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Comparison-Shopping Websites: An Empirical Investigation on the Influence of Decision Aids and Information Load on Consumer Decision-Making Behavior

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COMPARISON-SHOPPING WEBSITES: AN EMPIRICAL INVESTIGATION ON THE INFLUENCE OF DECISION AIDS AND INFORMATION LOAD ON CONSUMER DECISION-MAKING BEHAVIOR

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Abstract

Rapid advances in Internet commerce technology have brought about the emergence of comparison-shopping Websites, which act as agents to consolidate vast amounts of product information. Researchers have traditionally focused on incorporating the latest database interrogation technology and investigating the economic implications of the existence of comparison-shopping Websites. Little attention has been paid to understanding whether the decision aids provided are capable of assisting a consumer in managing a large quantity of information or, more importantly, are compatible with the decision-making behavior of the consumer. This study surveys several successful comparison-shopping Websites, enumerates two comercially successful forms of decision aids (i.e., screening and sorting), and examines their effects on decision effectiveness under different information loads. Based on a 3×2×2 factorial controlled experiment, we had three major findings. First, more sophisticated screening aids that assist a consumer in filtering a large quantity of information do not necessarily improve decision effectiveness. Surprisingly, our results even suggest that in some circumstances the opposite could be true. Second, the results indicate that the effectiveness of decision aids, to a large extent, depends on the information load. Third, decision makers are adaptive. One may supplement the absence of more sophisticated screening aids with the sorting aid.

Keywords: Comparison shopping, online shopping, decision aids, information load, consumer behavior, electronic commerce

Introduction

When dealing with the enormous amount of information on the Web, it is perhaps impossible for a consumer to make the correct purchase decision given the limited information processing capability of humans (Miller 1956). Hence, consumers are turning to comparison-shopping Websites such as Dealtime (**http://www.dealtime.com**) and mySimon (**http://www.mysimon.com**). These Websites act as intelligent agents to automatically interrogate a large number of merchants' databases for product information and present the resultant list to a consumer to extract. A consumer is now able to perform a more comprehensive price and product comparison than would have been possible by visiting every individual merchant's Web storefront. Given the wide price and product dispersion for consumer products across the Internet, comparison-shopping Websites provide immediate tangible benefits, such as cognitive saving (Brynjolfsson and Smith 2000; Clay et al. 2001). However, different comparison-shopping Websites provide different decision aids, which might produce different results for a consumer even when the same inputs are used. The multitude of decision aids and their unknown effectiveness make it extremely difficult for a consumer to know if she is obtaining the best information (product) from these Websites. The key question, then, is, "Do these decision aids actually improve consumer's decision-making?"

Despite their importance, very few studies have evaluated the effectiveness of different online decision aids. Those that did examine online consumer decision aids (e.g., Haubl and Trifts 2000) do not include information load as an influential factor. Given such incomplete studies, very little knowledge has been accumulated about how consumers extract enormous amounts of online information from different decision aids, or how this information influences decision effectiveness. Hence, research that aims to understand online consumer decision-making behavior must go beyond an analysis of merely examining a singular effect. This is because human decision-making behavior is contingent upon many interacting characteristics of the decision environment (Payne et al. 1993).

This study develops a conceptual framework for evaluating the decision aids of comparison-shopping Websites under different information load contexts and links them to theories of consumer choice heuristics. We focused on three generic screening aids—hyperlink-screening aid (HSA), attribute-screening aid (ASA), and weight-attribute-screening aid (W-ASA)—and a sorting aid (presence or absence) that are commonly being deployed. Table 1 depicts five of the most prominent product-focused comparison-shopping Websites surveyed. Linking the nature of these decision aids to the choice heuristic literature, we seek to establish differential choice outcomes (in term of decision quality) and search performances arising from the use of these aids under different information load. Specifically, we adopt an experimental approach to examine how different levels of screening and sorting aids influence consumers when they are required to identify and choose non-dominated alternatives in a high- or a low-information load environment. This approach, unlike previous studies that ignore the decision environment, provides a more direct and parsimonious test of the effectiveness of decision aids in an Internet shopping environment. Our findings have important implications for comparison-shopping Website operators, consumers, and merchants. A better understanding of how consumers make use of decision aids would allow operators to fine-tune their Website features to suit the consumers' decision needs and, therefore, offer more value to their merchant subscribers. Consumers could understand how different decision aids work and, hence, decide on the appropriate tools to use in different situations. Similarly, understanding the functionality of decision aids enables online merchants to make appropriate decisions on selecting and positioning their products for database interrogations by comparison-shopping Website agents.

Table 1. Types of Decision-Support Tools Available at Comparison-Shopping Websites

	mySimon[a]	**PriceScan[b]**	**Streetprice[c]**	**PriceWatch[d]**	**ActiveBuyerGuide[e]**
Screening aids					
Hyperlink-Screening Aid (HSA)	X	X	X	X	
Attribute-Screening Aid (ASA)	X	X			
Weight-Attribute-Screening Aid (W-ASA)					X
Sorting aid					
Presence (sort-able)	X		X		X
Absence (not sort-able)		X		X	

[a] **http://eurozdnet-de.mysimon.com**
[b] **http://www.pricescan.com**
[c] **http://www.streetprices.com**
[d] **http://www.pricewatch.com**
[e] **http://www.activebuyerguide.com**

Conceptual Foundation and Hypotehses

The purpose of comparison-shopping Websites is to facilitate consumer decision making. By focusing on two key aspects of comparison-shopping Websites, namely screening and sorting aids, we seek to model a consumer's information acquisition, processing, and evaluation processes for purchasing a 5-attribute and 15-attribute product (i.e., information load). Such an approach parallels the use of comparison-shopping Websites for product comparison, evaluation, and purchase. Figure 1 depicts the research model.

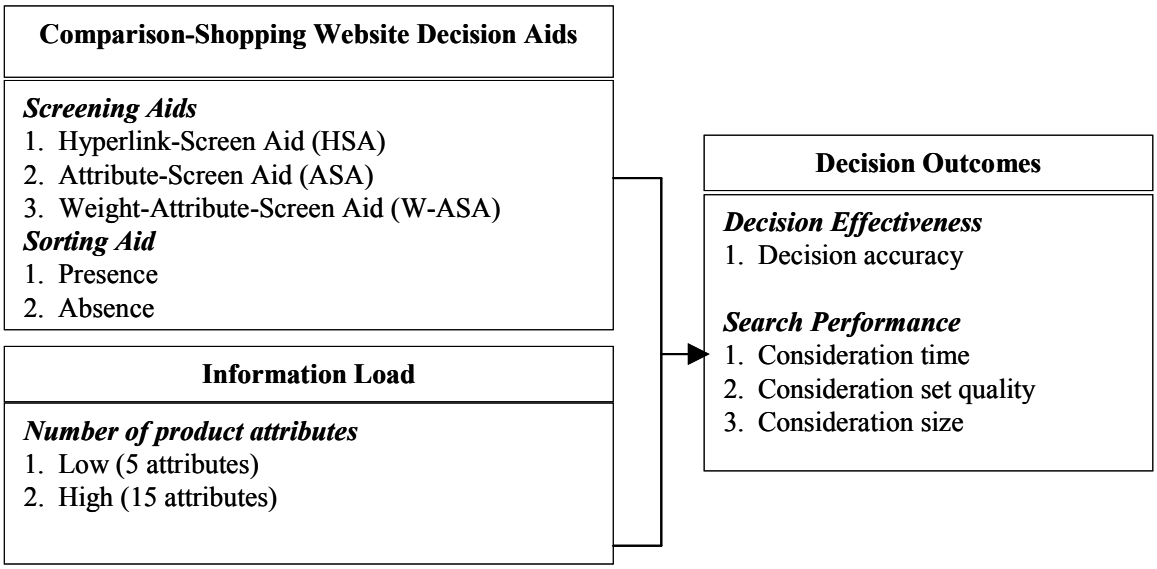

Figure 1. Research Model

Screening Aids Effects

A screening aid is conceptualized as an interactive tool that facilitates a consumer in narrowing down the alternatives to those few that are likely to be considered when the purchase decision is made. The consumer is only required to expend effort inspecting and evaluating the screened few, but is able to make quality decisions as good as if an exhaustive search through the entire electronic marketplace had been performed. The availability and appropriateness of this form of decision aid has been touted as the most important benefit to consumers in Internet Shopping (see Alba et al. 1997).

The availability of screening aids in the electronic marketplace affects consumers in several ways. First, by reducing the number of alternatives to be considered, it frees cognitive resources, allowing a capacity-constrained consumer to make a decision analysis that is more complete than would be possible without the aid. Second, the availability of a screening aid assists a consumer in improving the overall decision performance by reducing the difficulty of choosing between alternatives. In other words, the automatic elimination of less attractive alternatives should reduce decision difficulty insofar as it offloads the chore of scanning and makes explicit the trade-offs among all of the available alternatives.

Notwithstanding the potential benefits of cognitive saving and decision difficulty reduction from using a screening aid, under certain conditions, a screening aid may be viewed as a hazard to the consumer's freedom of choice and could adversely affect decision outcomes. First, the presence of a screening aid "forces" a decision maker to define the screening criteria to eliminate alternatives that are less likely to be considered in the early stage of the decision-making process. One is not given the freedom to visually examine the available alternatives to gauge the quality of the choices before delineating the cutoff levels. Because of this forced selective nature of screening aid, a consumer may experience a reactance style response by which the consumer may set less stringent filter criteria to reassert the perceived restricted freedom of choice. Consequently, it is likely that a large number of alternatives are not screened out, and the cognitive effort required for comparing options and making a decision increases. Hence, the elimination of alternatives through screening aids creates a certain level of uncertainty, and this could have an undesirable effect on decision performance (e.g., large quantity of alternatives extracted).

Furthermore, the assumption that a decision maker will reapply the cognitive saving provided by an aid conflicts with research suggesting that a decision maker places value on reducing effort (e.g., Beach and Mitchell 1978). For example, studies on contingent decision-making behavior suggest that strategy selection is the result of a compromise between the desire to make a correct decision and the desire to minimize effort (Shugan 1980). Decision makers may regard that effort minimization as an important consideration when selecting a decision strategy and may not process more information or expend more effort when provided with a decision aid. Hence, this cognitive miserliness mentality may encourage one to adopt the satisficing decision strategy where the first alternative presented by the screening aid is chosen. Such undesirable behavior could affect the overall decision quality negatively.

Although these studies are provocative in their implications, the extent to which a consumer benefits from cognitive saving with the use of a screening aid is still not well understood. Moreover, the availability of such an aid for a consumer, taken alone, does not determine the outcome, since the provision of different levels of decision support and capabilities can lead to diverse results. To meet this challenge, this study focuses on three variations of screening aids, specifically HSA, ASA, and W-ASA, because they represent the most typical assistance provided by most of the comparison-shopping Websites. These screening aids vary substantially in focus and capability but generally implement the aid that corresponds to the choice heuristics adopted by a consumer in making a product choice.

Hyperlink-Screen Aid

A HSA categorizes the entire set of alternatives according to predetermined single attribute values (see Figure 2 for an example). A consumer would access the subsets of alternatives through the hyperlinks generated from the categorization. The HSA in comparison-shopping Websites (across-merchants) differs from the merchants' online storefronts in that it allows a consumer to zoom into a particular subset of all alternatives by one attribute per attempt. The choice heuristic adopted would tend to be attribute-based in which processing is performed by comparing alternatives within an attribute (Bettman et al. 1990). A consumer follows the links to select alternatives that satisfy the preset criteria such as specific price range or delivery coverage area.

The HSA's main weakness lies in its restrictive single attribute-based processing assistance. Very often, a consumer is left with large number of alternatives to be evaluated manually. Given the row display of the alternatives, extensive scrolling is required which forces a consumer to adopt alternative-based comparison. While the alternative-based comparison may lead to higher decision accuracy (Keeney and Raiffa 1976), requiring a consumer to make explicit trade-offs may make the consumer emotionally stressed and be cognitively unbearable (Hogarth 1987). Coupled with the high amount of information to be processed cognitively, HSA might not be able to adequately support consumers' product comparison goals (Miles and Howes 2000).

Attribute-Screen Aid

An ASA is similar to the search engine mechanism and can easily be found in many of the comparison-shopping Websites (see Figure 3 for an example). It allows a consumer to specify the search criteria by entering values into predetermined parameters and specific product categories. An ASA is different from an HSA in two ways. First, the restriction on the single attribute search is removed. Second, a consumer is no longer constrained to the predetermined hyperlinks and is allowed to specify the attribute values criteria for alternatives screening. The difference in attribute search has two significant impacts on the choice heuristic. First, screening through the alternatives via single-attribute values using an HSA can be considered as the adoption of elimination-by-aspects heuristic (Tversky 1972). The relaxation of the constraint in an ASA would further allow a consumer to practice the heuristic to its fullest. Hence, a higher adoption of attribute-based processing is expected. Second, by allowing a consumer to set multiple attribute cut-off levels, the number of alternatives seriously considered for decision can be reduced drastically. This leads to lower cognitive effort required to compare the balanced alternatives (i.e., lower consideration set, lower consideration time, and higher consideration quality) and, hence, the efficiency of the evaluation process increases (i.e., higher decision accuracy) (Payne et al. 1993).

Weight-Attribute-Screen Aid

A W-ASA in comparison-shopping Websites (see Figure 4 for an example), such as ActiveBuyerGuide, is very similar to the assisted-preference construction tools in many other commercial Websites, such as AOL's PersonalLogic decision guides. The aid consists of two main components. First, a consumer is given the option to define the cut-off levels and the importance of the

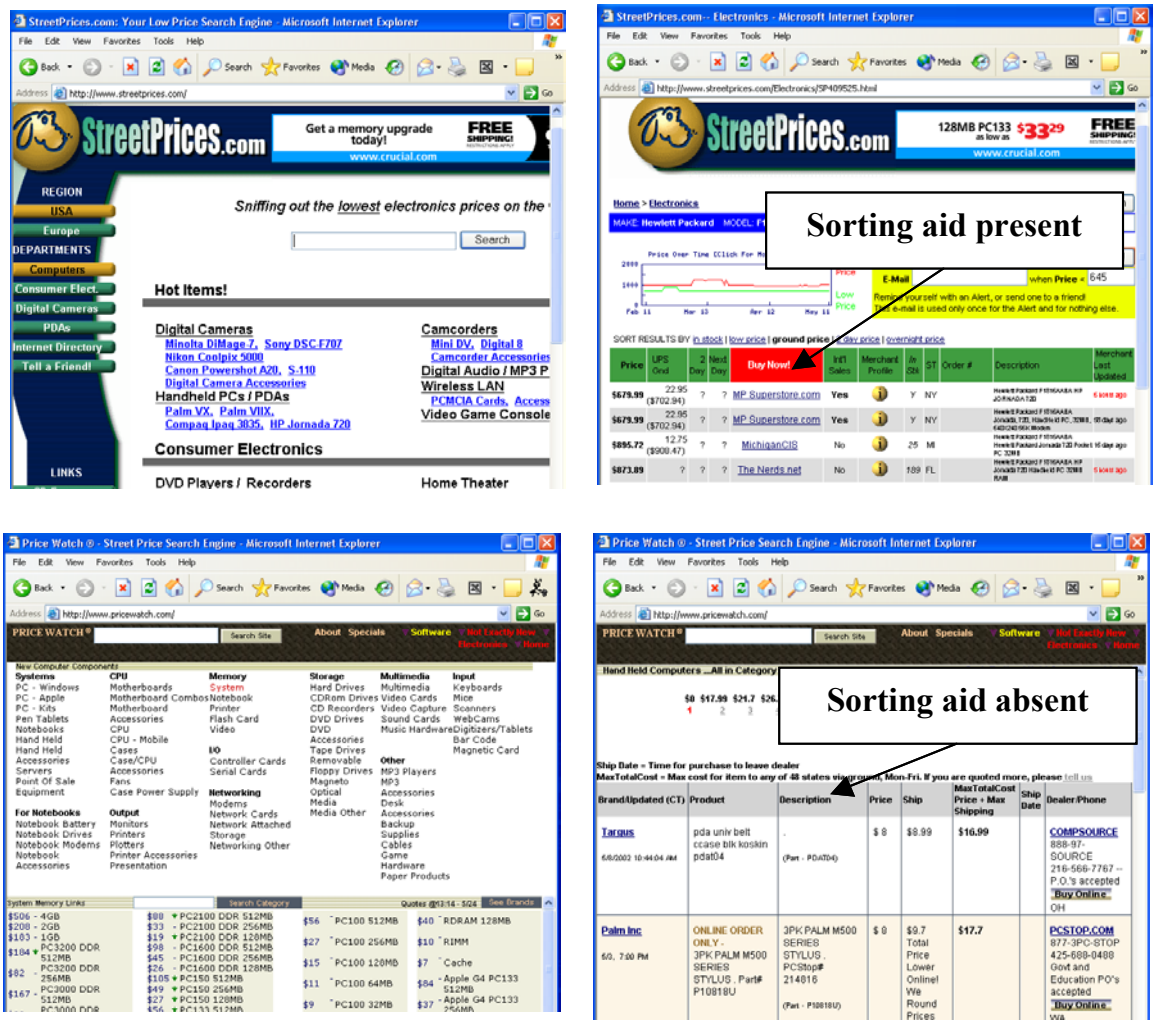

Figure 2. HSA Examples

Figure 3. ASA Example

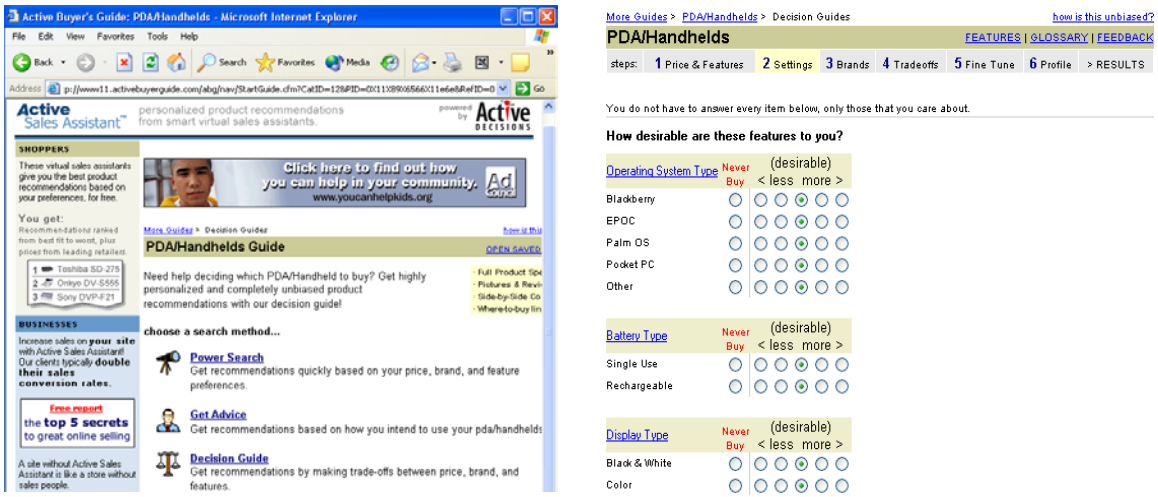

Figure 4. W-ASA Example

product attributes. Similar to an ASA, the decision aid bases on the predefined cutoff levels to eliminate all those alternatives that fail to meet the minimum levels. Next, based on the consumer's declared attributes importance, the extracted alternatives will be awarded a score that represents its overall evaluation. The score values can then be used to construct a linear model to assist in the evaluation (i.e., alternatives with higher score will be brought to the consumer's attention). Coupled with the alternative screening mechanism, a W-ASA is able to synergize the strengths of both choice heuristics while compensating for individual weaknesses. Hence, a W-ASA is hypothesized to reduce the consumer's cognitive effort significantly better than the other screening aids do while improving on the decision quality.

In summary, comparing the three screening aids, W-ASA is able to reduce the consideration time and consideration size and to increase consideration set quality the most by dramatically reducing the amount of information to be processed cognitively, followed by ASA and HSA. With a lower cognitive burden, consumers are free to focus on making better decisions, potentially leading to the highest decision accuracy in the presence of W-ASA, followed by ASA and HSA. Hypothesis 1 is summarized in Table 2.

Table 2. Hypothesis 1

Dependent Variable	Hypothesis	Screening Aids
Decision accuracy	(H1a)	HSA < ASA < W-ASA
Consideration time	(H1b)	W-ASA < ASA < HSA
Consideration size	(H1c)	W-ASA < ASA < HSA
Consideration set quality	(H1d)	HSA < ASA < W-ASA

Sorting Aid Effects

A sorting aid is conceptualized as an interactive tool that facilitates a consumer in making in-depth comparisons among those alternatives that are extracted by screening aids. The aid facilitates changing product information presentation by reordering the alternatives using certain product attributes (Figure 2) into a format that the consumer presumably finds suitable for evaluation and decision. Past studies on consumer information behavior have demonstrated that the format used to present information affects decision outcomes through the format's influence on the cognitive process (Painton and Gentry 1985). This is because individuals tend to work with information in the form in which they receive it due to cognitive constraints or cognitive miserliness (Slovic 1972). A nice illustration is provided by Russo (1977). He demonstrated that the use of unit price information increased when the information was presented to the consumer in the form of a sorted list where the available brands are ranked by

increasing unit price. He argued that the list display works because it makes price comparisons easier. Jarvenpaa (1989) showed that information acquisition and evaluation proceed in a fashion consistent with the graphical presentation format. For example, if a display encourages alternative-based processing, more alternative-based processing would be observed.

In more recent studies, Coupey (1990) showed that consumers might reorganize the display if the resultant display helps increase the ability to process information. Therefore, when consumers are given the option to process the information display, they may exploit that option to organize the information such that it minimizes cognitive efforts and improves overall decision effectiveness. In essence, information presentation format concerns not merely how the information is presented but how presentation of information facilitates mental processing (Bettmand and Kakkar 1977). Hence, we posit a direct positive effect on decision accuracy and search performance. Hypothesis 2 is shown in Table 3.

Table 3. Hypothesis 2

Dependent Variable	Hypothesis	Sorting Aid
Decision accuracy	(H2a)	Absence < Presence
Consideration time	(H2b)	Presence < Absence
Consideration size	No direct effect	
Consideration set quality	No direct effect	

Information Load Effects

The notion of information load has received considerable attention in the consumer behavior literature. The massive amount of information on the Internet underscores the importance of understanding information load. Research on information load suggests that there could be dysfunctional consequences resulting from providing consumers with overwhelming information (Jacoby et al. 1974). Wilkie (1974) argued that decision accuracy only decreased when the number of alternatives increased but not the number of attributes. Few studies examined information load under varying number of attributes. To date, the causes and effects of information load remains an important but unresolved question (Bettman et al. 1990).

Information load should not be tested in a vacuum. Any investigation which purports to say something regarding the possibility of information overload in real-world decision-making situations must permit a consumer to access and reject information at will (Jacoby 1984). Researchers must take into considerations that while a consumer can be overloaded, one will not permit himself to be overloaded in the real-world. Hence, a way to assess the impact of information load would be to examine how a consumer makes his purchase decisions under the availability of different decision aids. Specifically, this study focuses on how the decision aids affect performance when attribute information increases. Although we are interested in the interaction effects, we nonetheless follow the finding of Jacoby et al. (1974) that as the number of attributes increases (beyond the threshold of seven attributes), purchase accuracy decreases and the cognitive effort increases for lack of an *a priori* basis. Hypothesis 3 is summarized in Table 4.

Table 4. Hypothesis 3

Dependent Variable	Hypothesis	Information Load
Decision accuracy	(H3a)	High < Low
Consideration time	(H3b)	Low < High
Consideration size	(H3c)	Low < High
Consideration set quality	(H3d)	Low < High

Research Methodology

Controlled laboratory experiments were conducted to examine the role of comparison-shopping Websites in influencing decision strategy in the context of a multi-alternative, multi-attribute purchase choice. Subjects were required to choose one out of a large number of product alternatives, each of which is described by a common set of attributes. A Web-based system was developed to simulate the online comparison-shopping Websites.

Independent Variables

The laboratory experiment employs a 3×2×2 factorial, between-subject design, manipulating screening aids (HSA vs. ASA vs. W-ASA), sorting aid (presence vs. absence) and information load (5 vs. 15 attributes).

Dependent Variables

The dependent variables measured are listed in Table 5.

Table 5. Operationalized Dependent Variables

Dependent Variable	Operational Measure
Decision accuracy	A total of six brands per product category. Within each brand, there would be 20 alternatives. Only one alternative is non-dominated, while the other 19 are dominated. Across brands, none of the non-dominated alternatives would be dominated. Hence, if subjects select one of the non-dominated alternatives, it is considered an accurate decision.
Consideration time	Mean time spent evaluating alternatives before decision is made.
Consideration size	The last set of alternatives extracted (i.e., considered) before the purchase decision is made.
Consideration set quality	The number of non-dominated alternatives in the consideration set.

Controlled Variables

Other pertinent variables not studied in this research are kept consistent to ensure adequate control and internal validity of this study. Table 6 lists the control variables.

Table 6. Operationalized Control Variables

Control Variable	Operational Measure
Online buying experience Surfing experience	Random assignment of role and treatment group. Subjects answered pre-experiment questionnaires regarding their buying experience. Analysis of data reveals no significant effect.
Gender differences	Equal division of male-male and female-female dyads. Analysis of data reveals no significant effect.
Product familiarity	Subjects answered questions regarding product category knowledge. Analysis of data reveals no significant effect.
Product purchase order	Randomize the order of purchases. Analysis of data reveals no significant effect.

Experiment Task and Procedures

A total of 180 undergraduate subjects of an e-business course in an Asian-Pacific university were asked to select one best model from each of the three product categories, namely washing machine, personal digital assistant (PDA), and mini-audio system. The order of purchase was randomly determined by the system. There were two reasons for the choice of these products. First, all three products are under the consumer electronic categories and hence, getting 15 functional product attributes (inclusive of price) would be easier. Second, these combinations are not biased to any specific gender or vocation. Hence, more objective evaluations and purchase decisions can be obtained. In each product category, there are six brands with each brand having 20 alternatives, for a total of 120 alternatives. The task attributes were selected by consulting the Dealtime.com product listings. The subjects were told explicitly that there would be one or more best models in term of all product attributes. Subjects were told that they would be paid based on their performance in terms of purchase accuracy and timing. On average, each subject was paid about U.S.$10 for an hour's work.

Results

Manipulation Checks

To verify that the experimental manipulations were successful, subjects responded to manipulation check questions in a post-study questionnaire. All questions were measured on a Likert seven-point rating scale. Screening aids manipulation was checked by asking how easy it was for them to reduce the number of alternatives to be considered using the system. The mean ratings obtained from HSA, ASA, and W-ASA conditions are 4.68, 5.08, and 5.45, respectively. This difference in means is highly significant ($F = 4.726$, $p = 0.01$) using ANOVA, and in the intended direction. The sorting aid manipulation was checked by asking the subjects to rate how easy it was to compare different alternatives. The mean ratings obtained from sorting aid presence and absence are 2.078 and 5.867 respectively. This difference in means is highly significant ($p < 0.01$, $t = 23.24$) and in the intended direction. No manipulation checks were carried out for information load as the subjects gained access to the information through screening aids, and it was visually difficult to judge the information load based on the screened information. We concluded that all our manipulations were successful.

Data Analyses

The descriptive statistics for all four dependent variables studied are displayed in Table 7. Decision accuracy reflects decision effectiveness. The rest, consideration time, consideration size, and consideration set quality, were all search-related measurements. All statistical tests were assessed at the 5 percent level of significance.

Three dependent variables pertaining to search-related measurements were found to be significantly intercorrelated to justify the use of multivariate analysis of variance (MANOVA). Effects of the manipulated variables on decision accuracy were examined using logistic regression.

MANOVA test involving the three dependent variables was carried out. Significant main effects of screening aids ($F = 31.961$, $p < .05$) and information load ($F = 39.770$, $p < .05$), and interaction effect of screening aids*information load ($F = 17.211$, $p < .05$) were found. Weak main effect of sorting aid ($F = 2.141$, $p < .1$), and interaction effect of screening aids*sorting aid ($F = 1.570$, $p < .1$) were also observed. Univariate analyses were subsequently performed.

Decision accuracy was used to judge the overall decision effectiveness. Table 8 summarizes the results of the logistic regression on decision accuracy. Two interaction effects of screening aids*information load and screening aids*sorting aid were detected. Main effects for each of the three independent variables were also detected. H2a and H3a were supported. Since interaction effects analysis takes precedence over main effects, the two significant interaction effects were examined using the method of simple effects analysis (Keppel and Zedeck 1989).

The first analysis split the data along information load dimension. In low information load treatment, the effect for screening aids was found to be significant but not the effect for sorting aid. As depicted in Figure 5, the decision accuracy for subjects using HSA was much higher than than subjects using the other two screening aids in low information load. However, the difference diminished in high information load. Hence H1a was partially supported.

Table 7. Descriptive Statistics

Sorting Aid	**Presence**					
Information Load	**Low**			**High**		
Screening Aid	**HSA**	**ASA**	**W-ASA**	**HSA**	**ASA**	**W-ASA**
Decision accuracy	.730 (.450)	.440 (.500)	.330 (.480)	.470 (.500)	.440 (.500)	.310 (.470)
Consideration time	1.2663 (.4084)	1.1741 (.2252)	1.1647 (.3665)	2.3267 (.8093)	1.2993 (.4265)	1.3941 (.4799)
Consideration size	11.711 (4.338)	7.689 (4.296)	6.704 (4.114)	31.978 (16.247)	15.422 (17.156)	17.245 (16.333)
Consideration set quality	3.1778 (1.2076)	1.2000 (.6761)	1.3556 (.8588)	2.1111 (1.0209)	1.0222 (.8015)	1.3778 (1.0974)
Sorting Aid	**Absence**					
Information Load	**Low**			**High**		
Screening Aid	**HSA**	**ASA**	**W-ASA**	**HAS**	**ASA**	**W-ASA**
Decision accuracy	.620 (.490)	.530 (.500)	.490 (.510)	.330 (.480)	.400 (.500)	.470 (.500)
Consideration time	1.8021 (.8042)	1.2233 (.4073)	1.3519 (.5012)	2.8359 (1.0600)	1.4711 (.5321)	1.3315 (.5124)
Consideration size	13.267 (7.754)	5.682 (3.338)	8.333 (4.781)	32.756 (14.266)	11.622 (9.307)	12.622 (10.315)
Consideration set quality	3.244 (1.4610)	.8889 (.5998)	1.5778 (1.0576)	2.0000 (1.0465)	.9778 (.5972)	1.2889 (.9161)

Table 8. Logistic Regression Results for Decision Accuracy

Predictor	**Coefficient (Std. Deviation)**
Intercepts	.437 (.237)*
Screening aids	-.291 (.110)***
Sorting aid	1.106 (.475)**
Information load	-1.574 (.475)***
Screening aids*Information load	.536 (.220)**
Screening aids*Sorting aid	-.590 (.220)***
Sorting aid*Information load	.266 (.950)
Screening aids*Sorting aid*Information load	-.029 (.439)

*** $P < 0.01$; ** $P < 0.05$; * $P < 0.1$

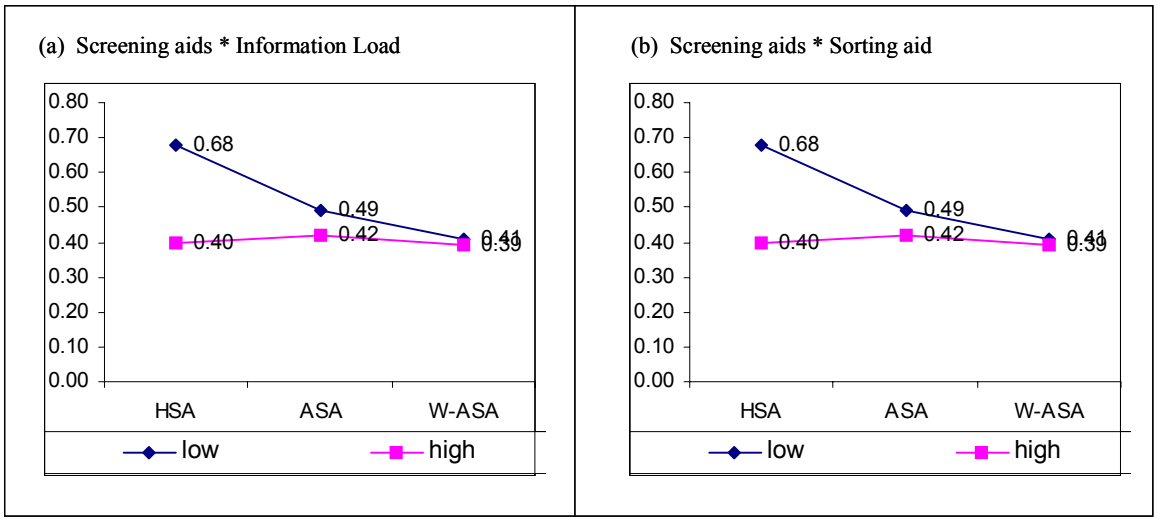

Figure 5. Decision Accuracy

The second analysis split the data along the sorting aid dimension (figure 5). In the presence of sorting aid, the effect for screening aid was found to be significant. In its absence, no significant results for screening aid were found. It is apparent that the presence of sorting aid complements HSA but was not obvious when used with the other two screening aids.

Consideration time was computed by taking the amount of time spent prior to making a decision. The interaction effects of screening aids*information load ($F = 11.819$, $p < .01$) and main effects of screening aids ($F = 33.097$, $p < .01$), sorting aid ($F = 6.989$, $p < .01$), and information load ($F = 25.872$, $p < .01$) were found to be significant. Weak significance for screening aids*sorting aid ($F = 1.920$, $p < .1$) was observed. Inspecting the descriptive statistics and Figure 6, there was sufficient evidence that the presence of the sorting aid led to a lower consideration time and that low information load resulted in smaller consideration time. H2b and H3b were supported.

The analysis of screening aids*information load interaction effect was performed by splitting the data along information load dimension (Figure 5). In both cases the Scheffe tests suggested that the significance was due to the gap between HSA and the other two screening aids. Hence, H1b was partially supported in the case of comparing HSA against ASA.

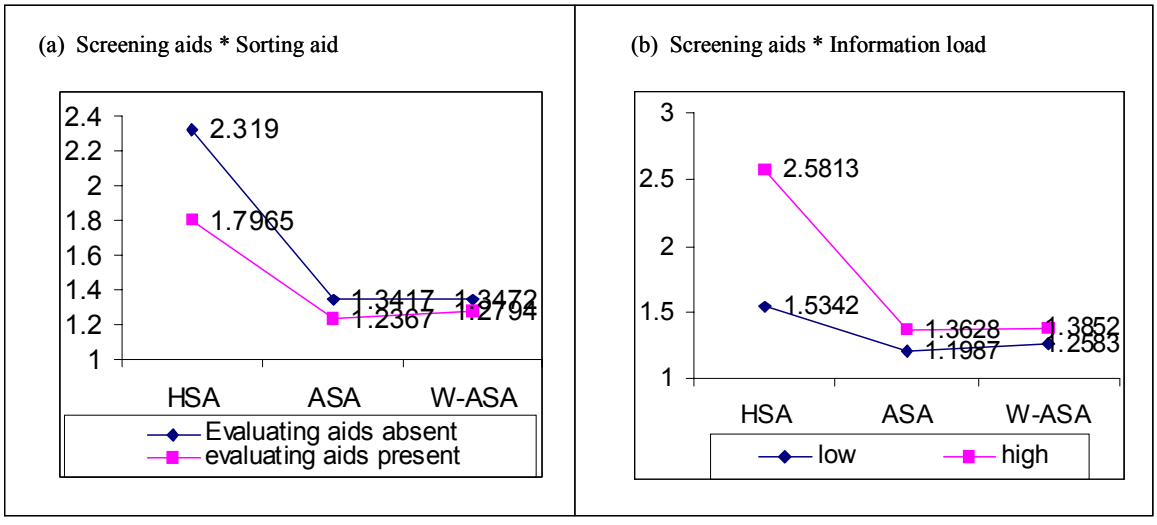

Figure 6. Consideration Time

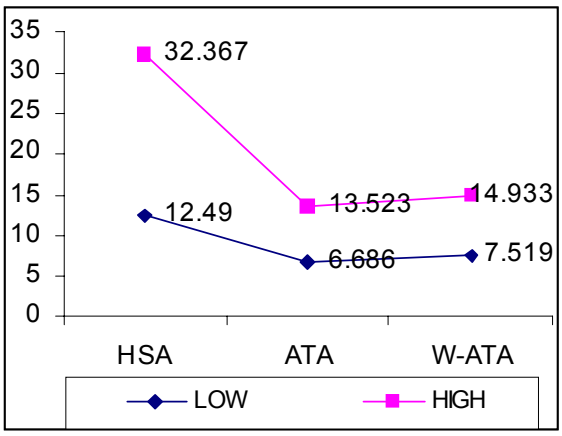

Figure 7. Consideration Size

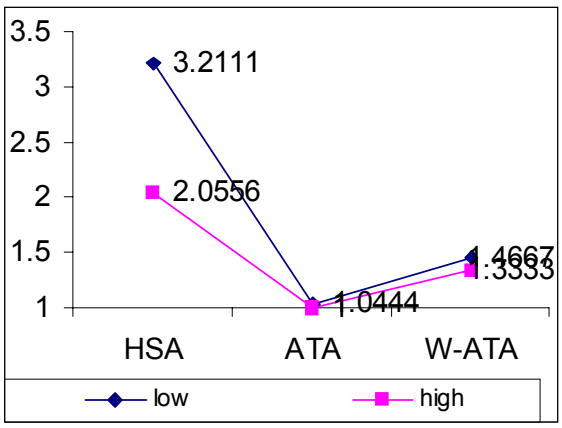

Figure 8. Consideration Set Quality

Consideration size was used as a proxy to represent the amount of information extracted for manual comparison. The interaction effect of screening aids*information load ($F = 7.133$, $p < .01$) and the main effects of screening aids ($F = 24.406$, $p < .01$) and information load ($F = 51.018$, $p < .01$) were found to be significant. H3c was supported.

The analysis of screening aids*information load interaction effect was performed by splitting the data along information load dimension (Figure 7). In both cases, the Scheffe tests suggested that the significance was due to the gap between HSA and the other two screening aids. H1c was partially supported.

Consideration set quality was used to indicate if a screening aid was, comparatively, effective in increasing the number of non-dominated alternatives in the consideration set. An interaction effect of screening aids*information load ($F = 11.437$, $p < .01$) and main effects of screening aids ($F = 45.033$, $p < .01$) and information load ($F = 9.398$, $p < .01$) were found to be significant. H3d was supported.

The analysis of screening aids*information load interaction effect was performed by splitting the data along information load dimension (Figure 8). In both cases, the Scheffe tests suggested that the significance was due to the gap between HSA and the other two screening aids. H1d was not supported.

Discussions and Implications

This study investigates the effectiveness of the decision support tools; the results are summarized in Table 9. Overall, the results extend our understanding of the use of comparison-shopping Websites in consumer decision-making behavior on several fronts.

Table 9. Summary of Results of Hypotheses Tests

Dependent Variable	Hypothesis 1 (screening aids)	Hypothesis 2 (sorting aid)	Hypothesis 3 (information load)
Decision accuracy	HSA < ASA < W-ASA *Partially supported*	Absence < Presence *Supported*	High < low *Supported*
Consideration time	W-ASA < ASA < HSA *Partially supported*	Presence < Absence *Supported*	Low < High *Supported*
Consideration size	W-ASA < ASA < HSA *Partially supported*	-	Low < High *Supported*
Consideration set quality	HSA < ASA < W-ASA *Not supported*	-	Low < High *Supported*

First, findings in this exploratory study show little support for the proposition that an increase in the sophistication of the decision aids would lead to lower cognitive effort and hence increase decision accuracy (i.e., purchase the best deal). This is because the use of heuristics that are hypothesized to save cognitive effort may lead to serious decision errors (Tversky 1969). For example, the use of HSA leads to a better purchase outcome than the use of ASA and W-ASA does because it allows the consumer to consider all available information (Todd and Benbasat 1999), while for ASA, the lower value attributes are not compensated with high value ones and hence the elimination of better alternatives prematurely may have occurred (i.e., non-compensatory). This is especially the case when the consumers do not know the overall quality of the product set. It is very likely that there is greater disappointment with the decision aids if there is a high occurrence of empty listing obtained through the elimination.

Second, the results indicate that when information load increases, the overall quality of the purchase decision decreases. Thus, it is not necessarily true that an increase in the number of attributes would increase the information level of consumers. When inspecting the magnitude, it reveals an interesting result. The accuracy for HSA appears to fare substantially better than the other screening aids in the low information load of five attributes. However, when the information load increases to 15 attributes, the marginal difference becomes obviously large in HSA. This suggests that, in a situation where the choice set is small, HSA could be a better alternative. However, when the choice set is large, it is not necessarily a better tool. Hence, it is important that, when we evaluate either decision aids or information load, we take into consideration the influence of the other factor(s). In sum, our results suggest that the effectiveness of screening aids, to a large extent, depends on the amount of information to be processed.

Third, hypothesis 2 predicted that because the ability to process (i.e. to sort) results would facilitate mental processing, there would be a direct effect on the decision effectiveness and overall search performance. This hypothesis was not supported. A sorting aid does have a measurable effect on decision accuracy but not on other measurements. Indeed, compared with screening aids, reordering the presentation format is only an issue after the alternatives are screened. Nonetheless, we find distinctive results on the interaction of screening aids and a sorting aid. The presence of a sorting aid actually raises the decision accuracy when using HSA. This could suggest that human decision makers are adaptive. The absence of better screening tools could be compensated for with a sorting aid.

This evidence has significant implications for academics and practitioners alike. From an academic researcher's perspective, the inclusion of information load leads to a more insightful understanding of decision aids. Rather than postulating a singular effect, researchers could focus on examining interactions among the variables. Decision-making theories should also attempt to measure the effectiveness of decision aids in term of the search process and not merely on final decision outcomes. Any exclusion would not lead to a clearer picture of the effectiveness of the tools. In other words, the implications for the study at the micro level have been to develop some fundamental techniques for the analysis of online-mediated purchases. From a practitioner's perspective, the findings suggest that different decision aids could lead to different choice quality. When designing decision tools, practitioners should consider how the consumers would use the tools and how the tools would lead to purchase decisions. It is not necessarily true that more sophisticated tools, in term of cognitive saving and/or decision support, would always yield a better purchase decision. Attention must be given to the appropriateness of the decision aids provided in the online decision environment.

While the present study provides valuable insight into the effects of decision aids on consumer decision-making in online shopping environments, we recognize that our study results are subject to some limitations. Laboratory experimentation may have precluded some level of realism while the use of undergraduate students further restricts the generalizability of the findings. Future research can extend our findings by replicating our study in field studies using actual consumers.

In conclusion, in the current information age, consumers have to make more complex purchase decisions, requiring them to gather, screen, evaluate, and interpret voluminous information. The application of appropriate decision aids in the information environment can help consumers to better cope with the challenges. Research along the direction of this study can contribute to a contingency theory on what form of decision supports and means of application are appropriate under what circumstances.

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References

Alba, J., Lynch, J., Weitz, B., Janiszewski, J., Lutz, R., Sawyer, A., and Wood, S. "Interactive Home Shopping: Consumer, Retailer, and Manufacturer Incentives to Participate in Electronic Marketplaces," *Journal of Marketing* (61), 1997, pp. 38-53.

Beach, L. R., and Mitchell, T. R. "A Contingency Model for the Selection of Decision Strategies," *Academy of Management Review* (3), 1978, pp. 439-449.

Bettman, J. R., Johnson, E. J., and Payne, J. W. "Consumer Decision Making," in *Handbook of Consumer Theory and Research*, T. Robertson and H. Kassarjian (eds.), Prentice-Hall, Englewood Cliffs, NJ, 1990, pp. 50-84.

Bettman, J. R., and Kakkar, P. "Effects of Information Presentation Format on Consumer Information Acquisition Strategies," *Journal of Consumer Research* (4:3), 1977, pp. 233-240.

Brynjolfsson, E., and Smith, M. D. "The Great Equalizer? Consumer Choice Behavior at Internet Shopbots," Working Paper, Heinz School, Carnegie Mellon University, Pittsburgh, PA, 2000.

Clay, K. B., Krishnan, R., and Wolff, E. "Prices and Price Dispersion on the Web: Evidence from the Online Book Industry," *Journal of Industrial Economics* (49:4), 2001, pp. 521-539.

Coupey, E. *Restructuring in Consumer Choice*, unpublished doctoral dissertation, Duke University, Durham, NC, 1990.

Haubl, G., and Trifts, V. "Consumer Decision Making in Online Shopping Environments: The Effects of Interactive Decision Aids," *Marketing Science* (19:1), 2000, pp. 4-21.

Hogarth, R. M. *Judgment and Choice: The Psychology of Decision*, John Wiley & Sons, New York, 1987.

Jarvenpaa, S. L. "The Effect of Task Demands and Graphical Format on Information Processing Strategies," *Management Science* (35:3), 1989, pp. 285-303.

Jacoby, J. "Perspectives on Information Overload," *Journal of Consumer Research* (10), 1984, pp. 432-435.

Jacoby, J., Speller, D. E., and Kohn, C. A. "Brand Choice Behavior as a Function of Information Load," *Journal of Marketing Research* (11), 1974, pp. 63-69.

Keeney, R., and Raiffa, H. "Decisions with Multiple Objectives: Preferences and Value Trade-Offs," John Wiley & Sons, New York, 1976.

Keppel, G., and Zedeck S. *Data Analysis for Research Designs: Analysis of Variance and Multiple Regression/Correlation Approaches*, W. H. Freeman and Company, New York, 1989.

Miles, G. E., and Howes, A. "A Framework for Understanding Human Factors in Web-Based Electronic Commerce," *International Journal of Human-Computer Studies* (52), 2000, pp. 131-163.

Miller, G. A. "The Magical Number Seven, Plus or Minus Two: Some Limits of Our Ccapacity for Processing Information," *Psychological Review* (63), 1956, pp. 81-97.

Painton, S., and Gentry, S. J. "Another Look at the Impact of Information Presentation," *Journal of Consumer Research* (12), 1985, pp. 240-244.

Payne, J. W., Bettman, J. R., and Johnson, E. J. *The Adaptive Maker*, Cambridge University Press, Cambridge, England, 1993.

Russo, J. E. "The Value of Unit Price Information," *Journal of Marketing Research* (14), 1977, pp. 193-201.

Shugan, S. M. "The Cost of Thinking," *Journal of Consumer Research* (7), 1980, pp. 99-111

Slovic, P. "From Shakespeare to Simon: Speculations and Some Evidence About Man's Ability to Process Information," *Oregon Research Institute Bulletin* (12:2), April 1972 (available online at **http://www.decisionresearch.org/pdf/dr36.pdf**).

Todd, P., and Benbasat, I. "Evaluating the Impact of DSS, Cognitive Effort, and Incentives on Strategy Selection," *Information Systems Research* (10:4), 1999, pp. 356-374.

Tversky, A. "Elimination by Aspects: A Theory of Choice," *Psychological Review* (79), 1972, pp. 281-299.

Tversky, A. "Intransitivity of Preferences," *Psychological Review* (76), 1969, pp. 31-48.

Weisberg, S. *Applied Linear Regression*, John Wiley & Sons, New York, 1985.

Wilkie, W. L. "Analysis of Effects of Information Load," *Journal of Marketing Research* (11), 1974, pp. 462-466.