Controlling the Information Flow: Effects on Consumers' Decision Making and Preferences

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One of the main objectives facing marketers is to present consumers with information on which to base their decisions. In doing so, marketers have to select the type of information system they want to utilize in order to deliver the most appropriate information to their consumers. One of the most interesting and distinguishing dimensions of such information systems is the level of control the consumer has over the information system. The current work presents and tests a general model for understanding the advantages and disadvantages of information control on consumers' decision quality, memory, knowledge, and confidence. The results show that controlling the information flow can help consumers better match their preferences, have better memory and knowledge about the domain they are examining, and be more confident in their judgments. However, it is also shown that controlling the information flow creates demands on processing resources and therefore under some circumstances can have detrimental effects on consumers' ability to utilize information. The article concludes with a summary of the findings, discussion of their application for electronic commerce, and suggestions for future research avenues.

One of the main objectives facing marketers is to present consumers with information on which to base their decisions (Anderson and Rubin 1986; Bettman 1975). Presenting such information is not simple, and it contains an interesting dilemma. On the one hand, a vast amount of information could be relevant, even very relevant, to some consumers. On the other hand, presenting superfluous information might impede consumers' ability to make good decisions (Bettman, Johnson, and Payne 1991; Jacoby, Speller, and Berning 1974; Malhotra 1982; Scammon 1977). Therefore the task facing marketers is not simply to present consumers with every piece of semi-related information but, rather, to present consumers with information that is *appropriate* for their specific current needs. The difficulty is that marketers cannot always know a priori what information is needed for any individual consumer. Without knowing what information is relevant, the amount of information that is potentially relevant can be very large. In order to solve this difficulty, marketers can provide consumers with interactive information systems that allow consumers to be appropriately selective in their own information search (Alba et al. 1997; Bettman 1979; Bettman and Zins 1979; Hoffman and Novak 1996; Wilkie 1975). In the spirit of this idea, the central goal of the current work is to examine the benefits and disadvantages of providing consumers with the ability to control the flow of their information system (control over what information will be presented, for how long it will be presented, and what information will follow). Such control over the information flow (information control) represents a fundamental way in which information systems can react and change in response to consumers' actions, creating interaction between the information system and the consumer.

The idea that different information systems provide consumers with different levels of information control has long been noted in the marketing literature (Bettman 1979; Weitz 1978; Wright 1973). In order to clarify this concept of information control, consider its levels for television and for print ads. In the case of television ads, consumers can change the channel or turn off the television set. Aside from this limited freedom, consumers have no control over what information will be presented, in what order, or for how long this information will be presented. On the other hand, in the case of print ads, consumers have much more freedom to choose the order in which to examine the different aspects of the ad as well as the amount of time and attention to give these aspects. For example, a consumer can browse through a newspaper to see which retailer has a certain model of Macintosh computer rather than paying attention to adjacent ads.

Although the concept of information control has been around for some time (Bettman 1979; Weitz 1978; Wright

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1973), with the development of computers and computerized networks, understanding information control has become much more important. This increase in relevance is primarily due to two characteristics of electronic communication. First, while traditional mass communication media such as television and print ads differ on their level of information control, this difference has not been very large. In contrast, electronic communication has the potential for extremely high levels of information control, tremendously increasing its possible range. Second, while traditional communication media have a fixed level of information control (e.g., television has a very low level of information control), the level of information control of electronic communication channels is variable and can be chosen by the marketer or information provider.

BENEFITS AND DISADVANTAGES OF INFORMATION CONTROL

Much like information search (Hagerty and Aaker 1984; Ratchford 1982), control over the information flow seems to have both advantages and disadvantages (benefits and costs). In terms of benefits, information control allows consumers to deal with information systems that better fit their individual informational needs and are more flexible (Kleinmuntz and Schkade 1993; Schkade and Kleinmuntz 1994), whereas in terms of the costs, information control requires the user to invest processing resources in managing the information flow. In the next sections, the mechanisms underlying the advantages and disadvantages associated with information control will be presented in more detail. The empirical part of the article will test the different aspects of information control, and the results will be discussed with regard to their implications for interactive media and in particular to electronic communication and commerce.

Advantages of Controlling the Information Flow

Initial support for the benefits of information control comes from work on learning relationships in probabilistic environments (see Hammond, McClelland, and Mumpower 1980; Hammond et al. 1975). In an interesting paper, Klayman (1988) examined how control over the learning environment influences subjects' ability to learn probabilistic relationship among attributes. Learning these relationships was done under one of two learning environments. In the interactive environment subjects determined for themselves the configuration of the stimuli to be tested (size, shape, and shading), while in the noninteractive environment subjects were given a specific and predetermined learning environment. The results showed that compared with subjects who were given a fixed learning environment, subjects who designed their own learning environment were more effective learners and had a better command of the environments' underlying structure.

Similar results were also found by Kuhn and Ho (1980) in a paper on the development of children's thinking. In this work, Kuhn and Ho (1980) showed that children who could choose the games in which they wanted to engage (a high level of control) had an improved ability to create new reasoning strategies compared with yoked (a low level of control) and control subjects. This improvement in reasoning ability was attributed by the authors to an improvement in the anticipatory schemas regarding the outcomes of their actions. That is, control not only improved understanding of a specific task but it also caused a more global improvement in formal operations.

Combined, these results suggest that information control improves performance by improving the fit between actions and outcomes and by improving anticipatory schemes (see also work on the development of the visual system, Held and Hein [1963]). In addition, increasing the ability to control information flow should also increase consumers' ability to explore and understand the information structure. Thus, the core hypothesis of the current article is that information control is beneficial because having an interactive and dynamic information system can maximize the fit between heterogeneous and dynamic needs for information and the information available (Alba and Hutchinson 1987; Einhorn and Hogarth 1981; Payne, Bettman, and Johnson 1993).

Within this general heterogeneity argument, information control seems to have two possible benefits: the first has to do with heterogeneity between consumers (Beatty and Smith 1987; Furse, Punj, and Stewart 1984; Jacoby, Chestnut, and Fisher 1978), and the second has to do with heterogeneity within consumers over time (Hauser, Urban, and Weinberg 1993). The first component of heterogeneity (which will be termed "individual heterogeneity") is conceptualized as a stable overall difference in individuals' preferences for information presentation and processing. For example, one consumer may prefer to view information by attributes, while another might prefer to view the same information by products. Consequently, consumers would choose different preferred formats on a permanent basis. One example for such a difference is the differential preference consumers have for content in "push technology" on-line media. The second, and more interesting, component of heterogeneity (which will be termed "dynamic heterogeneity") is conceptualized here as the changing needs for information during the information acquisition process itself (see Beach 1993; Wright and Barbour 1997). The notion of dynamic heterogeneity is that the benefits of controlling the information flow arise from the fact that information control allows for testing and updating hypotheses based on one's mental model. The human brain is assumed to be a sense-making organ, and having control over the environment permits information acquisition to be integrally linked into the act of sense-making. Having control over the stimuli allows consumers to generate and test the hypothesis in which they are interested. Such conceptualization of dynamic heterogeneity relates to the idea of constructive preferences and contingent strategies, where the information presented itself changes the need for future information (Payne et al. 1993; Slovic, Griffin, and Tversky 1990). As an example of this dynamic heterogeneity component, consider a consumer who notices a diagnostic difference on some attribute that changes his perception of different attributes and hence his needs for future information (see Ariely and Wallsten 1995; Montgomery 1983).

These two aspects of information control (individual heterogeneity and dynamic heterogeneity) are typically confounded or correlated in most real world information systems. High levels of information control often allow the users of information systems to have an overall strategy for the information presentation, while at the same time enabling them to pick specific characteristics of the information itself. Nevertheless, the task of teasing these two aspects apart could be theoretically important and will be dealt with later (experiment 3). To summarize, although the exact origin of the benefits related to information control is not yet clear, there are theoretical reasons to suspect that there is much potential for these benefits to emerge. However, as mentioned earlier, there are also reasons to suspect that information control can be associated with increased demands on processing resources and therefore could have a negative effect on consumers' ability to process information (Bettman 1975; Bettman, Payne, and Staelin 1986; Scammon 1977). The ideas underlying the processing costs of information control are presented in the next section.

Disadvantages of Controlling the Information Flow

In a highly interactive environment, having to control the information flow can be seen as a task in itself (see Posner 1986; Treisman and Davies 1973). In such environments, consumers have to perform two tasks: one is to understand the information and the second is to manage the information flow (choose what information will be presented first, for how long, what aspects of the information will be perused next, and in what order, etc.). If processing resources are limited (Broadbent 1971; Kahneman 1973; March 1978; Treisman 1969), such dual tasks can cause consumers in highly interactive environments to have reduced resources available to process the information itself (Anderson 1983).

More direct evidence supporting the idea that a secondary task can increase cognitive load and hence impede performance in the primary task comes from work on learning tactile mazes. Bongard (1995) showed that increased control over punishment contingencies causes subjects to have higher cardiovascular activity, increases the load on their cognitive capacity, and as a consequence decreases their performance on a comprehension task. Similarly, in their work on learning tactile mazes, Richardson, Wuillemin, and MacKintosh (1981) demonstrated that subjects who had control over the pattern of maze learning showed worse performance and learning speed compared to the passive (yoked) subjects who only experienced the maze and did not determine the search pattern within it. In sum, both of these studies on dual tasks show that under some conditions, the need to make decisions in one task (controlling the task) increased demand on cognitive resources and, because of cognitive limitations, decreased performance in the comprehension task.

Controlling the information flow in computerized search tasks is different from traditional dual tasks in two important ways (see Posner 1986; Shiffrin and Schneider 1977; Spelke, Hirst, and Neisser 1976). First, while in the dual task literature the tasks are usually independent from each other, in our case the two tasks of processing the information and managing it are related and depend on each other. Second, this dependency is in the "wrong direction." In the dual task literature there is a main task and a secondary task, and limited capacity is demonstrated by lower performance on the secondary task. In our case, the main task of understanding the information is dependent on the secondary task of managing it. In other words, in order to perform well on the main task (understand and judge the information), subjects have to be able to perform well on the secondary task (manage the information system). Despite these interesting differences, the ideas of increased demands due to additional tasks and their potential detrimental effects are applicable and most likely even stronger due to their dependency.

Summary and Hypotheses

To summarize, it seems that information control has both positive and negative effects on performance. The positive effect is due to the value of the information itself combined with the user's ability to select and process the specific information that is most relevant to the user (heterogeneity). The negative effect is due to the additional resources demanded by the task of managing the information flow coupled with limited processing capacity. In addition, considering information control as a task by itself with its own demands brings to mind notions regarding learning and automaticity over time (Alba and Hutchinson 1987; Bryan and Harter 1899; Spelke et al. 1976). As consumers continuously engage in such tasks, the cognitive effort required for controlling the information flow can be reduced, which can free some of the cognitive resources for processing the information itself.

A central prediction of these ideas is that for very simple electronic stores, having high information control will be better than having low information control. However, when dealing with electronic stores that are more complicated to understand and use, the pattern of results will be different. In such cases, the implication is that on initial use consumers who have high information control will suffer a larger performance loss than consumers who have low information control. However, with increased experience, consumers who have high information control will be able to improve faster and perform better. Therefore the overall prediction is a three-way interaction between the level of information control, the cognitive load imposed by the information system, and the amount of experience with the interface. The form of the interaction is that having high information control in a simple system always provides an advantage, but for more complicated systems having high information control is initially detrimental, and its positive effects reveal themselves only over time.

Thus far, general conceptualization for information control and its mechanism has been presented. The remainder of the current work is organized as follows: the first three experiments primarily address the benefits of information control in terms of ability to process and integrate information. Experiment 1 examines performance in the context of an agent/principal task, and experiment 2 examines performance for one's self. Having demonstrated the advantages of increased information control, experiment 3 attempts to tease apart the two different heterogeneity components underlying the benefits of information control (individual heterogeneity and dynamic heterogeneity). After achieving a better understanding of the potential benefits of information control, experiment 4 tests the full set of ideas, particularly the costs associated with information control. Finally, experiment 5 examines the consequences of information control for memory and knowledge structure about the decision environment.

EXPERIMENT 1: IS INFORMATION CONTROL USEFUL?

In order to test the effects of information control, a simple IHS (Interactive Home Shopping) simulation was created in which subjects were given information about different cameras and were asked to rate the overall quality of these cameras. Subjects performed this task under either high or low levels of control over the information flow. In the High-InfoControl condition subjects had complete freedom in selecting the sequence characteristics in which the information was displayed, whereas in the Low-InfoControl condition subjects had no freedom in determining the information's sequence characteristics, and they viewed the information in a manner similar to viewing a movie.

Method

Subjects. Thirty-six subjects participated in this experiment for class credit. In addition, a reward of $20 was promised to the subject with the best overall performance. During the task each subject examined and rated nine different cameras, taking approximately 10 minutes. Subjects were randomly assigned to either the High-InfoControl or Low-InfoControl conditions.

Task. In order to determine decision quality, it is useful to compare the judgments subjects make to a set of optimal judgments. For this reason an agent/principal task was utilized. In this task, subjects were given the importance (weight) that the principal places on the different attributes (we will refer to those as the principal's utilities) and were asked to make judgments according to these utilities (Ariely and Wallsten 1995; Huber, Ariely, and Fischer 1998; West 1996). One could argue that such agent tasks are not common; however, many of the decisions we make in our day to day lives are indeed agent tasks. For example, when we buy presents, go to restaurants or movies, and even buy food at the grocery store, the focus of many of these decisions is aimed at pleasing others and not ourselves.

At the onset of the experiment subjects were introduced to the task, given explanation about the product category, and were given three examples of the cameras in the set (including the best and the worst). Each of the cameras was depicted along four dimensions (lens, body, shutter, and engine), which were described and explained to the subjects. Ratings on these four dimensions were on a common 0–100 scale, with low numbers representing low desirability levels and high numbers representing high desirability levels. All other attributes were said to be equal. During the main task subjects were asked to use the computer interface to learn about the different cameras so that they could rate them according to the principal's utilities.

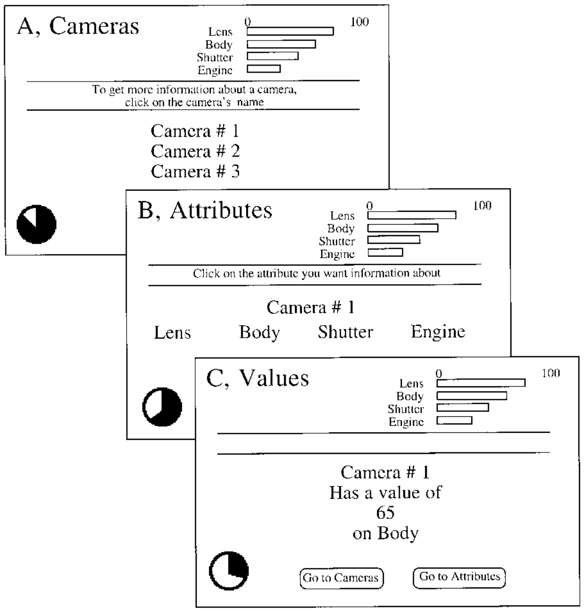
The nine different cameras were divided into three sets of three cameras each. Each of these three sets (composed of three cameras) was presented on a different trial for subjects to examine and evaluate. On each of the three trials, subjects first viewed information regarding the three cameras in the set and were then asked to rate each of them on a scale from 0 (not attractive at all) to 100 (very attractive). This task was repeated three times for each subject, so that nine cameras were examined and evaluated in total. Order of the cameras within and between trials was counterbalanced between subjects.

Stimuli. The stimuli were structured based on three levels (30, 60, and 90) for each of the four attributes (lens, body, shutter, and engine), which were combined to yield the 3^4 basic orthogonal design (see Addelman 1962). By using this approach the stimuli represented the entire range on the different attributes while at the same time keeping the correlations between the different attributes at zero, thus allowing maximally efficient estimates of utilities (attribute importance weights). These nine cameras constituted the basic camera set upon which all stimuli were based. The principal's "true" utilities were computed by assigning unstandardized weights of lens 85, body 70, shutter 55, and engine 40. By plugging each camera's (0–100) scores on those four dimensions into the principal's objective function, the overall value and rank order of each camera was calculated. Finally, in order to avoid regular values (such as multiples of 10) and to make the cameras appear more realistic, a small random component ($\pm$10 percent) was added to each of the values on each of the cameras. This random component was such that the rank ordering of the different cameras was not changed and values of 100 or above were excluded.

Procedure. The interface was presented as a hierarchical information system with three cameras represented at the top layer of the hierarchy, the names of the four attributes at the second level, and their values at the third level (see Fig. 1). Subjects were randomly assigned to pairs, and within each pair one subject was assigned to the High-InfoControl condition and one to the Low-InfoControl condition. During

FIGURE 1

AN EXAMPLE OF THE SCREENS IN THE HIERARCHICAL INFORMATION SYSTEM



NOTE.—Panel *A* represents the highest level of the system, panel *B* the middle one, and panel *C* the lowest level. Note that subjects in the Low-InfoControl condition viewed only the screens represented in panel *C*.

the task, subjects in the High-InfoControl condition had three minutes[1] to view the information before rating the three cameras in a set. During this time the High-InfoControl subjects were free to choose which pieces of information to view and for how long. Selection of information was done by using the mouse and clicking on different parts of the screen (see Fig. 1). Subjects in the Low-InfoControl condition were exposed to the same value information in the same order and timing as the High-InfoControl counterpart to whom they were yoked. These subjects could not control their flow of information, nor did they get the screens that allowed them to control the information flow (panels 1*A*, 1*B*). Once the time for examining the information was up, subjects in both conditions were asked to rate the three cameras in the set on a scale from 0 (the worst of all) to 100 (the best of all).

Results

In order to test whether information control has an impact on performance in an agent/principal judgment task, two types of performance measures were created: a rating-error measure and a weighting-error measure. The rating-error measure examines the difference between the subjects' and the principal's overall ratings. The weighting-error measure examines the fit between the declared importance weights of the principal (the true utilities) and the recovered utilities based on subjects' responses. These two types of measures will be discussed next.

The rating-error measure was composed of the mean absolute difference between the ratings each subject gave to the nine different cameras and their true ratings according to the principal (mean absolute rating error). Results for the rating-error measure showed that performance was better (i.e., closer to 0) in the High-InfoControl condition (M = 11.56) than in the Low-InfoControl condition (M = 18.7, $t(17) = 5.35$, $p < .001$). This result indicates that subjects in the High-InfoControl condition rated the different cameras in higher agreement with the principal, implying that they had better ability to integrate the information in this task.

The weighting-error measure was very different in nature and was based on the differences between recovered and true utilities. In order to develop this measure, the ratings of each individual subject were regressed on the values used for the nine different cameras (Ratings $= \beta_0 + \beta_{\text{Lens}} + \beta_{\text{Body}} + \beta_{\text{Shutter}} + \beta_{\text{Engine}}$). The overall results showed that the fit of the models were better in the High-InfoControl condition ($\bar{r} = 0.90$) than in the Low-InfoControl condition ($\bar{r} = 0.77$, $t(17) = 2.57$, $p < .01$), indicating that subjects in the High-InfoControl condition used their utilities (regardless of their exact value) in a much more consistent way than subjects in the Low-InfoControl condition. However, consistency does not necessarily imply better performance. Imagine, for example, a situation in which subjects in one of the conditions simplify the task by consistently using only one of the attributes to make their judgments. In such cases the regression model would capture almost all of the variance and hence yield a very high fit. Nevertheless, because of the simplification process these subjects would perform very poorly on the task of acting according to the principal's utilities. Therefore it is clear that in addition to the overall fit, a more careful look is required at the match between the utilities recovered by the regression models and the true utilities of the principal.

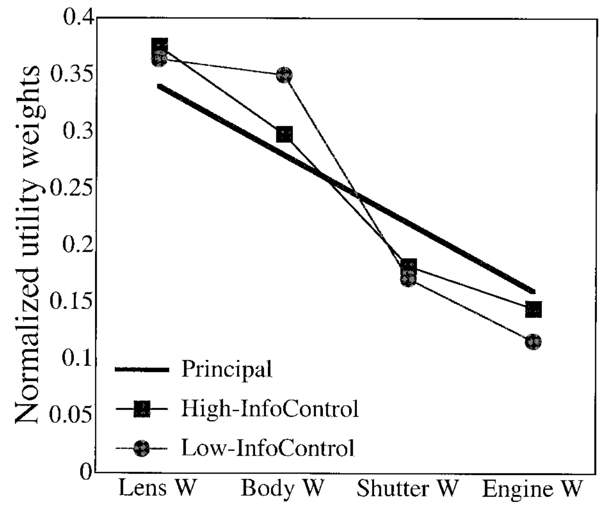
In order to examine the utility fit, the recovered utilities for each subject were estimated and transformed to a common scale in which the sum of the utilities was equal to 1. This transformation was done by dividing each of the recovered utilities by the sum of the four recovered utilities. By using this approach, the recovered utilities could be directly compared with the principal's (true) utilities. Next, the mean absolute deviations between the true weights for each of the four attributes and the four (transformed) weights estimated for each subject were calculated and compared across the two InfoControl conditions. The results showed that the mean of this weighting-error measure was smaller for subjects in the High-InfoControl condition (M = 6.4) than for subjects in the Low-InfoControl condition (M = 11.9, $t(17) = 4.43$, $p < .001$). Since this difference score is

[1]This value (as well as many of the other specific values used) was based on pilot experiments carried out with slightly different interface and stimuli.

a composite of four different attributes, one can also examine the fit between the two sets of utilities separately for each of the attributes. As can be seen in Figure 2, subjects in both conditions seemed to overestimate the two most important attributes (lens and body) and underestimate the two least important attributes (shutter and engine). However, this tendency was much stronger for subjects in the Low-InfoControl condition, which is the main reason for their diminished match and fit with the principal's utilities.

FIGURE 2

THE PRINCIPALS AND RECOVERED UTILITIES FOR THE HIGH AND LOW INFOCONTROL CONDITIONS



NOTE.—Each set of utilities is converted to a scale such that the sum of utilities in each set is equal to one.

Discussion

The goal of experiment 1 was to test whether differences in the level of control over the information flow produce differences in task performance. The results clearly support the notion that increased information control leads to increased performance for this simple task. This performance increase held for both the rating-error and weighting-error measures. The rating-error measure showed that subjects in the High-InfoControl condition rated the different cameras in a way that was more consistent with the principal. The weighting-error measure showed that subjects in the High-InfoControl condition were more consistent in their use of the model and matched the principal's utilities better. In addition, looking at the differences for the four individual utilities revealed an interesting pattern in which subjects in the High-InfoControl condition treated the weights of all four attributes differentially, while subjects in the Low-InfoControl condition simplified the task and treated the two most important attributes similarly.

EXPERIMENT 2: THE SELF-EXPRESSION EXPERIMENT

So far the discussion of information control has been expressed in terms of individual preferences, while experiment 1 utilized an agent/principal task. By using such a task, subjects did not express their own preferences but, rather, the utility structure of a known principal. The decision to use such an agent/principal task was made in order to achieve better measures of decision quality and accuracy. However, using such a task assumes that the process for expressing a principal's utilities is similar to the process by which one's own utilities are expressed. Although consumers commonly engage in agent tasks when purchasing goods for others (West 1996), being an agent for a principal with well-known and articulated utilities is not as common. Therefore, the goal of experiment 2 was to test if the same pattern of results hold when expressing one's own preferences. Note that the assumption made in experiment 1 (and again in experiments 3 and 4) is that the task of expressing utilities for one's self and for others does not interact with the factors manipulated in these experiments. In general this assumption seems reasonable, but nevertheless it is desirable to test it empirically.

Method

Subjects. Forty subjects participated in this experiment in exchange for $10. In addition, a reward of $20 was promised to the subject with the best overall performance. During the task each subject examined and rated 36 different cameras, taking approximately 40 minutes. Subjects were randomly assigned to either High or Low InfoControl conditions.

Task, Stimuli, and Procedure. The overall task was similar to the task in experiment 1, involving the same cameras and the same basic interface. There were, however, three main differences between the procedure used in this experiment and the one used in experiment 1. First, subjects in this experiment were asked to make judgments for themselves and not for the principal. Second, in order to increase the stability of the data, subjects examined and rated the three sets of three cameras twice, making it a total of 18 cameras during the main task (this was also done in experiment 3). Finally, since in this experiment there was no principal and therefore there was no standard of perfect performance, subjects' own ratings were used as a benchmark for their own performance. For this purpose, subjects were also asked to engage in two concurrent rating tasks of nine cameras that were based on the same structure of the cameras in the main task but different in their values. During each of the concurrent rating tasks, subjects simultaneously saw descriptions of nine cameras and were asked to give each of them an overall rating on the same scale they used to evaluate the cameras in the main task. By using this procedure, the concurrent rating task was simpler than the main task since it required no information search or memory. The utilities extracted from these two concurrent rating tasks were used as the standard for that particular subject.

Results

Because in this experiment there was no agent, the performance measures used were based only on subjects' consistency and not on performance accuracy. This drawback of self-preference measures is the main reason for using agent/principal tasks. First, as in experiment 1, the rating judgments for each subject were regressed on the structure of the orthogonal design. The overall fit of the individual's utility models to the rating (*r*) was taken as the consistency with which each subject used his own utilities and was in turn interpreted as a measure of performance level. Aside from the logical base for using consistency as a surrogate for performance level, additional support for this interpretation comes from the relatively high correlation between these two measures of weighting-error in experiment 1 ($r = 0.68$). The consistency results gave rise to the same conclusion as in experiment 1, where subjects in the High-InfoControl condition had a higher average consistency ($\bar{r} = 0.85$) than subjects in the Low-InfoControl condition ($\bar{r} = 0.74$, $t(19) = 2.70$, $p = .014$).

In addition to the consistency aspect of the weighting-error measure, an additional measure of weighting error was introduced in the current experiment. This measure was of a different nature, and it was based on the differences in the recovered utilities between the hierarchical information search task and the concurrent rating task. In essence this measure compares the attribute weighting when all the information is presented concurrently to when it is presented sequentially. Therefore, the difference between these two tasks can be used as an indication of the ability to integrate information over time, where smaller differences indicate a higher ability to integrate information over time. To construct this measure, a regression model was used on the concurrent rating tasks to recover each individual subject's utilities (based on 18 evaluations). Next, for each subject, the standardized utilities recovered from the concurrent rating tasks were compared to the standardized utilities recovered from the hierarchical information task. The mean absolute difference between these two was taken as a measure of ability to consistently make judgments across tasks. The results for this aspect of the weighting-error measure were again in the same direction, where subjects in the High-InfoControl condition had a higher judgment consistency ($M = 6.8$) than subjects in the Low-InfoControl condition ($M = 18.1$, $t(19) = 1.75$, $p = .096$).

Discussion

The goal of experiment 2 was to test whether the conclusion drawn from experiment 1 generalizes to individual preferences. Two measures of weighting error were used to evaluate performance in this self-task, and both indicated that performance in a simple task improves with increased information control. Therefore, the main conclusion from experiment 2 is that the results of experiment 1 do not seem to be due to the agent/principal task. Rather, the increase in performance associated with increased information control generalizes to expressions of both utilities for one's self and others. The following two experiments therefore will utilize an agent/principal task, while the conclusions will be assumed to hold for both agent/principal and self-tasks alike.

EXPERIMENT 3: BENEFITS OF INFORMATION CONTROL?

After establishing that for simple information systems, information control seems to improve subjects' ability to make good decisions, the next logical question one needs to ask concerns the origin of these benefits. Earlier, it was suggested that the source of these benefits is the heterogeneity in information needs (Beach 1993; Payne et al. 1993; Wright and Barbour 1997). More specifically, it was suggested that information control has two main components for its possible benefits; the first has to do with heterogeneity between consumers, and the second has to do with heterogeneity within consumers over time (individual heterogeneity and dynamic heterogeneity, respectively). A third explanation entailing anticipatory schemas was also offered as a different type of benefit that highly interactive environments could offer.

In order to separate these three explanations, two new conditions were introduced (Known-InfoControl and Self-InfoControl). In the Known-InfoControl condition, subjects viewed the information much like subjects in the Low-InfoControl condition, but with advance knowledge of the search strategy. This was done by giving subjects in this condition a map describing the search strategy for each of the three trials in the experiment. This map was based on a grid which showed the sequence of information that they would be exposed to on the next trial (shutter for camera 1, shutter for camera 3, lens for camera 2, etc.), but without specifying their actual information. As in the Low-InfoControl condition, the search itself (as well as the map) was based on the search pattern of the matching subject in the High-InfoControl condition. In the Self-InfoControl condition, subjects were asked to indicate their search strategy for each next trial, and this strategy was carried out for them. In order to indicate their preferred sequence of the information, subjects were given an empty matrix representing the different cameras and attributes. They were then asked to indicate the sequence in which they wanted to view the different pieces of information.

By examining these four experimental conditions and the differences in their performance, the two types of heterogeneity explanations could be separated. In order to understand how these comparisons can isolate these two effects, consider Table 1, in which the four different experimental conditions are presented with their different components.

TABLE 1

THE FOUR EXPERIMENTAL CONDITIONS USED IN EXPERIMENT 3, THEIR SOURCE OF BENEFITS, AND THE RESULTS OF THE MEAN RATING ERROR (BASED ON THE DIFFERENCE BETWEEN THE PRINCIPAL'S AND SUBJECTS' RATINGS)

	Comparison			
Condition	A fit to own overall strategy: individual heterogeneity	Knowledge of strategy: anticipatory schemas	Reacting to the information: dynamic heterogeneity	Rating error: mean (SE)
High-InfoControl	Y	Y	**Y**	12.85 (.56)
Self-InfoControl	**Y**	Y	**N**	21.75 (.97)
Known-InfoControl	**N**	**Y**	N	21.87 (1.06)
Low-InfoControl	N	**N**	N	21.99 (.80)

The effect of dynamic heterogeneity can be estimated by the difference in performance between High-InfoControl and the Self-InfoControl conditions. The effect of individual heterogeneity can be estimated by the difference in performance between Known-InfoControl and Self-InfoControl conditions. Finally, the role of anticipatory schemas in general can be estimated by the difference in performance between the Known-InfoControl and Low-InfoControl conditions.

Method

Subjects. One hundred forty-four subjects participated in this experiment for class credit. In addition, a reward of $20 was promised to the subject with the best overall performance. During the task, each subject had an initial practice trial with the information system, followed by the main test. Subjects were randomly assigned to four experimental conditions (High-InfoControl, Low-InfoControl, Self-InfoControl, and Known-InfoControl).

Task, Stimuli, and Procedure. The overall task was the same as in experiment 1, involving the same cameras, the same basic interface and the same responses. There were two main differences: the way information control was conceptualized in the two new conditions, and the addition of a practice trial at the beginning of the experiment. The practice trial had to be used for both the Self-InfoControl condition and the Known-InfoControl condition, because without it, these subjects could not understand the relationship between the strategy and the information. In order to keep all four conditions equivalent in terms of experience, this practice trial was used for all four conditions. Moreover, practice was the same for subjects in all four conditions and was based on the High-InfoControl condition, allowing the subjects to extract the most comprehensive understanding of the task at hand.

Results

In order to examine the differences in performance between the four different experimental conditions, a rating-error measure was created. Similar to the measure used in experiment 1, this measure was composed of the mean absolute differences between the ratings subjects gave to the different cameras and their true ratings (for the principal). Comparing this measure across the different conditions (see Table 1) showed a significant omnibus effect of InfoControl ($F(3, 105) = 30.1$, $p < .001$).

Earlier, three planned comparisons were presented in order to isolate the source of the benefits of information control (see Table 1). These three comparisons were between Self-InfoControl and Known-InfoControl to examine individual heterogeneity ($F(1, 969) = 0.11$, $p = .92$), between High-InfoControl and Self-InfoControl to examine dynamic heterogeneity ($F(1, 969) = 7.54$, $p < .001$), and between Known-InfoControl and Low-InfoControl to examine Anticipatory schemas ($F(1, 969) = 0.10$, $p = .92$). Thus, dynamic heterogeneity, but not individual heterogeneity or anticipatory schemas, appears to be a significant source of benefits in this interactive information system. In addition, as can be seen in Table 1, the only difference among the four conditions was due to the improved performance in the High-InfoControl condition ($F(1, 969) = 87.69$, $p < .001$). The rating error in the other three InfoControl conditions showed no observable difference ($F(2, 969) = 0.04$, $p = .84$). The similarity of performance in the Low-InfoControl, Known-InfoControl, and Self-InfoControl conditions again indicates that knowing the search strategy or being able to fit it to an individual's stable informational needs (individual heterogeneity) did not improve performance. The same results emerged for the overall fit measure (r), with High-InfoControl ($\bar{r} = 0.89$), being higher than Self-InfoControl ($\bar{r} = 0.65$), Known-InfoControl ($\bar{r} = 0.61$), and Low-InfoControl ($\bar{r} = 0.56$).

Discussion

The goal of experiment 3 was to try and separate out the different facets that may contribute to the benefits of information control observed in experiments 1 and 2. Two explanations for these advantages were offered, one based on heterogeneity between consumers (individual heterogeneity), and the other based on heterogeneity within consumers over time (dynamic heterogeneity). In addition, a third aspect involving anticipatory schemas was also suggested and tested. The four experimental conditions were designed to tease apart these three types of explanations by comparing performance in the different conditions (see Table 1). The results indicated that neither knowing the structure of the information flow nor being able to control it a priori matters. Dynamic heterogeneity, on the other hand, seems to be the most important contributor to the advantages associated with information control. In sum, the benefit of information control in our case did not stem from overall individual differences but from the freedom to change search strategy in reaction to the information acquisition process itself (dynamic heterogeneity).

EXPERIMENT 4: COSTS OF INFORMATION CONTROL?

The ideas presented earlier suggest that information control has two main components, processing benefits and processing cost. The processing benefits were hypothesized to be related to dynamic heterogeneity in information needs (Bush and Burnett 1987; Hauser et al. 1993), while the processing costs were hypothesized to be due to processing resource limitations (Broadbent 1971; Kahneman 1973; Treisman 1969). In turn, it was suggested that if the processing costs are due to processing limitations, then higher levels of information control should be more sensitive than lower levels of information control to a manipulation of cognitive load (complexity) and to the level of learning over time (Bryan and Harter 1899; Hoeffler and Ariely 1999; Klayman 1988).

Specifically, it was hypothesized that when dealing with simple information systems, the processing costs for searching and integrating information are lower than the processing capacity and therefore the overhead caused by having highly demanding systems does not amount to much. Under such conditions, performance in the High-InfoControl condition would be superior to the one in the Low-InfoControl condition. On the other hand, once the information systems become more complicated (by increasing search cost, processing cost, or reducing cognitive capacity), the predictions are very different. In such cases, the overhead caused by having highly demanding systems can cause processing demands to exceed capacity. Under these conditions it is expected that performance in the High-InfoControl condition would be lower than performance in the Low-InfoControl condition. Another test of these ideas has to do with learning. When consumers have opportunity to learn over time, the resources demanded by controlling the task can be reduced, which will cause performance in the High-InfoControl to improve more rapidly. Thus, even if high levels of information control are initially inferior to low levels, over the long run high levels of information control could prove to be more beneficial. Based on these ideas, the overall expected result is a three-way interaction in which increased information control will always be beneficial for simple information systems. However, for complicated information systems increased information control would be initially detrimental and its benefits would increase with experience.

Note that by examining together two separate sources of cognitive capacity (cognitive load and learning), the expected interaction pattern eliminates many alternative explanations. For example, one alternative explanation for the difference between high and low information control could be in terms of motivational differences between these conditions. Such main effects explanations cannot account for the expected learning effects over time or for the expected interactions between cognitive load and information control.

Method

Subjects. Seventy-two subjects participated in this experiment in exchange for $10. In addition, a reward of $20 was promised to the subject with the best overall performance. During the task each subject examined and rated 18 different cameras, which took approximately 20 minutes. Subjects were randomly assigned to one of the four experimental conditions (High or Low InfoControl crossed with high or low cognitive load).

Design, Task, Stimuli, and Procedure. Both the task and the stimuli used in this experiment were identical to those used in experiment 1, with two notable differences in the procedure. The first difference involved the cognitive load manipulation and hence the interface manipulation, and the second involved the length of the task and the number of trials within it. Note that the level of experience with the interface can be viewed as a second manipulation of cognitive load. The idea here is that over time, the resources demanded by the navigation task can be diminished below the capacity constraints, allowing the benefits of information control to emerge. Since testing this notion involves learning over time, it was important to conduct the experiment over a larger number of trials so that the effects of learning could be observed. In order to achieve this goal, each subject in experiment 4 observed and rated six sets of three cameras each. The structure of the first three sets was identical to those in experiments 1, 2, and 3. This structure was repeated twice, for a total of six trials and 18 evaluations. After completing the six trials, subjects were asked how confident they were in their judgments and also how much they liked the interface. Experiment 4 was therefore a 2 (cognitive load) by 2 (InfoControl) by 6 (experience) mixed design, with cognitive load and InfoControl manipulated between subjects and experience (the repeated trials) manipulated within subjects.

Cognitive load was manipulated on two levels (Low-Load and High-Load), which was achieved by manipulating the ease with which the information could be processed. In the Low-Load condition, the values of the cameras were presented as a single number on a scale from 0 to 100, while in the High-Load condition, the values of the cameras were presented as a compound of three numbers. Specifically, each of the values on each of the attributes was presented as a function of quality, durability, and reliability. The values on these components were determined randomly, with the restriction that their sum be equal to the original value they represented. Subjects were told that the agent had equal weights for all three components and that in order to get the value of the attribute they needed to combine (add) the values of all three components. This manipulation increased the number of steps needed to integrate and judge the information without providing any added informational benefit.

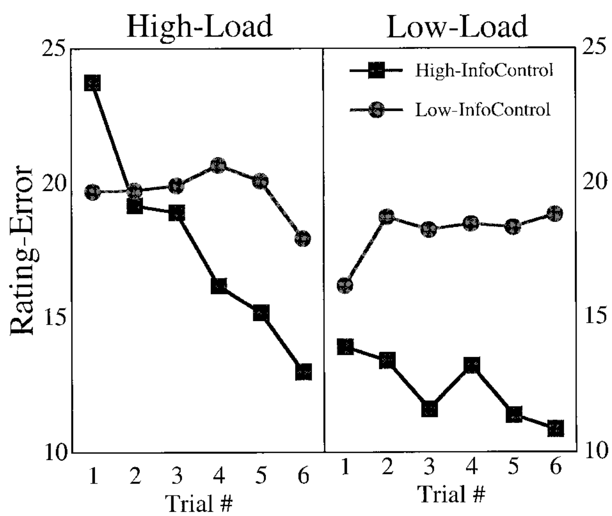
Results

Similar to experiments 1, 2, and 3, the rating-error measure was composed of the mean absolute difference between the ratings each subject gave to the different cameras and their true ratings (for the principal). However, because one of the main objectives of experiment 4 was to examine changes in performance level over time, the rating-error measure was based on the mean absolute differences for each individual trial (three cameras). This rating-error measure was then compared across the six trials, cognitive load, and InfoControl levels. As illustrated in Figure 3, the results replicate the main effect of InfoControl in the Low-Load condition while showing a very different pattern in the High-Load condition. In the High-Load condition, InfoControl was initially not beneficial, and its benefits only emerged over time. The results also suggest that the only condition under which learning occurred was the High-InfoControl/High-Load condition and, moreover, that this learning occurred rather rapidly. In order to test this improvement over time, the rating-error's linear trend across the six trials was estimated for each subject and compared across the different conditions. Testing these trends revealed a significant InfoControl by cognitive load interaction ($F(1, 34) = 4.38$, $p = .044$), with the only trend that was significantly different from zero being the one for the High-InfoControl/High-Load condition. These results, coupled with the overall interaction between InfoControl and cognitive load ($F(1, 34) = 7.18$, $p = .011$), give further credence to the notion that controlling demanding interfaces should be viewed as dual tasks susceptible to processing demands and capacity constraints.

In addition to the rating-error measures, it is also important to examine the weighting-error measures in order to estimate the veridicality and consistency with which subjects executed their judgment policies. Examining these measures is important because they represent subjects' ability to integrate the information and perform the task at hand. In order to get the different weighting-error measures, subjects'

FIGURE 3

MEAN RATING-ERROR MEASURE, BASED ON THE ABSOLUTE DIFFERENCE BETWEEN THE PRINCIPAL'S AND SUBJECTS' RATINGS



NOTE.—Plotted by InfoControl, cognitive load, and trial.

ratings were first regressed on the orthogonal structure of the stimuli. For each subject this was done twice, once for each of the two stimulus replications (first and second sets of nine cameras). Note that for a smaller number of cameras efficient estimates could not be obtained. These weighting-error measures were then compared across the four experimental conditions and the two sets. The overall fit of these regression models showed the same interaction pattern noted earlier, where the three-way interaction (InfoControl by cognitive load by set) was significant ($F(1, 34) = 6.18$, $p = .018$). This interaction was such that during the first three trials (set 1) High-InfoControl was beneficial for the Low-Load condition but detrimental for the High-Load condition. However, as experience accumulated this pattern changed, and High-InfoControl was always beneficial.

As mentioned earlier, it is possible to have an overall good fit for the model and still have a large mismatch with the utilities of the principal. For this reason all sets of utilities were transformed to a common scale in which the sum of the utilities was equal to 1. Examining the mean of the absolute differences between these sets of utilities and the agent's utilities points to the same result noted earlier, where the three-way interaction (InfoControl by cognitive load by set) was significant ($F(1, 34) = 4.21$, $p = .048$). Once again, during set 1 High-InfoControl proved beneficial under the Low-Load condition and detrimental under the High-Load condition. In addition, the pattern of these results was different with the accumulation of experience, where High-InfoControl was always beneficial.

Finally, it is interesting to examine not only the objective measures of performance but also some subjective measures. Regarding the Liking question, there was no effect for the cognitive load manipulation. However, there was a large effect for InfoControl where subjects in the High-InfoControl condition liked the interface more ($M = 66.1$) than subjects in the Low-InfoControl condition ($M = 36.7$, $F(1, 34) = 19.8$, $p < .001$). This was independent of cognitive load, as indexed by the nonsignificant cognitive load by InfoControl interaction ($F(1, 34) = 1.24$, $p = .28$). The confidence measure showed the same basic pattern with no effect for the cognitive load manipulation, but a positive effect for increasing InfoControl. For this measure, subjects in the High-InfoControl condition had more confidence in their ratings ($M = 74.7$) than subjects in the Low-InfoControl condition ($M = 55.3$, $F(1, 34) = 27.4$, $p < .001$).

Discussion

The results of experiment 4 clearly support the ideas presented earlier in the following ways: first, the data show that in Low-Load conditions, when the demands on processing resources are low, increased information control is beneficial. However, in High-Load conditions, when the demands on processing are higher, the results are somewhat different. In this case, on initial trials High-InfoControl is detrimental to performance, and it is only with increased experience that the benefits of High-InfoControl emerge. From both a theoretical and practical perspective alike the most interesting point is that it is exactly the High-Load conditions, where controlling the information flow is least attractive initially, for which there is the most improvement over time. In other words, the results from experiment 4 (i.e., the slopes with respect to trials) are also interpretable in terms of differential rates of learning in high and low information control environments. The other interesting results relate to the subjective measures of performance. These subjective measures are important because they are likely to be the most important inputs into decisions regarding future use of information systems. In sum, experiment 4 demonstrates the benefits of high levels of information control (replicating previous experiments and extending the results to subjective measures) but also its associated processing costs.

EXPERIMENT 5: THE MEMORY AND KNOWLEDGE EXPERIMENT

Thus far the discussion of the advantages and disadvantages of information control has been related to short-term consequences and outcomes. In other words, the measures used in the first four experiments examined the immediate outcomes of the information search process and how they were influenced by information control, cognitive load, and experience. However, in many contexts it is important to examine not only concurrent performance (at the time of the task) but also to examine different aspects of future performance. Experiment 5 was designed to test some of the long-term implications of information control on other dimensions of learning and performance, for example, memory and understanding of the structure of the task environment. The perspective taken in this experiment is that consumers will choose to use and stay with a certain information provider only under conditions of long-term benefits. In other words, we need a consumer's-eye analysis of not only the immediate benefits of information control—which might dictate trial—but also an analysis of what long-term benefits an information system provides.

One way to examine understanding of the problem space is to measure the level of implicit memory and implicit knowledge consumers have for the information (Brunswik 1955). In order to examine consumers' memory and knowledge, it is first important to conceptualize these constructs in the context of current tasks. Memory is conceptualized as the accuracy by which the specific values presented in the task could later be identified. Knowledge is conceptualized as the level by which the relationship between the levels of the different attributes is internalized. Together, these two tasks capture the understanding consumers have for both the specific values presented in the task (memory) and the relationship between them (knowledge). Thus, the goal of experiment 5 is to examine incidental memory and knowledge as a consequence of information control.

Method

Subjects. Forty subjects participated in this experiment in exchange for $10. In addition, a reward of $20 was promised to the subject with the best overall performance. During the experiment, each subject examined and rated nine different cameras, followed by a memory and knowledge task. Each subject took approximately 40 minutes to complete the experiment. Subjects were randomly assigned to either the high or low InfoControl conditions.

Stimuli. The stimuli used in this experiment were based on the same basic camera stimuli used earlier but with a correlated, rather than orthogonal, relationship between the values on the different attributes. The exact correlational structure used was: body $=$ lens $\times$ 0.75; shutter $=$ lens $\times$ 0.50; engine $=$ lens $\times$ 0.25. This relationship was set so that the value of the lens was the same as the values used in previous experiments, and the values of all three other attributes were determined in relation to it with the addition of a small random component (± 10 percent). In order to allow for unique identification, the values were constrained such that no value appeared more than once.

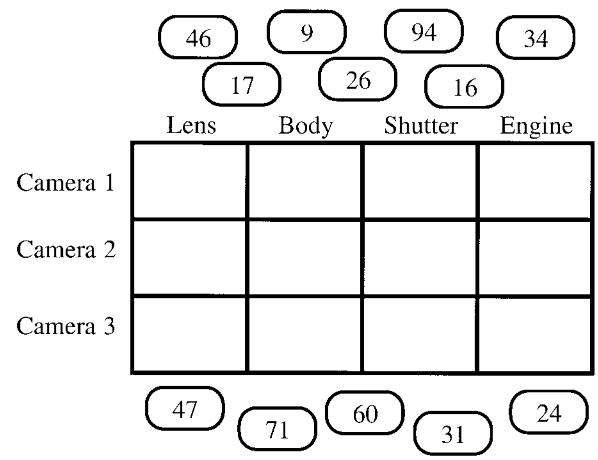
Task. After rating three sets of three cameras, subjects in this experiment completed an incidental memory task and a correlation knowledge task. The reason for choosing incidental rather than intentional learning tasks was to capture the secondary and long-term implications of information control. If subjects were aware that the goal of the experiment was to test their memory and knowledge, they would have set their goals to perform optimally on these measures.

In such a case, the relevance of these measures as an indication of future use would have been diminished (since they would reflect immediate and not long-term benefits). In the incidental memory task, subjects were given the values for the three cameras used in the last trial they experienced and were asked to place them (drag with the mouse) in their correct location in a matrix that represented the information system (see Fig. 4). In the correlation knowledge task (relationship between the different attributes), subjects were presented with a single attribute value for each one of nine new cameras, and were asked to predict the values of the other three attributes for each of these cameras.

Procedure. The procedure in this experiment was different than the one used in experiment 1 in two important ways. First, since decision quality was not the topic of concern, there was no need for accuracy measurements. Therefore, subjects were asked to perform the task for themselves and not for a principal (as in experiment 2). Second, the memory and knowledge tasks were introduced at the end of the experiment.

FIGURE 4

AN EXAMPLE OF THE MEMORY TASK



NOTE.—All the values used during the last trial are presented outside of the matrix, and subjects were asked to drag them to their correct location in the matrix.

Results

Based on the memory board procedure (see Fig. 4), two types of memory measures were created. The first related to the accuracy of placing the values in the matrix (memory-accuracy), and the second related to the order in which values were placed in the matrix (memory-structure). The notion of the memory-accuracy measure is simple. The more accurate subjects are in their memory for the different values, the higher will be the proportion of values that are correctly placed in the matrix. The notion of the memory-structure measure is substantially different, and it relates to the structure and organization of information in memory. This measure is based on the assumption that the order in which the matrix is regenerated reflects some aspects of the organizational structure of the information in memory. Therefore, analogous to information search measures (Payne et al. 1993), the order in which the different values were placed in the matrix was taken as an indicator for memory structure and its cohesiveness.

For the memory-accuracy measure, each subject received a score that reflected the proportion of values placed exactly in their correct location. These results showed that the subjects in the High-InfoControl condition had more accurate memory ($M = 0.50$) than the subjects in the Low-InfoControl condition ($M = 0.24$, $t(19) = 3.56$, $p < .002$). The same result also appeared when the memory-accuracy measure was defined less rigidly. This was done by counting responses that were either on the same row or the same column as the right response as correct.

Demonstrating that the amount of memory was higher for subjects in the High-InfoControl condition, the next question has to do with the organization of memory. The memory-structure measure was based on the proportion of consecutive values (all adjacent pairs of values) that were placed either on the same attribute or the same camera. This memory-structure measure showed that subjects in the High-InfoControl condition had a more organized memory structure ($M = 0.73$) than the subjects in the Low-InfoControl condition ($M = 0.56$, $t(19) = 2.172$, $p = .042$). In addition, one can calculate this measure separately for consecutive placements on the same attribute and for consecutive placements on the same product. Doing the analysis in this way revealed that the advantage subjects in the High-InfoControl condition have was a result of their consecutive placement on the same product ($t(19) = 2.74$, $p = .012$), but not on the same attribute ($t(19) = 0.9$, $p = .93$).

After establishing that subjects in the High-InfoControl condition had better memory-accuracy and memory-structure, the next question addresses their knowledge regarding the relationship between the different attributes (correlation knowledge). In the knowledge task, subjects received the level of a lens on a new camera and were asked to predict its values on the other three attributes (body, shutter, and engine). The knowledge measure was composed of the mean absolute differences between the real value of the different attributes and the estimates subjects gave for them. Examining this measure showed that subjects in the High-InfoControl condition had better knowledge ($M = 24.18$) than subjects in the Low-InfoControl condition ($M = 29.76$, $t(19) = 4.137$, $p < .001$). The same result emerged when examining each of the attributes separately.

In addition, this experiment included the same subjective measures of performance as experiment 4. The confidence measure showed the same basic pattern, where subjects in the High-InfoControl condition had more confidence in their ratings ($M = 79.9$) than subjects in the Low-InfoControl condition ($M = 66.7$, $F(1, 34) = 3.28$, $p < .002$). The liking measure showed that subjects in the High-InfoControl condition liked the interface more ($M = 74.3$) than subjects in the Low-InfoControl condition ($M = 43.9$, $t(19) = 5.55$, $p < .001$). Note that these results replicate and extend the conclusions drawn from experiment 4 to tasks in which subjects expressed their own preferences.

Discussion

The goal of experiment 5 was to start examining long-term implications of information control. Specifically, it was suggested that incidental memory and knowledge would capture some of the long-term benefits of an information system. The results showed that subjects in the High-InfoControl condition had both better memory and knowledge of their environment. The memory-accuracy measures indicated that subjects in the High-InfoControl condition had a more accurate memory for the information itself, while the memory-structure measure showed that they also had a better and more consolidated organization of information in memory. Aside from the memory-related measures, the correlation knowledge task examined what subjects internalized about the relationship between the values of the different attributes. The results for the knowledge measure also showed that subjects in the High-InfoControl condition had a higher level of knowledge for the relationship between the values of the different attributes. Finally, experiment 5 also included two subjective measures of performance level (similar to experiment 4). Both the confidence and the interface liking measure showed that subjects had a better perception of the information system under the higher level of InfoControl. Although the measures of confidence, liking, memory, and knowledge seem to suggest that information control has long-term implications and benefits, this interpretation should be taken with some caution. Specifically, the limitation in interpreting these results is that the measures for these constructs were taken *after* the experience took place. Therefore, with these results in mind we still do not know whether, initially, consumers would be attracted to or would shy away from highly interactive information systems.

GENERAL DISCUSSIONS AND MANAGERIAL IMPLICATIONS

The current work illustrates that the environment in which consumers encounter information has a substantial impact on the way this information is evaluated and integrated. Specifically, interactive communication that gives consumers control over the content, order, and duration of product-relevant information causes information to have higher value and to become increasingly usable over time. The experiments presented here demonstrate that control over the information flow has a substantial impact on consumers' ability to integrate, remember, and understand inputs to their judgments. Although the current work was carried out in the context of electronic communications, the applicability of the current results reaches beyond computerized interfaces. The same conceptual principles should extend to the analysis of any communication medium conveying information to be integrated over time (salespeople, television, and print advertising, for instance, could be compared in similar terms).

The overall results of the experiments presented here are both straightforward and promising for interface and communication design. First, the subjective reports showed that subjects in the High-InfoControl conditions both liked the interface more and had more confidence in their judgments compared with subjects in the Low-InfoControl conditions. Apart from these subjective measures, it was also shown that highly interactive information systems can help consumers integrate information and express utilities more consistently and accurately. If we consider the task of expressing a principal's utilities as analogous to expressing one's own utilities (taking into account the parallelism of results shown in experiments 1 and 2), then the conclusion is that a highly interactive system can allow for a better match between judgments and underlying utilities. In addition, it was shown that the value of information control does not simply stem from the ability to narrow-cast content that is more related to a shopper's interests. Rather, this advantage stems from the dynamic flexibility of the information system and its ability to change during the information search and the hypotheses formulation process.

In conclusion, one could claim that marketing communication has gone through waves of interactive communications. Initially, marketing was interactive, with the majority of marketing communication being carried out by salespeople and at the local general store. Subsequently, mass communication became more prevalent, and for the most part interactivity left marketing communications. With new developments in computers and computerized networks, marketers have the potential to integrate interactive communication systems back into mass communication (Deighton 1996). This is potentially wonderful news, because marketers can provide consumers with the advantages of information control without burdening the information provider with tremendous costs. However, it is also important to note that information control is not a panacea, and some caution should be taken when utilizing it. In particular, when the cognitive load is high (when the task is novel or difficult), High-InfoControl can be harmful. Therefore, when designing a communication system and considering the appropriate level of information control, marketers should pay attention to the processing demands of the information system (Carroll 1997; Simon 1969), the experience of the consumer with the same and similar systems, and the learning process over time.

FUTURE DIRECTIONS

1. Preference for Controlling the Information Flow

All the experiments presented here forced subjects to use computerized interfaces for some time and measured the outcomes of this experience. In the real world, consumers are not randomly assigned to conditions, and it is questionable whether they will demand more interactive interfaces in situations where the current research shows they are beneficial. In other words, for many marketing applications the important question is not whether a certain interface causes higher performance if used but, rather, whether it is used at all. Therefore in order to understand the role of information control in marketing applications, one needs to study preferences and not just performance.

2. Motivation and Information Control

Aside from resulting in differences in the ability to process and integrate the same information, there is the question of whether information control would increase consumers' motivation to search for and understand information. We know that consumers tend to dedicate more time to activities that are more pleasurable. Therefore, much as consumers who enjoy shopping spend more time at it than those who do not, one can ask whether a highly interactive information system would increase total time spent in computerized environments. Some evidence in this direction has come from work on optimal stopping rules (Saad and Russo 1996), which demonstrated that under conditions that allow more free search (High-InfoControl), people examine more information before they reach a point at which they feel they have sufficient information to make a decision. In addition, the ability to command a situation, that is, having control over its different aspects, has been shown to increase the pleasure of the event itself (Averill 1973; Gatchel and Proctor 1976; Shapiro, Schwartz, and Astin 1996; see also Sonoda 1990; Winefield and Fay 1982). Understanding such motivational factors is extremely important, because in the long run it will determine consumers' ability to fully utilize interactive and electronic communication channels.

3. Interactivity

Finally, the current work has concentrated on one aspect of interactive communications, namely, controlling of the information flow. Although this type of control can be considered one central aspect of interactive communication, it is also obvious that a broad understanding of interactive communications will reach far beyond this relatively narrow definition. Other more general and broad definitions of interactive communications could examine characteristics of the information system itself, as well as the dialog between information systems and their users.

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