Consequently, they misattributed their fluency experience to a frequently encountered cause of fluency variation—namely, the analog distance between the magnitudes. Our conceptualization suggests that if participants know that the fluency variations are induced by computational complexity, they will not attribute the experienced ease to numerical difference. Our follow-up experiment tested this hypothesis. We manipulated participants' awareness of the source of variation in processing fluency with 53 new participants. While some participants made the same judgments as in Experiment 1a, others were warned before each judgment whether the computation would be easy or difficult. Specifically, participants assigned to the aware-of-source condition saw a screen that said either "EASY" or "DIFFICULT" before judging each discount magnitude. The results revealed that the main effect of computational ease on judgments of discount magnitudes ($F(2, 102) = 10.13$, $p < .01$) was qualified by an interaction with fluency-source awareness ($F(2, 102) = 3.26$, $p = .04$). The ease of computation affected numerical judgments only when participants were not aware of the source of fluency variation. For participants assigned to the unaware-of-source condition, discounts were perceived as larger when the computations were easy (M_{easy} = 6.63) than when they were of the difficult–lower type ($M_{diff\text{-}lo}$ = 6.03; $F(1, 102) = 17.82$, $p < .01$) or of the difficult–higher type ($M_{diff\text{-}hi}$ = 6.05; $F(1, 102) = 16.77$, $p < .01$). However, for participants assigned to the aware-of-source condition, the magnitude of the computational easy discounts was perceived as no different from the magnitude of the difficult–higher type discount (M_{easy} = 6.00 versus $M_{diff\text{-}hi}$ = 5.95; $F < 1$), though it was higher than the difficult–lower type ($M_{diff\text{-}lo}$ = 5.70; $F(1, 102) = 4.14$, $p = .04$). These results support our hypothesis that participants misattribute the variations in processing fluency to numerical difference only when they are unaware of the actual source of fluency variation.

Having established that the ease-of-computation effect is due to misattribution of subjective experiences, we now turn our attention to the role of naive theories. Why do people believe that larger differences are easier to judge? We address this question in Experiment 3.

EXPERIMENT 3: NAIVE THEORY

In general, it is believed that the interpretation of processing fluency depends on the ecological relationship between the subjective experience and the judgment variable (Briñol, Petty, and Toramala 2006; Unkelbach 2006). In other words, people use associative rules they have learned from prior experiences to interpret their present subjective experiences. Such implicit or explicit beliefs about the nature of the relationship between two variables are often referred to as participants' naive theories of cognition. Our hypothesis for the naive theory underlying the ease-of-computation effect is that larger numerical differences are usually easier to process than smaller differences. As noted previously, we believe that this naive theory emerges from people's daily experiences with analog stimuli. If prior experience is the source of naive theories used for interpreting processing fluency, a manipulation of participants' prior experience should influence the interpretation of processing fluency. We designed this experiment to test this prediction.

This experiment uses the same numerical judgment task as in Experiment 1a. In addition, we manipulated participants' naive theory by introducing a learning phase before the discount evaluation task. Participants were randomly assigned to either the larger-is-easier or the smaller-is-easier conditions, and the stimuli used during the learning phase differed across the two conditions. In the larger-is-easier condition, participants' experiences during the learning phase were consistent with their default heuristic that larger magnitudes are easier to process. Specifically, in this condition, the prices in the learning phase were chosen such that discounts with larger magnitudes were computationally easier than smaller discounts. In contrast, in the smaller-is-easier condition, discounts with smaller magnitudes were computationally easier than larger discounts. After the learning phase, all participants completed the same discount evaluation task as in Experiment 1a. We wanted to test the effect of the manipulation of the learning phase on participants' responses to the difference evaluation task. We hypothesize the following:

> H_3: The ease-of-computation effect is less likely to manifest when participants learn that fluently processed pairs of numbers are associated with smaller versus larger magnitudes of numerical difference.

Method

Seventy-one students who participated in the experiment for partial course credit were randomly assigned to one of two between-subjects conditions: larger is easier versus smaller is easier. The general instructions to participants and the dependent measures were the same as in Experiment 1a. Before responding to the test phase, all participants responded to 16 practice trials presented in a random order. These practice trials served as the learning phase. Of these 16 practice trials, half were computationally difficult, and the remaining were computationally easy. The stimuli used in these 16 practice trials differed across the two conditions. In the smaller-is-easier condition, computationally easy prices were associated with smaller discounts. Specifically, the discount magnitudes were less than 3.00 for computationally easy prices and greater than 3.00 for computationally difficult prices. In contrast, in the larger-is-easier condition, the discount magnitudes were greater than 3.00 for computationally easy prices and less than 3.00 for computationally difficult prices. After completing the learning phase, participants were informed that the practice trials were over and that the next 24 trials would be the test stimuli. The stimuli used during the test phase were the same as in Experiment 1a and were the same across the two conditions.

Results

Learning phase. We examined the learning-phase data to test whether the manipulation of the correlation between response time and the size of the numerical difference worked as expected. We computed the Pearson correlation coefficient between the response time and the judged magnitude of the numerical difference separately for each of the two between-subjects conditions. In the larger-is-easier condition, the correlation was negative ($r = -.23$, $p < .01$), suggesting that in this condition, faster responses were associated with larger differences. In contrast, the correlation in the smaller-is-easier condition was not significant ($r = .03$, $p = .42$). This result indicates that preexisting associations might have interfered with the creation of new associations.

Magnitude judgments. We submitted magnitude judgments collected during the test phase to a 3 × 2 × 4 × 2 mixed factorial ANOVA with computational ease (difficult–lower, easy, difficult–higher), discount magnitude (approximately $1 versus approximately $3), and replicates (four levels) as the within-subjects factors and naive theory (larger is easier versus smaller is easier) as the between-subjects factor. The main effect of computational ease on judgments of discount magnitudes ($F(2, 138) = 17.11$, $p < .01$) was qualified by an interaction with naive theory ($F(2, 138) = 4.00$, $p = .02$). The effect of ease of computation was noticeably greater when participants' experience from the learning phase suggested that computationally easy discounts usually have larger magnitudes than computationally difficult ones. Specifically, in the larger-is-easier condition, the difference between the easy and the difficult–higher conditions was .51 (M_{easy} = 6.73, $M_{diff\text{-}hi}$ = 6.22, $M_{diff\text{-}lo}$ = 6.11; simple contrasts with M_{easy} were significant at $p < .01$). However, in the smaller-is-easier condition, the difference between the easy and the difficult–high conditions was only .26 and was not statistically significant (M_{easy} = 6.72 versus $M_{diff\text{-}hi}$ = 6.46; $F(1, 138) = 4.78$, $p = .03$; and M_{easy} = 6.72 versus $M_{diff\text{-}lo}$ = 6.54; $F(1, 138) = 2.27$, $p = .13$).

Response time. As we expected, the manipulation of naive theory during the learning phase had no effect on participants' response times. The main effect of computational ease on response time was significant ($F(2, 138) = 30.23$, $p < .01$). Neither the main effect of the naive theory manipulation nor its interaction with computational ease reached significance ($F < 1$). Ease of computation affected participants' response latencies in both conditions. Response latencies were shorter when the computations were easy (M_{easy} = 1942 milliseconds) than when they were of the difficult–lower type ($M_{diff\text{-}lo}$ = 2388 milliseconds; $F(1, 138) = 45.36$, $p < .01$) or of the difficult–higher type ($M_{diff\text{-}hi}$ = 2381 milliseconds; $F(1, 138) = 45.14$, $p < .01$). This pattern supports the argument that the moderating effect of our manipulation was not due to changes in fluency experiences but rather different interpretations of this experience.

As in the previous experiments, we tested the relationship between response latency and the discount magnitude judgment using a regression model with the mean perceived magnitude for each of the 24 pairs of numbers as the criterion variable and the mean response time and the actual discount magnitude for each of the 24 pairs of numbers as the predicting variables. We estimated this model separately for the larger-is-easier and smaller-is-easier conditions. In the smaller-is-easier condition, because participants' experiences during the learning phase were inconsistent with their naive theory, response latency did not have a significant effect ($\beta = -.29$, $p = .26$) on judged magnitude. However, in the larger-is-easier condition, because their experience during the learning phase was consistent with their naive theory, response latency was a significant predictor ($\beta = -.79$, $p < .01$) of judged magnitude. However, in contrast to most of the previous experiments, the traditional test of mediation analysis was not significant.[8]

Discussion

The results of this experiment show how prior experiences influence peoples' naive theories used in metacognitive processes. In the larger-is-easier condition, participants' observations during the learning phase of the experiment were consistent with their general belief about the ecological relationship between computation ease and numerical difference. They observed that whenever the processing was relatively difficult, the numerical difference between the two stimuli being compared tended to be small. Accordingly, during the test phase, participants assigned to this condition interpreted their fluency experiences using the heuristic that larger differences are easier to judge. In contrast, in the smaller-is-easier condition, participants' observations during the learning phase contradicted their general belief about the relationship between ease and numerical difference. Confused by conflicting observations, participants in this condition presumably did not know how to interpret their processing fluency experiences. Thus, in this condition, the effect of ease of computation was mitigated.

It is worth noting that the moderating effect of our naive theory manipulation on judgments was not due to changes in fluency experiences. The manipulation of the ecological relationship between fluency and numerical difference during the learning phase did not affect participants' fluency experiences per se (as measured by the response latency for judgments). It affected only the cognitive rules they used to interpret the fluency experiences. This result corroborates the notion that the ease-of-computation effect is caused by the interplay of two independent psychological constructs—namely, fluency experiences and naive theories about the meaning of those experiences.

GENERAL DISCUSSION

How do consumers know whether the difference between two prices is small or large? Intuition suggests that judgments of the size of a difference depend only on the arithmetic difference between the two prices. The larger the arithmetic difference between the two prices, the larger the perceived difference should be. However, recent insights from studies on processing fluency suggest that when making judgments, people rely not only on information content but also on the ease or difficulty with which the information is processed. Drawing on this body of literature, we propose that judgments of numerical differences also depend on such metacognitive experiences. The difference between 4.97 and 3.96 might seem smaller than that between 5.00 and 4.00, even though arithmetically it is not. We hypothesized that such feelings occur because people misattribute computational complexity to numerical difference. The results from a set of experiments support our hypothesis. We find that the ease with which the numerical difference between two numbers comes to mind affects judgments of the magnitude of the difference. Computationally easier numerical differences were (incorrectly) judged to be larger, and computationally difficult differences of similar magnitude were judged to be smaller in the domain of price discounts and price differences between competing brands.

We identified three moderators of this effect that offer considerable insight into the process that underlies the ease-of-computation effect. First, we show that this effect manifests only when the judgments entail variations in processing fluency induced by mental computations (Experiment 2). Second, even when there is noticeable variation in processing fluency, the effect does not manifest when people know the correct cause of the fluency variation (the follow-up to Experiment 2). Third, the ease-of-computation effect is more likely to manifest when prior experience activates

[8]The failure of the conventional mediation test could be a consequence of the learning phase in this study. In this study, the response times for the difficult computations were lower than the average response times in the previous studies by more than 170 milliseconds. It is possible that this effect of the learning phase influenced the mediation tests. It is also possible that this compression of response latencies necessitated sample sizes larger than the ones used in this study for mediation tests.

the heuristic that larger differences are easier to judge (Experiment 3).

Our findings have implications for buyer and seller behavior. Managers are often faced with the decision of whether to round prices to the nearest dime/dollar or to use precise markups and thus pass on the last cent to consumers. Our findings highlight the importance of choosing the right digits for prices. Although using precise markups might save consumers a few cents, it also makes mental computations difficult, which in turn might affect magnitude perceptions. Using precise prices can hurt sales of products that are offered on discount because it lowers the perceived magnitude of the discount. Conversely, using precise prices for an expensive brand could help sales because computational difficulty makes the price difference appear smaller. Our research also provides insight into how consumers can avoid the ease-of-computation effect in their judgments.

Because our interest was in the psychological mechanisms that underlie the ease-of-computation effect, this research examined data collected from laboratory studies. It is possible that the laboratory setting diminishes the role of metacognitive inferences in judgments. Heuristic inferences drawn from metacognitive experiences might exert a larger effect in a more realistic and complex setting, such as a supermarket, where the consumer's cognitive resources are taxed by countless stimuli. Examining the effects of ease of computation in field experiments and in scanner panel data could be a fruitful avenue for further research.

REFERENCES

Ashcraft, Mark H. and John Battaglia (1978), "Cognitive Arithmetic: Evidence for Retrieval and Decision Processes in Mental Addition," *Journal of Experimental Psychology: Human Learning and Memory*, 4 (5), 527–82.

Barth, Hilary, Kristen La-Mont, Jennifer Lipton, Stanislas Dehaene, Nancy Kanwisher, and Elizabeth Spelke (2006), "Non-Symbolic Arithmetic in Adults and Young Children," *Cognition*, 98 (3), 199–222.

Briñol, Pablo, Richard E. Petty, and Zakary L. Tormala (2006), "The Malleable Meaning of Subjective Ease," *Psychological Science*, 17 (3), 200–207.

Dehaene, Stanislas (1997), *The Number Sense*. New York: Oxford University Press.

Janiszewski, Chris A. and Tom Meyvis (2001), "Effects of Brand Logo Complexity, Repetition, and Spacing on Processing Fluency and Judgment," *Journal of Consumer Research*, 28 (June), 18–32.

Kelley, Colleen M. and Larry L. Jacoby (1996), "Memory Attributions: Remembering, Knowing, and Feeling of Knowing," in *Implicit Memory and Metacognition*, Lynne M. Reder, ed. Mahwah, NJ: Lawrence Erlbaum Associates, 287–98.

Kenny, David A., Deborah Kashy, and Niall Bolger (1998), "Data Analysis in Social Psychology," in *Handbook of Social Psychology*, 4th ed., Daniel Gilbert, Susan Fiske, and Gardner Lindzey, eds. New York: McGraw-Hill, 233–65.

Lee, Angela and Aparna A. Labroo (2004), "The Effect of Conceptual and Perceptual Fluency on Brand Evaluation," *Journal of Marketing Research*, 41 (May), 151–65.

McCloskey, Michael and Paul Macaruso (1995), "Representing and Using Numerical Information," *American Psychologist*, 50 (5), 351–63.

McGlone, Matthew S. and Jessica Tofighbakhsh (2000), "Birds of a Feather Flock Conjointly: Rhyme as Reason in Aphorisms," *Psychological Science*, 11 (5), 424–28.

Menon, Geeta and Priya Raghubir (2003), "Ease of Retrieval as an Automatic Input Judgments: A Mere-Accessibility Framework?" *Journal of Consumer Research*, 30 (September), 230–43.

Moyer, Robert S. and Thomas K. Landauer (1967), "Time Required for Judgments of Numerical Inequality," *Nature*, 215 (5109), 1519–20.

Raghubir, Priya and Geeta Menon (1998), "AIDS and Me, Never the Twain Shall Meet: The Effects of Information Accessibility on Judgments of Risk and Advertising Effectiveness," *Journal of Consumer Research*, 25 (June), 52–63.

Reber, Rolf and Norbert Schwarz (1999), "Effects of Perceptual Fluency on Judgments of Truth," *Consciousness and Cognition*, 8 (3), 338–42.

Schwarz, Norbert (2004), "Metacognitive Experiences in Consumer Judgment and Decision Making," *Journal of Consumer Psychology*, 14 (4), 332–48.

———, Herbert Bless, Fritz Strack, Gisela Klumpp, Helga Rittenauer-Schatka, and Annette Simons (1991), "Ease of Retrieval as Information: Another Look at the Availability Heuristic," *Journal of Personality and Social Psychology*, 61 (2), 195–202.

Tversky, Amos and Daniel Kahneman (1973), "Availability: A Heuristic for Judging Frequency and Probability," *Cognitive Psychology*, 5 (2), 207–232.

Unkelbach, Christian (2006), "The Learned Interpretation of Cognitive Fluency," *Psychological Science*, 17 (4), 339–46.

Wanke, Michaela, Gerd Bohner, and Andreas Jurkowitsch (1997), "There Are Many Reasons to Drive a BMW: Does Imagined Ease of Argument Generation Influence Attitudes," *Journal of Consumer Research*, 24 (September), 170–77.

Whittlesea, Bruce W.A. (1993), "Illusions of Familiarity," *Journal of Experimental Psychology: Learning, Memory and Cognition*, 19 (6), 1235–53.

———, Larry L. Jacoby, and Krista Girard (1990), "Illusions of Immediate Memory: Evidence of an Attributional Basis for Feelings of Familiarity and Perceptual Quality," *Journal of Memory and Language*, 29 (December), 716–32.

——— and Lisa D. Williams (2001), "The Discrepancy-Attribution Hypothesis: I. The Heuristic Basis of Feelings of Familiarity," *Journal of Experimental Psychology: Learning, Memory and Cognition*, 27 (1), 3–13.

Zbrodoff, N. Jane (1995), "Why Is 9 + 7 Harder Than 2 + 3? Strength and Interference as Explanations of the Problem Size Effect," *Memory and Cognition*, 23 (6), 689–700.