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Impact of Information Presentation Modes on Online Shopping: An Empirical Evaluation of a Broadband Interactive Shopping Service

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With the increasing cost-effectiveness of communication technologies, online shopping has emerged as one of the most important areas of electronic commerce. A major problem facing online shopping service providers is the heterogeneity of user profile. Unlike organizational systems that have a well-defined universe of users and system boundary, these shopping services are designed for public users with very different cognitive and demographic profiles. The major challenge lies in designing friendly and effective user interfaces for online shoppers. Previous studies on online shopping suggest that a good user interface with an appropriate mode of information presentation is the key to system acceptance. In this article, we report on an empirical study that looks at product information presentation modes in an actual broadband supermarket shopping environment. Four prototypes with different combinations of text and picture displays were developed and evaluated in an experimental setting. The findings suggest that there is a close relation between product familiarity and shopping effectiveness. When the system is used to purchase familiar product items, pictures are better than text in terms of both efficiency and effectiveness. However, when users are not familiar with the product items, the advantages of pictures over text diminish. Implications of the findings and future research areas are discussed.

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online shopping, information presentation mode, text-versus-pictures

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1. INTRODUCTION

Advances in information technologies have brought significant promises to electronic commerce [1, 2]. One emerging area of electronic commerce is online interactive services. These services, including video on demand (VOD), home shopping, home banking, infomercials, electronic payments, and networked games, are expected to have a major impact on the way individuals communicate and the way business entities interact.[1] Online services not only have a major impact on the business-to-business transactions; they will also fundamentally change the structure and operation of retail markets [1, 3]. The situation parallels the development of interorganizational relations between business partners (e.g., linking suppliers and buyers via electronic data interchange) in the sense that organizational computing systems, particularly those of retailers, will move beyond organizational boundaries to interface directly with end customers in the future.

Online shopping is an example of a direct electronic channel linking sellers and customers. It allows customers to select and purchase product items over an interactive electronic medium, typically through interactive television (iTV) or the Internet [4, 5]. As online shops proliferate, it becomes important for a service provider to differentiate its own shop from the rest by developing its own brand identity [6, 7]. Unlike physical retail outlets, where there is a larger degree of freedom for a marketer to develop a differentiation strategy, online shops are typically restricted to the same communication channel (e.g., Internet uniform resource locator [URL]), the same access mechanism (e.g., browser), universally adopted technology (e.g., HTML, Java), and very often the same product items (e.g., grocery items). Without doubt, a key factor in determining the uniqueness of an online shop is its content. However, the way these contents are presented to the customers is equally important. Whether online shopping is conducted over iTV or the Internet, a central question is how product information should be presented to customers. This is related to the information presentation mode and task performance issues that have long been of interest to management information systems (MIS) researchers.

Although electronic commerce has become an area of increasing importance among MIS researchers, as indicated by the launch of journals dedicated to electronic commerce,[2] it is surprising to find that little empirical work has been done so far. The majority of existing works have strong conceptual and normative perspectives and focus mainly on market structure and transaction mechanisms [8–10]. There is a gap between the proliferation of online shops and the development of behavioral research in this area. Findings about the behavioral impact of presentation mode will provide valuable guidelines on product indexing and the choice of visual aids for service providers. In this article, we report on a preliminary study on the effect of information presentation mode in the context of an online shopping environment. Although much work has been done on the relation between the choice of information display and decision-making tasks in previous MIS studies

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[1]According to Paul Kagan & Associates (http://www.webcensus.com/results.html), home shopping and infomercial revenues were $4.5 billion in 1997 and will approach $7.4 billion by 2000.

[2]Two journals with a focus on electronic commerce: *Journal of Organizational Computing and Electronic Commerce* and *International Journal of Electronic Commerce.*

[11–18], one must be careful in generalizing these findings to online shopping. Also, unlike most previous studies that were based on hypothetical systems, the work reported here is based on an actual online application built on top of a wide-area broadband interactive multimedia system launched in 1998. We believe the contribution of this work is twofold. First, it represents a pioneer effort to empirically study the impact of presentation mode on shopping behavior. Second, it adds to the cumulative body of user-interface studies by expanding the scope of analysis from a well-defined user profile to heterogeneous public users using a real online shopping system such as the experimental test bed.

The organization of this article is as follows. An overview of online shopping is presented in the next section, followed by a discussion on information presentation mode. The background of the project and the prototypes developed for the project are then described. Details of the experiment conducted are presented, followed by a presentation of the findings and a discussion thereof. The article concludes with a discussion of the implications of the study from both the research and managerial perspectives.

2. DEVELOPMENT OF ONLINE SHOPPING

Many believe online shopping can provide a win–win situation for both sellers and buyers in a number of dimensions. First, it can provide an expanded marketplace with enhanced functionality that improves market experience for both sellers and buyers. Online stores are not restricted by the physical limitations of store space and can carry a much larger variety of products of different styles and sizes. At the same time, customers can search through a wide variety of goods with low transaction costs [19]. A recent study of shopping patterns in the United States revealed that, between 1980 and 1990, pedestrian traffic in U.S. malls had declined by 50% [20]. The main reason for the decline of traffic is the hefty growth of alternative distribution channels such as mail order, direct marketing, and the Internet. Second, advocates of online shopping cite a basic difference between enjoyable, recreational shopping and shopping that becomes either routine drudgery or suddenly unpleasant due to holiday traffic congestion, weather, and overcrowded schedules. This is especially true for grocery and staple shopping. Third, retailers can better understand customer needs by directly observing and analyzing the interaction between a customer and the online shop [21]. Findings obtained from such analyses provide much richer information on the decision process of customers in addition to the purchase decision outcome obtained from scanner data.

Contrary to the current optimism toward online shopping,[3] early market reaction to online shopping services was disappointing. Between 1986 and 1991, at least 27 online stores shut down. A number of reasons have been suggested for this lack of success [22]. Among them, the poor design of shopping interfaces is considered

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[3]Forrester Research predicted that the Internet will generate $125.6 billion of revenue by 2000 ($66 billion from online merchants and intermediaries, $37 billion from online consumer-to-retail purchases, and $22.6 billion from electronic banking and financial services). In the business-to-business arena, the volume of commerce activity will approach $300 billion by 2002 according to International Data Corporation forecasts.

to be one of the primary factors. As commented by Baty and Lee [23] on early on-line shopping applications:

> Regrettably, the history of electronic [online] shopping is one of limited interfaces and navigation, where the promise of major shifts in marketing and consumer behavior goes unfulfilled. … These systems typically provide menu browsing of primarily textual descriptions of products and services. (p. 11)

Recent work in marketing supports the findings of Baty and Lee [23] on the effect of the user interface on system acceptance. For example, Alba et al. [6] suggested that one of the key incentives for customers to adopt online shopping services is an effective screening mechanism and the ease of performing product selection. Burke [21, 24] suggested that to be successful the system (online stores) must be made substantially easy to use and dramatically improve the customer interface.

3. INFORMATION PRESENTATION MODE AND THE ADOPTION OF ONLINE SHOPS

A review of popular online stores (e.g., amazon.com) reveals that independent of the type of online shops and the products they are selling, product information is accessed either by browsing through a hierarchy of product items or invoking a search engine. Although there may be direct links between product items for cross-merchandising or product bundling purposes, products are typically assigned to categories and categories are organized in a hierarchical fashion. For example, the books of amazon.com are organized into different categories such as art, horror, and business, which are further divided into subcategories as users navigate down the hierarchy. The product items reside at the lowest level of the hierarchy. Browsing provides a simple navigation mechanism for shoppers to browse from one category to another as if they are inspecting the shelf of a retail outlet. It also provides a means to systematically explore all product items available in a shop.

On the other hand, a search engine provides a shortcut to product items irrespective of their locations in the hierarchy. Customers invoke the search engine by providing key words related to the product items. Keyword matching is the basic function of a search engine. Some online shops have expanded the text search capability by supporting selection criteria based on product attributes such as size, price, brand, and so on. For example, a customer can retrieve all soft drinks packaged in bottle that cost less than $1. Currently, these intelligent search engines are made possible by linking the user interface with corporate product databases.

Browsing and searching correspond to two different shopping activities, which are essential in a shopping experience. Thus, both are supported in most online stores. Together with the visual and artwork elements of the user interface, they represent the communication channel between customers and shops. As discussed earlier, recent work in MIS and marketing points out that ease of use is a decisive factor in the adoption of online shopping services. To see how this work is related to the adoption of online shopping services, we draw on the technology acceptance model (TAM) developed by Davis [25, 26]. TAM is a salient model specifically designed for explaining and predicting user acceptance of information technology.
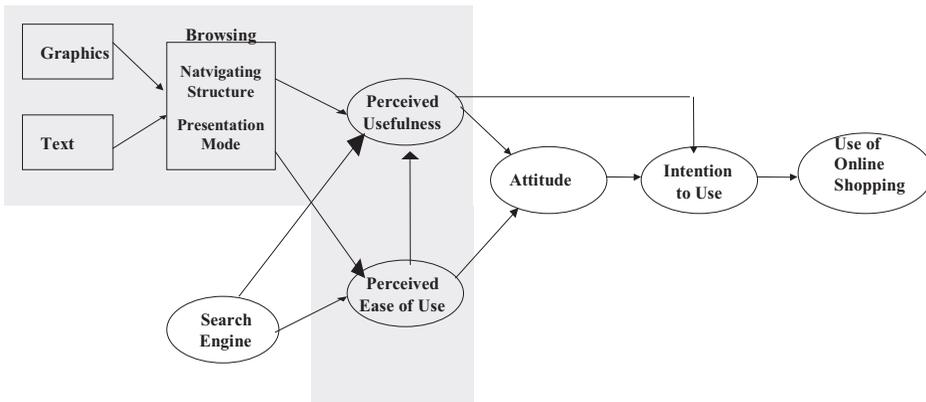
Figure 1.   Information presentation mode and ease of use in the context of the technology acceptance model.

TAM is built on collective findings suggesting that desired technology use is greatly dependent on user technology acceptance. As commented by Davis et al. [27], "as technical barriers disappear, a pivotal factor in harnessing this expanding power (of computer technology) becomes our ability to create applications that people are willing to use" (p. 982).

In the context of online shopping, TAM stipulates that a customer's intention to use an online shopping service is jointly determined by the perceived usefulness of the service and attitude toward using the technology, which is, in turn, determined by the perceived usefulness and the perceived ease of use of online shopping jointly. The model shown in Figure 1 illustrates the hypothesized links between the presentation mode, search engine, and navigation structure of product items in the adoption of online shopping services. Note that our objective is not to test the TAM per se but to use it as a framework to illustrate the chain of causal link between presentation mode and shopping system acceptance.

In this research, we focus on browsing, with particular interests in the effect of presentation mode on perceived usefulness and ease of use. This is highlighted in the shaded region of Figure 1. Although search engines are essential, they are not addressed here because the online service studied in this work is targeted for iTV in the initial phase. Customers will interact with a set-top box connected to a TV through a hand-held remote control device similar to those for VCRs and TVs. Unlike a keyboard, the device is restricted to selected functions with a limited number of buttons and therefore, cannot be used to input free text required by a search engine. It would be interesting to study the combined effect of searching and browsing, but that is beyond the scope of this article.

3.1 Product Information Presentation Mode

The model in Figure 1 suggests that product navigation and information presentation mode are two major elements of browsing. *Navigation* relates to product organization and the indexing structure behind it, and the *presentation mode* addresses how

easy product information can be comprehended to facilitate the shopping process. There are two major modes of information presentation: verbal and visual. In early online shopping environments, due to technological constraints, the verbal mode, in the form of text, was most popular. A serious problem with using textual information, however, was that "with vendors limited to textual information … the resulting product descriptions are so simple that all products seem very much alike" ([23], p. 11).

3.2   Overview of Related Works

The impact of text versus graphics on the decision-making process has long been an important research topic in MIS. Many previous studies adopted imagery theory as the theoretical basis to compare text and graphics [28]. The presentation mode issue in online shopping is different from that investigated in previous MIS works in two main ways. First, the majority of existing works focus on tables versus graphs in different task settings. For example, an early study by Remus [17] reported that compared with graphic display, tabular display was associated with better task performance. Benbasat and Dexter [11, 12] investigated the effects of display format (table vs. graphic) and color and field dependence on the performance of a marketing task. Experimental results of their study indicated that display format and color had an impact on task performance. Recent efforts have extended the table versus graph comparison to include schematic faces. These include works by MacKay and Villarreal [29] and Umanath et al. [28]. In these studies, text and graphics had the same information content but differed in their visual forms. For example, market share of competitive products could be displayed in a numerical format (e.g., 20%) or expressed in either a pie chart or a bar chart. The semantic content of alternative display formats remained the same. In short, previous works have typically focused on the choice of different presentation formats and the cognitive effort to manipulate them in performing different tasks. In online shopping, however, the textual description of a product and its image may be perceived very differently by a user. For example, Jarvenpaa and Dickson [15] questioned whether graphics have the same psychological effects as pictures. Thus, the direct application of findings in previous user-interface studies is questionable. For instance, a customer may easily identify the brand of a product by looking at its picture, but he or she has a difficult time recalling it if only the name (in text) is provided.

The second difference relates to the task being considered. Both DeSanctis [13] and Benbasat and Dexter [11, 12] asserted that the information display format must be evaluated on the basis of problem characteristics. Tasks employed in previous MIS studies are oriented toward problem solving. On the other hand, online shopping is closely related to recognition and recall. The different ways to present a product provide different degrees of cognitive stimulation to a patron in a shop. As suggested in marketing literature, the behavior of a retail shopper could to a large extent be influenced by the shop's physical environment, product location, and other hedonic variables associated with the shopping process [30, 31]. Such behavior deviates considerably from the rational and often utility-maximizing behavior expected from many problem-solving tasks in previous MIS studies. As Umanath et al. [28] pointed out, problem solving and decision making are complex com-

pounds of more fundamental human information processing skills, such as recall and recognition. A better understanding of these primitive constructs can help lay a stronger foundation for studying more complicated tasks such as product comparison and bargaining.

Recall is a measure of an individual's ability to retrieve information from memory that has been acquired earlier and retained. *Inference* is a measure of an individual's ability to manipulate information that has previously been stored in his or her memory to make sense of that information [32]. Comprehension of information depends on both recall and inference.

Paivio [33] proposed a dual-coding theory that can be used to investigate the issue of comprehension of information in different modes of presentation. According to the dual-coding theory, information comprehension consists of two separate but interdependent coding mechanisms: verbal and nonverbal. Verbal processes involve analytical encoding of text, whereas nonverbal processes (e.g., images and pictures) are analog knowledge representations. These two processes are believed to affect comprehension differently [28]. Nonverbal processes always involve parallel or synchronous processing in which all available information is processed simultaneously as, for example, in recognizing a face or an object. On the other hand, verbal processes usually involve sequential processing in which the processing of information generally follows a certain orientation or direction as, for example, in reading a piece of text from left to right or top to bottom. In general, this type of processing requires a greater memory load during storage than that of parallel processing. Therefore, the parallel processing mode tends to facilitate quicker scanning and decoding, both of which are important in the recognition and recall of products displayed on screen.

According to the dual-coding theory, information presented as pictures is more likely to be remembered. Compared with words, pictures are more likely to be dual-coded and thus enhance the retention of information. The rationale is that when one memory trace is lost, the other one is still available.

The preceding discussion suggests that product information presented in the form of pictures (the nonverbal mode) will facilitate a quicker and more accurate comprehension of product information than that in the form of text. The general research question, framed in the context of online shopping, is whether the different modes of presentation have any effect on shopping effectiveness and user perception. The answer to this question will have important implications for the design of online shopping systems.

4. EXPERIMENTAL DESIGN

4.1 Background

We were invited to engage in a project to design and develop prototypes for an online supermarket application to be launched as a broadband interactive multimedia service (IMS) in Hong Kong in 1998. A number of issues related to the user-interface design of the online home (supermarket) shopping project were studied. One issue was to investigate whether there were any differences, in terms of user-perceived usefulness and ease of use, between prototypes developed with different modes of

product information display on screen. The following gives some background information about the project.

In 1994, Hongkong Telecom (HKT), a major telecommunications carrier in Hong Kong, announced its plan to offer IMS in Hong Kong. In the plan, IMS would include a number of services including Internet access, video-on-demand (VOD), electronic home shopping, electronic home banking, infomercials, electronic payment services, cross-merchandising, educational services, and electronic yellow pages. To meet the required transmission capacity, HKT has linked all telephone exchanges by optical fiber and will build a US $640-million full-service network to install a hybrid fiber–coaxial physical medium supporting cable TV and broadband services across the urban area of Hong Kong by the end of the 1990s [34]. A brief introduction to the technical aspects of broadband multimedia services can be found in [35–37]. On the business side, HKT has collaborated with 40 major local retailers including department stores and supermarkets to form a consortium to develop an electronic marketplace in Hong Kong. A new subsidiary of HKT, Hongkong Telecom IMS (HKT–IMS), was formed to be in charge of the development and launch of the IMS.

Phase 1 of the IMS rollout began in April 1996 with a service called Netvigator. Through the Netvigator,[4] users can obtain services including online shopping, online magazines, and financial services via Internet access. Phase 2 was launched in 1998 and included VOD and electronic home shopping via iTV.

4.2   Product Item Organization and Presentation Mode

Without going into the technical details of the product organization for the online shopping system, we can simply describe the prototypes designed and developed for the project as a three-level structure (Figure 2). The decision to use a three-level structure was based on (a) findings from existing literature, (b) feedback from the user focus groups, and (c) the number of product items available in the system. The three-level structure is consistent with a recent study by Yamada et al. [38], who introduced the concept of *interface shallowness* to measure and represent the heaviness of the cognitive load of using a given system on users. They compared two interface designs: one with three levels and the other with six levels. The results of their experiment indicate that only 7% of the total number of accesses went beyond the third level, suggesting that many users avoid getting into deep levels that increase their cognitive load. The focus groups also commented that a deep navigation structure will require more mental effort to browse from one category to another as the depth of the hierarchy increases. This is consistent with a Bell Atlantic study [1] suggesting that a purchase decision over an electronic medium is perceived to be convenient if it can be completed in four steps. The existing categorization of product items of the participating supermarket also poses a restriction on the number of levels. Many existing product items can be easily fit into a three-level structure. The problem of adding more levels is that either artificial subcategories need to be cre-

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[4]More information about the Netvigator can be obtained from its home page at http://www.netvigator.com.
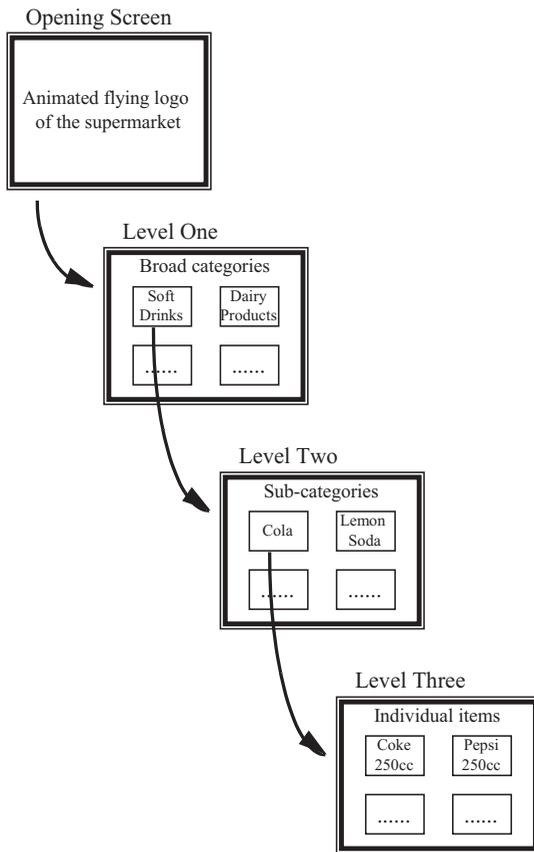
Figure 2.   A three-level structure of the online supermarket.

ated or the hierarchy is not balanced. Both will create considerable confusion to potential customers.

To facilitate shopping activities, it was decided that products would be organized according to a product catalog provided by a major local supermarket chain. This approach to product organization, as pointed out by Baty and Lee [23], can facilitate shopping activities by appealing to customers' existing product knowledge. When going into the online supermarket, a customer can continue to use his or her existing knowledge of product categorization to do shopping because the categorization resembles that in a conventional, physical supermarket.

The first level of the structure includes broad categories of products such as soft drinks, dairy products, and vegetables. The second level further divides the broad categories into subcategories. For example, soft drinks into cola, lemon soda, and so on. At the lowest level, individual product items with prices for specific sizes and packages are displayed. Based on this structure, a shopper can locate the product item that he or she wants by traversing three levels of navigation. The prototype contains over 230 screen pages covering approximately 2100 product items.

With this three-level structure, product information can be displayed either in the form of text or pictures. Although there could be a total of eight combinations of

text and pictures in three levels, given the advantages and disadvantages of text versus pictures discussed earlier and the feedback collected from pilot users, it was decided that only four combinations—(from the highest to the lowest level) pictures–pictures–pictures (PPP), pictures–pictures–text (PPT), pictures–text–text (PTT), and text–text–text (TTT)—would be tested. The PTP and TPT modes were not considered because it would have been too confusing for users to go through two switches of presentation modes to traverse from the top to the bottom level. The TPP and the TTP modes were discarded because feedback from the focus group indicated that when going from the top level to the second level and then the lowest level, information presented was from broad to specific, and switching from pictures to text seemed to be more natural than vice versa. Therefore, four prototypes were developed based on the three-level structure and four different combinations of the two product information presentation modes. Figures 3 through 6 are snapshots of these four prototypes at different levels.

5. EXPERIMENT DESIGN

5.1 Hypotheses

As suggested in Figure 1, different information presentation modes are hypothesized to have different impacts on perceived usefulness, ease of use, and the shop-

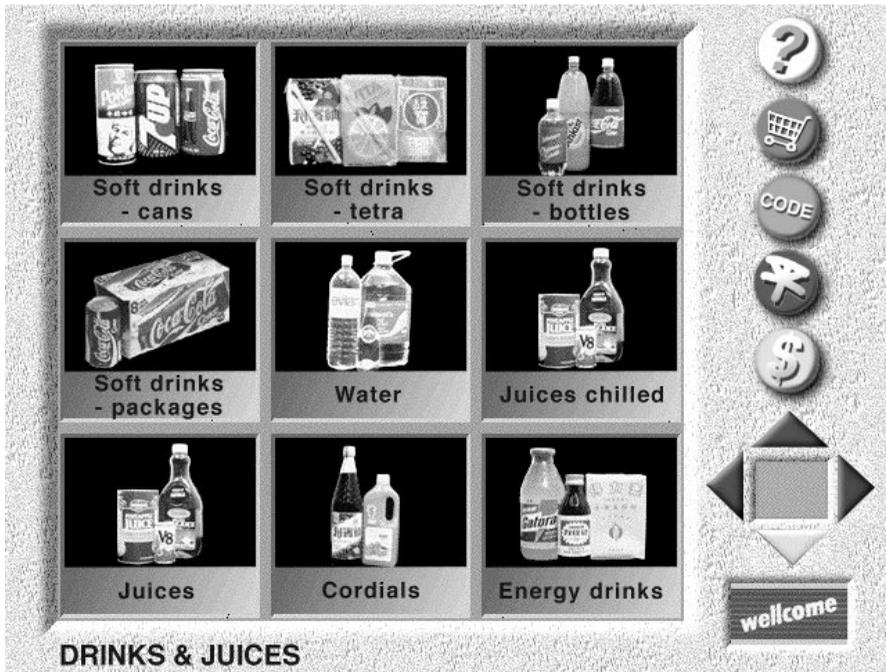**Figure 3.**   A snapshot of Level 1 of the online supermarket.

Figure 4. A snapshot of Level 2 of the online supermarket.

Figure 5. A snapshot of Level 3 of the online supermarket.

Figure 6.   Another snapshot of Level 3 of the electronic supermarket (text mode).

ping process itself. Impacts are operationalized in terms of both perception and process measures and evaluated in an experimental setting.

Perception measures focus on users' feedback on ease of use, usefulness of the system, and satisfaction with the navigation flow. A total of 11 items were used for these measures (Appendix A). These items were mainly adapted from previous studies on information technology acceptance (e.g., [26]). Each item is based on a 5-point Likert-type scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*). Process measures are based on data obtained from the log file of each participant in the experiment. They are related to timing, switches between levels, switches between pages, and correct purchases.

The first measure deals with the efficiency aspect of the shopping. The second and third measures evaluate the navigation load, both vertically and horizontally. The fourth measure assesses the effectiveness of the shopping. As mentioned earlier, a log file was kept for each participant for subsequent data analysis.

The main research questions are stated as null hypotheses as follows:

H1: There is no difference in performance among prototypes developed using any one of the following combinations of information presentation modes: PPP, PPT, PTT, and TTT, as measured by three different perception measures.

H2: There is no difference in performance among prototypes developed using any one of the following combinations of information presentation modes: PPP, PPT, PTT, and TTT, as measured by four different process measures.

An experiment was conducted to empirically evaluate these four combinations of presentation modes. As described earlier, different combinations of text and pictures for the three levels are the primary factor to be tested in the experiment.

5.2 Participants

A total of 95 individuals were successfully invited to participate in the experiment on a voluntary basis. The profile of the participants is consistent with the target market segment of the service. About half of them were men. Over 60% of the participants were in their 20s and another 20% were in the 31-to-40 group. Slightly more than half of the participants were university students (undergraduate and MBA students). Another 30% were business executives and 9% were teachers.

Participants in the experiment were divided into four groups, each using one of the four presentation modes to perform shopping tasks. The distribution is given in Table 1. Participants were randomly assigned to each group.

5.3 Shopping Tasks

Participants were asked to perform the following tasks. In the beginning, a 45-min demonstration of how to use the prototypes was given. Participants were then asked to conduct a number of tests for visual bias and recall capabilities that are beyond the scope of this article and are not discussed here. They were then asked to use the prototype provided to buy two lists of product items with nine items in each list (Appendix B).

The first shopping list contained "popular" items that customers frequently buy in the supermarket. They were selected from a list of popular items provided by the participating supermarket based on average sales volume. Examples included a can of Campbell's cream of chicken soup and a box of Flora margarine. The second shopping list contained items that are not popular and/or uncommon brands. Again, the "unpopular" items were selected from a list provided by the participating supermarket based on average sales volume. Examples in this list included a packet of Sukiyaki steak and a can of S&W garbanzo beans. No time constraint for the shopping was imposed.

After the participants had completed the shopping, they were asked to complete a questionnaire to give their feedback on the prototypes. This provided the data required for the evaluation of the prototypes based on a number of subjective mea-

Table 1
Distribution of Participants

Group	PPP	PPT	PTT	TTT
No. of participants	29	24	23	19

Note. PPP = picture–picture–picture; PPT = picture–picture–text; PTT = picture–text–text; TTT = text–text–text.

sures described in the previous section. During the shopping process, all actions of a user including selection, clicks, level of navigation, and timing were automatically recorded in a log file for subsequent analysis. The log file provided the primary data to evaluate process measures.

5.4 Testing Environment, Hardware, and Software

The experiment was conducted in a Macintosh laboratory with 30 Apple PowerMac 7100/80 AV systems. Participants in the same group shopped at the same time. Each user was allocated one machine to complete the experimental task. The electronic supermarket prototypes were developed using Macromedia Director.

6. DATA ANALYSIS

The three perception measures were evaluated for reliability, convergent validity, and discriminant validity. The reliability was assessed by computing Cronbach's alpha. The alpha values were .83, .87, and .76 for the three measures. Nunnally [39] suggested that a reliability of at least .7 suffices for early stages of research. Given the exploratory nature of this work, the measures are deemed acceptable. Factor analysis was used to examine the convergent and discriminant validity of the constructs. A principal components analysis using varimax rotation and specifying a three-factor solution was performed. Convergent validity is demonstrated if items load highly on their associated factors. Table 2 shows the results of the factor analysis. Without exception, all items load highly (loading > .50) on their associated factors, confirming

Table 2
Results of Factor Analysis

Item/Factor	Ease of Use	Usefulness	Navigation
E1	.8264	.1005	−.0876
E2	.5792	.1902	.4239
E3	.7980	.1466	.1883
E4	.5809	.0498	.3910
E5	.8210	.1628	.1871
U1	.1228	.8509	.0453
U2	.1824	.8881	.1358
U3	.1258	.8608	.2113
N1	.0449	.1655	.8447
N2	.2171	.0697	.7547
N3	.1668	.1179	.7383
Eigenvalue	4.3710	1.7035	1.4340
Percentage of variance	39.7	15.5	13.0

Note.   E1 = learning to use the system is easy; E2 = it is easy to get the system to do what I want it to do; E3 = the interactions are clear and understandable; E4 = the system is flexible to interact with; E5 = the system is easy to use; U1 = with the system, the supermarket shopping is quick; U2 = with the system, it is easy to do supermarket shopping; U3 = the system is useful for supermarket shopping; N1 = the sequence of screens is logical; N2 = the screens/steps are easy to follow; N3 = the number of steps required to do the shopping is acceptable. Factor loading > 0.50 are underlined.

Table 3
Comparison Based on Perception Measures

Measure	PPP	PPT	PTT	TTT	F Value	p Value
Ease of use						
M	2.3103	2.3000	2.2174	2.4737	0.73	.535
SD	0.5492	0.5242	0.6235	0.5665		
Usefulness						
M	2.4569	2.5208	2.7500	2.7895	1.22	.308
SD	0.6163	0.8305	0.7347	0.7372		
Navigation						
M	2.3448	2.2083	2.5072	2.3333	0.77	.511
SD	0.7042	0.6725	0.6732	0.6285		

Note. PPP = picture–picture–picture; PPT = picture–picture–text; PTT = picture–text–text; TTT = text–text–text.

the convergent validity of the factors. As for discriminant validity, the primary criterion is that each item must load higher on its associated factor than on any other construct. From Table 2, the condition for discriminant validity is also satisfied.

The four presentation modes were evaluated based on the three perception measures. As participants completed each shopping task in about 10 to 15 min on average, they did a single, subjective evaluation of the four presentation modes after finishing both shopping tasks but not one after each shopping. This eliminated the "carry-out" effect from one shopping task to another. Table 3 summarizes the results of the comparison. Participants in general felt positive about ease of use, usefulness, and navigation flow. However, none of the four prototypes was significantly superior to the others. Thus, the null hypothesis (H1) is not rejected.

This finding suggests that the presentation mode for product information does not affect the participant's evaluation of the system. As long as the quality of the system was acceptable, users simply used the system and did not care so much whether the product information was presented in text or pictures.

As for the process measures, comparisons among the prototypes were done twice, once for each shopping list, using analysis of variance at the 5% level of significance. Tables 4 and 5 summarize the results.

6.1 Shopping List 1

Products in this shopping list were popular items. Significant differences were found in all four measures: total time spent, number of switches between levels, number of switches between pages, and number of correct purchases. The general pattern was that PPP was the best and TTT was the worst. In all four measures, PPP scored the best in all four measures and TTT the worst in three out of four measures. Participants using the PPT prototype performed significantly worse than participants in other groups in terms of purchase correctness. Prototypes with more pictures than text were more efficient in helping users to complete their shopping tasks, although having more pictures did not necessarily lead to more accurate purchases. Also, as both the number of switches between levels and the number of

switches between pages were lower when pictures were used than when textual information was used, this finding suggests that using pictures can give benefits to both the customer and the service provider. For the customer, it lowers the search cost for products in terms of time and effort [19]. For the service providers, it reduces the load of vertical navigation and horizontal navigation (i.e., database access and retrieval), and thus improves overall system throughput.

6.2 Shopping List 2

Products in this shopping list were not familiar items. The general pattern of performance of the prototypes remained the same as that for Shopping List 1; that is, PPP

Table 4
Comparison Based on Process Measures (Shopping List 1)

Measure	PPP	PPT	PTT	TTT	F Value	p Value
Time spent						
M	597.3	612.8	672.9	903.8	5.01	.003
SD	309.9	196.2	245.5	389.3		
Switches between levels						
M	47.66	51.71	55.48	77.95	12.03	.001
SD	9.37	16.44	13.29	30.41		
Switches between pages						
M	52.93	62.75	58.09	77.68	3.48	.019
SD	26.04	26.12	16.83	36.26		
Correct purchases						
M	8.8621	8.1667	8.6957	8.6842	3.47	.019
SD	0.3509	1.3406	0.6350	0.5824		

Note.   PPP = picture–picture–picture; PPT = picture–picture–text; PTT = picture–text–text; TTT = text–text–text.

Table 5
Comparison Based on Process Measures (Shopping List 2)

Measure	PPP	PPT	PTT	TTT	F Value	p Value
Time spent						
M	790.3	740.5	822.2	905.3	1.39	.250
SD	166.0	235.7	352.7	317.2		
Switches between levels						
M	61.28	61.25	63.26	73.16	1.91	.134
SD	14.26	16.41	19.47	25.36		
Switches between pages						
M	67.38	79.62	79.39	84.63	2.00	.119
SD	15.24	26.04	34.61	27.34		
Correct purchases						
M	8.621	7.083	8.261	8.000	8.51	.001
SD	0.903	1.501	0.964	1.106		

Note.   PPP = picture–picture–picture; PPT = picture–picture–text; PTT = picture–text–text; TTT = text–text–text.

was the best and TTT was the worst. However, the differences among different presentation modes, except for the measure of number of correct purchases, were no longer statistically significant. Participants using the PPT prototype still performed significantly worse than participants in other groups in purchasing the items requested.

These findings give a mixed answer to H2. H2 is rejected under Shopping List 1 but is supported under Shopping List 2. In other words, significant differences among the prototypes were found when participants used them for shopping for popular items, but those differences became insignificant when the participants were not as familiar with the items. A plausible explanation of this difference is that when a participant was asked to purchase a product item that he or she was not familiar with, he or she might not have a good idea of what the item looks like. In the experiment because participants were given the shopping list in the form of text, textual information about the products, rather than pictures, might have better helped them to locate the target product. In this case, the matching process was easier in the case of text. Even though on average it took more time to complete the shopping for unfamiliar items than that for popular items, the differences between prototypes with different presentation modes diminished.

7. LIMITATIONS AND DISCUSSION

This study has a number of limitations. First, the theoretical support of the hypotheses tested in the study is exploratory and has not been tested extensively in previous works. As mentioned earlier, the TAM is used only as a reference frame and is not tested directly. Umanath et al. [28] recommended that researchers develop and conduct a series of systematically planned experiments to build on the findings of prior research. It would also be interesting to explore other conceptual models such as the one by Thompson et al. [40, 41] that investigated the link between prior experience and system utilization. The second limitation is that not all combinations of text and graphics are tested. Although feedback from the focus group indicates that four out of a total of eight combinations will suffice, one must take this into account in interpreting the findings. The third limitation is the number of variables examined in the study. At the information display level, other factors that could have been included in the study are text level, text type, picture quality, and text–picture integration. At the system level, the study does not consider the possible impacts of individual characteristics on the system [13, 42] or the different ways of processing verbal and visual information by different individuals [43]. Although including these factors may enrich the study, it may also confound the findings obtained.

Findings of this study have implications for both MIS practitioners and researchers. For practitioners planning to develop online shopping systems, the findings on the text versus picture issue provide insights for the design of the systems. However, one should understand that the information presentation mode is just one of many factors affecting screen design. Other factors, including information load, spatial arrangement, and various kinds of display features such as color, blink, and beep prompting, may also affect the overall effective-

ness of the system. More work should be carried out to build up our knowledge in this area.

The difference in shopping effectiveness between familiar and unfamiliar products suggests the close relation among customer profile, product variety, and interface design in developing online shopping systems. If the number of product items online is not large and shoppers in general are quite familiar with these items, using pictures as the product information presentation mode may be a better choice. On the other hand, if there are always new product items placed online, the number of product items is very large, and shoppers always come to buy different things at different times, using either pictures or text as the information presentation mode may not make any significant difference.

The findings also reveal the limitation of the traditional system development methodology, which assumes a well-defined universe of users whose requirements can be documented and modeled. In traditional system development, user acceptance can be enhanced by a well-designed migration plan together with training programs. However, developers of online shopping systems are faced with an unknown group of users with a diverse profile and usage pattern. New techniques or techniques from other disciplines are needed to supplement existing system development methodologies. Among these, focus group studies and behavioral experiments seem to be able to provide valuable guidelines in developing systems for public users. In this study, the artwork design, screen layout, and icon design of the shopping system used in the experiments went through a series of iterations with members of the focus groups. The design of an effective user interface requires a level of visual design skills beyond that of a typical MIS professional. For instance, the location of the icons was based on findings from our visual bias tests. The traditional system development team structure with a strong technical orientation seems incapable of meeting the challenges of building multimedia systems. Research is needed to investigate new compositions and forms of development team for electronic commerce applications.

Another implication is the possible inclusion of other forms of visual information presentation such as video and animation into online shopping systems. A recent study on a hypermedia system has found that the video quality has more influence on the overall enjoyability of use and usefulness of the system than the quality of the text [38]. Also, an increasing number of multimedia products in the information technology market have included functions to generate animation that, in theory, can provide a very dramatic visual effect. The rapid growth of Internet shopping applications and Java-based technologies has also fueled the growth of animation in Internet-based online shopping systems. Researchers should explore the advantages and disadvantages of having animation in the online shopping environment and its integration with other presentation modes in designing future online shopping applications.

8. CONCLUSIONS

Technology advancement has made online shopping the object of intense media interest and retailer enthusiasm. This article reports an empirical study that addresses the information presentation issue in an online supermarket environ-

ment. A number of interesting results were found. First, whether the product information is presented in text or picture form does not seem to be a significant factor in terms of customer perception on ease of use and usefulness. Second, when the system is used for the purchase of familiar product items, pictures help a great deal in terms of both efficiency and effectiveness. The use of pictures not only reduces the time required to complete the purchase but also lowers the navigation load. Third, when customers are not familiar with the product items, advantages of pictures over text diminish.

This article has extended the study of the value of text versus graphics to text versus pictures, an area that has thus far received little attention from MIS researchers and is believed to be extremely important in the study of factors affecting the acceptance of online shopping. Results of this work also encourage MIS researchers to reconsider the findings obtained in previous studies on information presentation modes and reexamine the concepts and theories applied in those studies. Can those findings be extended to an online shopping environment and can the concepts and theories used in previous studies also be applied in the new environment? These and other related questions not only pose new challenges to MIS researchers but also open up a new area for research.

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APPENDIX A
Perception and Process Measures

Ease of Use

  E1. Learning to use the system is easy.
  E2. It is easy to get the system to do what I want it to do.
  E3. The interactions are clear and understandable.
  E4. The system is flexible to interact with.
  E5. The system is easy to use.

Usefulness

  U1. With the system, the supermarket shopping is quick.
  U2. With the system, it is easy to do supermarket shopping.
  U3. The system is useful for supermarket shopping.

Navigation Flow

  N1. The sequence of the screens is logical.
  N2. The screens/steps are easy to follow.
  N3. The number of steps required to do the shopping is acceptable.

APPENDIX B
Shopping Lists

Shopping List 1

  1. One can of Campbell's cream of chicken soup.
  2. One bottle of Waston distilled water.
  3. One box of Flora margarine.
  4. One bottle of Nestlé Coffee Mate.
  5. One packet of Ethnicans potato chips.
  6. One bottle of Lee Kum Kee oyster sauce.
  7. One cup of Seafood Flavor Cup noodle.
  8. One can of Tulip mini hot dog.
  9. One packet of EverReady C2 batteries.

Shopping List 2

  1. One packet of Sukiyaki steak.
  2. One tetra pack of Vita lemon tea.
  3. One bottle of Canadian whiskey.
  4. One bottle of Skippy creamy peanut butter.
  5. One packet of Toblerone chocolate.
  6. One can of S&W garbanzo beans.
  7. One packet of Mr. Juicy orange juice.
  8. One can of Yeo's Grass jelly drink.
  9. One cup of Diary Farm strawberry yogurt.