

# The Effect of Discount Frequency and Depth on Consumer Price Judgments

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The intensity of price discounting by retailers and manufacturers raises important questions about consumer price judgments. In the extreme, discounting can take the form of frequent but shallow discounts or deep but infrequent discounts. The research reported here explores the effects of these strategies on consumer estimation of price levels for competing stores and brands. In an initial experiment in which subjects made brand choices over time, a depth effect was observed that contrasted with the frequency effect found in previous research. Subsequent experiments identified the conditions under which depth (vs. frequency) characteristics of price data dominate consumers' price-estimation judgments. Frequency information is more influential when sets of interstore or interbrand comparative prices exhibit complex and overlapping distributions (hence creating processing difficulty); in contrast, a depth bias occurs when prices have a simpler, dichotomous distribution. These results place pragmatically meaningful limitations on the influence of frequency information and illustrate the importance of context in determining consumer price judgments in a promotional environment.

Price is a salient attribute for nearly all consumers in virtually every product category. Basic economics teaches how changes in price can affect preferences for competing alternatives. Economics is a somewhat less useful paradigm for understanding the psychological aspects of prices and price changes. Consumer research is much more instructive in this regard, especially as it concerns consumer reactions to a specific price or price change for a particular brand (Monroe 1973, 1990). However, as Blattberg, Briesch, and Fox (1995) note, neither discipline is very informative regarding either the competitive or consumer implications of more complex pricing contexts in which a shopper must form a global impression of an alternative's price on the basis of frequently changing prices. The failure

to address this context is important because consumers, in an effort to reduce complexity, often employ heuristics to arrive at a judgment and then apply that judgment even after its factual foundation has eroded.

Consider two scenarios in which a price assessment potentially could be based on multiple price points. The first scenario involves price judgments about competing retail stores. Consumers can compare prices at the stores on as many items as are carried in common by the competitors. Given such a daunting task, consumers are likely to examine only a subset of the possible information and even may refrain from processing the subset fully. Retailers, aware of these propensities, attempt to shape consumer perceptions through a variety of methods, including the use of advertising to either communicate the size of their competitive price advantage on a small set of salient comparison objects or convey a fairly consistent price advantage across a majority of comparison objects. In marketing parlance, these tactics are known as high-low pricing and everyday low pricing, respectively. Alba et al. (1994) examined a situation in which two competing stores adopted these different pricing policies. One store was less expensive than the other on two-thirds of the items. The competitor store had, by comparison, an advantage on the remaining third but by an amount that was, on average, twice as large as its disadvantage on other items. Thus, the stores had equivalent total basket prices. Alba et al.'s (1994) results showed that sub-

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jects judged the store with frequent, shallow discounts as having a lower total basket price.

The second complex data scenario, which is the focus of the present research, involves the task of forming price judgments about only one or two items but on the basis of longitudinal data (cf. Jacobson and Obermiller 1990). Such a situation may arise when a consumer uses a single brand carried at two stores to determine which store has lower prices or which of two brands is less expensive, on average, at a particular store. As in the first scenario, consumer judgments regarding comparative store prices may be influenced by the relative frequency with which the stores discount a particular brand or, alternatively, by the depth of the discounts at each store. Under the assumption that processing is difficult because prices are observed over time, the default expectation in this context would again be a frequency effect (cf. Alba et al. 1994; Pelham, Sumarta, and Myaskovsky 1994); that is, the brand with a large number of small discounts would be perceived as having a lower average price than the brand with a few, deep discounts.

Yet, previous research that has explicitly analyzed purchase behaviors in a brands-over-time context suggests a stronger role of discount size in consumer purchase decisions. Meyer and Assuncao (1990) found that subjects overbought when pricing distributions were bimodal (i.e., offered more deep discounts) but bought appropriately when pricing distributions were uniform over time. Similarly, Krishna (1994) found that overstocking was more common with larger discounts. More recently, Jedidi, Mela, and Gupta (1999) found that deep discounts, more than frequent discounts, affect brand choice and purchase quantity. However, none of these studies explicitly examined the effects of price-discount distributions on consumers' price judgments.

## RESEARCH OBJECTIVES

As suggested above, our initial objective was to ascertain whether the Alba et al. frequency effect is manifested in the brands-across-time context.<sup>1</sup> Accordingly, we first conducted a pilot study to test whether frequency or depth cues are more salient in consumers' estimates of average brand prices. We employed a buying-game task that required subjects to view prices sequentially over several time periods, and it was found that the frequency effect described by Alba et al. does not generalize; in fact, a contrasting depth effect was obtained. Our consequent goal was to provide a theoretical account of the depth effect and identify the conditions under which a depth (vs. frequency) effect is likely to prevail. We do so in a series of studies that are described following a discussion of the pilot study.

## PILOT STUDY

We examined consumer perceptions of pricing in the context of a buying game that incorporated three brands

having different schedules of regular and discount prices over time. Mimicking the buying-game context used by Krishna (1991, 1994) and Meyer and Assuncao (1990; see also Kahn and Louie 1990), this game required subjects to minimize their prices paid and inventory costs incurred over multiple brand purchases within a single product category (shampoo). Subjects were presented with successive monthly prices for three brands in the category and on each occasion were required to decide whether to make a purchase and, if so, what quantity of each brand to purchase. In contrast to previous buying-game studies, our central interest was in subjects' game-ending judgments about brand prices rather than the intervening purchase behavior.

## Method

*Subjects and Design.* Twenty-eight MBA students participated. Subjects were presented with sequential monthly prices for three brands during a period of 36 game months. This design feature created a single, three-level within-subjects factor. Although the brands' promotion patterns differed with respect to the frequency and depth of their discounts, all three brands had identical average prices. The constant brand was priced at \$2.39 each month throughout the 36 months of the game. The frequency brand was priced at \$2.49 for 18 months but was on sale at \$2.29 in the other 18. The depth brand was priced regularly at \$2.49 for 33 periods but was discounted on three occasions to \$1.29. For convenience, we refer to this pricing structure as "6×" inasmuch as the depth brand's discounts were six times larger than the discounts of the frequency brand (conversely, the frequency brand was on sale six times more often than the depth brand). The discounts were distributed uniformly throughout the 36 months such that the frequency brand had exactly three sales randomly distributed throughout each six-period interval, and the depth brand had one sale every 12 periods. The depth brand's last discount did not appear in the final five periods in order to avoid a potential recency effect.

*Materials.* The experimental materials consisted of both a questionnaire booklet and a computerized slide show that presented the buying-game stimuli. The first page of the booklet overviewed the experiment by instructing subjects that they would be participating in a buying game for a grocery product and that the names of three actual brands would be disguised with the labels A, B, and C. The next page presented fictitious *Consumer Reports* ratings for the three shampoo brands. These ratings served to enhance task realism.

The booklet subsequently presented a work sheet to be used by subjects for tracking their inventory levels during each of the 36 successive purchase periods in the game. On each of these periods, a slide presented subjects with the three shampoo brands and their respective prices.<sup>2</sup> Subse-

<sup>1</sup>Because the Alba et al. research is cited repeatedly, we have removed the year of publication to facilitate exposition.

<sup>2</sup>The frequency (depth) brand always appeared in the left-most (right-most) of three columns, whereas the constant price brand always appeared

quent to observing each slide, subjects used their work sheets to indicate which brand(s) they selected (if any) on that purchase occasion, how many shampoo bottles they purchased (if any) during that occasion, and their resulting inventory. At the completion of the simulation, subjects answered a series of questions that constituted the dependent measures.

The 36 pricing slides were preceded by five instructional slides. These slides first described the task incentive—namely, that the two subjects with the lowest combined purchase and inventory costs would win prizes (logo coffee mugs). The introductory slides next provided instructions regarding how to calculate the inventory to be recorded on the inventory worksheet (i.e., current inventory = past inventory + current purchases - current consumption). Subjects were instructed that consumption equaled one bottle per month.

*Procedure.* After reading the cover page of the booklet, subjects were given 1.5 minutes to examine the *Consumer Reports* data. They then answered initial brand-quality questions. Instructions for the buying game followed. The game then began, and each month's prices were presented on the screen for 20–30 seconds—30 seconds in the first two periods to give subjects a chance to learn the use of the worksheet and 20 seconds thereafter.

*Buying-Game Task.* Subjects were instructed to assume that they consumed one bottle of shampoo per month and were given the objective of minimizing their total purchase cost over the 36-month period. They were informed that total purchase cost included both the shampoo's purchase price and a \$.10 per bottle cost for each bottle inventoried but not consumed. On presentation of the three brands' prices in each period, subjects decided (i) whether to buy, subject to a constraint that they must consume one bottle per period; (ii) what brand to buy; and (iii) what quantity of that brand to buy. Once the brand choice and quantity decisions were made, subjects used the worksheet to calculate ending inventory and waited until the next month's prices were revealed to proceed. This process was repeated for each of the 36 periods.

*Measures.* In light of our objective to assess frequency and depth effects à la Alba et al., our dependent variables focus on several dimensions of subjects' beliefs about the brands' prices at the end of the simulation. Following the final purchase period, subjects provided retrospective estimates of each brand's average price, sale price, regular price, and promotional frequency. Unrelated to this study, subjects also provided estimates for each brand of perceived quality and pricing fairness.

## Results and Discussion

A repeated-measures ANOVA was used in analyzing subjects' price-related ratings for all three brands. The effect

in the middle of the brand set. Subsequent experiments determined that counterbalancing the order of brand presentation did not influence results.

TABLE 1  
PILOT STUDY AND STUDY 1 RESULTS

	Pricing pattern			p-value (brand)
	Constant price	Frequency	Depth	
A. Pilot study:				
Average price:				
Actual	2.39	2.39	2.39	
Estimated	2.36	2.33	2.18	.002
Promo frequency:				
Actual	.00	18.00	3.00	
Estimated	6.48	9.33	4.22	.002
B. Study 1:				
Average price:				
Actual	2.39	2.39	2.39	
Estimated				
No flag	2.39	2.35	2.24	.000
Flag	2.40	2.37	2.31	
Promo frequency:				
Actual	.00	18.00	3.00	
Estimated				
No flag	4.38	6.14	3.19	.000 <sup>a</sup>
Flag	2.18	13.05	3.68	

<sup>a</sup>Both the main effect of flag ( $F(1, 41) = 3.93, p = .054$ ) and the flag-by-pattern interaction ( $F(2, 40) = 8.77, p < .01$ ) were significant with regard to their effect on estimated promotion frequency.

of pricing pattern (i.e., constant, frequency, and depth) was significant both for the average-price estimate ( $F(2, 26) = 7.72, p < .01$ ) and perceived promotion frequency ( $F(2, 25) = 8.24, p < .01$ ). The means for each brand are reported in Table 1, part A. In contrast to Alba et al.'s findings, the average-price estimate for the depth brand was significantly lower than that for the frequency brand ( $t(27) = 3.45, p < .01$ ) and for the constant brand ( $t(27) = 4.00, p < .01$ ).<sup>3</sup>

It is noteworthy that a follow-up analysis revealed that for nearly one-third of our subjects (9 of 28) the average-price estimates for the frequency and depth brands were arithmetically flawed. That is, these nine subjects' estimates of a brand's average price actually equaled the brand's regular or discounted price, which of course represent infeasible averages insofar as during the 36-month buying game the frequency and depth brands' prices varied between regular and sale prices. Because these subjects apparently used the mode, rather than the arithmetic mean, to estimate average prices, we label them "modals." Importantly, the inclusion of modal responses in the full analysis actually favored a frequency effect because they typically led to high estimates (i.e., \$2.49) of the depth brand's average price. Thus, as a source of error variance, these subjects suppressed the

<sup>3</sup>These conclusions are confirmed when controlling for experiment-wise error via the Tukey procedure (Keppel 1982, pp. 155–157). In the pilot study, the Tukey minimum significant difference—that is, the smallest difference in the mean prices between brands that would be significant with a constant experiment-wise alpha of .05—is \$.095. This supports the depth effect, as the depth brand is \$.15 lower than the frequency brand and \$.18 lower than the constant price brand. In subsequent studies involving multiple brand comparisons, the Tukey test provided similar confirmation.

strength of the depth effect detected in this pilot study. On removing modal subjects, the average-price estimate for the depth brand (\$2.17) remained significantly lower than that for the frequency brand (\$2.35;  $t(18) = -3.25, p < .004$ ), which offers even stronger evidence for a depth effect.

## TOWARD A RECONCILIATION

The depth effect was unexpected and strong. In fact, this finding is the first evidence that counters the robust frequency effect observed by Alba et al. with regard to price perceptions. In view of various differences between Alba et al.'s studies and our pilot, several explanations might account for the conflicting evidence. These include (a) biases in estimates of promotional frequency, (b) overweighting of the deep sale price, and (c) heuristics for coping with stimulus complexity. We discuss these explanations and outline a series of experiments designed to examine each.

### Biased Estimates of Promotion Frequency

The rational model provides one potential process for subjects' construction of average-price estimates. Anderson's (1964, 1968) information integration framework is prototypical of this processing style. Anderson posited that a subjective response (such as an estimate of the average of a series of stimuli),  $R$ , is formed by

$$R = \sum_k w_k s_k, \quad (1)$$

where  $s_k$  = value of the  $k$ th stimulus and  $w_k$  = weight given to that stimulus. In the context of price evaluations, the model implies that beliefs about the average price of brands are formed by weighting estimated prices by the perceived promotion frequency (Krishna and Johar 1996); that is, perceived average price,  $\bar{p}$ , is given by

$$\bar{p} = \frac{f_d D + (T - f_d) R}{T}, \quad (2)$$

where  $D$  is the perceived sale price,  $R$  is the regular price,  $T$  is the number of periods, and  $f_d$  is the perceived frequency of discount occurrence.<sup>4</sup> As such, the estimates of  $f_d$  play a

<sup>4</sup>Anderson (1964) notes that the information integration model is subject to a recency effect (i.e., more recent stimuli carry greater weight), a finding confirmed by Levin (1975). Adaptation level theory (Helson 1964) and reference price theory (cf. Kalyanaram and Winer 1995) also suggest recent prices should carry greater weight in price judgments. As such, the depth effect observed in our pilot study could be due to subjects being overly influenced by the last few prices presented. However, additional analysis suggests that this bias was not operating. Applying a geometric (proportional-change) weighting scheme to the pilot study price lists (Anderson 1964) with a weight of 0.9 (Greenleaf 1995) produces end-period reference prices of \$2.39 for the frequency brand and \$2.38 for the depth brand. The simple arithmetic mean of the prices was \$2.39 for each brand. Thus, the geometrically weighted and unweighted models make similar price predictions for our price lists, a fact likely due to our effort to spread the discounts over the time periods. In sum, the depth effect does

crucial role in the rational model of price expectations. If the frequency of promotions is underestimated, the perceived average price will be higher.

Research on frequency estimation suggests that underestimation of frequent events and overestimation of infrequent events is common (Howell 1973). Further, a number of theories indicate such a bias should exist in the context of promotions. Krishna (1991), invoking Kahneman and Tversky's (1979) subjective probability function, notes that high promotion probabilities are likely to be underestimated and low probabilities overestimated. Second, assimilation/contrast theory (Monroe and Petrosius 1981; Sherif 1963) suggests that small discounts may be subsumed into a normal latitude of acceptable prices and may not be noticed. In particular, for many subjects the frequency brand's \$.20 promotions (discounted from \$2.49 to \$2.29) may have fallen in a region of perceptual indifference around the \$2.49 reference price (Kalyanaram and Little 1994; Monroe 1977; see also Della Bitta, Monroe, and McGinnis 1981). Third, interference effects, by which one brand's sale events may be attributed to another, may have occurred (Malmi and Samson 1983). Specifically, the constant price brand was perceived as having some sales. These sales may have been erroneously assigned to the constant brand instead of the frequency brand, thereby lowering the number of perceived discounts for the frequency brand.<sup>5</sup>

All of these theories point to a greater likelihood of observing a depth effect; that is, a higher perceived average price for a frequently promoted brand and a lower average price for an infrequently promoted brand. Of course, the same tendency to undercount would have held in the Alba et al. studies that, nonetheless, reported a robust frequency effect. However, eliminating misperception of true frequencies would only work in Alba et al.'s favor (by strengthening the frequency effect) and against the depth effect observed in our pilot study. Study 1, then, seeks to address this bias by assessing the impact of improved frequency estimates on price judgments.

### Overweighting the Sale Price

The rational model suggests not only that perceptions of promotion frequency affect price estimates, but that subjective estimates of promotion depth (i.e., sale prices) do so as well. People often judge new stimuli against an adaptation level (Helson 1964), with stimuli close in value to the adaptation level receiving some neutral response and stimuli noticeably different receiving a more intense response (Monroe 1977; Monroe and Petrosius 1981). Yet, by definition, that adaptation level adapts to new stimuli as well. Even price stimuli that sharply contrast with reference

not appear to be explained by a greater weight placed on more recent prices. Study 3 also supports this conclusion.

<sup>5</sup>Note that the \$2.39 price of the constant price brand was often the lowest price when neither of the other brands was on sale, apparently giving the appearance of a sale. Malmi and Samson (1983) also find that numbers from one numeric distribution can be confused with another, especially as the distributions become more similar.

prices still lead to a shift in those reference points (Sherif 1963; Urbany, Bearden, and Weilbaker 1988). Anderson (1968) found, in fact, that outliers were systematically overweighted by subjects in estimating numeric averages (see also Spencer 1961, 1963). Accordingly, the depth brand's deep discounts may exert a disproportionate amount of influence on price judgments.

*Vividness/Availability.* This evidence would suggest that extreme prices in our pilot study may have been weighted by something other than (or in addition to) the frequency of appearance. One possibility is that the depth brand sale price is overweighted because it is highly available in memory at the time of price estimation due to the intense impression created by its extremity on observation (Tversky and Kahneman 1973a). In contrast, the larger price differences in Alba et al. were not as extreme, and base price points varied significantly. Study 2 examines this explanation by substantially raising the depth brand's sale price to a level closer to its regular price and thereby reducing its extremity.

The experimental task used for our pilot study provides another potential reason why the depth brand's sale prices may be more available in memory, relative to the Alba et al. task. When subjects made brand choices in the pilot study, they may have been especially attentive to the specific prices they were paying for each brand (particularly because most stocked up on the depth brand when it went on sale).<sup>6</sup> As such, the deep discounts, which were chosen by most subjects, may have been especially memorable. Conversely, subjects may have been less likely to attend to nonsale prices. Accordingly, study 3 tests these propositions by adapting our brands-over-time pricing stimuli to a paper-and-pencil task (Alba et al.) that obviates purchase and therefore precludes subjects from giving special attention to prices paid.

### Stimulus Complexity

The pilot study used a dichotomous price distribution. That is, the frequency and depth brands were always priced at either a single regular or a single discount price (consistent with the context of brand-to-brand price comparisons across time). Conversely (and consistent with the context of store-to-store price comparisons across categories), the distribution in the Alba et al. studies was nondichotomous and more complex, with price differences between stores on 60 different items varying from very small (\$.03–\$.05) to relatively large (\$.18–\$.20). In addition, the 60-item price list in Alba et al. had widely varying base prices; that is, some items were priced at less than \$1, and others were priced at more than \$3. In contrast, our pilot study presented a single base price (\$2.49) for both the frequency and depth brands.

This variation in stimulus complexity may explain why Alba et al. observed a frequency effect and why we observed a depth effect in the pilot study. Pelham et al. (1994)

showed that individuals are especially likely to rely on the numerosity (frequency) heuristic when cognitive resources are strained. The brands-over-time context, by definition, presents a relatively simple, dichotomous price distribution consisting of only two price points for each brand that appear repetitively. In contrast, Alba et al.'s stimuli posed a far more taxing challenge to their subjects' cognitive abilities. It therefore is possible that the nondichotomous price distribution in Alba et al.'s study prompts reliance on a frequency heuristic in order to reduce the cognitive demands of comparing complex pricing patterns. With simpler price data, however, depth information is more easily perceived and processed, and the frequency heuristic is less likely to be invoked.

*Anchor and Adjust.* A depth effect for dichotomous prices (and not for nondichotomous prices) would be especially likely if subjects follow an anchor-and-adjust strategy in estimating average prices, as Krishna and Johar (1996) suggest. A subject invoking this heuristic first imputes a sale price and then adjusts upward toward the regular price in order to obtain an overall mean price judgment. This heuristic produces a bias because adjustment is often insufficient. When prices have a dichotomous distribution, each brand's sale price is quite clear, particularly the sale price of a brand regularly using very large discounts. To determine whether distributional complexity moderates depth/frequency effects, studies 4 and 5 manipulate the dichotomous/nondichotomous nature of the price distributions.

*Research Questions.* In sum, the specific questions that the research program addresses are the following:

1. Does a frequency effect occur in a brands-across-time context? (pilot study)
2. Is the depth effect reversed by correcting biased estimates of promotion frequency (i.e., by increasing attention to the frequency brand's promotions)? (study 1)
3. Is the depth effect reversed by reducing the extremity of the depth brand's sale price? (study 2)
4. Is the depth effect reversed by switching from a purchase task to a perceptual task? (study 3)
5. Is the depth effect reversed when the price stimuli are made more complex? (study 4)
6. Does stimulus complexity (dichotomous vs. nondichotomous prices) moderate frequency and depth effects? (study 5)

### STUDY 1

The goal of study 1 was to determine whether the depth effect observed in the pilot study could be attributed to biased estimates of promotional frequency. This was accomplished by repeating the buying game in the pilot study while more clearly demarcating the regular and discount

<sup>6</sup>We wish to thank a reviewer for suggesting this possibility.

prices of the competing brands. For half of the subjects, a discounted price in any period was signaled by a sale marker, or flag—a procedure akin to the use of shelf-talkers in retail environments (cf. Inman, McAlister, and Hoyer 1990). Flags accompanying discounts were used to heighten the accuracy of subjects' promotion-frequency estimates by drawing attention to the frequency brand's promotions and thereby potentially reducing the tendency to misassign promotions to the constant price brand.

## Method

*Subjects and Design.* Forty-three undergraduates participated in study 1. The study used a  $2 \times 3$  mixed design with the same three-level, within-subjects factor from the pilot study (pricing patterns: constant, frequency, and depth) and an additional between-subjects factor (discount flags: present or absent).

*Materials and Procedure.* The materials used in the buying game differed from the pilot study in two ways. First, in the flagged condition, the word "sale" appeared each time the frequency or depth brands were discounted. Second, the *Consumer Reports* ratings used in the pilot study were replaced by scanned images of shampoo bottles (both front and back sides of the bottle) to achieve greater ecological validity. To eliminate potential brand-based effects, all brand-identifying text was removed from the package labels and replaced with Brand A, Brand B, and Brand C. In addition, price-related claims were removed from the labels to prevent the package text from influencing price estimates. The bottle images for the three brands were fully counterbalanced across the constant-, frequency-, and depth-brand price manipulations. Subjects were told that package information was provided to familiarize them with the brands in the simulation. They received 1.5 minutes to review the package information and then were asked to rate the quality of the three brands on 10-point scales (1 = very low quality). All remaining aspects of the buying game were identical to the pilot study. On completion of the buying game, subjects again provided estimates of each brand's average price, sale price, regular price, and promotional frequency.

## Results and Discussion

Table 1, part B, presents the mean estimates of average price and promotion frequency for each brand in both the flagged and nonflagged conditions. Because the objective of this experiment was to assess whether increasing the accuracy of the frequency estimates mitigates the price advantage of the depth brand, we first consider the estimates of promotion frequency. Pricing pattern ( $F(2, 40) = 25.86, p < .01$ ), flag presence ( $F(1, 41) = 3.93, p < .06$ ), and their interaction ( $F(2, 40) = 8.77, p < .01$ ) all significantly influenced subjects' promotion-frequency estimates. In the nonflagged condition, as in the pilot study, subjects substantially underestimated the 18 promotional events for the

frequency brand (6.14 compared to 18 actual) and overestimated the number of constant price brand promotions (4.38 compared to 0 actual)<sup>7</sup> but were reasonably accurate in their estimates for the depth brand (3.19 compared to 3 actual). The presence of flags led to a large improvement in the accuracy of subjects' estimates of the frequency brand's discounts (13.05), although underestimation of frequency was still observed. The flags also substantially increased estimation accuracy of the number of sales offered by the constant price brand (2.18). Assessment of the number of discounts offered by the depth brand remained relatively accurate (3.68).

Although the flags greatly increased the accuracy of sale frequency estimates, they had no significant effect on average-price estimates. The main effect of flag ( $F(1, 41) = 2.19, p > .10$ ) and the flag-by-pricing pattern interaction ( $F(2, 40) < 1$ ) failed to reach significance. The depth effect was still obtained, as the main effect of pricing pattern was significant ( $F(2, 40) = 10.83, p < .01$ ). Summing over the flag/no flag manipulation, contrasts indicate that the means for each brand (constant-price brand = \$2.39, frequency brand = \$2.36, depth brand = \$2.27) are each significantly different from the others (all  $t$ 's(42)  $> 2.68, p < .01$ ). It is noteworthy that, as in the pilot study, a relatively high percentage of subjects (12 of 43) used the modal price as their estimate of a brand's average price that, as noted previously, is arithmetically infeasible. Excluding these subjects from the analysis, we once again found that the main effect of flag ( $F(1, 29) = 2.35, p > .10$ ) and the flag-by-pricing pattern interaction ( $F(2, 28) < 1$ ) were not significant. The depth effect remained, as the effect of discount pattern was significant ( $F(2, 28) = 14.47, p < .01$ ). The means for the constant, frequency, and depth brands were \$2.39, \$2.36, and \$2.23, respectively.

Consistent with the pilot study, the results suggest that infrequent but deep discounts in the brands-across-time context lead to lower average-price estimates than do frequent but small discounts. Given the interactive effects of pricing pattern and flagging on promotion frequency but only a main effect of pricing pattern on the average-price measure (independent of flagging), it is apparent that variation in perceived promotion frequency cannot fully account for the depth effect observed in the pilot study and now in study 1. Thus, we can rule out frequency misperceptions as the sole underlying cause of the depth effect. We next investigated an explanation suggested by previous research regarding information integration, namely, that a depth effect occurs because consumers overweigh sale prices.

<sup>7</sup>As noted earlier, the fact that subjects perceived the constant price brand as having some price discounts may have been due to encoding and retrieving occasions on which the constant brand (\$2.39) was less expensive than the regular price (\$2.49) of the other brands. Although such confusion is not unexpected (Kalwani and Yim 1992; Malmi and Samson 1983), we attempt to minimize it in the next experiment.

## STUDY 2

As indicated previously, outlying stimuli such as deep discounts can have an extreme influence on pricing evaluations (Anderson 1968; Helson 1964; Monroe 1977; Monroe and Petroschius 1981; Spencer 1961, 1963). Therefore, reducing the extremity of such information should reduce the influence of outliers and possibly eliminate or reverse the depth effect. Accordingly, study 2 employed the buying game used in study 1 but reduced the extremity of the depth event so that it paralleled the magnitude advantage adopted in the Alba et al. studies. It is important to note that Alba et al. obtained consistent and strong evidence for a frequency (vs. depth) effect using the exact same magnitude advantage that we use in the present study.

### Method

*Subjects and Design.* Thirty-nine undergraduates participated in a study involving pricing pattern (constant, frequency, and depth patterns) as a single, three-level within-subjects factor. (No sale flags were included.)

*Materials.* The primary change in study 2 involved increasing the number of deals for the depth brand and reducing the magnitude of those deals. In both the pilot study and study 1, the depth brand had been discounted by \$1.20 three times during the 36 periods. In the current study, the depth brand was discounted by \$.30 on 12 occasions, and the frequency brand was discounted by \$.15 on 24 occasions. Thus, the depth brand in this study had half the number of sales as the frequency brand, but its discounts were twice the magnitude. The depth brand's discounts were therefore reduced from six times (6 $\times$ ) the frequency brand's discount magnitude to twice (2 $\times$ ) its magnitude, with a corresponding increase in the number of depth brand discounts. This pattern (2 $\times$ ) replicates the relative depth/frequency magnitude-of-discount structure used by Alba et al. The depth brand's discounts were again uniformly distributed across the 36 months and had an average price equaling that of the constant and frequency brands (\$2.39).

*Procedure and Measures.* We employed the same buying-game procedure used in the previous studies. Subjects, on completion of the game, again provided estimates of each brand's average price, sale price, regular price, and promotional frequency.

### Results and Discussion

The effect of pricing pattern on the average-price estimate was again significant ( $F(2, 37) = 25.46, p < .01$ ). The average-price estimates were \$2.35 and \$2.31 for the frequency and depth brands, respectively ( $t(38) = 2.67, p = .01$ ), thus evidencing a depth effect. Similar to the results of the pilot study and study 1, the average price for the constant price brand was estimated at \$2.41, which was significantly higher than the estimated prices for both the frequency ( $t(38) = 7.23, p < .01$ ) and depth brands ( $t(38)$

$= 5.03, p < .01$ ). After removing four (of 39) modal subjects, the depth effect remained significant ( $F(2, 33) = 23.94, p < .01$ ; constant brand mean = \$2.41, frequency brand mean = \$2.35, depth brand mean = \$2.29).

Promotion frequency estimates were reasonably consistent with the earlier studies. That is, subjects accurately recognized the larger promotion frequency for the depth brand (12.87 vs. 12 actual), underestimated promotion frequency for the frequency brand (6.46 vs. 24 actual), and perceived the constant price brand to be on sale occasionally (3.31 vs. 0 actual).<sup>8</sup>

Whereas Alba et al.'s studies revealed a consistent and strong frequency effect, we again produced a depth effect. Insofar as both Alba et al. and we assigned the identical (2 $\times$ ) magnitude advantage to the depth brand (*vis-à-vis* the frequency brand), we can conclude from study 2 that the depth effect cannot be explained completely by the size of magnitude advantage per se. Moreover, the results continue to suggest that the depth effect is a reliable finding.

Inasmuch as all of the experiments presented thus far have involved the buying-game task, we cannot at this point rule out the possibility that the depth brand's sale prices received extra weight in the average-price calculus because prices paid in the task were more available in memory. In addition, although we have no definitive explanation for the modal response problem, it appears that some subjects simply misinterpreted the average-price question. A small follow-up study revealed that some subjects apparently believed that our average-price question asked for a normal or most frequent price (both of which are infeasible as averages).<sup>9</sup> Study 3 addresses both concerns.

## STUDY 3

In this study, we shift from the buying-game exercise to a paper-and-pencil task comparable to that employed by Alba et al. The intention is to eliminate unique attention to sale prices motivated by purchase incentives. We additionally supplement the average-price measure from our previ-

<sup>8</sup>Again, the perceived promotion frequency for the frequency brand may have been so low because its small discounts were subsumed into the regular price variation across brands. However, note that the perception that the depth brand had *more* sales than the frequency brand in study 2 could explain the depth effect. A follow-up study indicated, however, that promotion frequency estimates are not the critical explanatory factor. The study ( $n = 38$  undergraduates) presented only the frequency and depth brands and used the original 6 $\times$  pricing structure. Otherwise, the procedure and design were the same as study 2. Subjects continued to underestimate promotion frequency for the frequency brand (12.71 relative to 18 actual) and to overestimate promotion frequency for the depth brand (5.18 relative to 3 actual). In this instance, the frequency brand was perceived to have more sales than the depth brand, yet the estimated average prices for the frequency brand (\$2.35) and the depth brand (\$2.31) were identical to those obtained in study 2.

<sup>9</sup>The specific wording for our average-price question was, "If you took an average across all the 36 months and you had to give one number for each brand, what would you say was the average price for [name of brand]?" Our emphasis on providing a single number may have led some subjects to believe they were to select the one number from the distribution of prices they had seen most often (as opposed to the average).



ous studies with the basket-price measure used by Alba et al. to enhance comparability to their work and provide insight into our modal subjects' behavior.

## Method

*Subjects and Design.* Subjects were 70 undergraduates who participated in a classroom setting. All prices were presented simultaneously in the questionnaire booklet, and the buying-game instructions were replaced with Alba et al.'s more incidental processing instructions. A 2 (within subjects)  $\times$  2 (between subjects) design was employed. Pricing pattern (frequency vs. depth patterns) represented the two-level within-subjects factor. (We presented prices for only the frequency and depth brands in order to simplify the task, eliminate interference from the constant-price brand, and maximize similarity to Alba et al.) The between-subjects factor was the discount ratio of the depth brand relative to the frequency brand (2 $\times$  vs. the 6 $\times$  used in the earlier buying-game studies). This factor was manipulated to determine whether the extremity of the depth cue affects price perceptions in the simultaneous presentation format.

*Materials and Procedure.* All experimental materials were contained in a booklet distributed to subjects. The first page provided a general description of the study and indicated that the following page would present a price list for two competing brands of shampoo. The instructions further noted that subjects would have three minutes to look over prices for the two brands for a recent 36-month period, after which they would be asked about the relative value of the shampoo brands. The prices were presented in a three-column format following the instructions on a page that listed month number, Brand A price, and Brand B price. The frequency and depth price patterns were counterbalanced across columns.

Subjects were assigned randomly either to the 2 $\times$  or 6 $\times$  condition. The experimenter timed subjects' exposure to the price list for three minutes, announcing the halfway point and the stop time. Subjects then turned to the final pages and completed the measures.

*Measures.* The final two pages of the booklet contained measures of subjects' price and promotion beliefs. Subjects responded to two different measures of brand price estimates, the order of which was counterbalanced. One measure was the perceived average price at each store (as in the preceding studies), and the other was the perceived overall basket price (as in the Alba et al. studies). The basket measure was worded as follows (cf. Alba et al.): "On the price lists you just saw, the total price at each store was less than \$100 but more than \$70. With this range in mind, please estimate as accurately as possible the total price for the shampoo brand at each store over the 36-month period. In other words, assume that you bought the shampoo every month at the same store. How much would you have paid in total?"

## Results and Discussion

Thirty-four subjects responded first to the basket-price measure, and 36 responded first to the average-price measure. Because the first measure taken influences the second, we report only the first measure from each subject. We found that the 2 $\times$ /6 $\times$  manipulation did not affect the difference in means for either the basket measure ( $F(2, 32) < 1$ ) or the average-price measure ( $F(2, 34) = 1.37, p < .21$ ). This result supports our earlier finding that the depth effect is robust across discount levels. Consequently, the remaining results were pooled across this factor.

The mean basket price was \$83.51 for the depth brand and \$85.26 for the frequency brand ( $t(33) = 1.88, p < .07$ ), again demonstrating a depth effect. The results for the average-price measure were not significant; the depth brand's mean was \$2.38, and the frequency brand's mean was \$2.36 ( $t(35) < 1$ ). Further inspection of the average-price measure revealed a large number of subjects (14 of 36) who responded by providing the modal price. On excluding these subjects, a significant depth effect was obtained: the depth brand received a significantly lower average-price estimate, \$2.34, than the frequency brand, \$2.38 ( $t(21) = 2.27, p < .02$ ).

The presence of the basket measure provides us with a means of assessing the appropriateness of holding out modal subjects in the previous analysis. Remarkably, the implied monthly average-price estimates of the 34 subjects who answered the basket question were very similar to the average-price estimates provided by the nonmodal subjects: \$2.32 for the depth brand (\$83.51/36) and \$2.37 for the frequency brand (\$85.26/36). Taken together, the data provide consistent evidence of a depth effect in an experimental context that paralleled Alba et al.'s paradigm.

These results rule out experimental context (buying-game vs. simultaneous-presentation format) and its associated effect on availability as an explanation for the depth effect. It also seems unlikely that the depth effect is due to mere recency bias insofar as the price data for each period in the present study were presented simultaneously. Finally, the greater involvement likely produced by the buying game in the preceding studies cannot alone explain the depth effect; the same effect was obtained in the less-involving task employed in the present study.

Our third major conceptual explanation yet to be addressed is the complexity of the price distribution. To this point, we have presented subjects with simple dichotomous price distributions containing prices that vary for each brand only between regular and sale prices. Pelham et al.'s (1994) findings suggest that the difficulty of processing a more complex price distribution may increase reliance on a frequency (numerosity) heuristic. Distributional complexity, the remaining potential moderator of the depth effect, is examined in studies 4 and 5.

## STUDY 4

In study 4, we examine other aspects of the price distribution that distinguish the current studies from Alba et al.'s.



Consider the 2 $\times$  condition in study 2, in which the price structure was dichotomous. When the depth brand was on sale, its advantage over the frequency brand invariably was \$.30; the frequency brand's advantage was always \$.15 when it was on sale. These price differentials were constant, easy to calculate, distinct from each other, and repeated frequently. In contrast, the store price differentials in Alba et al.'s price lists varied significantly. That is, the store with larger discounts (the magnitude store) had an advantage as large as \$.19 on some items and as small as \$.03 on others. In addition, the price distributions were overlapping; that is, some of the magnitude store's price advantages were smaller than the frequency store's. Further complicating subjects' task of tracking these variable price differentials in the Alba et al. studies was the widely varying base prices for items in their price lists, which varied from under \$1 to over \$3. Consequently, the frequency effect consistently observed by Alba et al. may have arisen due to the increased complexity of the pricing distribution and subjects' corresponding invocation of a numerosity heuristic (Pelham et al. 1994). In study 4, therefore, we introduced varying sale prices to create a nondichotomous distribution of prices. We additionally manipulated whether the price differentials were overlapping.

## Method

*Subjects and Design.* Subjects were 45 undergraduates. The experiment involved a paper-and-pencil task, as in study 3. To create an even closer resemblance to Alba et al., the price stimuli were presented as prices for a single shampoo brand available at two supermarkets that, pursuant to Alba et al., were named Clark's and Taylor's. The study had a 2  $\times$  2 mixed design. Pricing pattern (frequency and depth patterns) was again a within-subjects factor, whereas the nature of price-list distributions (overlapping or non-overlapping) was manipulated between subjects. As in Alba et al., but in contrast to our previous studies, the two price-list distributions contained nondichotomous prices such that sale prices were variable for the frequency and depth stores rather than constant. Using the Alba et al. price list as a reference point, price lists for study 4 were generated as follows:

1. We retained the same pattern and order of price advantages conveyed in the first 36 items in the Alba et al. list. This means that the pattern of frequency-store and depth-store advantages in our price list is identical to Alba et al.'s first 36 items. For example, in the Alba et al. list, the frequency store had lower prices on the second, third, fifth, and sixth items. In our price lists (see the Appendix), the frequency store had lower prices on the exact same items (now labeled "months"). For a given period, we assigned a price of \$2.49 to whichever of the two stores priced the item higher.
2. In the nondichotomous price list, the frequency and depth stores' prices were initially set using the

identical between-store price differentials for each of the first 36 items used by Alba et al. So, whichever store was lower priced in a given period in the list, it was lower by the same margin as the corresponding store in the Alba et al. price list. For example, on item 1 in the Alba et al. list, the frequency store was priced \$.32 higher than the magnitude store. On item two, the frequency store was priced \$.16 lower. These differences were replicated in our price list.

3. The price list was then adjusted to create equal totals by subtracting \$.01 from each of the depth brand's sale prices (its regular prices remained \$2.49). This \$.01 adjustment was needed because Alba et al. equated the prices of the stores across 60 items, whereas we borrowed only the first 36. This slight adjustment corrected the small discrepancy between the two stores' total prices.

This procedure resulted in a price distribution in which, as in Alba et al., the between-store price differentials were overlapping; that is, the frequency store had some price advantages that were as large as those in the depth store's. The mean price of the shampoo at each store was \$2.45, and the range of the price advantages was \$.03–\$.13 for the frequency store and \$.06–\$.18 for the depth store. We then created a second, nonoverlapping price distribution in which the depth store's price advantages would be more obvious when shampoo in that store was on sale. That is, price advantages for the depth store were larger than the price advantages for the frequency store when shampoo in that store was lower priced. To create this nonoverlapping price distribution, a constant \$.18 was subtracted from the depth store's sale prices in the overlapping price list, and a constant \$.09 was subtracted from the frequency store's sale prices. These modifications resulted in nonoverlapping mean shampoo prices of \$2.39 at each store. The price advantages ranged from \$.12 to \$.22 for the frequency store and from \$.24 to \$.36 for the depth store. The Appendix provides the nonoverlapping price list under the column labeled "Nondichotomous Price List." Note that, consistent with Alba et al., (i) the depth advantage was 2 $\times$  on average, (ii) depth and frequency stores never promoted in the same period, and (iii) at least one store promoted in each of the 36 periods. As before, the frequency- and depth-store price patterns were counterbalanced across columns.

*Materials and Procedure.* As in study 3, subjects were presented with a booklet containing all the experimental materials. The study 4 booklet was identical to that used in study 3 except for the insertion of a nondichotomous price list (either the overlapping or nonoverlapping version) and alteration of the text in reference to retail stores as opposed to brands. Study 4 followed the same procedure as in study 3.

*Measures.* In light of the fact that the price lists presented prices from different retail stores and assuming that

consumers tend to think of retail prices more in terms of baskets rather than averages, we obtained only the basket-price measure in study 4. The other measures (promotion frequency, sale price, regular price) were the same as obtained in earlier studies.

## Results and Discussion

Initial analysis revealed that the overlapping and non-overlapping conditions produced nearly identical differences in price estimates for the frequency and depth stores. Subsequent analysis accordingly was based on data collapsed across these conditions. For the first time in our series of studies, the results replicated the frequency effect reported by Alba et al. The mean basket price for 36 months of shampoo at the frequency store was \$84.05, whereas the corresponding mean for the depth store was \$86.69 ( $t(44) = 1.92, p = .06$ ). Interestingly, the frequency store's estimated basket-price advantage of \$2.64 (for 36 periods) is smaller than the \$7–\$8 basket-price advantage for the frequency store that was typical in the Alba et al. studies (for 60 items). This comparison suggests that the nonvarying base prices in the current studies (i.e., a constant regular shampoo price of \$2.49) yielded a less complex pricing distribution that was less taxing for subjects to process in comparison to the price differentials in Alba et al.'s studies.

From the results of our first four studies, we have obtained several insights into the research questions enumerated before study 1. In particular, frequency misestimation, depth extremity, and purchase task do not appear solely responsible for the depth effect. In contrast, the finding in study 4 strongly suggests that a nondichotomous, or cognitively complex, price distribution is capable of inducing a frequency effect. To provide a more complete assessment of price distribution as the primary switch responsible for inducing a frequency or depth effect, the next study systematically manipulates dichotomous versus nondichotomous pricing structures. Moreover, in study 5 we return to the brands-across-time context to control for study 4's potential, albeit unlikely, contextual confound, namely, the use of stores instead of brands.

## STUDY 5

Study 5, like the previous study, uses the general Alba et al. framework consisting of a paper-and-pencil instrument, simultaneous presentation of price lists, and subsequent measurement of brand price perceptions. The key differences between studies 4 and 5 are that, in the latter, we present prices for two brands in one store over time (as opposed to prices for one brand in two stores), manipulate whether the price distribution is dichotomous or nondichotomous (as opposed to including only nondichotomous prices), and obtain measures of both average and basket prices (instead of only basket prices). Given the preceding theoretical discussion and the foregoing evidence from previous studies, we hypothesize an interaction between pro-

motional strategy and price-distribution complexity on price estimation. Specifically,

- H1a:** Compared to the depth brand, the frequency brand will be perceived as being lower priced when the price distribution is nondichotomous (i.e., varying sale prices).
- H1b:** Compared to the depth brand, the frequency brand will be perceived as being higher priced when the price distribution is dichotomous (i.e., nonvarying sale prices).

## Method

*Subjects and Design.* Sixty-one undergraduates participated. The study employed a 2 (within subjects)  $\times$  2 (between subjects) design. Consistent with previous studies, frequency- and depth-brand pricing patterns were manipulated within subjects. Price distribution (dichotomous vs. nondichotomous) was a two-level, between-subjects factor.

*Materials and Procedure.* The experimental booklet was essentially the same as that used in studies 3 and 4. In particular, prices were presented simultaneously, and shampoo remained the focal product. The Appendix presents the two price distributions used in study 5. The dichotomous distribution was identical to that used in study 2 (i.e., 2 $\times$ ); the nondichotomous distribution was the same as in study 4. Only the nonoverlapping version of the nondichotomous distribution was used, in which the brands had mean prices of \$2.39 to match the dichotomous list. The regular price of each brand was \$2.49. In the dichotomous condition, the frequency brand offered 24 discounts of \$.15; the depth brand offered 12 discounts of \$.30. In each of the four cells the mean price was \$2.39. In neither price-distribution condition did the frequency and depth brands discount concurrently. The procedure was identical to those used in studies 3 and 4.

*Measures.* Following inspection of the price list, subjects again provided responses to questions about brand prices and promotion frequencies. Half the subjects ( $n = 30$ ) answered the basket question first, whereas the other half ( $n = 31$ ) responded first to the average-price question. As before, we report results based on just the initial measure administered to each subject.

## Results and Discussion

*Basket Measure.* A repeated-measures ANOVA indicated an interaction between the frequency/depth and dichotomous/nondichotomous factors ( $F(2, 28) = 3.74, p < .06$ ). Consistent with the directional hypotheses, all subsequent contrasts are conducted with one-tailed tests. In the dichotomous condition, the mean basket prices for the frequency and depth brands were \$84.74 and \$83.50, respectively, but the \$1.24 depth-brand advantage was only directional ( $t(15) < 1$ ). In the nondichotomous case, the total perceived basket price for the frequency brand was \$83.74

and for the depth brand  $\$86.68$  ( $t(13) = 2.46, p < .02$ ). Results for the basket measure therefore are consistent with the hypothesized interaction.

*Average Measure.* The interaction effect failed to achieve significance when all subjects were included in the analysis ( $F(1, 28) < 1$ ). However, on excluding modal responses, a significant interaction emerged that mirrored the result for the basket-price measure ( $F(1, 23) = 4.72, p < .04$ ). In the dichotomous condition ( $n = 13$ ), the mean price of the frequency brand was perceived to be  $\$2.39$ , and the mean price of the depth brand was estimated at  $\$2.36$  ( $t(12) = 1.31, p < .11$ ). In the nondichotomous case ( $n = 12$ ), the frequency brand's mean price was  $\$2.34$ , and the depth brand's mean price was  $\$2.37$  ( $t(11) = 1.74, p < .06$ ). These results generally comport with predictions of a frequency effect when prices have a nondichotomous distribution (Hypothesis 1a) and a depth effect when the distribution is dichotomous (Hypothesis 1b).

*Pooling across Measures.* A similar and stronger conclusion is reached when pooling across the average and basket measures via Rosenthal's (1991) Z-test procedure.<sup>10</sup> Basket-price estimates were divided by 36 to obtain an equivalent average-price figure. The depth effect was marginally significant in the dichotomous condition ( $Z = 1.37, p < .09$ ), and the frequency effect was significant in the nondichotomous condition ( $Z = 2.68, p < .01$ ).

*Perceived Promotion Frequency and Sale Prices as Explanators.* In seeking to explain these robust differences for the two price-distribution conditions, it is useful to revisit promotion frequency in study 5 as a potential explanatory factor. The perceived discount frequencies of the depth and frequency brands in study 5 are nearly identical across the dichotomous and nondichotomous cases. The mean number of perceived sales for the frequency brand was 18.4 for the dichotomous case and 19.7 for the nondichotomous case (actual = 24). The mean perceived frequency for the depth brand was 13.4 in both cases (actual = 12). The interaction was not significant ( $F(1, 50) < 1$ ). Thus, although the tendency to underestimate frequencies for the frequency brand persisted, there was no effect of price distribution on the promotion frequency estimates for either brand. Consistent with study 1, these findings suggest that the perceived promotion frequencies were not responsible for the reversal in brand price estimates in the dichotomous and nondichotomous conditions.

Given that perceived promotion frequency does not differ across the price-distribution conditions, the rational information integration model (Eq. 2) points to perceptions of regular price or sale price as potential causes of the reversal.

Although the cell means for perceived regular prices do vary somewhat (ranging from  $\$2.45$  to  $\$2.49$  compared to an actual of  $\$2.49$ ), they provide little insight into the differential frequency/depth effects in the two price-distribution conditions. However, the perceived sale prices are more diagnostic. Study 5 evidences substantial inaccuracy in the encoding of sale price information in the nondichotomous condition, in which the frequency effect is obtained. The frequency brand's sale price was estimated to be  $\$2.27$  (actual =  $\$2.34$ ), and the depth brand's sale price was estimated at  $\$2.23$  (actual =  $\$2.19$ ). In contrast, subjects showed more accurate perceptions of sale prices in the dichotomous condition, in which the frequency and depth brands' sale prices were estimated to be  $\$2.33$  and  $\$2.21$ , respectively. These between-group differences are supported by a significant brand-by-distribution interaction ( $F(1, 51) = 8.45, p < .01$ ).

The accurate sale price estimates provided by subjects in the dichotomous condition are likely the result of repeated exposure to a single discount level for each brand. In contrast, the less accurate estimates in the nondichotomous condition may have been driven by declining attention or interference. The former would be an understandable outcome of frustration from trying to maintain an accurate mnemonic record of such complicated information. An interference explanation is supported by prior research indicating that subjects may confuse the respective sources of two overlapping distributions (Malmi and Samson 1983). Interference suggests that subjects attributed some of the depth brand's discounts to the frequency brand and vice versa. This outcome is consistent with subjects' reported price beliefs and is also compatible with Spencer's (1961) conclusion that "increased scatter leads to greater uncertainty in judgments" (p. 326).

The between-group differences in estimated sale prices are interesting in light of the lack of difference in estimated frequency. In the case of the nondichotomous condition, the results support Alba et al. Relative sale frequency was perceived accurately, whereas differences in the depth of the sale were barely perceived. Consequently, estimated average prices of the two brands favored the frequency brand. In the case of the dichotomous condition, both relative discount frequency and absolute discount depth were encoded more accurately. Two explanations can account for why these subjects favored the depth brand. First, employing the rational model, relatively accurate estimation of depth combined with biased perception (overestimation) of absolute promotion frequency leads arithmetically to a lower average price for the depth brand. However, the preceding studies do not provide strong support for a pure arithmetic explanation. Across studies, the depth effect appears to be uninfluenced by large shifts in perceived frequency. A second possibility involves the ubiquitous anchoring-and-adjustment heuristic (Tversky and Kahneman 1973b). That is, subjects who had firm beliefs about the sale price of the brands may have anchored on this price when generating their average price. Insufficient adjustment upward from the discount prices would result in a lower perceived price for the depth brand.

<sup>10</sup>Let  $s$  index studies ( $s = 1, \dots, N$ ), then

$$z = \sum_{s=1}^N \frac{z_s}{\sqrt{N}}$$

Rosenthal (1991) argues the Z-test is the most robust pooling test under the widest range of conditions. See also Mosteller and Bush (1954).

**TABLE 2**  
SUMMARY OF RESEARCH QUESTIONS AND RESULTS

Research question	Study	Effect observed	Answer to research question
1. Does a frequency effect occur in a brands-across-time context?	Pilot study: Buying game, three brands—frequency, constant price, and depth pricing patterns	Depth effect (brand with a few very deep discounts was perceived to have a lower average price than a brand with many small discounts)	No; frequency effect is not just mitigated, it is reversed (the depth cue becomes dominant) in the brands-across-time context
2. Is the depth effect reversed by correcting biased estimates of promotion frequency (i.e., by increasing attention to the frequency brand's promotions)?	Study 1: Promotion flags versus no flags manipulated	Depth effect occurs in both flagged and unflagged conditions	No; suggests that biased estimates of promotion frequency do not fully explain the depth effect <sup>a</sup>
3. Is the depth effect reversed by reducing the extremity of the depth brand's sale price?	Study 2: Depth brand discounts reduced to 2× (from 6×)	Depth effect	No; suggests that overweighting of extreme sale prices does not explain the depth effect <sup>b</sup>
4. Is the depth effect reversed by switching from a purchase task to a perceptual task?	Study 3: Adapted brands-over-time price lists to the Alba et al. paper-and-pencil paradigm where brand prices are presented simultaneously on a single page	Depth effect	No; task motivation/attention to prices paid do not explain the depth effect <sup>c</sup>
5. Is the depth effect reversed when the price stimuli are made more complex?	Study 4: Still using the study 3 task, changed sale prices for each brand so that they varied	Frequency effect	Yes; more complex price distribution reversed the depth effect back to a frequency effect
6. Does stimulus complexity (dichotomous vs. nondichotomous prices) moderate frequency and depth effects?	Study 5: Still using the study 3 task, manipulated price distribution: dichotomous versus nondichotomous	Depth effect for dichotomous prices Frequency effect for nondichotomous prices (see also results pooled across studies)	Yes

<sup>a</sup>This conclusion is further supported in study 5 in which different price distributions produce similar promotion frequency estimates yet lead to different effects of promotion frequency and depth on average-price estimates.

<sup>b</sup>This conclusion is further supported in study 3 in which the manipulation of promotional depth again failed to eliminate the depth effect.

<sup>c</sup>This conclusion is further supported in study 5 in which a depth effect is again evidenced without a purchase task.

As is typically the case, direct process evidence for an anchoring-and-adjustment explanation is difficult to obtain. However, debriefing of a small number of subjects yielded articulations of a processing strategy that were consistent with such an explanation. Prior evidence for the use of minimum perceived levels in the estimation of averages has been reported by Spencer (1963), who found nearly half of all subjects use perceived minimum numbers in the calculation of averages.

## GENERAL DISCUSSION

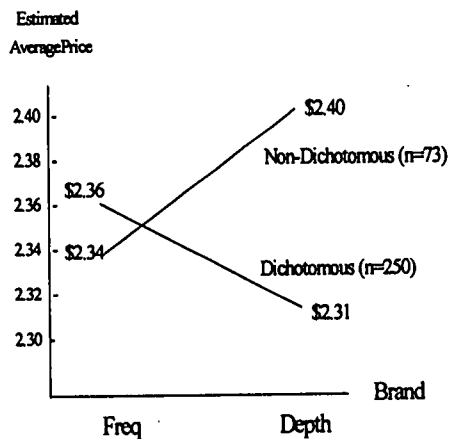
In contrast to the traditional economic view of price as a decision variable reflecting objective budgetary sacrifice, behavioral researchers have argued that consumers may interpret price information in a biased manner (Emery 1970; Monroe 1973, 1990; Monroe and Krishnan 1985). Our research is consistent with the latter view in finding that two different discounting strategies with identical average prices led to very different price estimations. After empirically examining several possible conceptual accounts of the depth effect (including underestimation of promotion frequency and memory availability), we conclude that the direction of

the differences depended on the complexity of the price distributions. Table 2 presents a summary of this experimental program and the answers to our research questions.

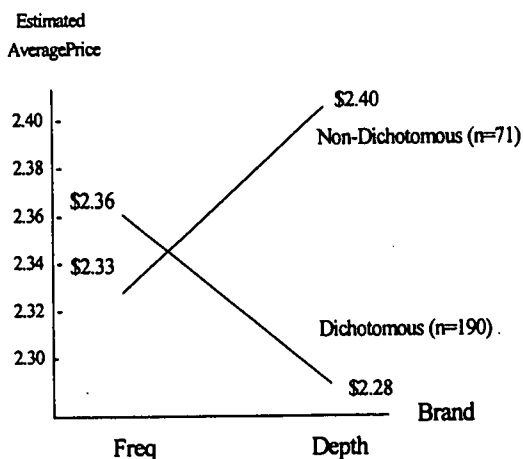
Previous research has suggested that frequent, shallow price differences lead to lower price perceptions. We conclude, however, that the findings of Alba et al. do not always generalize. When brand prices vacillate between a constant regular price and single sale price, the opposite is often true; deep, infrequent discounts lead to lower perceived prices than do shallow, infrequent discounts. This result is illustrated more powerfully by pooling across all studies. We aggregated means and sample sizes from each of our six studies (pilot through study 5) and then employed Rosenthal's (1991) Z-test to compare means. In combining results across different conditions in which the basket- and average-price measures were taken, we divided basket-measure responses by 36 to obtain equivalent units. Across all studies, 250 subjects (including modals) were presented with a dichotomous price distribution, whereas 73 subjects were exposed to a nondichotomous distribution. The average-price estimates across all subjects are plotted in Figure 1A. The results provide strong support for the brand-by-price distribution interaction hypothesis. Specifically, a significant

FIGURE 1  
POOLED AVERAGE-PRICE ESTIMATES

### A. All Subjects



### B. Nonmodals Only



NOTE.—To combine the basket and average measures, we divided the basket measure by 36 periods to obtain its equivalent average price. (This operation is independent of the pooling test.)

depth effect emerges when prices are distributed dichotomously (i.e., when each brand has a single sale price;  $Z = 4.29$ ,  $p < .01$ ), whereas a significant frequency effect occurs when the brands' prices have a nondichotomous distribution (i.e., each brand's sale prices are variable;  $Z = 2.49$ ,  $p < .01$ ). This pattern is even stronger when modals are excluded from the sample (Fig. 1B). The analysis suggests the findings are valid across studies, subjects, and measures, even accounting for measurement error introduced by subjects who misinterpreted the average-price question.

What would explain these effects? One possibility is that subjects use an anchor-and-adjust strategy when forming price judgments in the brands-over-time context (Krishna

and Johar 1996). Using this strategy, subjects would first formulate a sale-price judgment and then adjust upward from that base price toward the regular price to arrive at a judgment regarding a brand's average price. In the dichotomous condition, where deep discounts are vivid and perceived readily, estimated prices for the depth brand are lower (vis-à-vis the frequency brand) because the anchor is itself lower. In the nondichotomous condition, discounts are less vivid because the pricing distributions are more complex. Moreover, when prices are nondichotomous, interference (Malmi and Samson 1983) may blur the distinction between the frequency and depth brands' sale prices. As a result, depth is less diagnostic and frequency becomes the dominant cue. This account is consistent with other paradigms and empirical results examining retrospective judgments of events such as the frequency heuristic outlined in Alba et al., the salience of vivid or more extreme events (Frederickson and Kahneman 1993; Taylor and Thompson 1982), and the regularity and similarity of promotional events (Menon 1993).

We note that the foregoing explanation does not rule out other potential processes that may be invoked by consumers when forming price judgments, nor is it an explanation that may be invoked in all contexts. For example, the simple dichotomous distribution may enable and encourage within-brand processing, which highlights depth of discounts, while the complex nondichotomous price distribution may instead lead to a default cross-brand processing heuristic. Our intent is not to disregard other reasonable processes whereby consumers make these judgments, but rather to offer one potential explanation for our findings. Clearly, more research is needed to understand how and when consumers process price information to arrive at price judgments, how those judgments are represented in memory, and how they influence purchase decisions. For example, new methodologies that tap implicit (rather than explicit) memory have recently provided some interesting insights into consumers' memory representations of price (Monroe and Lee 1999).

### Implications

These findings hold important implications in at least two different contexts: (a) when consumers form price judgments about stores based on relative competitive prices and (b) when consumers form price judgments about brands that discount over time. Managerial action in both instances calls for choosing between shallow, frequent price advantages or deep, infrequent advantages. Given that managers inherently trade off depth and frequency, does it benefit the firm or store (image-wise) to have more, but smaller, competitive price advantages or fewer, yet bigger, advantages? The differential price beliefs engendered by adopting these alternative pricing schedules are an important factor in understanding which discount structure is optimal in which context. Stores, for example, generally wish to create a low-price image. Conversely, brands may wish to be perceived as higher priced should they desire to position them-

selves in a premium category. Interestingly, our results suggest that these disparate outcomes are each better served by a frequency strategy.

### Future Research Directions

There are a number of extensions to our work that merit consideration. Several are discussed in turn below.

*Number of Stimuli.* First, the number of brands or stores considered may impact the nature of processing. An increase in the number of interstore price comparisons suggests other simplifying strategies may be used (e.g., a minimum-price heuristic whereby consumers count the number of times the store had the lowest price in the set). One expectation is that a larger choice set may complicate processing sufficiently to increase the diagnosticity of frequency information, even when prices are distributed dichotomously. Alternatively, consistent and deep discounts may continue to stand out even when there exist more than two or three stimuli.

*Promotion Patterns.* A second fruitful area of inquiry concerns promotional pattern, particularly its degree of regularity (Krishna 1991, 1994). Specifically, Krishna's work suggests that irregular and sporadic patterns of promotions are less memorable and predictable and as a result dampen the consumer's expectation of future sales and his/her tendency to postpone current purchases in anticipation of obtaining future discounts. Accordingly, the timing of promotions relative to competitors' promotions may also have effects on consumers' brand price beliefs.

*Expectations.* Third, and relatedly, our analysis keys on retrospective evaluations of prices. How these evaluations affect expectations regarding the forthcoming distribution of prices remains an area of interest (Jacobson and Obermiller 1990; Mela, Jedidi, and Bowman 1998). For example, Emery's (1970) argument that a price reduction may actually lead to lower sales if consumers believe it is a harbinger of future, deeper reductions is provocative, suggesting that a temporal (forward-looking) component to the consumer's brand price perception may materially influence purchase behavior. This possibility may be particularly relevant for durable goods.

*Inferences.* Fourth, attitudes and inferences can be affected by the discounting strategy (Raghubir and Corfman 1995). Results using the fairness data from our early studies (unreported previously in the article) suggested that the deep, infrequent discount pattern led to lower perceived fairness because subjects believed that the brand was priced too high during nondeal periods. Research is needed that examines whether a long-term store of dissatisfaction accrues with such a pricing strategy and whether it materially influences purchase behavior. In addition, disentangling whether the effects of promotions on brand evaluations is attributable to changing price expectations or quality inferences is a priority.

*Effect Size.* Fifth, note that the depth effect appears to have gotten smaller between the initial pilot study (where it was a robust \$.15) and the later experiments (\$.03–\$.05). Because even a small bias may have a large effect on consumer price reactions, this article has focused on the conditions that encourage a depth effect. It is clear, however, that understanding and explaining the size of the effect is of future research interest.

*Theoretical Underpinnings.* Last, and perhaps most important, is the need to explore the cognitive and perceptual underpinnings of price impressions. Consideration has been given here to anchoring and adjustment, information integration, assimilation/contrast, interference, and consumer use of the frequency heuristic. Yet, we do not uncover a single explanation of the depth/frequency effects we observe. In addition, there exist other interesting frameworks or phenomena that may contribute to explaining how consumers form price perceptions (e.g., representativeness, categorization). Further, future studies can examine how and why consumer price estimates differ from those estimated from Equation 2, which provides a rational metric against which to compare observed behavior. By understanding the fundamental mechanisms underlying the formation of these perceptions, disparate findings can be better reconciled, and future, novel predictions regarding pricing perceptions can be made.

## APPENDIX

TABLE A1

DICHOTOMOUS AND NONDICHOTOMOUS PRICE LISTS

Month	Dichotomous price list (studies 2 and 5)		Nondichotomous price list (studies 4 and 5)	
	Frequency brand	Depth brand	Frequency brand	Depth brand
1	2.49	2.19	2.49	2.17
2	2.34	2.49	2.33	2.49
3	2.34	2.49	2.29	2.49
4	2.49	2.19	2.49	2.19
5	2.34	2.49	2.35	2.49
6	2.34	2.49	2.33	2.49
7	2.34	2.49	2.35	2.49
8	2.49	2.19	2.49	2.25
9	2.34	2.49	2.37	2.49
10	2.49	2.19	2.49	2.19
11	2.34	2.49	2.34	2.49
12	2.34	2.49	2.37	2.49
13	2.49	2.19	2.49	2.21
14	2.34	2.49	2.35	2.49
15	2.34	2.49	2.33	2.49
16	2.34	2.49	2.27	2.49
17	2.34	2.49	2.37	2.49
18	2.49	2.19	2.49	2.19
19	2.49	2.19	2.49	2.13
20	2.34	2.49	2.33	2.49
21	2.34	2.49	2.37	2.49
22	2.34	2.49	2.35	2.49
23	2.49	2.19	2.49	2.25
24	2.34	2.49	2.31	2.49

TABLE A1 (Continued)

Month	Dichotomous price list (studies 2 and 5)		Nondichotomous price list (studies 4 and 5)	
	Frequency brand	Depth brand	Frequency brand	Depth brand
25	2.34	2.49	2.35	2.49
26	2.34	2.49	2.29	2.49
27	2.49	2.19	2.49	2.13
28	2.34	2.49	2.34	2.49
29	2.49	2.19	2.49	2.19
30	2.34	2.49	2.31	2.49
31	2.34	2.49	2.34	2.49
32	2.34	2.49	2.35	2.49
33	2.49	2.19	2.49	2.17
34	2.34	2.49	2.33	2.49
35	2.34	2.49	2.37	2.49
36	2.49	2.19	2.49	2.14

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