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Modifying consumer search processes in enhanced on-line interfaces☆

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Abstract

The study examines the impact of on-line interface type on consumer search processes and choice. The article describes two major types: 2D interfaces which possess primarily interactivity capability versus the enhanced 3D interfaces that have superior vividness capability. The research addresses the question whether a particular family of interfaces is expected to force out the other or, alternatively, whether consumers would vary the usage of the type of interfaces under different shopping circumstances. The findings indicate that consumer search processes are indeed affected by the on-line interface type with different advantages to each, depending on the search situation. They provide support for its central hypotheses regarding process variables, such as shopping duration, number of examined brands, and the sequence of search. The effect due to interface is further reflected in the interaction between consumers' internal and external search and extends to consumer preferences and choice processes.

Keywords: On-line interface; Consumer search processes; Internet; Virtual reality; 3D; On-line consumer behavior

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1. Introduction

Despite the rapidly changing environment and frequent introduction of new highly vivid and interactive Internet interfaces, it seems that the focal consumer-related question is no longer whether our previous accumulated body of knowledge regarding the way people process information and make decisions is still relevant (e.g., "what makes the Internet different?", Johnson et al., 2000). Instead, what seems to emerge as the central query is how those approaches we have at hand regarding consumer information processing can be adapted in the context of web navigation considering differences in consumer-specific shopping orientation, product and service consumption, prior related experiences, etc. While much of the relevant research to-date focuses on the factors underlying search (e.g., Lynch and Ariely, 2000) the present study focuses on the *process of search* invoked by alternative types of new interfaces. Particularly, it addresses the question whether in view of the improved display and accelerated transmission speed we ought to expect that a particular family of environments will dominate and eliminate the others or, alternatively, that consumer orientation and specified goals would maintain demand for use of alternative types of interfaces that will coexist and be adopted under different shopping circumstances. Addressing this question helps us understand the mechanisms that would lead one format to be more effective than the other under specific circumstances.

Within the many opportunities that new interfaces offer, cybertechnology appears to comprise two main properties: Interactivity and Vividness. These major properties are frequently inversely related (Shih, 1998) such that allocation of resources to improve one aspect of the interface detracts from, or at least does not improve, the quality of the other. In particular, 2D interfaces are *highly interactive*; they are capable of improving reaction speed, download, and efficiency of mouse motion and clicking. Interactivity is defined as the ability of the communication system "to answer" the consumer, almost as if a real conversation was taking place (Rogers, 1986). An important factor influencing the degree of interactivity of the mediation is the consumer's degree of control over the medium, that is, "the ability to modify the causal relation between a person's intentions or perceptions and the corresponding events in the world" (Schloerb, 1995). A website is considered more highly interactive to the extent that its response speed is higher or to the extent that it allows the user to manipulate the content (Shih, 1998).

In contrast, *highly vivid interfaces* such as 3D cyberstores provide a culture of stimuli, meanings and communication which are represented objectively. They create ultimate imaging and their effectiveness in e-commerce lies in their ability to generate a virtual environment for the consumer in which experiences will mimic, as close as possible, the physical environment (Burke, 1996). In the case of cyberspace shopping, the consumer visits an environment that is an image of a genuine store. The consumer is able to move around this store as an individual who moves in a genuine store. Pioneered by Burke (1996) interfaces were created in which the image can be repeatedly represented and the consumer may "pick-up" an item that attracts his attention, for a closer view. The possibility of examining a product from different angles and rotating it in a three-dimensional visual is absent in other shopping modes, such as browsing a catalogue (Venkatesh, 1998). Simulated reality enables the representation and manipulation of an image of the "real world" at no risk, inconvenience or cost to the consumer (Rada, 1995).

For our study we created two comparable interfaces focusing on breakfast products. One interface was a 3D cyberstore, which allows navigation in a store environment in a one-touch motion while enabling participants to examine brands during navigation and to express their purchase decisions. The other interface was a 2D hyperlink interactive program with a matching number and kind of brands to that of the 3D interface. Those two types of interface differ in their dominant capacity. Whereas the 3D interface has highly vivid capability, 2D interface is oriented more toward interactive search. Preceded by identical instructions, we compared the process of search and its key parameters, as well as the impact of prior shopping habits and experiences. We were interested in characterizing the unique features of the on-line shopping processes, in differences in the shopping processes invoked by the alternative environments, and in the differential impact aroused by varied prior experiences on the appropriateness of each type of interface.

2. Characteristics of the process of on-line search

Researchers suggest unique characteristics of the process of on-line search, such as greater opportunity for consumers to realize their purchase fantasies (Venkatesh, 1998), thereby reducing anxiety related to lost opportunities (Alba et al., 1997). Furthermore, by using efficient filtering consumers can use more information in their decision-making process (Kardes and Kalyanaraman, 1992; Russo, 1977) without reducing the efforts for their precision of the purchase as appearing in the brick-and-mortar environment (Todd and Benbasat, 1994).

3. Interface-based differences in information processing

In addition to these unique features of on-line search, differences in shopping experiences between high vividness and high interactivity interfaces are largely affected by the superior retention of images in memory relative to that of corresponding verbal information (Paivio, 1975; Childers and Houston, 1984; Costley and Brucks, 1992) . This difference has three principal explanations. First, images have a holistic quality, with all of its elements provided as a

comprehensive whole; each single element can evoke the entire image (Bower, 1970, 1972). Second, images are comprised of a figure and background. Background details provide a large number of clues regarding the figure. Third, concepts and words are abstract. Whereas semantic networks strip the concrete attributes of objects, the image retains its unique and distinct nature. In the marketing domain, it seems that despite the large memory load that images charge, they are more accessible and easily elicited by consumers in performing electronic shopping. Keller (1991) notes that the vividness and holistic nature of the information enhances accessibility to internally stored information; the consumer browsing in a highly vivid store is exposed to a larger quantity of familiar cues which facilitate access to stored information.

Nevertheless, high interactive shopping environments are rich with information cues which facilitate retrieval of information from memory. Their advantage is apparent when consumers' imagery of the product category is well developed. Consumers can then make use of their memory when selecting brands for purchase (Alba and Chattopadhyay, 1985; Hutchinson et al., 1994) and in fact the process is then dependent on recall and processing of internal information.

The construction of a network of images at the earlier stages is preferred not only from a cognitive standpoint; it appears to be desired emotionally as well. The high vivid interface, compared to the high interactive interface, allows consumers to be virtually transported to the 3D store space, providing a sense of presence in that space, accompanied by pleasure and desire to prolong the experience (Shih, 1998; Venkatesh, 1998). A useful image of a desired brand generates positive arousal that increases the desire for the brand. In addition to the positive affect stemming from the image itself, the image of consuming the brand generates concrete positive emotions and emotional benefits.

3.1. Impact of interface differences on search duration and brand examination

The foregoing review may have important implications regarding the time that consumers spend in the shopping interface, the number of brands they wish to pick-up and examine, and the time each of these brands is to be examined. Regarding the first implication, highly vivid interfaces is expected to extend shopping duration, both because consumers wish to prolong the experience due to their enhanced pleasure and involvement (Celsi and Olson, 1988) and because they are attracted to forming the rich imagery network expected to improve accuracy of their future choices. According to the same reasoning, consumers are expected to prolong the time they spend in examining each brand.

H1. Duration of total search is longer in 3D interface than in the 2D interface.

H2. Duration of brand examination is longer in the 3D interface than in the 2D interface.

This does not imply, however, that consumers will pick-up and examine more brands in a 3D environment. Search processes in 3D interface involve two complementary processes. The first one places more emphasis on overall learning and collection of information which occurs during surfing the store in a one-touch navigation. The second process involves comparative analysis, which occurs at time of product pick-up. While the first requires little cognitive resources and involves mainly pleasure, the second requires added cognitive resources. In addition, pick-up products cause repeated breaks in surfing the store and inhibit pleasure while surfing the store. This last process has high cognitive effort and is perceived as interference with surfing experience. In this case the consumer wishes to minimize the interference by limiting the number of pick-ups performed. Isen and Means (1983) found that when consumers are in a positive mood, they prefer to limit the range of their search. The researchers concluded that consumers prefer to prevent a negative affect of the search process on their positive emotional state.

Thus, we hypothesize:

H3. The number of examined brands is larger in 2D interface than in the 3D interface.

3.2. The effect of prior knowledge

Prior knowledge has been found to play a dual role in search behavior. A number of studies have indicated an inverse relation between the scope of existing knowledge and the amount of external search (Moore and Lehmann, 1980; Newman and Staelin, 1972). In contrast, other studies (Srinivasan and Ratchford, 1991; Beatty and Smith, 1987) indicate a positive relation between prior knowledge and search. One other interesting finding was that moderately experienced consumers process more of the available information and rely less on prior experience than high- and low-experienced consumers resulting in inverse U relationship (Johnson and Russo, 1984).

When an interface permits extrapolating to a context of sequential navigation and exposure to information, such interface superiority depends largely on the consumer's prior representative knowledge. Assume, for instance, that the consumer has just acquired a new pet and is interested in learning about the assortment of pet food brands. Creating a rich imagery network of the brands and products can be achieved by highly vivid interfaces. Navigating in a simulated environment will enable generating the desired knowledge base, which will enable the consumer to enhance accessibility to stored knowledge and perform the choice task most satisfactorily. Highly vivid environments are, therefore, advantageous when the consumer originally lacks such knowledge. In contrast, heavy use of mouse click and complex navigation network demanded by high interactivity

interfaces under similar circumstances, may involve technical complexity of mouse motion, download, etc., which may harm choice performance (Hoque and Lohse, 1999) and even result in overload, miscomprehension, selective processing and inappropriate utilization of the offered information. Finally, regarding on-line verbal information, note that reading verbal information on the screen is slow relative to standard reading speed of printed material (Muter and Maurutto, 1991). Thus, we hypothesize:

H4. Prior knowledge will cause a decrease in shopping duration.

H5. Prior knowledge will be associated with focusing more extensively on fewer, selective, brands.

3.3. Sequence of search

Measurement of the dynamics of search has been successfully applied in past behavioral process research (e.g., Jacoby et al., 1987; Payne, 1976; Bettman and Jacoby, 1976; Payne et al., 1993). One unique aspect of this research that explicates the continuity of search is the "transition analysis" (Jacoby et al., 1976). The method examines the transition from item n to item n+1, out of N items available for examination. While originally the analysis was used for analyzing an item X attribute matrix, it has been adapted in other studies, depending on their focal query. In the present study, the transitions of interest were in accord with the common formats of presentation in Internet interfaces. Thus, four transitions were defined: (1) re-examination of the brands, (2) transitions within a category, (3) transitions to non-complementary category, and (4) transitions to complementary category.

On-line consumers exhibit more exploratory surfing behavior when they experienced positive affect in the beginning of the on-line shopping (Menon and Kahn, 2002). Cross category searching demonstrates this exploratory behavior.

Regarding the focal comparison of the present study, 2D and 3D interfaces are expected to dictate a differential sequence of search by consumers. 2D interfaces typically induce consumers to pursue a structured search strategy that is less exploratory in nature. This is likely to involve transitions within a category and transitions to complementary categories. In contrast, a 3D environment, which enhances enjoyment and exploratory behavior and enables consumers to switch more naturally to different locations in the store (mimicking the formats of actual stores), heightening the accessibility of non-complementary categories as well.

Thus:

H6. In 2D interfaces subjects tend to engage in relatively structured search, namely, progressing by adoption of within category transitions and transitions to complementary categories. In contrast, in 3D interfaces subjects adopt a relatively less structured search strategy.

4. Method

Two comparable interfaces focusing on breakfast products were created. Breakfast products were chosen since those products are well known and demonstrate sufficient variety, which enables subjects to perform a wide-ranging search toward achieving their buying decision. As such, it has been satisfactorily adopted in previous related research (Burke, 1996).

One interface was a 3D cyberstore, which allows navigation in a store environment in a one-touch motion, while enabling participants to examine brands during navigation and express their purchase decisions. The other interface was a 2D hyperlink interactive program with a matching number and kind of brands to that of the 3D interface. Those two types of interface differ in their dominant attribute. While 3D represents a highly vivid interface, 2D has highly interactive interface capability. Descriptions of interfaces and stimuli appear in detail in the Appendix.

4.1. Pretest

The purpose of the pretest was to examine whether the 3D interface enhances enjoyment and satisfaction, relative to the 2D environment. The pretest was conducted among 50 subjects, divided evenly and assigned randomly to the two interface conditions. They were paid for their participation. The subjects were requested to perform on-line purchases of breakfast foods. All subjects were run individually in separate sessions, minimizing the chance of interaction among them. Both "stores" were identical in the available product categories, offerings, prices and information for each product. Study objectives and instructions presented to the subjects were identical in both conditions. All subjects received general instructions on how to conduct an information search and make purchases in the appropriate interface, including a brief warm-up task. They then performed the actual task. After completing their purchases, all subjects were requested to fill out a questionnaire about their enjoyment, satisfaction, and clarity of the available information.

Enjoyment was measured on a seven-point scale anchored by (1) "I did not enjoy using this interface" and (7) "I highly enjoyed using this interface". Satisfaction was measured by a seven-point scale ranging between (1) "I did not find this interface to be very satisfying" and (7) "I found this interface to be very satisfying". In all measures, the 3D interface was significantly higher than the 2D interface ($p<.01$ in all comparisons). In measuring clarity of the information presented ("Not clear at all" (1) to "Very clear" (7)) no significant difference was obtained ($t<1$).

4.2. The study

4.2.1. Subjects and procedure

There were 114 students recruited to participate in the study. They were paid for their participation. As in the pretest, all subjects were run individually in separate sessions, minimizing the chance of interaction among them.

Subjects were assigned randomly into two groups: the first group, consisting of 54 students, was directed to make purchases in a 3D interface. The second group (60 students) made purchases in a 2D interface. The procedure was similar to that described in the pretest: both stores were identical in the available product categories, offerings, prices and information for each product. Study objectives and instructions were identical for all subjects.

Subjects performed a brief warm-up task. After the brief warm-up task and completion of the actual on-line task, all subjects were requested to fill out a questionnaire about their shopping habits and prior purchase experience (see below). Finally, record files of subjects' actual and prior purchase experiences were analyzed to characterize and compare patterns of behavior.

4.3. Measures

The parameters of the search process were drawn directly from the log file, which tracked the search process. Other measures of prior purchase habits were taken by a questionnaire filled out by each of the subjects.

The following parameters were drawn from the on-line purchase log file: overall time elapsing between initiation and termination of the on-line shopping, number of examined brands, duration of brand examination, sequence of search, actual purchases, and the attached budget of the purchased products. All time measures were not affected by time delays attributable to technological reasons.

As a measure of prior knowledge, extent of own purchases of breakfast goods and the frequency versus purchase by others was used. Specifically, the subjects were asked to indicate one of two options: (1) "I generally purchase my food products myself" versus (2) "Someone else purchases the food products, which I consume". Subjects were then asked to indicate the shopping frequency in a genuine supermarket: (0) "I never buy in supermarket myself" (1) "Once in a month", (2) "twice a month", (3) "three times in a month", and (4) "at least once a week".

In order to measure the correspondence between products purchased in the simulated task and purchases performed in daily life, subjects were asked to indicate their favorite "menu", that is, the combination of products they typically consume. Subjects were asked to indicate whether they typically eat cereal with milk, crackers with cheese, etc. In addition, loyalty was measured by asking subjects to indicate on a six-point scale if the sentence "I always buy the same products for breakfast" is "correct" (6) or "incorrect" (1). Internet surfing experience, too, was measured on a two-point scale, (1) "I am experienced in Internet surfing" and (2) "I don't have any experience in Internet surfing".

In order to measure the correspondence between shopper enjoyment and search effort, subjects were asked to indicate if they generally enjoy their shopping in the context of grocery shopping. Specifically, the subjects were asked to point out one of two options: (1) "I enjoy shopping" and (2) "I don't enjoy shopping". Finally, the participants were asked to indicate the amount of money allocated to each category (cereals, cheese, etc.) out of the total expenditure on breakfast products.

5. Results

5.1. Depth and content of search

The first hypothesis focused on the total time subjects spent in the "store". Specifically, we hypothesized that duration of total search would be longer in the 3D interface than in the 2D interface. Indeed, subjects in the 3D interface spent more time in search before making their final choices and terminating the process ($M=378.2$) than those engaging in the high interactive interface search ($M=250.4$; $t(112)=3.68$, $p<.001$), supporting hypothesis 1.

In addition, a significant correlation was obtained between loyalty and shopping duration that was confined only for the case of 3D experience ($r^2=0.275$, $p<.05$) but was not obtained in the 2D experience ($r^2=0.015, p>.9$). Although it would seem that the loyal consumer is generally an efficient shopper and, thus, expected to decrease the shopping duration, this was not supported and in fact reversed in the case of 3D. It seems that the 3D interface stimulated subjects to question or validate their loyalty by searching for a longer time, relative to their non-loyal counterparts.

We further hypothesized (H2) that duration of brand examination would be longer in the 3D experience than in the 2D experience. This hypothesis, too, was supported. Subjects in the 3D environment spent more time examining brands ($M=22.05$) than those in the 2D environment setting ($M=14.9$; $t(111)=3.63$, $p<.001$).

Concerning the number of examined brands, we expected (H3) that the number of examined brands would be larger in the 2D environment than in the 3D environment. Indeed, the mean number of brands examined was higher in the 2D interface environment ($M=8.73$) than in the 3D environment ($M=5.83$; $t(112)=3.10$, $p<.01$). To insure that this finding is not a consequence of a trade-off between duration of brand examination and number of examined brands, we tested the correlation between these variables and no correlation was found ($r=.134$ and $r=.149$, both not significant (n.s.) in 3D environment and 2D, respectively).

Moreover, to control for a possible confounding due to differences in previous shopping enjoyment as well as previous experience with on-line browsing, low and high levels of previous shopping enjoyment and prior on-line

Table 1
Key search and outcome measures in each interface type

	3D experience		2D experience	
	Experienced shoppers	Less experienced shoppers	Experienced shoppers	Less experienced shoppers
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Mean shopping duration	336.23* (178.76)	439.26 (230.7)	249.87 (159.3)	250.28 (169.1)
Number of examined brands	5.00** (2.03)	7.045 (3.26)	8.39 (5.5)	8.946 (6.835)
Mean duration of brand examination	24.78** (14.63)	18.20 (9.91)	16.30 (7.03)	14.02 (7.20)
Overall purchase expenditure	26.437** (11.90)	41.189 (19.15)	36.649 (20.98)	37.486 (21.26)

*Simple effect within the interface type is significant at $p<.05$.
**Simple effect within the interface type is significant at $p<.01$.

browsing experience were compared; in both cases no differences were obtained.

To enable the proposed interpretation it was important to rule out an alternative explanation attributing the difference to novelty disparity or to the added complexity charged by the 3D interface, particularly in view of studies that indicated the possible intervention of these factors in other contexts (e.g. Mehrabian and Russell's, 1974; Kellaris and Kent, 1993; Patterson et al., 1997 for the relevant marketing literature and Sebrechts et al., 1999; Cockburn and McKenzie, 2001; Cockburn and Mckenzie, 2002 for the computer human interface literature). By using novelty and complexity measures used by Novak et al. (2000) we found that no difference exists between the two stimulated stores used in our research. Specifically, all subjects in the study were asked to report the complexity feeling they engage during buying in the virtual store with 4 questions including: (1) "This site has challenged me", (2) "This site provides a good test of my skills", (3) "This site challenges me to perform to the best of my ability", and 4) "I find that this site stretches my capabilities to the limits". To measure novelty, subjects were asked to report their novelty feeling with respect of the following 3 questions: (1) "During the browsing I feel creative", (2) "During the browsing I sense the novelty", and (3) "During the browsing I feel original". Regarding all questions no significant difference was obtained between groups ($p>.10$ in all comparisons).

5.2. Effects of prior knowledge

The subsequent analysis was intended to examine the effect of prior knowledge. Specifically, we hypothesized (H4) that prior knowledge would decrease depth. We also hypothesized (H5) that prior knowledge would result in focusing more extensively on fewer, selective, brands.

Table 1 summarizes these results. Prior knowledge had an impact only in the case of 3D experience environment. In particular, those with high prior knowledge spent less total time in the virtual store. In addition, their search was more focused as manifested in the smaller number of brands they examined, which they viewed for a longer time. In contrast, a comparison within the 2D environment shows that prior knowledge did not affect the above-mentioned parameters of search.

Interestingly, while no difference was found in overall purchase expenditure between the environment types, prior knowledge appears to have played an important role in distinguishing between the two types of experience. The data indicate that the 3D environment is more suitable for the low prior knowledge subjects, resulting in higher purchase expenditure, compared with high prior knowledge subjects. Overall, this difference in patterns of purchase expenditures resulted in a significant interface × prior knowledge effect ($F(1,110)=3.80$, $p<.05$). Note that the interaction effect was not significant for the other parameters reported in Table 1.

In light of the theory and empirical findings regarding the inverse U shape relationships between prior experience and responses reported by Johnson and Russo (1984) further analysis was performed in examining whether such a pattern exists in the present data. The inverse U shape relationships was supported by quadratic curve estimation ($F(1,51)=3.04$, $p<.05$) as showed in Fig. 1 where the exponent was significant ($t=2.09$, $p<.05$). In contrast, no effect was obtained in the 2D environment on the shopping duration time (both the quadratic curve estimation and the exponential term were non-significant).

An inverse U shape pattern was also observed when the number of examined brands was analyzed as showed in Fig. 2. In the 3D condition the quadratic curve estimation was significant ($F(1,51)=3.04$, $p<.05$, exponential term: $t=1.9$, $p<.06$). Unlike the analysis of duration time, in the

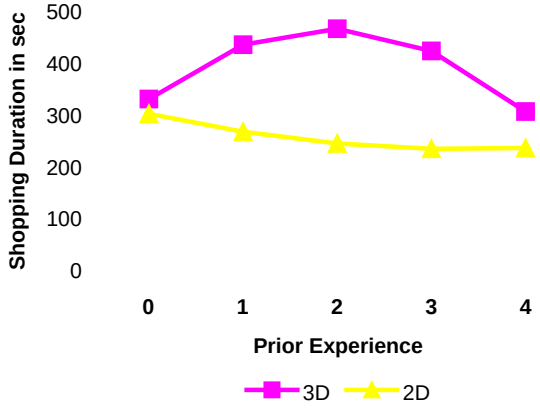

Fig. 1. Relationship between prior experience and search time.

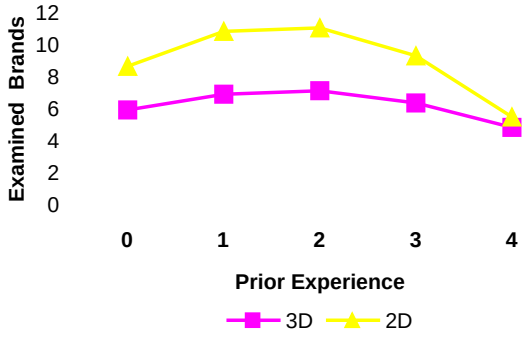

Fig. 2. Relationship between prior experience and number of examined brands.

case of number of examined brands, inverse U shape was observed also in the case of 2D interface, although the estimation was only marginally significant (quadratic curve estimation: $F(1,57)=2.72$, $p<.07$, exponential term: $t=1.94$, $p<.06$).

5.3. Sequence of search

We hypothesized that in the 2D interface subjects would tend to search in a more structured manner, namely, by transitions within a category and transitions to complementary categories and, in contrast, in 3D environment subjects were expected to adopt a less structured search strategy (H6).

Table 2 summarizes the mean number of transitions of each transition type. The results indicate that within the 2D environment subjects tended to switch more within the same category, or to complementary categories. In contrast, the 3D environment had a more frequent occurrence of re-examination of brands and transitions to non-complementary categories. These results support the hypotheses that search was more structured in the case of 2D environment.

Viewed from a different angle, the findings indicate that 3D experience causes consumers to engage in a more "experiential" search and are distracted away from efficiency consideration as opposed to the structured search followed by those engaging in 2D environment. Does this intensive experience also affect consumer preferences?

Table 2
Sequence of search in each interface type

	3D interface	2D interface
	Mean % (SD)	Mean % (SD)
Re-examination of brands	11.7* (19.78)	4.24 (11.64)
Transitions within a category	33.42 (25.72)	49.66** (29.52)
Transitions to non-complementary category	40.22* (25.51)	29.37 (22.18)
Transitions to complementary category	14.64 (21.59)	16.71 (15.19)

*Simple effect within the interface type is significant at $p<.05$.
**Simple effect within the interface type is significant at $p<.01$.

Table 3
Correspondence between prior preferences and on-line purchases

	3D interface (%)	2D interface (%)
Consistent with prior preferences	20.5	44.4
Inconsistent with prior preferences	79.5	55.6

$\chi^2=2.844$, $p<.10$.

To address this question we compared the preferences of breakfast products as indicated by the subjects' past behavior with that manifested in their choices following the on-line task. Table 3 shows the correspondence between past and current preferences. Although only marginally significant, the observed pattern indicates that subjects performing the task in the 3D interface tended to choose products that were less related to their prior preferences relative to the more consistent behavior subjects exhibited in the 2D interface condition.

Further support to this pattern of behavior was found in the data of the relative expenditure subjects devoted to the purchase of breakfast products. Among the most frequently consumed products (cheese and cereals) the correlation between past and present allocation of budgets was highest in the case of 2D experience ($r=.31$, $p<.05$ and $r=.47$, $p<.01$ for cheese and cereals, respectively). In contrast, the corresponding correlation was lower and non-significant in the case of 3D experience ($r=.23$ and $r=.12$ for cheese and cereals, respectively).

6. Discussion

The present paper examines the impact of on-line interfaces on consumer behavior in the framework of "in vivo" decision-making processes. It seems that the high degree of telepresence in the 3D store allows consumers to be virtually transported to the 3D store space, providing a sense of presence in that space, accompanied by pleasure and a desire to prolong the experience.

Prior experience appears to influence the search process in both types of interface. In particular, an inverse U shape emerges in the relationship between two key search characteristics, namely search duration and number of examined brands and the extent of prior experience. Interestingly, however, in the case of duration, the inverse U shape is observed only in the 3D condition. Search duration in 2D was found to be insensitive to the extent of prior experience. In contrast, inverse U shape is obtained for the number of examined brands under both 3D and 2D conditions. The obtained inverse U shape is in accord with previous theorizing and empirical results and suggests that the on-line environment uncovers some new dimensions which enrich this research area. For example, the finding that the inverse U shape in search duration is confined only to 3D conditions represents an extension that generalizes this research paradigm, previously obtained in less dynamic contexts.

Interface type also affects continuity of search, a finding consistent with various studies which focused on the effect of information format on the selection process and strategy and which is also consistent with the premises of the constructive consumer choice process (Bettman et al., 1998; Park and Mittal, 1985). 3D interface shoppers tend to progress in less structured manner while 2D interface shoppers tend to examine within category and other complementary brands.

The 3D experience store format and the arrangement of brands on the shelves and aisles may influence the type of transitions to product categories. The same cannot be said about the 2D experience store in which a complete list of product categories is displayed, allowing consumers to move between categories based on the associative links between categories. The 3D environment, in contrast, inhibits such associative browsing, due to the physical arbitrary arrangement of the brands. One important outcome of display differences is manifested in the experiential nature of navigation in the 3D store, which has the power of converting preferences. In contrast, the 2D environment enables consumers to make better decisions within their awareness and choice sets but inhibits expansion of the considered scope of products and brands and change in their preferences.

Interface type may also affect variety seeking behavior and purchase composition. Such a conclusion is consistent with results of studies that suggest that boredom and low stimulus level are key factors contributing to variety seeking behavior (Lattin and McAlister, 1985; McAlister, 1982). Although the high degree of similarity between the traditional shopping experience and the 3D environment store potentially leads to certain boredom on the part of the consumer, picking-up brands most likely dispels the boredom and offsets it. The position of Ratner et al. (1999), suggesting that brand pick-ups also stem from the pleasure derived from this action may also be valid in the present context. The present findings regarding variety seeking behavior are partially supported by conceptualizing such behavior as part of the consumer's learning strategies (Ratner et al., 1999). This may indicate a far-reaching effect that goes beyond a single purchase situation. Further investigation on this aspect of behavior is recommended.

Differences between interface types transcend the differences previously identified among information display formats (Russo, 1977; Russo and Lecelerc, 1991). Indeed, the latter has been intensively researched in the past when the speed of interaction and the richness of the pictorial and verbal information were far less developed than those that are currently developing. Thus, by reducing the cognitive effort the consumer can use a more accurate strategy. Those findings were supported by a study of Johnson et al. (1988) about strategy shifts as a function of information format display. However, it is not surprising that the criticism about artificiality and validity issues about the ability of traditional formats to mimic the real world formats was more relevant in the case of traditional format. Nevertheless, current studies on display types should be distinguished from traditional research on formats in at least three perspectives. First, the traditional formats' orientation was on emphasizing the mode of information delivery whereas the current type's emphasis is on the interactivity. Second, the 3D experience may be perceived as a phase transition enabled by the current and developing resources. Finally, differences between the traditional displays and the current ones may also reflect differences in the buying strategies which is a query raised in previous research as well (e.g., Johnson et al., 1988; Bettman et al., 1998). For example, the advanced virtual shopping enables consumers to engage in impression formation and perform an exploratory search to get the true feeling of "being there" in a genuine store, as their initial shopping objective. Such a strategy is unlikely possible by the traditional information display options.

Despite all these differences, it is notable that the hypotheses in the present research, which emanated from previous findings, were generally supported and confirmed for the context of advanced on-line interfaces. It indicates the robustness of consumer inherent search processes and that future research in this direction should focus on adaptability of past theories rather than on remarkable changes and discontinuous differences.

Appendix A. Interfaces and stimuli

A.1. 3D interface store

The store was developed and installed on a UNIX server using a Silicon Graphics computer. The website was based on VRML technology (partially using JAVA and COSMO capabilities) which allows the representation of three-dimensional images and browsing through the cyberstore (see Fig. 3). To guarantee high response time related to the heavy

Fig. 3. 3D Interface environment.

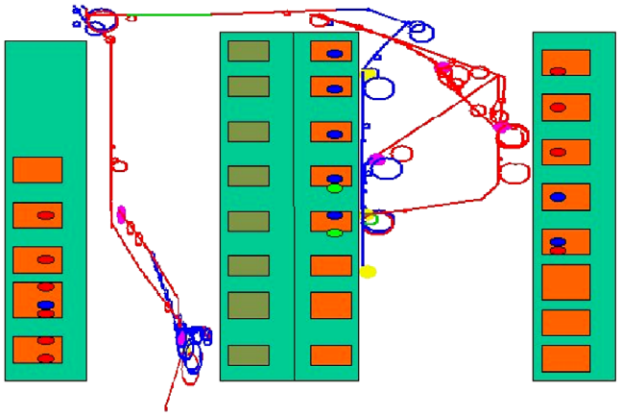

Fig. 4. 3D Interface log.

graphic components in the highly vivid interface, the study was conducted on the web server itself. The store consists of two active aisles on the shelves on which various breakfast-related packages were placed. In order to simulate an actual store environment, background images of a traditional store including checkout counters, vegetables and other products, were displayed. Using a Netscape browser, subjects entered the store website. The initial screen displays a 3D depiction of the store and a control panel. Subjects browsed using a mouse and control panel keys displayed in the lower portion of the browser dialogue box.

By pressing either the upward or downward buttons the subjects could first adjust "their height" in the store. They then began moving around in the store by pressing on the mouse (one touch) and moving it, according to the coordinates and speed they desired. Selection of the appropriate buttons on the control panel during the search itself elevated or lowered the consumer's perspective, allowing subjects to focus on the contents of the desired shelf. When interested in focusing on and further examining a brand on the shelf, a double click on a brand would allow subjects a close up view of the brand. A new window was opened, in which the brand was displayed enabling 3D rotation and taking a close or long view of the product. To terminate the action, subjects indicated whether they wanted to "buy" or "not buy" the brand and return to the store by pressing on the appropriate buttons. This sequence constituted a brand "pick-up". The subjects could continue this shopping tour until they decided they purchased the breakfast products they desired.

This software tracked and recorded the browsing, the purchase activities, and the relevant time intervals. These data were stored in a log file, which was decoded in graphic form at a later stage (see Fig. 4). The following are the key recorded characteristics:

- Colored lines between the shelves represent buyer's movement. Different colors represent buyer's viewing angle during navigation (red—bottom shelves; green—middle shelves; and blue—top shelves).
- Colored circles represent a product picked-up by the buyer. A yellow circle represents a purchase while a purple circle represents a non-purchase pick-up. By pressing on the circle a snapshot of the store is elicited bringing back the exact position and angle from which the brand was originally picked-up for examination.

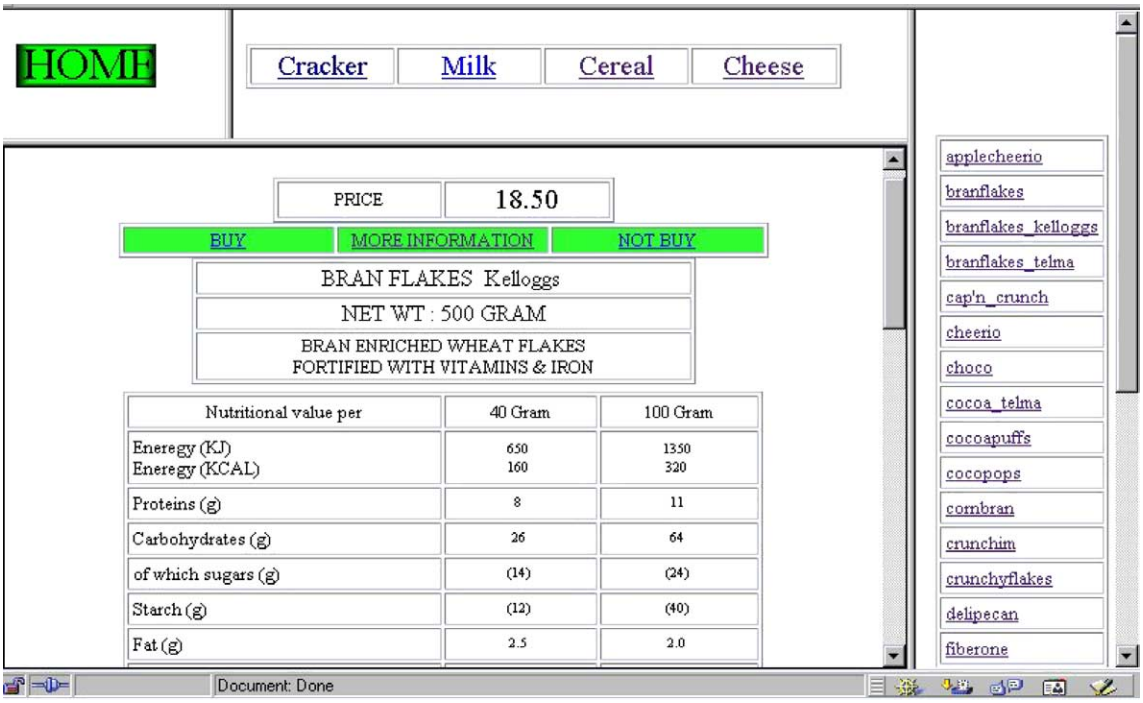

Fig. 5. 2D Interface environment.

– Unfilled circles represent places where buyers stopped for an extended period. Size of circles represents duration of pause. The point on the shelf that attracted buyer's attention is also marked.

A.2. 2D interface store

The PC workstation on which the software was installed was equipped with an Internet server. The site is based on standard HTML technology including windows-like representation of work screens combined with PERL language elements, which enable the recording of purchase actions (see Fig. 5).

Four screens (windows) were developed for the store including: a "categories screen" displaying a list of product categories; a "products" screen displaying a list of products belonging to the selected category, an "information" screen displaying product information and an "exit" screen which allows the buyer to exit the store. The "information" screen contained textual information—the available verbal information related to the product. It also made visual information available—an image of the product, from all sides—6 images in total.

Similar to the 3D store, four identical breakfast product categories were defined (milk, cheese, cereal products and crackers). Browsing was exclusively mouse-enabled. This choice of products comprised sets of what is typically consumed as complementary product classes (milk and cereals, cheese and crackers) versus sets of categories that can be generally perceived as non-complementary which consist of different combinations of these categories (e.g., crackers and cereals).

Subjects accessed the store through a NETSCAPE browser. Browsing and information search was enabled by pressing screen links using a mouse. In the entrance to the store, a category screen displayed a list of the four product categories participating in the present experiment. The subjects clicked to select a category. A product screen appeared with a list of the products in the selected category. Upon clicking on one product to access the information screen relating to the selected product, textual information appeared. The buyer could make a purchase, request additional information (an image of the product) or continue the search for another product. If subjects selected "additional information", a screen appeared with the product's image. The subject then had the choice of making a purchase, returning to textual information or continuing search, similar to the 3D environment.

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