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Designing Product Lists for E-commerce: The Effects of Sorting on Consumer Decision Making

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One common information display design that appears in nearly all electronic shopping sites is product lists on Web pages. Many electronic shopping sites provide sorting functions for product quality attributes. However, the extant literature has not been particularly insightful on how consumers respond to product lists sorted in different orders (i.e., ascending, descending, and random). Despite the intuitive postulation that products appearing in an early position of a list may draw more attention, it is not evident whether and how different sorting of products in a list affect consumers' purchase decisions. The purpose of this research is to investigate how product sorting influences consumers' decision making. Specifically, the focus is on the effect of sorting by product quality attributes on the importance of quality and price in consumers' product choice and on the formation of their consideration set. Results from the experiment show that, when product quality and price are positively but not perfectly correlated, individuals perceive quality to be more important and they tend to include products with higher quality in their consideration set when they are exposed to a descending list than when they are exposed to a random or ascending list. Therefore, online vendors could apply descending sorting to promote the sales of high-quality products.

1. INTRODUCTION

E-commerce is growing steadily over the years. Online vendors are embracing the advantages of dynamic interface design to keep shoppers happy and spending. One way to increase profit for electronic shopping sites is to encourage consumers to purchase high-end products in a product line because those products often have higher markups and profits (Marn & Rosiello, 1992). According to Marn and Rosiello, for an average company, improving sales volume by 1% yields a 3.3% increase in profit assuming no decrease in price. But a 1% increase in price, assuming no loss of volume, can boost profit by 11.1%. Our study, therefore,

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attempts to demonstrate that carefully designing a product list can help online vendors promote high-end products in the list, that is, those products with higher quality and price. This is possible because the information displayed in an online environment is very malleable (West et al., 1999) and consumers' purchase decisions are often constructed on-site under the influence of product information presentation (Bettman, Luce, & Payne, 1998; Bettman, Payne, & Staelin, 1986; Hong, Thong, & Tam, 2005).

This study focuses on the design of a product list, which is a common form of information display in e-commerce (Hong, Thong, & Tam, 2004; Hong et al., 2005). In a product list, a number of products are displayed sequentially in a Web page for consumers to search and choose (Diehl & Zauberman, 2005). A product list could be used to present a product catalog or the result of a keyword search (Diehl, 2005). Although some Web sites do not explicitly manipulate their product list, recognizing its practical impact on consumer decision, others list the most popular products upfront (Tam & Ho, 2005). Still others provide sorting functions by price or by product attributes such as brand, customer rating, or quality indicators.

With an aim to sell high-end products of a product line, this study is particularly interested in the effect of product sorting by quality attributes on consumers' purchase decision. In this study, we investigate the effects of a special type of product quality sorting—*hierarchical quality sorting*, in which products are first sorted by the attribute that is most important to consumers. For products that assume the same value for the most important attribute, they are then sorted by the second most important attribute in a nested fashion, and this process repeats. Quality attributes refer to the product attributes that indicate the configuration of the product. For example, in a digital camera purchase, the value of megapixels is often the most important criterion, followed by optical zoom, LCD screen resolution, and so on. In this case, a hierarchical quality sorting of digital cameras is to sort all the models by megapixel first; for the models with the same megapixels, they are then sorted by optical zoom, LCD screen resolution, and so on. In this study, *quality* refers to the objective overall configuration of a product. We define the *average perceived quality* of a product as the average of subjective quality perceptions by a panel of judges based on the overall configuration of a product. Average perceived quality summarizes the multiple quality attributes of a product into an overall perception. The advantage of hierarchical quality sorting is that it makes product comparison much easier for consumers, but it does not necessarily sort products by average perceived quality. For example, in descending hierarchical quality sorting, a digital camera with high megapixels and low optical zoom could be displayed before a camera with slightly lower megapixels but much higher optical zoom, even though the latter might have a higher average perceived quality. Hierarchical quality sorting (hereafter *quality sorting* for simplicity) could easily be realized online but, to our knowledge, has not been adopted.

Our focus is not on the design of this sorting tool. Instead, we are interested in how consumers respond to a product list sorted by quality. The intuition is that different quality sorting (i.e., in a descending, ascending, or random order) would affect the importance consumers attach to product quality and price in a purchase decision, which in turn affects consumers' product choice. In short, our research question is, How does quality sorting affect consumers' perceptions of quality importance and price importance in product choice and the formation of consumers' consideration set? Consideration set refers to those products that consumers seriously consider and regard as interchangeable when making a purchase decision (Hauser & Wernerfelt, 1990). We term the effect of hierarchical quality sorting as a *sorting effect*. Sorting effect should be differentiated from order effect. The latter refers to the impact of position that a product assumes in a list on consumers' evaluation of the product (Hogarth & Einhorn, 1992), whereas sorting effect investigates the impact of the sorting method of a list (i.e., ascending, descending, or random) on consumers.

The extant literature on product display has largely focused on how to increase consumer welfare such as decision quality and effort (Diehl & Zauberman, 2005; Haubl & Murray, 2003; Hong et al., 2004). In contrast, we approach this issue by focusing on how to design a product list to influence consumers' behavior, which in turn affects vendor's sales. An understanding of sorting effect helps marketers to strategically construct product lists that lead to better business performance. In the following sections, we first review the literature on product sorting and catalog design. We identify that the principle of concreteness and loss aversion are particularly useful to explain sorting effect. Hypotheses are proposed based on the two theories. We then report on an empirical study and findings. We conclude with discussion of findings and implications.

2. THEORETICAL BACKGROUND AND RESEARCH HYPOTHESES

2.1. Product List Display and Consumer Decision Making

In both marketing and information systems literature there are two streams of studies related to product list design. The first stream of studies has investigated the effect of product price sorting on consumers' purchase decision. Quality information was not available to consumers (e.g., Garbarino & Slonim, 1995; Kosenko, 1989). For example, Garbarino and Slonim reported that participants exposed to descending prices purchased more pens than participants exposed to ascending prices and were more likely to consider their final purchase as of good value. Bennett, Brennan, and Kearns (2003) employed two types of products: fast-moving consumer goods and household appliances. Their study tested the effects of price sorting and other variables on the average price respondents were willing to pay. Price sorting was found significant for fast-moving consumer goods but not for household appliances. There was a lack of theoretical explanation for the mixed result.

Going beyond price information and price sorting alone, Diehl, Kornish, and Lynch (2003) investigated the effects of quality sorting on consumers' evaluations of electronic birthday cards. They suggested that consumers' price sensitivity will increase when products are sorted by quality because products close to each other are more substitutable in terms of quality. Consequently, consumers would find a lower price in a sorted list than in a random one.

The second stream of studies does not investigate sorting but focuses on consumers' quality or price sensitivity as a function of Web site design. One of the earliest and influential studies is consumers' choice of supermarket products. Russo (1977) showed that when product price information was easier to process, sales could increase by 11%. Creyer and Ross (1997) examined how the availability of information about the value of a product, expressed as a ratio of quality per dollar, influences preference formation. Their results indicated that the presence of the quality–price ratio increases the likelihood of consumers choosing a product with a lower price and higher value compared to consumers presented with separate price and quality information. However, in their purchase simulation, the quality rating of products was assigned by researchers rather than perceived by consumers. In the e-commerce literature, Alba et al. (1997) suggested that online retailing reduces the information search costs for price. Hence consumers will become more price sensitive. Lynch and Ariely (2000) showed when an online retailer makes quality information easier to search and compare, consumers became less price sensitive. Haubl and Murray (2003) found that when a product attribute is included in a product comparison matrix produced by recommendation agents, this attribute becomes more processable, hence more prominent in consumers' purchase decision. Diehl (2005) proposed that, although a sorted product list lowers the search cost for consumers, searching too much in a sorted list could degrade choice quality.

In short, the extant literature has found that price sorting affects consumers' purchase decision and that the ease of processing quality information tends to boost the weight of quality in consumer decision making. However, very few studies have investigated quality sorting.

The effect of different quality sorting methods on consumers' decision making is expected to be a two-step process. First, we believe that quality sorting affects consumers' quality importance and price importance in product choice. Second, consumers' perception of quality importance and price importance affects the average quality and price of products in their consideration set.

Consumers are guided by their perceptions of the importance of various product attributes in information seeking, product evaluation, and purchases (Goldstein, 1990; Mackenzie, 1986). Attribute importance could influence consumers' product selection and evaluation process regardless of whether a compensatory (e.g., weighted sum of attribute utility) or a noncompensatory (e.g., lexicographic or elimination-by-aspects with products evaluated by attributes in descending importance) strategy is used in decision making (Heath & Ryu, 2000; Sanbonmatsu, Kardes, Houghton, Ho, & Posavac, 2003). Quality and price are the most important yet competing product attributes. When there are multiple quality attributes, consumers often have to consolidate them into one "meta-attribute" and then make a trade-off between quality and price (Kivetz, Netzer, & Srinivasan, 2004). This trade-off is determined by the subjective weights consumers assign to product quality and price. In this study, *quality importance* (QI) refers to a consumer's perception of the importance of product quality in the consumer's purchase decisions (cf. Kalra & Goodstein, 1998). Similarly, we define *price importance* (PI) using a similar conceptual base as sensitivity to price. Given product and price importance, the notion of *relative importance of quality over price* (RIQP) can be defined as the perceived relative importance of quality as compared to the importance of price. Relative importance of quality over price represents a consolidated measure to capture consumers' trade-off in purchase decision.

We chose consideration set composition as the ultimate dependent variable because consumers often adopt a hierarchical choice process to simplify complicated choice problems. They filter out unwanted products first to form a consideration set that contains substitutable products, among which they make a final choice (Alba et al., 1997; Bettman, 1979; Nedungadi, 1990). Empirical studies suggested that consideration sets play an important role in quantitative models to predict consumer choice (Hauser & Wernerfelt, 1990; Simonson, Nowlis, & Lemon, 1993).

With these concepts laid out, we resort to the principle of concreteness and loss aversion in consumer behavior to explain the effect of quality sorting on consumers' decision making.

2.2. Sorting Effect: The Principle of Concreteness

The first mechanism in a sorted product list is the principle of concreteness (Slovic, 1972). An important concept in the principle of concreteness is processability, which refers to the ease with which information can be interpreted and used (Bettman et al., 1986). Based on the constructive preference perspective of decision making, consumers tend to construct quality and price importance as well as their preferences on the spot when product information is prompted (Bettman et al., 1998). Based on the principle of concreteness, decision makers tend to (a) use only the information that is explicitly displayed in a stimulus environment and (b) process information in the particular form in which it is presented. Decision makers are often unwilling to spend more cognitive power to reorganize information or search for more. When there are multiple information items, the one that is more processable is often picked up (Creyer & Ross, 1997).

Compared to an unsorted (i.e., randomly ordered) list, when products are sorted by quality, quality information should be relatively more processable because quality attributes can be easily compared. Based on the principle of concreteness, the enhanced processability of product quality information will, in turn, increase its importance in purchase decisions. In other words, the processability of quality attributes makes quality more salient as a criterion in selecting alternatives (Areni, 1999). Therefore, we conjecture that when products are sorted by product quality, either in ascending or in descending order, consumers will attach higher importance to product quality than when products are in a random order. We hypothesize the following:

- H1a: The quality importance is higher in consumers' purchase decision when a product list is sorted in a descending order of quality than when it is in a random order (i.e., $QI_D > QI_R$, where the subscript indicates the hierarchical quality sorting method of descending, ascending, or random).
- H1b: The quality importance is higher in consumers' purchase decision when a product list is sorted in an ascending order of quality than when it is in a random order (i.e., $QI_A > QI_R$).

Next, we consider the influence of sorting on price importance. Typically, in the real marketplace, product price often positively correlates with product quality. In such a case, a sorted list based on product quality is also a partially sorted list by product price. Again, based on the principle of concreteness, the price importance should increase in a sorted list compared with a random list, given that quality and prices are positively correlated. However, the degree of the increase in price importance might depend on the correlation between quality and price. We hypothesize the following:

H2a: The price importance is higher in consumers' purchase decision when a product list is sorted in a descending order of quality than when it is in a random order (i.e., $PI_D > PI_R$).

H2b: The price importance is higher in consumers' purchase decision when a product list is sorted in an ascending order of quality than when it is in a random order (i.e., $PI_A > PI_R$).

2.3. Sorting Effect: Loss Aversion

The second mechanism is loss aversion. Considerable work in behavioral decision making has suggested that decisions depend on the frame of reference from which a choice is made (Kahneman & Tversky, 1979; Tversky & Kahneman, 1991). A well-accepted concept is the notion of loss aversion in the prospect theory (Kahneman & Tversky, 1979). As Kahneman, Knetsch, and Thaler (1991, p. 199) stated, "Changes that make things worse (losses) loom larger than improvements or gains. The choice data imply an abrupt change of the slope of the value function at the origin".

Applying the notion of loss aversion to consumer choice in a product list, consumers usually conduct pairwise comparisons among options in a sequential order (Hogarth & Einhorn, 1992). Several studies have shown that the current option serves as a subject of comparison and the earlier observed options serve as references (Houston & Sherman, 1995; Mantel & Kardes, 1999). In particular, when consumers are exposed to a descending list, products with higher quality and higher price are more likely to serve as references because they appear early in the product list. This phenomenon was also discussed in Heath and Ryu's (2000) study on asymmetries in price and quality competition. Heath and Ryu suggested that consumers anchor on the brand they choose initially, and the subsequent brand's relative strengths and weaknesses can then be translated into gains and losses, respectively.

Extending their findings from two-brand choice situations, we conjecture that this loss aversion mechanism could be applied in consumers' choice among a list of products. In the descending list, the declining product quality is likely to produce a series of stimuli of *quality loss* (decreasing quality) and *price gain* (economic gain, which is equivalent to a cut of price) when price and quality are positively correlated (Cha & Aggarwal, 2003). Conversely, in an ascending list, products with lower quality and lower price serve as references. Consumers experience series of quality gain and price loss. Based on the concept of loss aversion, the psychological impact of quality loss in a descending list looms larger than the quality gain in an ascending list. In a similar vein, the psychological impact of economic loss in an ascending list looms larger than economic gain in a descending list. We hypothesize the following:

H1c: The quality importance is higher in consumers' purchase decision when a product list is sorted in a descending order of quality than when it is in an ascending order (i.e., $QI_D > QI_A$).

H2c: The price importance is lower in consumers' purchase decision when a product list is sorted in a descending order of quality than when it is in an ascending order (i.e., $PI_D < PI_A$).

When consumers' perception of quality importance is affected by different order of sorting, if the importance of price were to remain stable, the RIQP would be very easy to predict. However, this is only possible when product quality and price are independent or close to independent. In reality, product quality and price are often positively correlated (Cha & Aggarwal, 2003). How would the relative importance of product quality over price change in this situation? The following equations could provide a reasoning process to answer how RIQP changes.

$$\text{Based on loss aversion of product quality: } QI_D > QI_A \tag{1}$$

$$\text{Based on loss aversion of product price: } PI_A > PI_D \tag{2}$$

$$\text{Define RIQP in a descending list as: } RIQP_D = QI_D / PI_D \tag{3}$$

$$\text{Define RIQP in an ascending list as: } RIQP_A = QI_A / PI_A \tag{4}$$

$$\begin{aligned}\text{Compare } RIQP_D \text{ with } RIQP_A: (3)/(4) &= (QI_D / PI_D) / (QI_A / PI_A) \\ &= (QI_D / QI_A) \quad (PI_A / PI_D) > 1\end{aligned} \tag{5}$$

In other words, according to the concept of loss aversion, although the quality importance in a descending list is higher than the quality importance in an ascending list, the price importance works in a reverse way (Equations 1 and 2). Consequently, comparing the RIQP in a descending list with the RIQP in an ascending list, RIQP would be higher in a descending list than in an ascending list (Equation 5). We hypothesize the following:

H3a: The relative importance of quality over price is higher in consumers' purchase decision when a product list is sorted in a descending order of quality than when it is in an ascending order (i.e., $RIQP_D > RIQP_A$).

Further, based on the principle of concreteness, the price importance should increase in a sorted list compared with a random list, given that quality and prices are positively correlated. However, the degree of the increase in price importance might depend on the correlation between quality and price. In other words, as far as quality and price are not perfectly correlated (i.e., the Spearman Rank Correlation Coefficient is smaller than 1), the concreteness effect might be stronger for quality than for price because the list of products is completely sorted in quality but only partially sorted in price. Hence, we hypothesize the following:

H3b: The relative importance of quality over price is higher in consumers' purchase decision when a product list is sorted in a descending order of quality than when it is in a random order (i.e., $RIQP_D > RIQP_R$).

H3c: The relative importance of quality over price is higher in consumers' purchase decision when a product list is sorted in an ascending order of quality than when it is in a random order (i.e., $RIQP_A > RIQP_R$).

We expect the influence of product sorting methods on the relative importance of product quality over price will be reflected in consumers' choices. We conjecture that consumers will prefer high-quality, high-price products when they are presented with a sorted list than when they are presented with a random list. The net result is that the average quality and price of the consideration set will be greater with a sorted list than with a random list. Because the average perceived quality summarizes product configurations, we hypothesize the following:

H4a: When products are sorted by quality in a descending order, the average perceived quality and price in consumers' consideration set will be higher than when products are in a random order.

In addition, comparing an ascending list with a random list, the relative importance of product quality over price will also be reflected in consumers' choices. That is, the higher relative importance of product quality over price leads to the inclusion of high-quality, high-price products in the consideration set. We propose the following:

H4b: When products are sorted by quality in an ascending order, the average perceived quality and price of products in consumers' consideration set will be higher than when products are in a random order.

In the same vein, when comparing a descending list and an ascending list, we hypothesize the following:

H4c: When products are sorted by quality in a descending order, the average perceived quality and price of products in consumers' consideration set will be higher than when products are sorted by quality in an ascending order.

3. RESEARCH METHODOLOGY

A laboratory experiment was used to test our hypotheses. The empirical design of this study comprised two phases: a pretest and a main experiment. The pretest served two purposes: to identify the most important quality attributes for hierarchical quality sorting and to obtain the average perceived quality for each product from independent judges.

In the main experiment, a laboratory experiment was employed to test the effects of quality sorting on consumers' perception of quality importance, price importance, and consideration set characteristics. To enhance the realism and generalizability of findings, we selected digital cameras as our product for three reasons: (a) Digital cameras are popular in online shopping, (b) student participants were relatively familiar with digital cameras, and (c) digital cameras were suitable in multiattribute decision making tasks and had been used extensively in previous experiments (e.g., Chernev, 2004; Kardes, Cronley, Kellaris, & Posavac, 2004) and e-commerce studies (Wang & Benbasat, 2007).

3.1. Pretest

To prepare the product information, nine digital cameras of the same brand were gathered from http://www.ecost.com. We also collected nine product attributes that can be measured in numerical values. Detailed definitions and explanations of these attributes were obtained from manufacturers' Web sites as well as http://www.bizrate.com. Product price was converted to the local currency based on the current exchange rate. We carefully examined the product quality and price information to ensure that there was no objectively dominating product or dominated product in the product list.

Thirty undergraduate students were recruited from a major university in Singapore for the pretest. Product information and attribute definitions were listed in a questionnaire. Participants worked as independent judges to rate the importance of each attribute in an 11-point Likert scale. Their ratings were then averaged for each attribute. Then, they were asked to rate the nine digital camera models in terms of their quality on a 100-point scale. They were told that quality refers to the technical configuration and specification of a product's nonprice attributes. The order of digital cameras was counterbalanced. Participants' ratings were averaged to form the average perceived product quality.

The averages of participants' rating of quality attribute importance showed that megapixels, optical zoom, LCD screen resolution, and digital zoom were the four most important attributes. These attributes were later used in hierarchical sorting such that products were first sorted by megapixels, then by optical zoom, and so on. The rank correlation coefficient between product quality and price in a sorted list was .92, indicating a very high correlation.

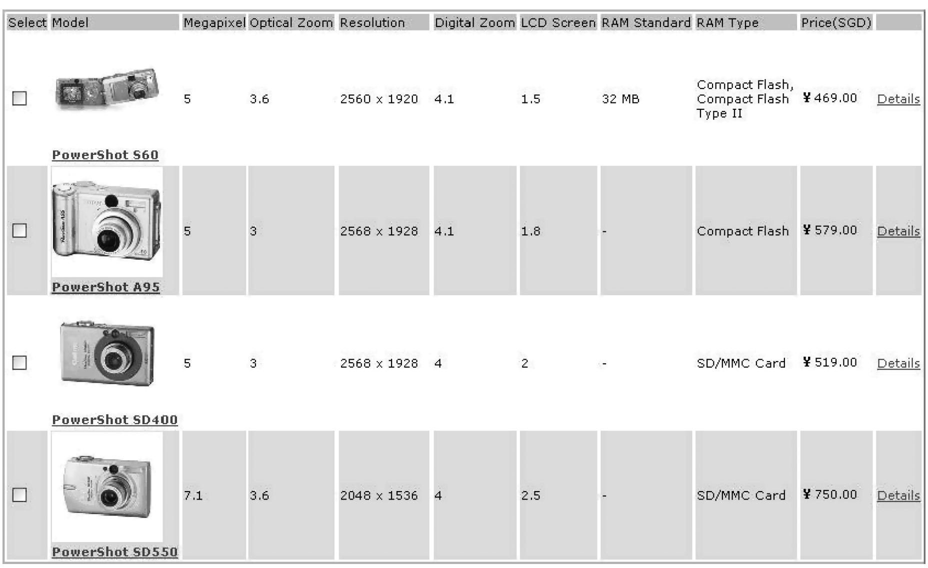
Regarding participants' perceived product quality, the Cronbach's alpha of their ratings was .93, implying a high level of agreement across judges. Therefore, these ratings could be averaged to form the perceived quality of products.

3.2. Main Experiment

Participants and incentives. Sixty-two student participants were recruited from the same university. The experiment was a one-way factorial design with product quality sorting being manipulated as three sorting methods (i.e., ascending, descending, and random). Participants were randomly assigned to one of three treatment conditions. Fifty-eight valid responses were returned. There were 19 participants in the ascending treatment, 20 in the descending treatment, and 19 in the random treatment. The participants were paid a nominal reward for their participation. To motivate them to take the experiment seriously (e.g., Wang & Benbasat, 2007), we asked them to justify their choices, and we provided extra incentives for those who justified their choice well.

The experimental Web site. A retailing Web site was designed for this experiment to simulate the online shopping process. Nine digital cameras were displayed on the Web site. They were organized in a list form, with each row corresponding to a product and each column to an attribute in which the option is described (Kleinmuntz & Schkade, 1993). Product images, product quality attributes, and price information were presented to participants when they logged onto the Web site (see Figure 1). A separate product information page containing all attribute information was displayed when the participants clicked on the product name.

Variables and manipulation. The independent variable is the sorting method that was manipulated by presenting subjects with a list of nine digital



Select	Model	Megapixel	Optical Zoom	Resolution	Digital Zoom	LCD Screen	RAM Standard	RAM Type	Price(SGD)	
☐	PowerShot S60	5	3.6	2560 x 1920	4.1	1.5	32 MB	Compact Flash, Compact Flash Type II	¥469.00	Details
☐	PowerShot A95	5	3	2568 x 1928	4.1	1.8	-	Compact Flash	¥579.00	Details
☐	PowerShot SD400	5	3	2568 x 1928	4	2	-	SD/MMC Card	¥519.00	Details
☐	PowerShot SD550	7.1	3.6	2048 x 1536	4	2.5	-	SD/MMC Card	¥750.00	Details

FIGURE 1 Screen captures of a portion of the product list page.

cameras in a descending or ascending order using hierarchical quality sorting, or in a random order.

Our dependent variables are quality importance, price importance, relative importance of quality over price, the average perceived quality of consideration set, and the average price of consideration set. We used subjective rating to measure the quality importance and price importance because it has been used extensively in the literature as a measure of attribute importance (e.g., Goldstein, 1990; Goldstein & Mitzel, 1992; Mackenzie, 1986). Particularly, we asked respondents, "Please indicate the degree to which product quality (or product price) is important to you by rating them with a 1–100 scale, where 1 indicates 'not important at all' and 100 indicates 'very important' (see the appendix)." The relative importance of product quality over price could be calculated from the quality and price importance measures. However, we were also concerned about the limitation of derived relative measure because it could amplify measurement error. The literature suggests that consumers often make trade-offs between product quality and price when they form product preferences (Chernev, 2004; Creyer & Ross, 1997). Therefore, it is reasonable to directly measure relative importance with an item. Following Goldstein (1990) and Goldstein and Mitzel (1992), we asked participants, "Please indicate the relative importance of product quality over price if you were to buy a digital camera" with 1 indicating that price is much more important than quality and 11 indicating the reverse. As to the characteristics of the consideration set, we averaged the average perceived quality and price of digital cameras in a participant's consideration set.

Procedure. Participants were invited to a research lab. They were first asked to complete a questionnaire measuring their knowledge of digital cameras, Internet shopping experience, and demographics. They were briefed of the general background of the study (without revealing the research model), the incentives, the shopping task, and key definitions such as quality and price. Then they were asked to browse through the given Web site to evaluate and choose a few products that they were most likely to purchase. They were randomly assigned to a treatment when they visited the Web site.

After they picked their favorite products, they were asked to note them down with their justifications. Then they were asked to answer a set of questions including manipulation check (i.e., their awareness of product sorting), product quality importance, price importance, and the relative importance of quality over price. Manipulation checks were taken before the measurement of dependent variables to prevent bias from the dependent measures (Perdue & Summers, 1986).

4. DATA ANALYSIS

4.1. Demographics

Among the 58 participants who returned valid responses, 35 (60.3%) were male and 23(39.7%) were female. The average age of the participants was 21.22 (*SD* = 1.85). On average, they had 6.55 years (*SD* = 2.42) of Internet experience. Twenty-one (36.2%) participants had no online purchasing experiences in the past year, and 37 (43.8%) had more than one. Ten (17.27%) participants use the Internet for product information less than once per month, and the rest (82.73%) searched for product information online more than once per month. Thirty-five (60.3%) participants already had a digital camera, and 23 (39.7%) did not.

4.2. Manipulation Checks

The manipulation of product sorting was checked with a 5-point scale to assess the degree to which participants noticed the sorting method they were exposed to. Participants were asked, "Based on the product quality, what is the general sorting pattern of the product list you've seen? (1–ascending, 2–partial ascending, 3–random, 4–partial descending, and 5–descending)" The means of participants' evaluations in the three conditions were consistent with expectations: The mean was 1.58 (SD = 0.51) for the ascending group, 3.90 (SD = 0.91) for the descending group, and 3.00 (SD = 0.47) for the random group. A statistical analysis of the results using an analysis of variance (ANOVA) indicated that the three groups were significantly different (F = 59.85, p = 0.00, MSE = 26.59). A Tukey's post hoc comparison confirmed significant differences between the three groups (Table 1). Therefore, the manipulation was successful.

We performed statistical tests on gender, Internet experience, use of Internet for product search, digital camera usage, subjective product knowledge on digital cameras, possession of a digital camera, and future purchase plan of a digital camera to check the results of random assignment. Product knowledge items were adapted from Smith and Park (1992)'s study ("I feel very knowledgeable about digital cameras"; "I feel very confident about my ability to tell the difference in quality among different brands of digital cameras"; "If I were to purchase a digital camera today, I would need to gather very little information in order to make a wise decision") and measured with 7-point Likert scales. A multivariate analysis of variance (MANOVA) procedure was used to test product knowledge difference among treatments. No significant difference was found. Chi-square tests for gender and possession of a digital camera across three treatments also confirmed the random assignment check. There is no significant difference in terms of gender (χ^2 = 0.57, p = .97), or possession of a digital camera (χ^2 = 1.09, p = .58). Further, ANOVA tests were conducted for other variables. No significant difference was found. Therefore, the randomization was considered adequate. Table 2 presents the means and standard deviations of the dependent variables. Illustrations of the mean levels of QI, PI, and RIQP across the three treatments are presented in Figures 2 and 3.

Table 1: Manipulation Check Based on the Mean Difference Among Groups

Group	*Descending*	*Random*	*Ascending*
Descending	—	0.90*	2.32*
Random		—	1.42*
Ascending			—

*p < .01.

Table 2: Mean and Standard Deviation of QI, PI, and RIQP

Dependent Variables	*Ascending M (SD)*	*Descending M (SD)*	*Random M (SD)*
QI	72.63 (15.31)	82.00 (11.05)	64.47 (14.99)
PI	79.21 (13.67)	66.00 (10.95)	68.68 (13.52)
RIPQ			
Calculated	0.97 (0.37)	1.28 (0.28)	0.97 (0.27)
Direct measure	5.63 (0.35)	7.20 (0.34)	5.47 (0.35)
Average perceived quality	73.78 (5.67)	79.45 (4.63)	74.19 (4.57)
Average price	666.81 (163.95)	800.58 (141.97)	672.08 (128.24)

Note. QI = quality importance; PI = price importance; RIQP = relative importance of quality over price.

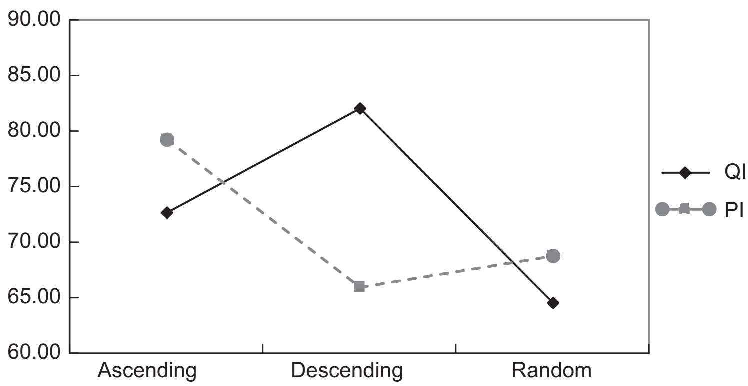
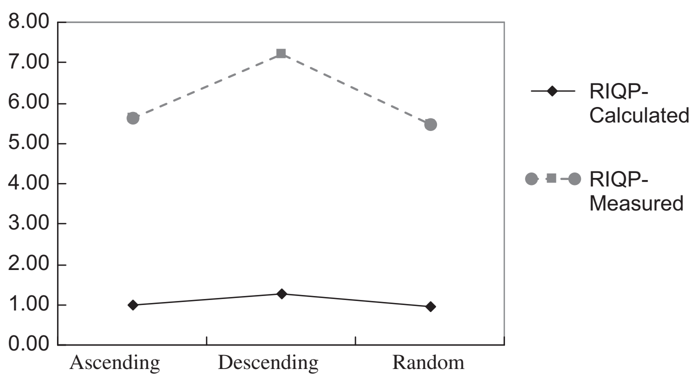


FIGURE 2 Illustration of means of quality importance (QI) and price importance (PI) in three groups.



RIQP-Calculated: Quality Importance / Price Importance

FIGURE 3 Illustration of means of relative importance of quality over price (RIQP) in three groups.

4.3. Hypotheses Testing

Table 3 presents the hypotheses testing results. Because we have multiple dependent variables which were conceptually related, a MANOVA was first conducted to check the general significance of quality sorting to dependent variables. The four indices all showed an overall significant impact of sorting method (Pillai's Trace: $F = 4.40$, $p = .00$; Wilks' Lambda: $F = 4.34$, $p = .00$; Hotelling's Trace: $F = 4.28$, $p = .00$; Roy's Largest Root: $F = 5.36$, $p = .00$). Tests of between-subject effects showed a significant influence of sorting method on all dependent variables (QI: $F = 7.80$, $p < .01$; PI: $F = 5.79$, $p < .01$; RIQP (measured): $F = 7.79$, $p < .01$; RIQP (calculated): $F = 6.63$, $p < .01$; Average perceived quality of consideration set: $F = 7.94$, $p < .01$; Average price of consideration set: $F = 5.34$, $p < .01$).

Hypotheses testing were conducted in three steps. First, for each of the dependent variables, an ANOVA was conducted to show the existence of an overall effect of three treatments. Second, we employed ANOVAs to compare treatments stated in each hypothesis (Table 3). Finally, a series of Tukey's post hoc tests were conducted (Table 3). Because there were pairwise comparisons among all three treatments, we used Tukey's post hoc test as the final indicator of the

Table 3: Summary of Hypotheses Testing on QI, PI, and RIQP

			ANOVA Results				*Tukey's Post Hoc Test Results*		
Hypotheses	*Dependent Variable*	*Contrast*	*F*	*Sig.*	*Power*	*Effect Size*	*M Difference*	*Sig.*	*Overall Result*
	QI	Overall	7.80	.01	—				
H1a		D vs. R	30.56	.00	0.98	0.45	17.53	.00	Supported
H1b		A vs. R	2.75	.11	0.37	0.07	8.16	.18	Rejected
H1c		D vs. A	4.84	.03	0.57	0.12	9.37	.10	Rejected
—	PI	Overall	5.79	.01		—			—
H2a		D vs. R	0.15	.70	0.07	0.00	–2.68	.79	Rejected
H2b		A vs. R	5.69	.02	0.64	0.14	10.53	.04	Supported
H2c		D vs. A	11.15	.00	0.90	0.23	–13.21	.01	Supported
	RIQP- Calculated	Overall	8.62	.01	—				
	RIQP- Measured	Overall	7.95	.01	—				
H3a	RIQP- Calculated	D vs. A	8.62	.01	0.82	0.19	0.31	.01	Supported
	RIQP- Measured		7.95	.01	0.78	0.18	1.57	.01	Supported
H3b	RIQP- Calculated	D vs. R	12.80	.00	0.94	0.26	0.31	.01	Supported
	RIQP- Measured		14.94	.00	0.96	0.29	1.73	.00	Supported
H3c	RIQP- Calculated	A vs. R	0.00	.96	0.05	0.00	0.01	1.00	Rejected
	RIQP- Measured		0.12	.73	0.06	0.00	0.16	.95	Rejected
	Average Q	Overall	7.94	.01	—				
	Average P	Overall	5.34	.01	—				
H4a	Average Q	D vs. R	12.73	.00	0.94	0.26	0.53	.01	Supported
	Average P		8.77	.01	0.82	0.19	128.50	.02	Supported
H4b	Average Q	A vs. R	0.06	.81	0.06	0.00	–0.41	.97	Rejected
	Average P		0.01	.91	0.05	0.00	–5.27	.99	Rejected
H4c	Average Q	D vs. A	11.76	.00	0.92	0.24	5.67	.00	Supported
	Average P		7.44	.01	0.78	0.17	133.77	.02	Supported

significance of the hypotheses to avoid the inflation of Type I error with ANOVA where the contrasts were not orthogonal (Tukey, 1953).

Sorting effects on QI, PI, and RIQP. First, for quality importance, ANOVA results showed that sorting method collectively had a significant effect on consumers' perceptions, $F(2, 55) = 7.80$, $p < .01$. Pairwise comparisons among the three treatments showed that quality importance was significantly higher in the descending treatment than in the random list ($F = 30.56$, $p < .01$). Tukey's post hoc test indicated the same result, hence Hypothesis 1a was supported. However, between the ascending list and random list, there was no significant difference in quality importance as indicted by both ANOVA ($F = 2.75$, $p = .11$) and Tukey's post hoc test, rejecting Hypothesis 1b. For Hypothesis 1c, although the ANOVA indicated that quality importance was significantly higher in the descending list than in the ascending list ($F = 4.84$, $p = .03$), Tukey's post hoc test did not support it. Therefore, Hypothesis 1c was not supported.

Second, for price importance, ANOVA results showed that sorting methods collectively had a significant effect on price importance ($F = 5.79$, $p < .01$). Pairwise comparison indicated that the mean of price importance was not significantly higher in the random list than in the descending list ($F = 0.15$, $p = .70$). Tukey's post hoc test showed the same result, rejecting Hypothesis 2a. For Hypothesis 2b and 2c, price importance in the ascending treatment was significantly higher than in the random treatment ($F = 5.69$, $p = .02$) and in the descending treatment ($F = 11.15$, $p < .01$). Consistent results were found in Tukey's post hoc test, supporting Hypothesis 2b and 2c.

Third, we investigated the impact of product sorting on the relative importance of quality over price. The effects of sorting method on the two different measures of RIQP were fairly consistent. The ANOVA indicated that both the calculated RIQP ($F = 8.62$, $p < .01$) and directly measured RIQP ($F = 7.95$, $p < .01$) were higher in the descending treatment than in the ascending treatment, and the same result was observed with Tukey's post hoc test, supporting Hypothesis 3a. Moreover, the directly measured RIQP ($F = 14.94$, $p < .01$) and the calculated RIQP ($F = 12.80$, $p < .01$) were significantly higher in the descending treatment than in random treatment. Tukey's post hoc test showed the same result, hence Hypothesis 3b was supported. However, there was no significant difference in RIQP between the ascending treatment and the random treatment with both calculated RIQP ($F < 0.01$, $p = .96$) and directly measured RIQP ($F = 0.12$, $p = .73$) in ANOVA and Tukey's post hoc test, rejecting Hypothesis H3c.

Sorting effects on consideration set formation. Hypotheses about the sorting effect on consideration set were tested with the average perceived quality and average price of all products in a participant's consideration set as dependent variables.

ANOVA results showed that sorting methods collectively had significant effects on average perceived quality ($F = 7.94$, $p < .01$) and average price ($F = 5.34$, $p < .01$). ANOVA results indicate that the average perceived quality and price of products in the consideration set were significantly higher in the descending treatment than in the random treatment (average perceived quality: $F = 12.73$, $p < .01$; price: $F = 8.77$, $p < .01$) and ascending (average perceived quality: $F = 11.76$, $p < .01$; price: $F = 7.44$, $p = .01$). Together with the consistent Tukey's post hoc testing result, Hypothesis 4a and 4c were supported. However, there was no significant difference in average perceived quality and price between the ascending and the random treatment in either ANOVA or Tukey's post hoc test, rejecting Hypothesis 4b.

We also checked the statistical power (Cohen, 1988) of supported hypotheses. Because there was no prior study comparing such effects, the post hoc power and the actual effect sizes were obtained from the experiment. Judging from the effect size, most hypotheses with medium to large effect size were supported, except for H1c. Although Hypothesis 2b had relatively low power (0.64), it was supported. Hypothesis 1c, which compared quality importance between the descending list and the ascending list had low power (0.57) and was not supported in Tukey's post hoc test, although the effect size is medium (0.12). Therefore, the insignificance of Hypothesis 1c in Tukey's post hoc test could plausibly be due to low statistical power. Overall, the result indicated that the statistical power was generally adequate, but a larger sample size is needed in future studies.

5. DISCUSSIONS AND IMPLICATIONS

This study focuses on the effect of a special aspect of Web site design—hierarchical quality sorting on consumers' decision making in an online product list. In particular, we are interested in the impact of sorting on consumers' perceptions of quality importance, price importance, and relative importance of quality over price, as well as the impact of sorting on the average perceived quality and price of consideration sets.

Our empirical test indicates that consumers' quality importance was higher in a descending list than in a random list (H1a). However, the difference between an ascending list and a random list was not significant (H1b) and the difference between a descending list and an ascending list (H1c) was not conclusive because of low statistical power. Regarding consumers' price importance, we found it was higher in an ascending list than in a random list or in a descending list (H2b, H2c). However, the difference between the descending treatment and random treatment was not significant (H2a). In consistence with these findings, the relative importance of quality over price showed significant difference between a descending list and a random list or an ascending list (H3a, H3b), but the difference between an ascending list and a random list was not significant (H2c). The effects of sorting on the relative importance of quality over price were also reflected in consumers' consideration set formation, such that the average perceived quality and average price were significantly higher in a descending list than in a random list or an ascending list (H4a, H4b), but no significant difference was found between an ascending list and a random list (H4c).

In sum, if we take the random sorting as a benchmark, the result indicates that a descending quality sorting leads to a significant increase in quality importance but not in price importance. Conversely, an ascending quality sorting leads to a significant increase in price importance but not in quality importance. The message is very clear: If vendors are to sell high-end items, descending quality sorting is the best choice for their product list. Either random or ascending quality sorting will not serve the purpose. This conclusion is also confirmed by the significantly higher relative importance of quality over price in the descending list than in other lists. However, some of our hypotheses for relative importance of quality over price were not supported. The result showed that there was no significant difference in quality importance between an ascending list and a random list (H1b), and there was no significant different in price importance between a descending list and a random list (H2a). Consequently, there was no significant difference between the relative importance of quality over price between an ascending list and a random list (H3c), which in turn led to insignificance of differences in the average perceived quality and price (H4b). A plausible explanation is that in an ascending list, quality information still attracts a lot of attention because of its concreteness, which offsets the attention grasped by price loss.

5.1. Theoretical Implications

This study offers a number of important theoretical implications. First, it extends the current literature on product sorting by investigating sorting effects on quality and price simultaneously. Although the studies by Diehl and colleagues (Diehl, 2005; Diehl et al., 2003) did study the issue of quality sorting, they used e-cards as products. Consumers' quality perception of such products might be more variable as personal taste differs. Such personal variations in taste could easily nullify the supposed quality difference of two adjacent products in a sorted list. Consequently, the quality sorting effect was reduced and gave way to a substitutability effect (Diehl et al., 2003). In contrast, we used multiple quantifiable product attributes, which were more objective for quality sorting. Although substitutability might still exist among products, product sorting was made visually explicit. Our quality sorting is also better tailored to consumer decision strategies for complicated choice problems in an electronic shopping context. Therefore, this study departs from many past studies of quality sorting and advances into a new context of multiattribute products with objective product information and complicated decision strategies.

Second, this study proposed two mechanisms that collectively provide a good explanation of quality sorting on consumers' quality and price importance: the concreteness effect and loss aversion. Although both effects have been observed in other contexts (e.g., Creyer & Ross, 1997; Haubl & Murry, 2003; Lynch & Ariely, 2000), they have not been tested in the quality sorting context. These two mechanisms offer an alternative explanation to Diehl et al.'s (2003) substitutability argument. This alternative view raises some interesting questions: For example, when would some effects be more dominant? Would the subjectivity of product quality perception or product list length be a contingent variable? Future research is needed in this direction. This study also enriches the loss aversion account. Although the loss aversion phenomenon has been applied in explaining asymmetries in price and quality competition (e.g., Heath & Ryu, 2000), prior research has largely focused on a two-brand (product) choice situation, where a consumer's choice clearly anchors on the first option. Our study complements the current literature by suggesting that loss aversion could be observed when consumers make choices from a list of sorted products, that is, a "moving-anchor" situation. In the quality sorting context, we demonstrate that the focus of loss shifts between quality and price in response to different sorting methods. This is a theoretically interesting finding. It suggests that in multiattribute decision making, without relying on message framing, loss aversion can be manipulated toward a certain attribute with the aid of an appropriate information display format. From this perspective, this study enriches the current literature on consumer decision making (Bettman, 1979).

Third, this study investigates a new product presentation format—hierarchical quality sorting—which has not been investigated in either consumer literature or information systems research. In the past, researchers often used priming techniques to influence consumers' choice (e.g., Haubl & Murray, 2003; Mandel & Johnson, 2002). Hierarchical quality sorting could achieve a similar effect in a more natural way. Because consumers are often aware of a marketer's intent to persuade through feature-based priming techniques, hierarchical quality sorting implicitly affects consumers' internal reference state and could lead to less resistance to a marketer's persuasion attempt.

5.2. Practical Implications

This study also bears important practical implications. As a general implication, this study proposes a simple yet effective technique to sell high-end products in a product line. For product categories that have a higher markup for high-end products, this technique can effectively increase a vendor's revenue and profit. For example, in this experiment, the average price of consumers' consideration rose from $672 (random) to $801 (descending), which is a 19% increase!

In terms of more detailed guidelines for product list design, first our findings suggest that a descending list of products by quality could make consumers more quality sensitive. Applying the finding, online vendors should adopt the descending product sorting to promote high-quality, high-price items. This study suggests that many current practices that vendors adopt, such as unsorted product lists or ascending lists by price, might harm a vendor's performance. Providing ascending sorting by quality attributes might also hurt a vendor's performance. Vendors need to be aware of the trade-off between consumer welfare and firm revenue. Second, descending quality sorting can be applied not only to online product catalogs but also to the display of consumer search results and product recommendation agents.

The actual implementation of a hierarchical sorting strategy should be tailored to consumers' preference. An online retailer might want to conduct a survey of product attribute importance first to determine the hierarchy of sorting. For a particular consumer, idiosyncratic preference of attributes can be solicited to customize the hierarchy of sorting. Such means would enhance the effort of sorting.

However, this strategy should be applied with caution. Sorting products in a descending order might raise consumers' perception of the vendor's price image.

One solution to this problem is to filter products first for a particular consumer segment, so that the products listed are within their purchase power but with high quality products listed first. This technique could be applied to the display of consumer search results and product recommendation agents.

6. LIMITATIONS AND CONCLUSION

Before we conclude this study, it is important to note its limitations. First, participants in the experiment were college students who might not be representative of all types of online consumers. This sample should be considered as a convenience sample. It is important to replicate this study with real online consumers for empirical generalization (Blair & Zinkhan, 2006). Second, we used a relatively small sample. Although practically significant, two of our hypotheses had low statistical powers. Third, we selected only digital cameras for the experiment. Products of different quality subjectivity might be subject to different degrees of sorting effect. Several hypotheses in this study are built on the assumption that product quality and price are highly correlated. The correlation between product quality and price is another factor that could moderate the relationship currently observed. Future exploration in this direction is meaningful.

In conclusion, although most of the studies on product presentation focused on quality information accessibility or price sorting, this research tackles the complicated issue of quality sorting in the presence of price information and quality–price correlation. We propose a hierarchical quality sorting technique and study the impact of different sorting orders (i.e., descending, ascending, and random) on consumers' quality importance, price importance, and consideration set formation in decision making. Our result indicates that descending quality sorting is effective in boosting consumers' quality importance without increasing price sensitivity too much. Conversely, ascending quality sorting boosts consumers' price sensitivity but not quality sensitivity. Therefore, descending quality sorting is an effective method to shift consumers' focus onto product quality and hence helps promote high-end products. Our findings not only suggest a practical means to improve vendor sales but also shed insight on the cognitive process of consumer decision making in the context of sorted product lists.

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APPENDIX

Major Items in the Questionnaire

Personal Information

1. E-mail address.
2. Gender (Male, Female).
3. Education level.
4. For how many years have you been using the Internet?
5. How many times have you made purchases online within the last 12 months? (None, 1–3 times, 4–6 times, 7–10 times, More than 10 times).
6. How often do you search/browse for product information online? (Less than once per month, 1–3 times per month, 4–6 times per month, 7–10 times per month, almost every day).
7. Please indicate the degree to which you would agree with the following statements by choosing a number from 1–7, where 1 indicates "strongly disagree" and 7 indicates "strongly agree."

—I feel very knowledgeable about digital camera.
—If I had to purchase digital camera today, I would need to gather very little information in order to make a wise decision.
—I feel very confident about my ability to tell the difference in quality among different brands of digital camera.

8. How frequently do you use a digital camera? (Almost every week, about 2–3 times per month, about once per month, about once every two months, about once every six months, even less frequent).
9. Do you have a digital camera which you can conveniently use? (Yes, No).
10. Do you have a plan to buy a digital camera? (No plan within one year, I will buy one in 6 months to 1 year, I will buy one in 1–6 months, I will buy one within 1 month, I will buy one within 2 weeks).

Product Choice

1. Based on the product quality, the general pattern of the product list you've seen is sorted in which order? (ascending, partial ascending, random, partial descending, descending).
2. Please write down the models of the product (from the list) that you are most likely to purchase (you can indicate as many or as few as you want).
3. Please explain in details why do you consider these products as good choices?
4. Please indicate the relative importance of product quality to price if you were to buy a digital camera? (11-point, 1–price is far more important than quality, 6–equally important, 11–quality is far more important than price).
5. Please indicate the degree to which the product quality/product price is important to you by rating them with a 1–100 scale, where 1 indicates "not at all important" and 100 indicates "very important" (product quality, product price).

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