What Recall Errors Tell Us About Price Memory

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It is difficult to retain multiple prices, or complex prices that are long to pronounce. We advance that consumers often resort to adaptive strategies, simplifying prices to remember them. This leads to apparent “errors.” Depending on the setting (lab, in front of the shelf, exiting store, entering store), short-term memory or long-term memory is involved. Relying on Dehaene’s conceptual framework, we develop a classification of “errors” (rounding, truncating, verbal confusions, interference between different prices, etc.), separating simplification strategies from actual mistakes. “Errors” are not random, but depend on the structure of the true price, the setting, and individual ability.

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**SYMPOSIUM SUMMARY**

*Encoding, Remembering, and Using Numeric Information: Implications for Pricing*

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**SESSION OVERVIEW**

Price cognition plays a pivotal role in models of consumer behavior postulated in the economics as well as the psychology literature (Monroe 2003; Winer 2006). Both streams of literature concur on the following assumption: A buyer’s subjective judgment of the magnitude of a price should be an important determinant in purchase decisions. However, the psychological processes that underlie price magnitude judgments and the strength of the association between price magnitude judgments and choice continue to be topics of debate. In this symposium, we present three new papers that offer novel perspectives on how consumers encode, process, and use price information. The first two papers draw on the numerical cognition literature and focus on how consumers encode and process price information, while the third paper examines factors that lead to a dissociation between price perceptions and choices.

The first paper by Thomas, Simon, and Kadiyali examines whether the precision or roundedness of numbers influence people’s judgments of magnitude. This paper draws on the numerical cognition literature to examine how consumers encode the magnitude information from a string of digits in a multi-digit number. Specifically, drawing on previous research on the distribution of numbers and on the role of associative processes in everyday judgments, they suggest that that people nonconsciously learn to associate precise prices with smaller magnitudes, and that this association influences their price magnitude judgments and willingness to pay. They test this hypothesized precision heuristic in laboratory experiments as well as using data from real estate transactions.

The second paper by Vanhuele and Laurent examines why consumers are less adept with prices that are not rounded. They suggest that short-term memory constraints induce consumers to apply mathematical rounding, truncate price endings, or resort to approximations. Their conceptualization suggests that what typically are considered as recall errors may therefore actually be the result of adaptive simplification strategies. They analyze patterns of price recall errors to show that errors follow systematic patterns that reveal these strategies.

The third paper by Danziger, Gal, and Morwitz examines the influence of price magnitude perceptions on product and retailer choice in an environment where price discounts are sometimes offered and vary in their depth and frequency. Past research (Alba et al. 1999; Lalwani and Monroe, 2005) has studied the effects of depth and frequency of price discounts on price perceptions. In the present research, the authors challenge the implicit assumption of this past research, that price perceptions guide choices. They find that although respondents’ price perceptions are lower for retailers offering deep infrequent discounts, they buy more often from retailers offering frequent shallow discounts. They discuss the implications of this finding for our understanding of how consumers encode, process, and use price information.

**EXTENDED ABSTRACTS**

*“Do Consumers Perceive Precise Prices to be Lower than Round Prices? Evidence from Laboratory and Market Data”*

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Research on factors that affect consumers’ magnitude judgments in general (see Krishna 2006 for a review) and price magnitude judgments in particular (Greenleaf 1995; Monroe 2003; Morwitz, Greenleaf and Johnson 1998; Wathieu and Bertini 2007; Winer 2006) has not only unveiled several new behavioral phenomena, but also has enhanced our understanding of the consumers’ cognition processes. Given the centrality of perceived price magnitude in buyers’ decision making, we examine a ubiquitous, yet hitherto unexplored, aspect of price magnitude judgments: Do consumers perceive round prices to be higher or lower than prices that are not rounded? Consider the following illustrative example: A seller of a house can list the house for a more round price $365,000 or $364,000 or a more precise price such as $364,578.

How would the precision in the price affect buyers’ evaluation of the list price?

To explore whether people use precision as a cue in magnitude judgments, and if it does, in which direction, we ran a short online survey. Sixty nine students from a university were asked to respond to the following question: “Consider two six-digit numbers X and Y. The number X is rounded to the nearest thousand. The number Y is not rounded. Which number is likely to be smaller: X or Y?” A majority of the respondents (68%) said that the number that is not rounded (Y) is likely to be smaller, and this response rate was significantly different from chance (p<.01). This result suggests that people might be using precision as a cue for smaller magnitudes in their day-to-day numerical judgments. We refer to this decision rule as the “precision heuristic” in price magnitude judgments. In this article, we examine whether this heuristic can influence on buyers’ behavior in high involvement purchases such as buying a house, and try to gain some insights into the psychological basis of the precision heuristic.

Two important clarifications about our approach are due right at the outset. First, our definition and operationalization of roundness is consistent with the extant literature (Sigurd 1988, Dehaene and Mehler 1992, and Rosch 1975). We consider the number of zeroes in a number as the measure of roundness of the number. Further, our operationalization of roundness is consistent with the notion that there can be gradations in perceived roundness of numbers; that is, some round numbers might be perceived to be more round than others (Jansen and Pollmann 2001). For example, $364,500 is more round than $364,578, but less round than $364,000. Second, we note that our discussion of roundness is distinct from the well-established literature on nine-endings in pricing (e.g., Stiving and Winer 1997). A precise price can have a nine-ending (e.g., $364,999) or not (e.g., $364,578). Comparing consumers’ evaluations of a nine-ending precise price with that of the corresponding round price (e.g., $364,999 vs. $365,000) is problematic, because the effect of precision will be confounded with the nine-ending effect. Therefore, in our experiments we do not use prices that end in nine,
and in the analyses of the market data we find that our results are robust to controlling for the nine-ending effect.

We report four studies that test our hypotheses. We examine whether consumers systematically judge precise prices to be higher than round prices and whether this biased judgment influences their buying behavior. Our laboratory experiments provide evidence consistent with the precision heuristic and its effect on buyer behavior. Results from study 1 offer evidence for the effect of precision heuristic in price magnitude judgments. Specifically, we find that under conditions of uncertainty, buyers are more likely to judge the magnitude of a precise price (e.g., $364,578) to be lower than the magnitude of a comparable round price (e.g., $364,000 or $365,000). Study 2 was designed to demonstrate (i) that it is possible to create an association between precision and subjective magnitude judgments, and (ii) that the activation of such an association could influence participants’ judgments and decisions. The results from this study show that house buyers are likely to pay more for a house with a precise list price (e.g., $364,578) than for a comparable house with around list price (e.g., $364,000 or $365,000). Further, we show that this effect of list price precision on buyers’ willingness to pay is mediated by the bias magnitude judgments. In study 3 we use responses from a nationwide sample comprising mostly homeowners and corroborate the external validity of our results. Finally, in study 4 we analyze the data from more than 27,000 residential real estate transactions to provide evidence that the precision heuristic influences buyers’ behavior, even in what is likely the largest purchase that most buyers will make in their lives. We conclude with a discussion on the limitations of this research and directions for future work.

“What Recall Errors Tell Us About Price Memory”
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In order to buy at the right price many consumers verify prices, and make comparisons across products, across purchase locations, and over time. Memory plays an important role in these comparisons. When the to-be-compared prices are present at the same location, they have to be held in short-term memory. It is also often useful to call on long-term memory to retrieve prices from the past or from another purchase location.

A series of price knowledge surveys have shown that price memory is weaker than what prior research, for instance on reference price, suggested. In-the-aisle surveys (Dickson and Sawyer 1990) suggest that many consumers do not watch prices and, when they do pay attention, price information is easily erased from short-term memory. Vanhuele, Laurent, and Drèze (2006) examined the constraints of short-term memory. In experiments in which multiple prices have to be retained in short-term memory, a requirement for the price comparisons described above, they show that auditory short-term memory has a capacity constraint in terms of the time it takes to pronounce the to-be-remembered information. Two prices with decimals often surpass this capacity constraint which leads to loss of information.

We advance the thesis that consumers are somehow intuitively aware of the difficulty of retaining price information when prices become long to pronounce and adapt their price encoding by simplifying observed prices. They may apply mathematical rounding, truncate price endings, or resort to approximations. What typically are considered as recall errors may therefore actually be the result of adaptive simplification strategies. So-called recall “errors” should therefore follow systematic patterns that reveal these strategies.

The theoretical basis for our work is provided by the triple-code model of Dehaene (1992). This model is a synthesis of the key research findings in numerical cognition, a sub-domain of cognitive psychology that examines how numbers are represented and processed in the cognitive system. Dehaene (1992) proposes that numbers can be mentally represented and manipulated in three different forms, in function of the task people are executing. The visual Arabic code represents numbers on a spatial visual medium on the basis of their written form in Arabic numerals (e.g., 35). The auditory verbal code is generated through a phonological representation in which each number is represented by a sequence of phonemes (e.g., /thaɪ/ /fɪv/). Finally, the analogue magnitude code represents numbers as approximate quantities on an internal dimension termed the “number line” (e.g., about 35, slightly less than 40, or somewhere between 30 and 40).

Vanhuele, Laurent, and Drèze (2006) found evidence of all three codes, but also observed the dominance of the auditory verbal code. This observation highlights the importance of the verbal capacity constraint of short-term memory. Baddeley’s (1992) work examined this constraint in detail. He postulates the existence of a phonological loop, which consists of a phonological store to hold speech-based information for the duration of 1.5 to 2 seconds and an articulatory control process to hold data within the phonological store through subvocal repetition. Vanhuele, Laurent, and Drèze (2006) found three types of evidence of the impact of the phonological loop: prices that are longer to pronounce (independently of the number of digits) are less well remembered, participants who use verbal shortcuts (e.g., pronouncing 245 as two four five instead of two hundred forty-five) have better price memory, and participants who habitually speak slower have poorer price memory.

To examine our thesis that consumers use adaptive simplification strategies, we ran new price recall surveys but also examined the data used for previous publications. For these publications, the probability of a correct response, or response within a certain error range, was taken as dependent variable. Here, we examine the types of errors that are made.

We have three types of data sets: (i) Immediate memory tests in which participants make a deliberate attempt to retain price information in short-term memory for a number of seconds, (ii) Store-exit surveys where supermarket shoppers are questioned on the prices of items they just paid for, and (iii) A store-entry survey that examines long-term memory for products consumers purchased on previous shopping occasions. As first step of our analysis we made a content analysis of the errors. Each recall response was compared to the correct price and the error was then labeled. After a couple of iterations we found that the following classification covers most of the errors: interference from other prices; rounding down one or more decimals (e.g. from 3.24 to 3.20 or 3). We reserve the word “rounding” for the mathematically correct operation of rounding down decimals below 0.5 and rounding up from 0.5 onwards; rounding up (e.g. from 3.79 to 3.80 or 4); simplifying down (e.g. from 3.79 to 3.70 or 3). Simplifying refers to a mathematically incorrect operation; simplifying up (e.g. from 3.24 to 3.30 or 4); approximations.

We then examined with statistical analyses whether the occurrence of the different types of errors had systematic drivers. Our main findings are the following:

a. Price recall errors are not randomly distributed but fall instead into clear patterns because they often are the result of simplification strategies.
b. Simplification strategies are in large part determined by the structure of the price. Whether a consumer will round or simplify is determined by the first digit(s) (euro in our case) and by the price ending (the cents part). In other words, a price of 1.XY euro will be treated differently than a price of
2.XY euro, just like a price of X.85 euro will be treated differently than one of X.99 euro. This suggests that consumers scan the most notable features of a price before registering a simplified version.

c. Our initial analyses suggest that consumers with really good price recall do not use simplification strategies, but that consumers with poorer recall ability benefit from these strategies.

“Do Price Judgments Always Influence Choice? The Effects of Retailer Discount Frequency and Depth”
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According to economic and marketing theory, product price is a major determinant of consumer choice. When multiple retailers offer the same product or a single retailer offers very similar products, consumers who are aware of price differences usually purchase the cheapest product. Therefore, retailers offer various price discounts to influence consumers’ perceptions of retailers’ and products’ prices, and ultimately their choices of which retailer to purchase from and which product to buy (Alba et al. 1999; Lalwani and Monroe, 2005). Two aspects of discounts that retailers manipulate are discount frequency (how often discounts are offered) and discount depth (the magnitude of the offered discounts). Past research has examined the effect of discount frequency and depth on consumers’ perceptions of average prices, but has not examined how that in turn influences choice. In contrast our work focuses on the impact of type of discount strategy on choice and, importantly, finds a dissociation between perceptions of the average price and choice.

Alba et al. (1999) examined the effect of depth and frequency discounting on consumers’ price perceptions. They presented respondents with the prices of two brands over multiple trials (simulating weekly purchases) and asked them to indicate on each trial the brand they would choose. After all trials, participants estimated the average price of each brand. The true average price was identical for both brands. They found that when each brand was priced at only two (multiple) levels, the depth (frequency) brand was perceived to have the lower average price. Lalwani and Monroe (2005) used similar procedures to test the hypothesis that relative salience determines which discount strategy yields lower perceived prices. They found that when discount frequency (depth) is more salient, a frequency (depth) effect is found. Thus, these studies demonstrate that discount frequency and depth influence perceptions of the average price and they determine conditions when one or the other strategy is more effective in lowering price perceptions. Importantly, both papers implicitly assume that perceived average price in turn influences retailer or brand choice. However, their procedures do not allow them to examine this because respondents always saw both product prices prior to choice. Under such conditions respondents can simply select the cheaper of the two prices shown. Therefore, it is likely that respondents in these studies estimated average price only when asked to do so after the choice phase and did not use it in choice. Also, their procedures only consider the case when full price information is available for both products. In many real world shopping situations, consumers must decide which retailer to visit based only on their price expectations, and not on the actual prices of retailers.

In our research, in contrast, we explicitly examine the effects of depth and frequency discounts on consumers’ choice of retailer and on several price judgments. In two experiments respondents were instructed that they would be making multiple decisions (simulating weekly purchases) regarding where to purchase a product that was available at two stores. They were also told that each store offered the product at either a regular price or at a discounted price, that they would make 100 choices, and that their goal was to minimize overall spending. An incentive compatible procedure was used. Critically, as is the case in actual retailer choice situations when consumers are not exposed to price advertising, respondents were told that their decisions would be made in the absence of current retailer price information. In other words, on each purchase occasion respondents’ choices likely reflect their predictions about which store they thought was offering greater savings. In the ‘chosen’ feedback condition that most closely mimics many real world shopping experiences, in each trial, respondents saw only the chosen retailer’s price after choice. In the ‘both’ feedback condition, for each trial, respondents saw the prices of both retailers after choice. This condition enabled us to examine risky choice under conditions of full price information. Following the choice phase, respondents estimated each retailer’s average price, discount frequency and depth, and rated each retailer’s price attractiveness and price fairness.

116 respondents participated in Experiment 1. The design was 2x2x2 with independent variables price feedback (chosen retailer only vs. both retailers; between subjects), frequency of depth discount (13% vs. 25%; between subjects) and type of discount (frequent and shallow vs. infrequent and deep; within subjects). The regular price for the three distributions was 9.89 and the average price was 8.89. In the frequent discount distribution the discounted price of 7.89 was offered on 50% of the purchase trials. In the 13% (25%) discount condition the discounted price of 2.19 (5.89) was offered on 13% (25%) of the trials.

190 respondents participated in Experiment 2. The design was 2x2x2 with independent variables price feedback (chosen retailer only vs. both retailers; between subjects), EDLP (discount vs. no discount; between subjects) and type of pricing (EDLP vs. frequent and deep; within subjects). The regular price for the EDLP no discount distribution was 8.39, for the EDLP discount distribution it was 8.89 and for the infrequent and deep distribution it was 9.89. The average price of the three distributions was 8.39. In the EDLP discount (infrequent and deep) distribution the discounted price of 7.89 (4.89) was offered on 50% (30%) of the trials.

The same pattern emerged in both experiments. The retailer offering frequent but shallow discounts (Experiment 1) or the retailer offering every day low prices (Experiment 2) was chosen more often than the retailer offering deep but infrequent discounts even though perceived average price was lower for the latter. Also, retailer choice was more associated with perceived price fairness than with perceived average price. Thus, these results suggest that when retailers’ prices are unavailable, as is often the case, choice is driven by internal price perceptions other than the perceived average price.

REFERENCES


