Direct Evidence of Ending-Digit Drop-Off in Price Information Processing

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ABSTRACT

Research has suggested that pricing products at one cent below a whole number (e.g., $4.99 instead of $5.00) can be an effective method for increasing purchases. Although many reasons for this have been suggested, a commonly proposed explanation is that consumers tend to drop off, or pay less attention to, the rightmost two digits. This drop-off mechanism has garnered much indirect support, but only limited research has been conducted to directly test it. In this study, respondents provided estimates of how many products they could purchase for $73. Analyses indicated that respondents thought they could buy significantly more products priced with 99 endings than products with comparable 00-ending prices. Follow-up analyses showed that (a) errors made by respondents showed a pattern consistent with a drop-off mechanism, and (b) motivation to carefully provide quantity estimates moderated the effect. The study therefore provides rare direct evidence that the drop-off mechanism may contribute to the effectiveness of 9-ending pricing. © 2005 Wiley Periodicals, Inc.

The digits of a price can be divided into two categories: (1) the leftmost digit and (2) the digits to the right of the leftmost digit, or *ending digits*. This distinction is important because retailers tend to favor the use of high

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numbers, such as 9, in price-ending digits, thus producing prices such as \$5.99, \$49.95, and \$18,900 (Friedman, 1967; Kreul, 1982; Rudolph, 1954; Schindler & Kirby, 1997; Twedt, 1965). Although this phenomenon has been referred in the past to as "odd–even pricing," this term is somewhat misleading, because it suggests the importance of whether a price is an odd or even number. In this article, the practice of including one or more 9's in the ending digits of a price will be referred to as *9-ending pricing*.

There is evidence that this practice can have a substantial effect on sales (e.g., Anderson & Simester, 2003; Kalyanam & Shively, 1998), although the effect does not seem to be uniformly strong. A number of researchers have found stronger or more distinct 9-ending sales effects for some products or situations rather than others (Blattberg & Wisniewski, 1987; Schindler & Kibarian, 1996; Stiving & Winer, 1997), and some researchers have failed to find a 9-ending sales effect at all (e.g., Georgoff, 1972). To identify the factors that determine the strength of these sales effects, it is helpful to understand the psychological mechanisms by which the retailer's use of 9 endings can affect consumer purchasing.

This article focuses on one of the most commonly proposed mechanisms, the tendency of consumers to drop off, or give less attention to, a price's rightmost digits. The past research on this 9-ending mechanism is reviewed, and a study is described that both demonstrates the occurrence of a consumer tendency to drop off ending digits and points to factors that determine when this effect is most likely to occur.

PROPOSED MECHANISMS OF 9-ENDING EFFECTS

A number of psychological mechanisms have been proposed to account for the effects of 9-ending pricing. One of the earliest suggested mechanisms is that consumers perceive a 9-ending price as indicating that they are receiving something back from the higher round number (Bader & Weinland, 1932). A variety of mechanisms have been suggested since then, including such fanciful ideas as the possibility that 99-ending prices attract attention because they are perceived by consumers as eyes looking at them (Whalen, 1980). Recently, the *meaning mechanism* has received considerable research attention (Naipaul & Parsa, 2001; Schindler, 1991; Simmons & Schindler, 2003; Stiving, 2000). This view holds that the use of 9's in a price ending serves as a signal or communicates an image, such as that the product is low-priced or on sale.

Perhaps the psychological process that is most often mentioned to account for 9-ending effects, however, is the *drop-off mechanism* (Basu, 1997; Brenner & Brenner, 1982; Stiving & Winer, 1997). This is the possibility that consumers ignore, or give very little attention to, the ending digits of a price. For example, consider how people react to the ending of an item priced at \$3.99. Although the price ending is 99 cents (practically equal to a dollar), people may either treat the ending as zero (yielding behavior consistent with a price of $3.00) or as a number significantly below the full dollar increase (yielding behavior consistent with a price somewhere between $3 and $4). Further, this mental drop-off may take place upon immediate perception of the price (at exposure) or not until the number is subsequently processed (after exposure). It should be noted that, if it does exist, the drop-off mechanism would have a high potency. The Gedenk and Sattler (1999) analysis suggests, for example, that if dropped-off 9 digits are perceived as 0's in products with typical consumer brand price elasticities (i.e., around –1.76), then consumer drop-off need occur only as little as 3% of the time for the practice of 9-ending pricing to be profitable to retailers.

RESEARCH ON THE DROP-OFF MECHANISM

Although the drop-off mechanism has often been mentioned in the literature, there is little evidence that numerical digit drop-off actually occurs. Further, much of the evidence for the drop-off mechanism that does exist is only circumstantial. For example, Carslaw (1988) tallied the second-from-the-leftmost digits of profit numbers appearing in corporate financial statements and found that 0 occurred more often than would be expected and 9 less often. This is consistent with the possibility that because of anticipation that readers of financial statements will tend to drop off rightmost digits, corporate officers attempt to enhance readers' perception of high profits by taking steps to increase 9-ending profit numbers just enough to raise their leftmost digits (e.g., $2,978 to $3,106 when in thousands of dollars). Thomas (1989) extended this finding by showing that, although 9's are underrepresented in the second-digits of net-income numbers when profits are reported, they are over-represented when losses are reported.

More recently, Schindler and Kirby (1997) surveyed retail prices appearing in newspaper advertisements. They found that retail managers were more likely to use 9-ending prices when the 0-ending price one cent (or one dollar) higher would have changed the price's leftmost digit (e.g., $3.99 → $4.00 or $199 → $200) than when the one-cent (or one-dollar) increase would not have changed the price's leftmost digit (e.g., $3.49 → $3.50 or $149 → $150). They argued that this behavior is consistent with the managers assuming that at least some consumers drop off a price's rightmost digits when making purchasing decisions. Similarly, Kahn, Pennacchi, and Sopranzetti (1999) surveyed retail interest rates for money market deposit accounts and for certificates of deposit. They found that whole-number integer values (versus integers with fractions) were overrepresented and that when fractional values were used, they were more likely to be slightly above rather than slightly below the whole-number integer value. They showed that this behavior is consistent with bank managers assuming that at least some retail customers drop off the rightmost digits of interest rates when making decisions concerning where to deposit their money.

Despite this circumstantial evidence of the widespread belief that investors and consumers drop-off rightmost digits when processing numbers, there have been few published studies that have experimentally tested whether or not such numerical drop-off behavior actually occurs. Schindler and Wiman (1989) showed respondents a set of either 0- or 9-ending retail prices and asked them to recall those prices 2 days later. Although there was evidence for numerical drop-off in prices where the 0/9 manipulation affected the price's leftmost digit (e.g., $79.99/$80.00, $299.99/$300.00), Schindler and Wiman (1989) were not able to observe numerical drop-off on the entire price sample. Further, when Schindler and Kibarian (1993) tested short-term price recall (i.e., recalling the digit after a delay of approximately 1 min), there was almost no evidence for substantial numerical drop-off.

The failure of these two studies to provide a robust experimental demonstration of numerical drop-off could be due to at least two reasons. For one, both of these experiments used a free-recall task. Because free-recall responses are open-ended, there can be extremely high response variation. For example, a respondent unable to recall the price of a $100 chair might guess a price several times higher. This greatly diminishes a study's ability to demonstrate between-group differences. The second reason, present in the Schindler and Kibarian (1993) study, is that the experimental task may have led the respondents to pay more attention to the prices than they would have done in everyday life. Schindler and Kibarian (1993) gave respondents several minutes to examine a single advertisement that displayed only one price. The unrealistically high level of attention likely to be evoked in this artificial situation may have led respondents to process the price numbers more carefully than they otherwise would have, and thus the respondents were less likely to drop off rightmost digits.

OVERVIEW AND HYPOTHESES

The goal of the present study is to directly test whether consumers do indeed tend to drop off rightmost numerical digits. To accomplish this, a procedure was used that both avoids the difficulties created by free recall and provides respondents with a task that is not unrealistically simple. Respondents in the study were presented with a hypothetical item's price and were asked to give the number of those hypothetical items that could be purchased for $73. The ending digits of the price was varied—half of the time it was a 99-ending price (e.g., $2.99, $4.99) and the other half of the time it was the 00-ending price one penny higher (e.g., $3.00, $5.00). If respondents tend to drop off the ending digits in this task, then one would expect them to give higher estimates of the number of items that could be purchased for $73 when the item's price has a 99 ending than when the item's price has a 00 ending. Formally, it is hypothesized:

H1: In judgments regarding the number of items that can be purchased for $73, estimates will be higher when the item is presented with a 99-ending price than when it is presented with a 00-ending price.

If respondents tend to drop off the ending digits of the prices in this estimation task, one would also expect that the pattern of erroneous number-of-item estimates should reflect this. To examine this, all of the respondents' incorrect numerical estimates were classified into two categories. An incorrect estimate was classified as a *drop-off error* if it was an estimate that would have been correct if the item's price had been up to one dollar less than it actually was (i.e., consistent with a dropping-off of the last two digits). All other incorrect estimates were classified as *non-drop-off errors*. If the respondents tended to ignore one or both of the price's ending digits, then a price such as $2.99 would be treated as if it were closer to $2.90 or $2.00. By contrast, ignoring the 0's in $3.00 would *not* lead it to be treated as if it were lower than $3.00. Thus, if respondents tend to drop off ending digits, one would expect a higher frequency of drop-off errors when the item's price has a 99 ending than when it has a 00 ending. Because non-drop-off errors are likely due to a large number of diverse factors, such as arithmetic mistakes and idiosyncratic guessing strategies, they would not be expected to be closely related to the item's price. Thus, one would expect no effect of the item's price ending on the frequency of non-drop-off errors. It is hypothesized:

H2: In judgments regarding the number of items that can be purchased for $73, there will be more errors consistent with a drop-off mechanism when the item is presented with a 99-ending price than when it is presented with a 00-ending price, but there will be no difference between the two price endings in the number of non-drop-off errors.

If the effect of the 99 ending on respondents' number-of-item estimates is indeed due to their tendency to ignore or give very little attention to a price's ending digits, then that effect should be moderated by the amount of attention the respondents devote to the task. Consumers who are less motivated to process information in the task can be expected to give the item's price less attention and thus show a larger 99-ending effect. In the study, both external and internal motivation to process the numbers in the task were considered. First, respondents' external processing motivation was controlled by varying instructions: respondents were told either to give as their response a first quick impression (low external motivation) or to take their time and think carefully (high external motivation). Second, respondents' internal processing motivation was considered by measuring naturally occurring differences: the responses of respondents scoring relatively low on the need-for-cognition scale (NC; Cacioppo, Petty, & Kao, 1984) were compared with the responses of respondents scoring relatively high on the NC scale. Overall processing motivation was categorized as low when there are lower levels of both external and internal motivation. It is hypothesized:

H3: When processing motivation is low, there will be a larger effect of 99 ending on the number-of-item estimates than when processing motivation is high.

METHOD

One hundred twenty-two respondents at Eastern Illinois University took part in the study in partial fulfillment of a course requirement. Respondents were each seated at individual computers utilizing MediaLab research software (Jarvis, 2002). The computer informed respondents that they would be asked to provide estimates of how many of variously priced items they could purchase for $73.00. They were not allowed to use scratch paper or calculators, and were further instructed to provide integer answers. Once respondents finished reading the instructions, the computer asked respondents, "How many [price] items could you buy for $73.00?" Respondents then entered their estimate into a text box at the bottom of the screen. After the respondent pressed the "Enter" key, the computer presented the next trial to the respondents. After completing all trials, respondents completed the short form of the need-for-cognition scale (Cacioppo et al., 1984), and were then debriefed and dismissed.

Trials

Respondents completed two sets of trials. Each of the two sets consisted of 20 items. The eight prices relevant to the study ("target" prices) were $2.99, $3.00, $3.99, $4.00, $4.99, $5.00, $5.99, and $6.00. To minimize respondents' recall of their prior responses, 12 "filler" prices of similar length were also included in each set. The order of the prices was randomly determined for each respondent within the set. After respondents completed the 20 items in the first set, they completed the same 20 items (but in a different random order) in the second set. Thus, by the end of the study, each respondent provided 16 target observations and 24 filler observations.

Manipulation

Processing motivation was manipulated between respondents. Half the respondents were assigned to the "think-quickly" condition. They were told that the researchers were interested in only their first impressions and that they should not think too carefully when providing their responses. They were told that it was acceptable to simply provide guesses. The remaining respondents were assigned to the "think-carefully" condition. They were told instead that it was very important for them to be careful in providing their answers and to think as carefully as they could before providing estimates.

RESULTS

Estimation Analyses

Number-of-item estimate scores (which will from here on be referred to as *quantity estimates*) were computed for each respondent by averaging across the two observations at each price. That is, respondents' two estimates for the \$2.99-priced item were averaged to create one estimate, respondents' two estimates for the \$3.00-priced item were averaged to create another, and so forth. This yielded eight values (one for each target price) for each respondent.

Respondents' scores were submitted to a repeated-measures analysis of variance (ANOVA) in which price level (\$3, \$4, \$5, and \$6) and price ending (\$X.99, \$Y.00) served as the within-respondents factors and quantity estimate served as the dependent measure. There was a main effect of price ending, $F(1, 121) = 15.77, p < .001, \acute{\eta}^2 = 0.12$, such that respondents provided higher estimates for 99-priced items ($M = 18.33$) than for associated 00-priced items ($M = 17.51$). Thus, although the actual difference in price between the 99-priced and 00-priced items across all trials was only 0.2%, the difference between these two conditions in the quantity estimates was 4.5%.[1] Therefore, Hypothesis 1 is supported: respondents did indeed provide higher quantity estimates for 99-priced items than for 00-priced items. Table 1 presents the mean quantity estimates for all eight observations.

Error Analyses

To determine if the pattern of errors displayed by respondents was consistent with the drop-off mechanism, each quantity estimate made by a respondent was assigned to one of three categories. First, an estimate was coded as "correct" if it was an accurate quantity estimation within one unit. For example, one can purchase 24.4 items priced at \$2.99 for \$73,

[1] Not surprisingly, there also was a main effect of price level; $F(3, 119) = 212.52, p < .001, \acute{\eta}^2 = 0.84$. As expected, respondents provided higher estimates for lower-priced items than for higher-priced items ($M_{\$3} = 24.55$, $M_{\$4} = 18.83$, $M_{\$5} = 15.29$, $M_{\$6} = 13.01$). Importantly, the price-level × price-ending term was not significant, $F(3, 119) = 1.07, p = .37, \acute{\eta}^2 = 0.03$, so in all subsequent analyses, the data were collapsed across price level.

Table 1. Mean Quantity Estimates as a Function of Price Level and Price Ending.

Price Level	Price Ending .99	.00
$3.00	25.21	23.90
$4.00	19.18	14.49
$5.00	15.81	14.77
$6.00	13.12	12.90
Mean	18.33	17.51

Table 2. Percentages of Correct, Drop-Off-Error, and Non-Drop-Off-Error Estimates as a Function of Price Ending.

Response Type	Price Ending .00	.99
Correct	62.2	55.9
Drop-off error	7.6	12.1
Non-drop-off error	30.2	32.0
Total	100.0	100.0

so estimates of 24 or 25 were classified as "correct." Second, an estimate was coded as a "drop-off error" if it was a quantity estimate that indicated a mental dropping-off. For example, although one can purchase 24.4 $2.99-priced items, if a respondent ignored the last digits and perceived the price as $2, the then-correct estimate would be 37. Thus, for $2.99, estimates of between 26 and 37 were coded as drop-off errors. Finally, an estimate was coded as a "non-drop-off error" if it could not be categorized as correct or a drop-off error. In the example of $2.99, all estimates greater than 37 or less than 24 would be classified as non-drop-off errors.

The classification of these responses was carried out separately for 00- and 99-ending prices, thus yielding, for each respondent, six categories: the number of times the estimate for a 99-priced item was correct, the number of times the estimate for a 00-priced item was correct, the number of times the estimate for a 99-priced item was a drop-off error, the number of times the estimate for a 00-priced item was a drop-off error, the number of times the estimate for a 99-priced item was a non-drop-off error, and the number of times the estimate for a 00-priced item was a non-drop-off error. The percentages of errors that fall into each of these categories can be seen in Table 2.

These six scores were then entered into a repeated-measures ANOVA with two within-subjects factors. The first factor, "response type," was a three-level variable referring to whether the score was classified as correct, drop-off error, or non-drop-off error. The second factor, price ending, was a two-level variable referring to whether the score came from 99-

priced or 00-priced items. First, there was a main effect of response type, $F(2, 120) = 279.30, p < .001, \acute{\eta}^2 = 0.82$, indicating that there was a higher percentage of correct estimates ($M = 59.1$) than drop-off-error estimates ($M = 9.9$) or non-drop-off-error estimates ($M = 31.1$). More important, this was qualified by a response-type × price-ending interaction, $F(2, 120) = 6.21, p = .003, \acute{\eta}^2 = 0.09$. Pairwise comparisons indicated that this interaction resulted from more drop-off errors for the 99-priced items than the 00-priced items—$F(1, 121) = 10.29, p = .002, \acute{\eta}^2 = 0.08$—and more correct estimates for the 00-priced items than for the 99-priced items; $F(1, 121) = 8.88, p = .003, \acute{\eta}^2 = 0.07$. There was no significant difference between the number of non-drop-off estimates for 00-priced and 99-priced items; $F(1, 121) = 1.04$, ns, $\acute{\eta}^2 = 0.01$. Thus, Hypothesis 2 was supported: respondents were more likely to make errors consistent with a drop-off mechanism for 99-ending prices than for 00-ending prices.

Analyses of Moderation

Finally, the moderation of the motivation to think carefully during the task on quantity estimates was assessed. The scores from the estimation analyses were submitted to a mixed-design ANOVA. Price ending ($X.99 or $Y.00) served as a within-respondents factor, whereas the condition to which the respondent had been assigned (think-quickly or think-carefully) and whether the respondent's score was above or below the sample's median NC score (high-NC or low-NC) served as between-respondents factors. As before, there was a main effect of price ending; $F(4, 115) = 5.79, p < .001, \acute{\eta}^2 = 0.17$. More important, this effect was qualified by a three-way price-ending × condition × NC interaction; $F(4, 115) = 2.73, p = .03, \acute{\eta}^2 = 0.09$.

To examine this interaction, the condition in which participants had neither high external motivation (i.e., was assigned to the think-quickly condition) nor high intrinsic motivation (i.e., was a low-NC respondent) was compared to the three conditions in which the respondent had at least one of these two types of motivation. Among respondents without either type of motivation to think carefully, the effect of price ending was significant—$F(4, 26) = 6.51, p < .001, \acute{\eta}^2 = 0.50$—with respondents providing higher estimates for the 99-price<zad items ($M = 19.80$ items) than the 00-priced items ($M = 18.14$ items). However, among respondents with external and/or internal motivation to think carefully, there was only a marginal effect of price ending—$F(4, 88) = 1.98, p = .11, \acute{\eta}^2 = 0.08$—with means trending in the same direction as that of the low-motivation respondents ($M_{99} = 17.79, M_{00} = 17.33$).

Together, then, these analyses support Hypothesis 3. There was a larger effect of price ending when motivation to process prices carefully was low. Specifically, respondents lacking both external motivation (from the instruction set) and internal motivation (from high levels of need for cognition) showed a significant price-ending effect, whereas respondents with either type of processing motivation showed only a marginally significant effect.

DISCUSSION

The results of this study provide direct evidence for the existence of the drop-off mechanism in price information processing. First, as predicted by the drop-off mechanism, respondents estimated that significantly more items with 99-ending prices could be purchased for a given amount of money than items with the 00-ending prices only one cent higher. In effect, items with 99-ending prices were thought of as more affordable than those with 00-ending prices. Second, an analysis of estimation errors indicates that a substantial proportion of the items with 99-ending prices, but not those with 00-ending prices, were treated as if their values were up to a dollar less than they actually cost. Third, the presence of either high external motivation or high internal motivation to process price information moderated the size of the price-ending effect. More motivated respondents showed smaller price-ending effects, consistent with the possibility that their greater motivation led them to give more attention to the prices' ending digits.

By providing direct evidence for the drop-off mechanism, the present study supports the existence of this commonly suggested explanation for the effects of price endings on consumer sales. Previous support for the drop-off explanation has been indirect and circumstantial or has been weak evidence concerning ending-digit drop-off in price recall. It should be noted that this recall evidence may have resulted entirely from the processes of memory rather than from the processing of numbers for immediate use. By contrast, this study provides a clear demonstration of *perceptual* drop-off under controlled conditions.

Of course, demonstrating one mechanism of price-ending effects does not in any way negate the possibility that other mechanisms also exist. This study's evidence for the existence of ending-digit drop-off tells us little about the existence and importance of other mechanisms, such as the image mechanism, that might play a role in the sales effects of price endings. In fact, the evidence for some drop-off effect among even the high processing-motivation respondents suggests that the drop-off effect itself may also involve processes other than simply choosing to pay less attention to a price's ending digits.

Implications

Although there may be more than one mechanism of price-ending effects, knowing that the drop-off mechanism exists suggests situations when it would be especially appropriate for the manager interested in creating a low-price impression to consider the use of 9-ending prices. One such situation would be when motivation to fully process the price stimuli would be low. Product categories for which consumers typically have low purchase involvement, such as canned vegetables, toothpaste, or paper towels, might be particularly good candidates.

Consistent with this possibility, research has found that the incidence of 9-ending prices for grocery items can be as high as 80% (Wisniewski & Blattberg, 1983). There may also be a role for 9-ending prices in products that are more involving, such as appliances or automobiles. In these products, even though the final decision can be expected to receive considerable processing effort, consumers may give very low effort to subsidiary component decisions, like whether or not to visit a particular dealership based on perusing the newspaper flyers (Schindler, 1995).

For consumers, these results suggest prices in importance of devoting some extra attention to prices with 9 endings when the item's price level is of concern. Doing so would be particularly important for purchases consisting of multiple units of a good or of multiple months of payments. Such extra processing effort would probably also be warranted for any purchase occasion where 9-ending numbers are involved in price-related arithmetic calculations, such as computing discounts or determining the price after sales tax or shipping charges (Estelami, 2003).

Directions for Future Research

Although the present research provides important support for the role of the drop-off mechanism in the consumer's price information processing, it also raises some important questions for future research. For example, it may be worthwhile to learn why relatively high levels of motivation to carefully provide estimates led to weaker 9-ending effects. At least two possible mechanisms may underlie this finding. First, it may be that people with motivation engage in less cognitive dropping off. That is, when participants are motivated, they may give fuller attention to each price digit rather than ignoring the last digits. Alternatively, the effect might be attributable to applying a more careful and accurate adjustment to the price-level anchor provided by a price's leftmost digit (Tversky & Kahneman, 1974).

Future research may also be carried out to determine precisely where in price-information processing the drop-off effect takes place. As alluded to earlier, the mental dropping-off could take place at various points in the process between exposure to a price and ultimate behavior (see Jacoby & Olson, 1977). It may be that the 9-ending prices are actually perceived as being smaller at an early stage of the process: consumers may drop off the ending upon immediate perception of a price. Conversely, it may be that 9-ending phenomena do not influence behavior until later in the process: consumers may not drop off the ending until just before a purchase decision is made.

CONCLUSION

That retailers often set their prices at values that end with 9's is a well-known fact. Jars of mayonnaise cost $1.99, pairs of tennis shoes cost $79.99, and gasoline prices typically end in nine-tenths of a cent. Though it has been well documented that this pricing strategy can affect the consumer's purchasing decision, the underlying mechanisms for these effects have been surprisingly unclear. The current research adds to the understanding of the 9-ending sales effects by demonstrating that, at least when processing motivation is low, 9-ending prices are truly interpreted as lower, and that this appears to be due, at least in part, to a mental dropping-off of rightmost digits. Although future research may gauge the influence of price-ending meanings and other mechanisms, the current research serves as an important early step in understanding what drives the ability of 9-ending prices to increase product sales.

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