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Sifting customers from the clickstream : behavior pattern discovery in a virtual shopping environment

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ABSTRACT

SIFTING CUSTOMERS FROM THE CLICKSTREAM: BEHAVIOR PATTERN DISCOVERY IN A VIRTUAL SHOPPING ENVIRONMENT

by
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While shopping online, customers' needs and goals may change dynamically, based on a variety of factors such as product information and characteristics, time pressure and perceived risk. While these changes create emergent information needs, decisions about what information to present to customers are typically made before customers have visited a web site, using data such as purchase histories and logs of web pages visited. Better understanding of customer cognition and behavior as a function of various factors is needed in order to enable the right information to be presented at the right time. One approach to achieving this understanding is to develop predictions about what information to present based on inferences made from cognitively-grounded models of the customer, calibrated according to an analysis of what behaviors can be observed during the online shopping experience (e.g., clickstream produced by mouse clicks and typing). As a step in achieving this objective, this research tests hypotheses about how differences in product involvement, time pressure, and uncertainty and riskiness of choice may impact a customer's search and decision strategies, time on task, and perceived risk while shopping online. It draws upon the results of prior research, as well as two pilot studies, to motivate the design of a study involving human participants making purchasing decisions in an online shopping environment. The main data sources are the think-aloud protocols and clickstreams of the participants, as well as pre- and

post-experiment questionnaires. This work is expected to improve understanding of how contextual, personal and product-related factors help shape online shopping behavior, and to generate insights into the cognitive processes that inform this behavior. Future work beyond the thesis is likely to involve more formal modeling of human cognition in online shopping environments.

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To my talented and open-minded father who knows what it takes to achieve something
and to my beloved mother who loves me unconditionally and steadfastly

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LIST OF SYMBOLS AND DEFINITIONS

B	Breadth-first Search
C	Compensatory Strategy
CRONBACH's ALPHA	A Measure of Reliability
D	Depth-first Search
IDB	Information Display Board
IRB	Institutional Review Board
KAPPA	Inter-rater Agreement Statistics (kappa)
MANOVA	Multivariate Analysis of Variance
NC	Non-Compensatory Strategy
PI	Product Involvement
PR	Perceived Risk
RC	Uncertainty and Riskiness of Choice
TP	Time Pressure
U	Expected Utility Function

PREFACE

This research arose from my interest in providing explanations for consumer behavior. My research philosophy is that a deep understanding of customers' search and decision strategies is best obtained by examining their strategies at cognitive and behavioral levels. Traditionally, research on the behaviors of online shopping has focused on analyzing data collected from purchasing histories, interviews, self-report questionnaires, or experiments. My work is expected to complement this research by including a cognitive perspective in consumer behavior studies. The motivation for obtaining cognitive-level data comes from Card et al. (2001), who argue that mining through purchasing histories and web logs (clickstream data) does not capture the thinking processes behind customer behavior. As detailed in this work, I combine both behavioral and cognitive approaches, drawing on factors derived from prior literature and from the in-depth investigation of concurrent verbal protocols (Newell & Simon, 1972). My approach continues with modeling to understand how and why purchasing decisions and behaviors may change with the information encountered. Synthesis of relevant literature, experimentation, and modeling are used to refine understanding and to generate questions regarding the relationships between individual and contextual factors and online shopping behaviors. The resulting plan of investigation is intended to produce data that will lead to immediate results and provide the foundation for longer-term research.

CHAPTER 1

INTRODUCTION

Online shopping allows individuals to browse for and purchase goods and services at the location of their choice (Bellman, Lohse, & Johnson, 1999). One important observation is that shoppers are rarely loyal to a specific website due to the low costs of visiting multiple online stores compared to traditional ones, enabling online shoppers to compare offers from various companies quickly and easily. However, the advantages of online shopping do not eliminate the impacts of uncertainty and time pressure that customers may encounter. There are both theoretical and practical reasons for investigating the behaviors of online customers. From a theoretical perspective, numerous factors affecting the actual purchasing behavior are left to be fully explored (Limayem et al. 2004). From a practical perspective, online marketers recognize the importance of designing a satisfactory shopping experience (Cho et al. 2003). Yet, studies of online shopping behaviors are relatively rare compared to those of traditional brick-and-mortar shopping behaviors (Bucklin et al. 2002).

The needs and goals of both online and in-store customers may change while they are shopping based on information they encounter (Chen, Park, & Yu, 1998; Cooley, Mobasher, & Yu, 1999; Detlor, Sproule, & Gupta, 2003; Koufaris, 2002; Rabin, 2001). Yet, decisions about what information to present to customers are typically made before a customer's arrival, using sources such as purchase histories or focus group studies. The online environment offers an opportunity to tailor information needs to customers in nearly real-time. But to accomplish this, customers' needs and goals must be identified as the shopping experience unfolds.

Numerous methods, such as agent-based collaborative filtering (Kim et al. 2004; Maes et al. 1999), rule-based filtering (Maes et al. 1999), profiling (Kendall, 2003) and marketing studies are being used to improve understanding of customer behavior. For example, collaborative filtering (an automated "word-of-mouth" recommendation mechanism) allows companies to make recommendations to online shoppers, particularly for preference-oriented product categories such as books, movies, and music (Heckerman et al. 2000; Huang et al. 2004). Clickstream data may be employed to help describe customer behavior (Van den Poel & Buckinx, 2005), but collection of such data does not capture thinking processes behind the behavior (Card, Pirolli, & Wege, 2001). From the business perspective, it is important to provide better overall shopping experiences to retain customers with successful transactions (Koufaris, Kambil, & LaBarbera, 2001). Potential customers may leave a website unsatisfied due to frustration resulting from information overload (Maes, 1994) or a feeling of being lost in navigation. There are, therefore, both theoretical and practical reasons to develop models of customer cognition and behavior that capture the dynamics of the e-commerce shopping experience, and that can be applied to better inform the presentation of information to online customers.

This study seeks to explain how internal (i.e., customer-level) and external (i.e., environmental and product-related) factors can influence how customers think and behave while shopping online. Synthesis of prior research leads to a set of propositions (Chapter 2), which are then investigated through two preliminary studies (Chapter 3). This leads to a model of how certain critical factors can affect how customers browse for products and respond to the choices available to them. The main experiment, entailing analysis of online browsing behavior and cognition, is then described (Chapter 4). Study

results from both quantitative and qualitative analyses are then presented and discussed (Chapter 5). The paper concludes with the expected contributions of this work and possible extensions for future study (Chapter 6).

CHAPTER 2

THEORETICAL BACKGROUND

Environmental, personal and product-related factors can affect online shopper's cognition and behavior as reflected in search and decision strategies, perceived risk, and time on task[1]. This chapter first defines (and discusses the measurement of) three factors (time pressure, product involvement, and uncertainty and riskiness of choice) that may influence cognition and behavior (as reflected in search and decision strategies, perceived risk, and time on task). A discussion of the impact of these factors on cognition and behavior is synthesized into a series of propositions that provide the main theoretical focus for the proposed work.

2.1 Search Strategies

Online shopping, like traditional shopping, requires customers to search for information in order to support purchasing decisions. Search for product information while shopping may be conceptualized as navigation through a tree structure (Card et al. 2001; Foster, 2003; Liu, Hu, & Hsu, 2000; Zhong et al. 2004). Each node in a tree is an object containing attributes, which represent different types of web pages or different product attributes. Figure 2.1 depicts an idealized search space, consisting of product type, name and feature, and also shows a particular instantiation of this space, using data associated with a digital camera (type), including various models (name) and corresponding attributes (features).

[1] A broader theoretical background, which includes topics not in the scope of the main empirical study, is given in the state of the art (SOTA) paper found in Appendix (A).

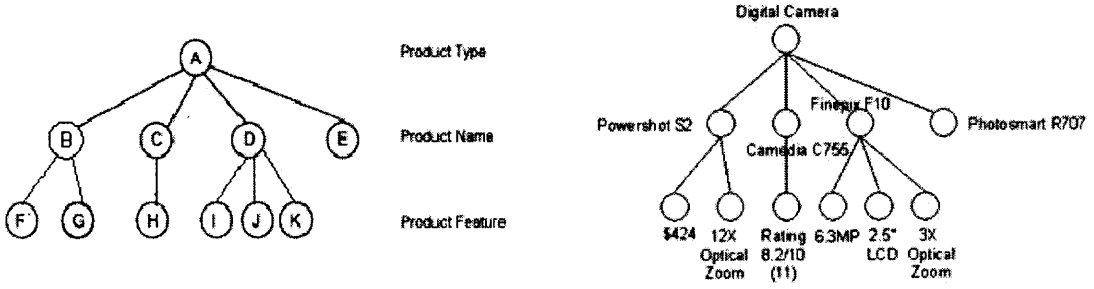

Figure 2.1 Search space for product information.

Customers may employ depth-first or breadth-first search strategies (or some combination of these two) to search this space (Jenkins, Corritore, & Wiedenbeck, 2003). Depth-first search means customers scan through the tree branch-by-branch till reaching the bottom. Breadth-first search means that customers start from exploring as many product selections as possible and then read detailed information later on. Depth-first search is often described as an *alternative-wise* information-seeking strategy, while breadth-first search is an a*ttribute-wise* strategy (Weenig & Maarleveld, 2002; Benson & Beach, 1996; Payne, 1976). Customers' strategy may change, because they might modify or refine their preferences during the buying process (Hodkinson, Kiel, & McColl-Kennedy, 2000; Rowley, 2000), their search strategies may change. For example, in a digital camera purchasing task, depth-first search shows that customers follow the links of a specific camera model and find out all the information about product description, price from different vendors, technical specification, customer ratings and reviews, and so forth. In contrast, breadth-first search shows that customers notice the variety of television models available to them first and may only scan through the basic product description and price to narrow down the best alternatives, without following the detailed information links.

Customers often start in an exploratory seeking mode and then gradually move towards goal-directed search with a progressively narrow focus (Detlor, Sproule, & Gupta, 2003; Shim et al. 2001). Inspired by those studies, keeping trace between mode switching by different product class is worth investigating.

Moreover, the decision aids, such as search engine and sorting capability provided by each site, may also affect customer's navigation style (C. H. Tan, 2003). We need to carefully control which kind of information aid we provide to the test subjects in the experiment, as it may lead to different navigation results.

Online search strategy may be observed by logging the nodes (e.g., individual web pages) viewed by a customer, the time spent at each node, the decision point to stay or exit a node (or the site itself), and the choices of which links to follow (Bucklin et al. 2002). A long-established approach to identifying the cognition that drives search is to examine the contents of working memory, typically by asking individuals to "think aloud" while performing the task (Ericsson & Simon, 1996). Working memory can be defined as "a system for the temporary holding and manipulation of information during the performance of a range of cognitive tasks such as comprehension, learning and reasoning" (Baddeley, 1992). Early working memory theory stated that this memory is structured as a small number of slots (i.e., the magical number seven, plus or minus two) in which information could be temporarily held (Miller, 1956). Ericsson, his colleagues and others have expanded this theory considerably (Chase & Ericsson, 1982), further establishing the relevance of working memory to studies of problem solving and decision making.

2.2 Decision Strategies

A purchase is a decision (i.e., an allocation of resources), and, as with other types of decision making, it is possible to describe decision strategies as either compensatory or non-compensatory (Chu & Spires, 2003). With compensatory rules, a poor evaluation on one attribute (e.g., size) may be compensated by a positive evaluation on another attribute (e.g., price). With non-compensatory rules, poor evaluation on one attribute makes that attribute an impossible choice. As discussed below, these archetypical strategies are likely to be informed by different cognitive processes.

Two compensatory strategies are the weighted additive procedure (WADD), and the equal weight method (EQW); three non-compensatory strategies are satisficing method (SAT), lexicographic (LEX), and elimination-by-aspects (EBA) (Payne, Bettman, & Johnson, 1988). With WADD, an overall score for each object is obtained by first multiplying the object's score on each attribute by an importance factor and then summing these products. The EQW method uses a simple additive method – essentially ignoring any relative importance of the factors (Chu & Spires, 2003; Hayne & Smith, 1996; Smith, Arnold, & Sutton, 1997). SAT evaluates alternatives one at a time and then discards choices where the constraints decided beforehand are not satisfied. LEX narrows the sets of alternatives by focusing on one attribute at a time. The process of LEX starts from the most important attribute, which has been decided beforehand, and the alternative with highest value is chosen. If there is a tie, the process starts with the second most important attribute till the highest value is found (Kamis & Stohr, 2003). EBA is a variant of LEX in which selection of attributes is probabilistic.

2.3 Perceived Risk in Online Shopping

Perceived risk is a customer's perception of the overall negativity of a purchase decision based upon assessments of the magnitude and probability of possible negative outcomes associated with the decision. Perceived risk is viewed as resulting from uncertain and unanticipated consequences of a product purchase (Dholakia, 2001; Tan, 1999). For example, a customer purchasing a digital camera from an unknown manufacturer may consider the possibility of it breaking down in less than a year, while another customer may be concerned that its memory capacity is insufficient for storing high-resolution pictures.

Risk is a multifaceted concept, and a number of dimensions of how these facets are perceived may be identified (Jacoby & Kaplan, 1972; Murray & Schlacter, 1990; Stone & Grønhaug, 1993; Griffith & Chen, 2004). Psychological risk is the perception that a negative effect on a customer's peace of mind may be caused by a defective product. Financial risk is the perception that a certain amount of money may be lost or required in order to make a product work properly (Garner, 1986; Pavlou, 2003). Performance risk is the perception that a product may fail to function as originally expected (Kim & Lennon, 2000). Physical risk refers to the perception that a product may be dangerous to health or safety when it does not work properly (Roselius, 1971). Social risk refers to the perception that a product may result in disapproval by family or friends (Dowling & Staelin, 1994). Privacy risk is the potential loss of control over personal information, such as invasion of privacy (Ramakrishnan et al. 2001). Perceived risk for online products may be one of the significant discriminators between those who purchase products online and those who do not (Jarvenpaa & Todd, 1997), and helps to explain

why many customers still use the Internet for browsing rather than purchasing (Wintrob, 1995).

2.4 Time on Task

Time on task is a reflection of the effort expended by a decision maker (e.g., the total time spent on a specific shopping task) (Bucklin et al. 1993). Investigations into online customer search patterns can be supported by measuring time duration per page visited, total time spent on a specific shopping task, number of pages a customer viewed, average duration of a visit, total past visit time, the decision point to stay or exit the site, and choices of which links to follow or which page to view (Bucklin et al. 2002; Johnson et al. 1993; Van den Poel & Buckinx, 2005).

2.5 Time Pressure

Time pressure can be defined as a feeling of anxiety and stress and a need to cope with the limited time (Ordonez & Benson III, 1997). It is related to but distinct from time constraint, defined as the time available for the completion of a task. Some people may feel pressure in a long time constraint while others may not feel the pressure in a short time constraint. For example, given 25 minutes to purchase a birthday gift, some customers may feel the need to hurry, while others may not.

Time pressure is believed to be an important factor in studying customer behavior (Moe, 2003; Pedersen & Nysveen, 2003). Yet while most customers feel time pressure—especially during holiday seasons (Walker, 2003)—few studies (Fisher, Chengalur-Smith, & Ballou, 2003) have investigated information-seeking behavior under time

pressure in non-shopping situations, and none examine online shopping behavior under time-pressured situations. Direct observation of behavior and cognition—either through experiments or field studies—is rare, despite the potential insights that such approaches might yield. This may in the past be due to the difficulty in simulating and measuring time pressure in traditional store-shopping environments. In light of the presence of Internet databases and time-coded information, it is possible now to easily integrate transactional and attitudinal data and to quickly create frequency data, not only at the aggregate level, but also at the individual-consumer level (Dekimpe & Hanssens, 2000).

In judgment and decision making research, a gambling or a bargaining game is often used to simulate time pressure. For example, the number of available product choices (Sutter, Kocher, & Straub, 2003) may be reduced over time to increase the perception of time pressure. A post-experiment survey may then be given to gather information about the participant's perception of time pressure under different levels of time constraint (Fisher et al. 2003). Another method, which also needs to be confirmed with post-experiment survey of participant's perception of time pressure, is to give subjects exactly the same amount of time but to create the different level of anxiety by phrasing the task instruction differently. For example, in Mann & Tan's study (Mann & Tan, 1993), subjects in time-pressured condition were told: "You have 25 minutes to complete the tasks, so that is not much time. You need to hurry. Keep your eye on the clock to make sure you are keeping up." While subjects in no-time pressure condition were told: "You have 25 minutes, so that's plenty of time. Don't hurry, just take your time." One alternative method is to depict an analog clock that counts down for a specific number of minutes or seconds (Payne, Bettman, & Johnson, 1988).

2.6 Product Involvement

Involvement may be defined as a perceived relevance of the object based on a customer's interests, needs, or values (Zaichkowsky, 1985). Product involvement is a relationship between consumer and product that refers to "an unobservable state reflecting the amount of interest, arousal or emotional attachment evoked by the product in a particular individual" (Bloch, 1982). Hence product involvement is a "consumer-defined" construct (Quester, Karunaratna, & Lim, 2003). A customer can be involved with advertisements, purchase decisions, or products. High involvement products can be roughly defined as those for which buyers prepare to spend considerable time and effort in searching, while low involvement products are defined as those for which buyers spent minimum thoughts and efforts in searching because these products are of no vital concern nor have any great impact on the customer's lifestyle (Laurent & Kapferer, 1985).

Consumer Involvement Profiles (CIPs) may be used to measure product involvement along its various dimensions (Laurent & Kapferer, 1985; Kapferer & Laurent, 1993). Accordingly, Kapferer and Laurent (1985) propose measuring product involvement through four dimensions: 1) perceived importance of the product, 2) perceived risk associated with the product, 3) the symbolic or sign value attributed by the consumer to the product, and 4) the hedonic value of the product (i.e., its emotional appeal or its ability to provide pleasure). Validity of the measuring scales for these four dimensions has been tested. Based on the findings, detergent, oil, and other groceries are categorized as lower-involvement products; in contrast, electronic and fashion products are mostly categorized as higher-involvement products. In most of the cases, high involvement products represent higher risk of a customer than a low involvement product

(Zaichkowsky, 1985). Customers may not evaluate or not experience risks associated with low-involvement product class (Dholakia, 2001). Another measurement of product involvement is Personal Involvement Inventory (PII) which was first proposed by Zaichkowsky (1985). McQuarrie and Munson (1992) later proposed a revised 10-item 7-point scale Product Involvement Inventory with improved usability and validity.

2.7 Uncertainty and the Riskiness of Choice

Uncertainty and riskiness of choice is defined as incompleteness, imprecision or missing product information resulting in a risky choice (Kivetz & Simonson, 2000). Online shoppers have to deal with multiple choices having various degrees of uncertainty resulting in a risky choice, where the key tradeoff is between greater payoff and lower risk. The precision (degree of completeness) associated with options may be manipulated in order to vary uncertainty. Two example methods are *min-max* and *midpoint* (Hansen & Helgeson, 2001). A third method is to make the values of certain attributes unavailable (Kivetz, 1999) as shown in Table 2.1.

Table 2.1 Laptops/Notebooks Described with Min-Max, Midpoint, and Missing Information

Laptops & Notebooks	***Speed* *(range: 1.2 to 3.0 Ghz)***	***Memory* *(range: 256 to 1000 MB DDR2 SDRAM)***	***Battery Life* *(range: 1 to 11 hours)***
A	1.6 GHz	1000 MB	4-8 hours
B	(Information Unavailable)	512 MB	6 ±3 hours
C	2.4 GHz	(Information Unavailable)	3 hours

To measure the riskiness of a choice, the utility of an outcome may be weighted by its probability of occurrence (Von Neumann & Morgenstern, 1944). Individuals should show no difference in choices with equal expected utility (Hunton, McEwen, & Bhattacharjee, 2001). However, prospect theory states that utility may be preference-based (Kahneman & Tversky, 1979). It describes how an individual evaluates gains and losses that passing through a certain reference point, there is a bigger impact of losses than gains. For instance, people are more willing to take risks to avoid potential losses than they are willing to engage in risky behavior to improve their current positions (Kahneman & Tversky, 1979). The latter theory is often referred to as a lottery or a gambling game. It is here assumed that individuals will show no difference in assigned-choice tasks with equal expected utility when their demographic backgrounds are similar (as measured by age, educational level, and financial status). Hence the manipulation of uncertainty and riskiness of choice is governed by expected utility model.

2.8 Impacts of Factors on Search and Decision Strategies

Having reviewed the individual independent variables (Time Pressure, Product Involvement, and Uncertainty and the Riskiness of Choice) and dependent variables (Search and Decision Strategies, Perceived Risk, and Time on Task,) the impacts of changes in the independent variables on the dependent variables are now presented in the form of research propositions.

Time Pressure. Search and decision strategies may change in a number of ways based on time pressure. There are three types of macro-strategies to overcome time pressure: filtration, acceleration, and adaptation (Johnson, Payne, & Bettman, 1993;

Hayne & Smith, 1996). Filtration is done by eliminating segments of the available information, hence ignoring certain pieces of information. Acceleration is accomplished by increasing the rate at which information is processed (Janis & Mann, 1977). Adaptation is accomplished by reframing the problem or decomposing the larger problem into a sequence of smaller problems (Connolly & Deutch, 1980). Subjective valuations of available information may also influence search and decision strategies (Wright, 1974). People weigh negative information more heavily, which may be interpreted as more risk-averse behavior. Time pressure leads to more frequent use of non-compensatory strategies (Ordonez & Benson III, 1997; Svenson & Edland, 1987; Zakay & Wooler, 1984). Filtration tends to be the most widely used strategy in purchasing choice task under time pressure (Weenig & Maarleveld, 2002). It would be beneficial to know whether customers behave differently while shopping for a product needed in two days compared to that needed in a month. However, only a few studies (Chu & Spires, 2003) investigate how customers use strategies to shop online, and none of them investigate search and decision strategies under different levels of time pressure. Proposition 1 states that a difference is expected in search strategy when time pressure is varied.

Proposition 1: Time pressure alters customers' search strategies and behaviors. When time pressure is high, customers tend to use a non-compensatory strategy to narrow down the alternatives and accelerate the choice process.

Product Involvement. Product involvement is believed to influence customer information seeking behavior and decision-making processes (Quester & Smart, 1996). "People become an avid seeker to obtain knowledge when they are highly involved with the product, but they do not actively seek information when they are less involved"

(Laurent & Kapferer, 1985). Thus, depending on the level of involvement, a customer's decision process will differ greatly (Kotler, 2000), leading to proposition 2:

Proposition 2: Customers with high product involvement will try to explore and research product-related information in detail.

While discussing the navigation modes of online customers, many researchers also emphasize the relevance of working memory capacity and functioning. As with many other types of tasks, for example, online customers tend to search for a small number of the "first-best" alternatives (Montgomery, Li, & Liechty, 2003), as stated in proposition 3:

Proposition 3: Customers will consider a small number of best alternatives while shopping online.

Uncertainty and the Riskiness of Choice. The absence of certain product information leads to uncertainty in choice. In these situations, customers appear to overweigh attributes for which values are available for them to make direct comparison between considered options at the expense of unique attributes for which values are unavailable for some options (Kivetz, 1999; Kivetz & Simonson, 2000; Slovic & MacPhillamy, 1974). Customers may first identify what they view as the critical product attributes, and then eliminate products with missing or incomplete information on these attributes. They may also dismiss the significance of a missing value based on the comparisons of common attributes between considered options (Kivetz, 1999). That means a non-compensatory strategy will be used to deal with a risky choice situation. At the same time, customers may need to browse specifications of products in order to make

a purchase decision. This may imply customers probably will spend more time in depth-first search, leading to propositions 4 and 5:

Proposition 4: Customers use non-compensatory strategy when riskiness of choice is caused by missing or incomplete product information.

Proposition 5: Customers spend more time on depth-first search than on breadth-first search when product information is missing or incomplete.

The following chapter reports on the results of a preliminary investigation into some of the propositions presented in this section.

CHAPTER 3

PRELIMINARY RESULTS

Two studies have been conducted in order (i) to gain some preliminary results in identifying and assessing the impact of critical factors on customer cognition and behavior in an online shopping environment[2] and (ii) to support the development of instruments for use in a more comprehensive main experiment. In these studies, shoppers followed given scenarios to make purchases and then thought-aloud either concurrently with task performance or retrospectively while watching a video recording of their participation. The design and results of the studies are now presented, followed by analyses of clickstream data and statements in the think-aloud protocols. A discussion of how these studies inform the design of the proposed work concludes the section.

A 2 x 2 design was deployed in the first two exploratory studies, with one subject in the first study and four in the second. The independent variables of product involvement and price were used, each at a low and high level, thereby yielding the four classifications of product type shown in Table 3.1.

Table 3.1 Product Types

		Product Involvement	
		Low	**High**
Price	**Low**	Harry Potter V	Fashion Accessories
	High	Photo Editing Software	Digital Camera

Subjects were graduate students in the Information Systems department of a technological university in the northeast U.S., all with low income. The low value for

[2] Complete results are given in (Chang et al. 2004), which is included as Appendix (K).

price is set as less than US$50, while high value for price is set as more than US$500. Product choice as a representative of either high or low product involvement is based on the classifications extracted from prior studies (Figueiredo, 2000; Laurent & Kapferer, 1985).

3.1 Exploratory Study 1

In Exploratory Study 1, a single subject (the author) shopped online for four different types of products under low and high time pressure conditions.

3.1.1 Procedure

Exploratory Study 1 was used to discover factors that might impact online shopping behavior and to provide a preliminary evaluation of the feasibility of the experimental method. As discussed previously, experimental factors of product involvement and price were used, each at a low and high level, thereby yielding the four classifications of product type. Two different types of web sites were used since—in the early phases of this research—it was thought that customer behavior may vary depending on the type of web site visited. Clickstream data were collected as the subject thought out loud while accomplishing the tasks shown in Table 3.2. Two dependent variables—time on task and the type of information used in making the purchase decision—are the main focus in this study.

Table 3.2 Four Tasks in Exploratory Study 1

Tasks	Task Descriptions
T1	You can't wait to get "Harry Potter V: the Order of the Phoenix." However, it is out of stock from most of the bookstores. You decide to purchase it online now.
T2	Your mother's birthday is at the end of next month. You think a digital camera will be a great gift for her. She is an amateur in photography. Therefore, a high-resolution (maybe 5 megapixel) camera would be good enough for her. Also, it will be ideal if the camera has better zooming capability. You expect to spend $700-$1,000 for this gift. Some memory expansion and accessories are considerable.
T3	You decide to buy a photo editing software to edit your personal/ family photos. You know Adobe is quite a brand name in this industry. You know you can get a better price online.
T4	You want to find an earring or a necklace to match your black evening dress. Products pricing around $50 or less are considerable.

3.1.2 Results

The subject used various price comparison sites either to begin searches or evaluate search results. The subject spent more time (approximately 51 minutes) in finding information (such as reviews) and looking for alternatives for the high involvement high price product than for the low involvement and low price product (5 minutes). If the subject had insufficient knowledge of a product, both expert and objective opinions were sought. The results suggest that a higher product price leads to more price comparisons.

For both high price products, product brand was used to narrow down the number of alternatives. For example, in the digital camera task (T2), the subject visited the sites of three prominent vendors to obtain more detailed technical information. Since the subject appeared to be highly involved with the digital camera task, without time limitation she spent almost one hour to obtain all available information to make a best decision. Detailed technical information and third-party opinions, particularly in which

are of pros and cons evaluation toward a specific model, were taken into account. Finally, when time pressure was high (T1) or moderate (T3), the subject requested third-party opinions to enable the decision to be made sooner. Finally, more time was spent shopping for high involvement than for low involvement products.

3.1.3 Discussion

One effect of time pressure may be seeking help from third-party opinions. The results begin to suggest how customers under the same degree of time pressure will react while purchasing different types of products. It may also be advantageous to apply prior research in online information-seeking modes and users' expertise to investigate customers' online shopping (Jenkins et al. 2003). Some insights were gained into how to improve the study methodology. Most importantly, allowing the subject to use different sites introduced an unnecessary factor into the design. As a result, only a single web site was used in the second pilot study. No major changes to the data collection method were recommended.

3.2 Exploratory Study 2

In Exploratory Study 2, subjects were given tasks T1 and T2 (shown in Table 3.2) to complete.

3.2.1 Design and Procedure

Exploratory Study 2 follows the design shown in Table 3.1. This study was used to gather information on cognition during a high time-pressure purchase. One site (amazon.com) was used for browsing and purchasing due to its being an industry leader, so that most online shoppers are familiar with its information layout. Four subjects, of approximately the same level of computer skill, frequency of online shopping, and income, took part in the study (see Table 3.3). Instruments used for collecting the data in Table 3.3 are given in Appendix G.

Table 3.3 Subjects' Characteristics

Subject	Sex	Age	Frequency of Online Shopping Experiences	Level of Computer Skills	Income	Knowledge level of Digital Camera	Products purchased online before
S1	F	26-35	2-6 times a year	Expert	Under $15,000	Serious Amateur	Book, Clothes/Shoes / Accessories, Electronics, and Toy
S2	F	26-35	2-6 times a year	Expert	Under $15,000	Advanced Amateur	Book & Computer
S3	F	26-35	2-6 times a year	Expert	Under $15,000	Beginner Amateur	Book, CD/VCD/DVD, and Computer peripherals
S4	M	36-45	2-6 times a year	Expert	$15,000 - $24,999	Novice	Book

Subjects were first instructed in how to give a retrospective verbal protocol (Ericsson and Simon, 1996). As subjects searched for a product, the contents of the computer screen were recorded as digital video. Once they completed a task, they watched the video while recalling, out loud, what they had been thinking (Ericsson and Simon, 1996). They were each given tasks T1 and T2 shown in Table 3.4 (note that T1 is identical to T1 in Table 3.2, and that T2 is nearly identical to T2 in Table 3.2, except that a certain degree of time pressure is added). Subjects completed T1 before beginning T2. The tasks were introduced and described as follows:

> *All the tasks should be completed within the provided web site (amazon.com). The tasks are considered completed once you place the order.*

Table 3.4 Two Tasks in Exploratory Study 2

Task Number	Task Description
T1	You can't wait to get "Harry Potter V: the Order of the Phoenix." However, it is out of stock from most of the bookstores. You decide to purchase it online now.
T2	Your mother's birthday is approaching. You need to make a purchase now to make sure your gift can be delivered in-time. You think a digital camera will be a great gift for her. She is an amateur in photography. Therefore, a high-resolution (maybe 5 megapixel) camera would be good enough for her. Also, it will be ideal if the camera has better zooming capability. You expect to spend $700-$1,000 for this gift. Some memory expansion and accessories can be considered.

Once they had given the protocol, they were asked to explain how they came up with their product selections and how they made their final decision. All protocols and the responses were audio- and video-taped. Subjects were then debriefed. Protocols were later transcribed. Finally, an annotated file that summarized the clickstream and protocol data was created, as shown in Figure 3.1. A sample from one time-coded and annotated protocol is shown in Table 3.5.

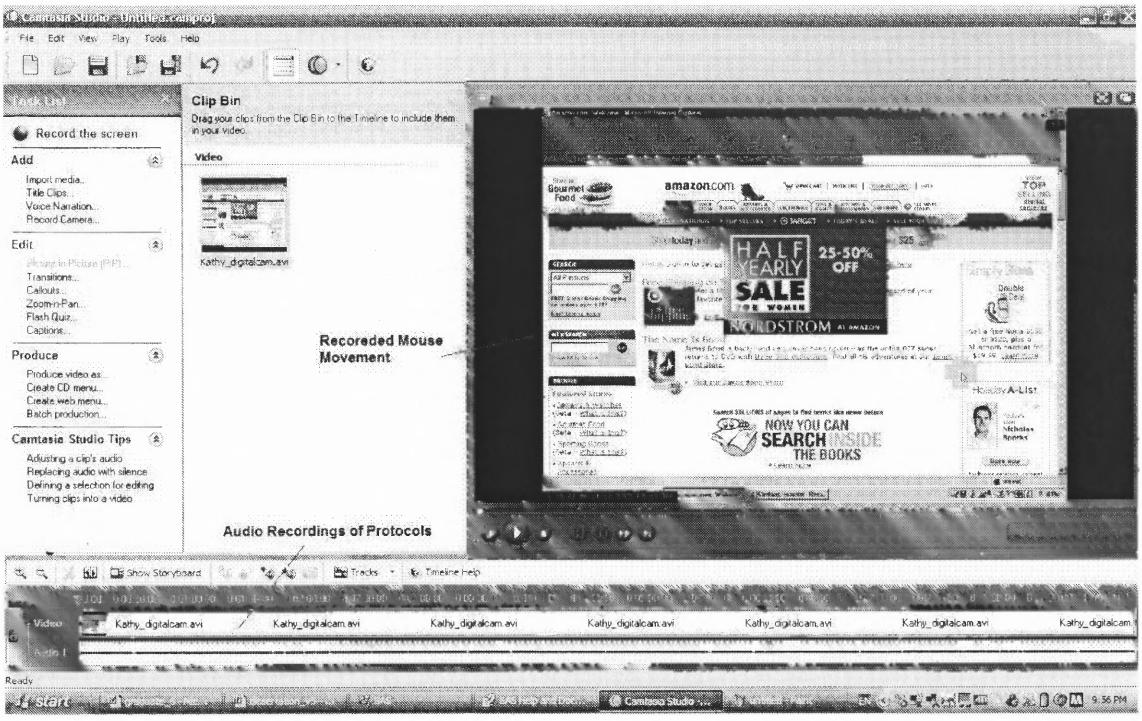

Figure 3.1 Screen shot.

Table 3.5 Sample of Protocol

4. (5:11:30) [Scroll down & up] "S2: But it only gives me three choices at the first shot. It seems that there are not many choices for me. Ex: It's very weird that it didn't give you choices of digital camera. S2: yeah…it only gives me PDA and video software… " 5. (5:12:17) [Click on the picture of Canon EOS 6.3MP…] "S2: I click on Canon to see the details if it matches my expectation." 6. (5:12:21) [Scroll down to read the product descriptions.] "S2: I need to buy camera with very large zoom, but this camera only has 18-55 mm. So I think the zoom range is not so big. What do I do now?" 7. (5:12:48) [Click on "Digital Camera" from the menu at the top] "S2: I want to see more product selections." 8. (5:12:57) [Click on Browse digital camera by 5 megapixel & up.] "S2: Actually, I try to find if it has feature which can rank all the digital cameras by their zoom, but there is no such feature. So I have to browse through all the cameras."

3.2.2 Results

For Task 1, purchasing the book *Harry Potter V* (a low price, low involvement product), all four subjects directly typed in either "harry potter" or "Harry Potter: the order of the phoenix" to search within the book category. All said they were familiar with the book and had an acceptable price in mind. They did not read the product description and customer reviews. Two of them checked the price of used and new books, and then decided to buy the least expensive one in either new or like-new condition. According to the recordings of their mouse movements and their protocols, they all started to search this product in depth-first search mode: they went directly to the book they were looking for, checked the price, read shipping and discount information, and then made a purchase. Two of them checked alternative vendors for lower price; therefore, they switched from a depth-first search to a breadth-first search mode by browsing through product selections without clicking through and reading the detailed product information and editorial reviews. Switching from a depth-first search to a breadth-first search mode was counted as one switch and vice versa. The average number of search-mode switches for Task 1 is 0.5 times and the average completion time of Task 1 was 1.7 minutes (see Table 3.6 for results).

Table 3.6 Results by Product Type

Measures	Low Price/ Low Involvement	High Price/ High Involvement
Product	Harry Potter V	Digital Camera
Average Task time	1.7 minutes	9.72 minutes (excluding subject S1)
Average alternatives lookup	1	3 (excluding subject S1)
Search Mode	Depth-first Search	Breadth-first Search
Average Search-mode Switching	0.5 times	5 times (excluding subject S1)

For Task 2 (high price, high involvement)—purchasing a 5 megapixel digital camera as a gift for mother—all subjects except subject 1 considered three or four alternatives. The result is consistent with Montgomery's finding that people tend to search among a small number of the best alternatives in order to reduce working memory load (Montgomery et al. 2003). The subjects then read and re-read related information several times. Two of them used the "Back" button to retrieve the best alternatives; the other subject opened each alternative in a new window, thereby using a sort of external memory aid. The average completion time of Task 2 is 9.72 minutes, considerably higher than Task 1 (see Table 3.6). Results of Task 2 show that shoppers switched between the two search modes about an average of five times (See Table 3.6). In addition, subjects used their perceived best digital camera brands to narrow down their search. For example, Subject 1 expressed her preference for Sony brand early. Moreover, she said that she owned and was pleased with a Sony digital camera. Thus she chose not to look for another (brand) alternative, but went straight to a Sony model. Subject 2 stated that "I used one Fujifilm digital camera before. Actually I like this brand. Brand is very important, at least for me. I have one camera which is made by Nikon. Nikon is good too."

Four questions (shown in Table 3.7) were asked of each subject once the study was completed. The questionnaire responses, summarized in Table 3.8, suggest some insights into shopper behavior and cognition. Subjects all wanted to consult more sites while performing the second task than the first task. They indicated that they wanted more product-related information. Most importantly, they also wanted to compare price

and then chose a vendor with great reputation and relatively good return policy. Memory aids were used to keep the information about alternatives that had been looked up.

Table 3.7 Four After-Tasks Questions

Questions	Descriptions
Q1	What are the main features of the web site (amazon.com) that you use most?
Q2	What kind of feature(s) do you think should be added to the web site to improve your online shopping experience?
Q3	Do you think the setup of this experiment close to your true online shopping experiences? If not, please specify the reasons.
Q4	What are the major concerns when you are making a purchase online?

Table 3.8 Summary of Answers to Interview Questions

Questions	Subject 1	Subject 2	Subject 3	Subject 4
Q1	Search price and product. Similar product comparison and used product information.	Search function, Sort, and product details	Search function, and customer reviews	Search function, product category, and sort by price.
Q2	N/A	Sort by product features (e.g., Camera with zoom)	Clear product category	Price and product comparison.
Q3	"Yes, especially for books. However, for camera, I would like to search from other sites instead of only one site. (e.g., I like Sony camera, so I would like to search it from Sony web site.)"	"Yes. But I would like to compare products and see product reviews from different web site for digital camera."	"Yes, very close. But I want to switch site and look for more information for digital camera."	"It's a working web site, so it's pretty close to true online shopping experiences. But you need to remind me that I have to pretend that I will shop for myself as I usually do."
Q4	Price, Brand, and my own budget.	Product features, services (return policy), and price.	Price, return policy, detailed description of the product, customer reviews/rates about the vendor	Price, condition (e.g., New or used product), vendor.

All four subjects said that they wanted the search engine to provide only the information they were looking for. For example, while searching product selections for a digital camera, Subject 2 said that "...it only gives me PDA [personal data assistant] and video software?" and Subject 4 stated that "a lot of phones come out, not what I want." They spent a considerable time to reach a certain amount of product selections they were looking for. This suggests that measures such as the number of alternatives and the amount of information on each page could help explain variation in choice time between high-involvement/high-price products and low-involvement/low-price products.

3.2.3 Discussion

With some limitations (discussed below), the results of both studies suggest that variation in product type leads to variation in shopping behavior and cognition. Additionally, customers may switch between breadth-first and depth-first search depending on the degree of product involvement. The results further suggest that repeatedly switching between depth-first and breadth-first search may indicate that the shopper is searching for a high-involvement and high price product, since they began to explore product selections in breadth-first search until finding one product for which they looked up detailed information. They then switched to depth-first search to read through the product descriptions, product features, editor reviews, customer reviews, and technical specification. After they gained more knowledge about the digital camera, they began to search for alternatives, bringing them back to breadth-first search. Repeating this process several times, they decided to compare major features and price for the best two products. The findings may be reflected in the variation in clickstream data regarding (i) *time spent*

on one product and its alternatives and (ii) *information-seeking behavior*, leading to predictions about the types of product a customer is seeking based on these measures. Finally, price and brand also seem relevant to these purchasing decisions, confirming a previous study's finding that choice time would be reduced if the customer has strong preference in brand (Tyebjee, 1979).

Based on the findings from the previous two studies, subjects' prior knowledge of products and subjects' attitudes toward brand could both be confounding factors. Since brand is important to customers, especially in buying electronic products, a refined experiment either needs to address brand directly or eliminate it as a factor (e.g., by using fictitious brands). It may be possible to assess subject knowledge about products, or to train subjects so that their product knowledge is roughly equivalent. The uncertainty risk associated with a purchase (Dholakia, 2001), which may alter customers' purchasing behavior and cognition, may also be worth investigating. In keeping with some prior research (Moe and Fader, 2002; Montgomery et al. 2003), it may also be appropriate to assess the correctness of customers' purchase decisions given the information shown to them.

The results suggest that understanding of customer needs and goals may be improved by analyzing cognitive-level data, in addition to behavioral data such as clickstreams. Models resulting from this work should have both theoretical and practical significance. The chief benefits to theory may be in the development of models which may be tuned in real-time through the use of clickstream data analysis, then compared for their similarity to the behavior and thinking processes of actual online shoppers. A benefit to online merchants should be that improved customer models lead to improved

information displays, and then to improvements in the shopping experience. The integration of protocol and clickstream data is anticipated to provide a powerful source of information to predict customer behaviors and enable greater efficiency in online shopping. Those concerns lead to the current design for the main study, as introduced in the following chapter.

CHAPTER 4

MAIN EMPIRICAL STUDY

The main empirical study investigates how changes in the levels of environmental, personal and product-related factors impact customers' cognition and behavior during online shopping. Specifically, three factors (time pressure, product involvement, and uncertainty and riskiness of choice) are included. Cognition and behavior are investigated by examining three phenomena: search and decision strategies, perceived risk, and time on task. Brand and subjects' prior knowledge toward online shopping investigated in the exploratory studies are controlled by using fictitious brands and by selecting a homogeneous student group. A 2×2×2 factorial designed experiment is then used to investigate the relationships between the independent variables and dependent variables.

The first set of hypotheses concerns how the independent variables affect subjects' *perceived risk.* High involvement products are expected to represent higher perceived risk for a customer than low involvement products (Zaichkowsky, 1985), leading to H1a:

> **H1a:** *The higher the product involvement, the higher the risk customers will perceive.*

Since time pressure increases the level of anxiety and stress a customer may feel, this study assumes that the customer would perceive higher risk in making a satisfactory purchase without gaining more product knowledge or comparing products in detail. Thus leading to H1b:

H1b: *The higher the time pressure, the higher the risk that customers will perceive.*

Based on prior studies (Kivetz, 1999), customers tend to eliminate product choices with missing or incomplete information on critical attributes. The reason behind this phenomenon could be that customers perceive greater risk in purchasing products when important details are unavailable, leading to H1c:

H1c: *The higher the uncertainty and the riskiness of product choices, the higher the risk customers will perceive.*

The second set of hypotheses concerns how the three independent variables relate to time spent using a *non-compensatory strategy* versus a *compensatory strategy*. P*roposition 2* states that customers with high product involvement will try to explore and research more product related information. Thus, customers will tend to obtain information on all critical attributes and form an overall score for each product choice when they are highly involved, leading to H2a:

H2a: *Customers will spend more time using a compensatory strategy while shopping for high involvement product (as opposed to non-compensatory strategy).*

Proposition 1 states that time pressure will alter customer's search strategies. When time pressure is high, customers tend to use *non-compensatory strategy* to narrow down the alternatives and accelerate the choice process, leading to H2b:

H2b: *The higher the time pressure, the greater the percentage of time using a non-compensatory strategy (based on proposition 1).*

In *proposition 4*, prior studies (Kivetz, 1999; Kivetz & Simonson, 2000; Slovic & MacPhillamy, 1974)) point out that customers use a *non-compensatory strategy* to deal with high uncertainty and riskiness of choice occurred with missing or incomplete product information, leading to H2c:

> **H2c:** *The higher the riskiness of product choices, the greater the percentage of time using a non-compensatory strategy.*

The last set of hypotheses concern how three independent variables affect subjects' time spent in *breadth-first* search mode versus in *depth-first* search mode. As stated in *proposition 2*, customers tend to read more product-related information while shopping for a high involvement product, leading to the hypothesis H3a that customers will use depth-first search when they are highly involved with the product:

> **H3a:** *Customers will spend more time in depth-first search mode while shopping for a high involvement product (as opposed to breadth-first search mode).*

This study also assumes that customers will not spend too much time reading all relevant product information in detail when they are under severe time pressure. Hence they will try to explore as many as possible alternatives using breadth-first search by looking at a small number of attributes to accelerate the choice process, leading to H3b:

> **H3b:** *The higher the time pressure, the greater the percentage of time using breadth-first search mode.*

Proposition 5 states that customers spend more time on depth-first search than on breadth-first search while encountering incomplete or missing product information, leading to H3c:

> **H3c:** *Customers will spend more time using depth-first search mode and reading product specifications in detail while shopping for high uncertainty and riskiness of product choice (as opposed breadth-first search mode).*

Table 4.1 summarizes the hypotheses and the data sources that will be used in testing them (analytic methods are discussed in the next section). The model resulting from the interrelation of these hypotheses is illustrated in Figure 4.1. The hypotheses state that time pressure, product involvement, and riskiness of choice all increase customers' perceived risk. While time pressure and riskiness of choice increase the percentage of time customers will use non-compensatory (NC) strategy, product involvement shows an opposite effect. In addition, while time pressure increase the percentage of time customers in using breadth-first search mode, riskiness of choice and product involvement increase the percentage of time customers use depth-first search.

Table 4.1 Research Hypotheses (First Order Effects) and Data Sources

Labels		*Hypotheses*	*Data Sources*
Perceived Risk	H1a	The higher the product involvement, the higher the risk customers will perceive.	Pre- and post-questionnaires
	H1b	The higher the time pressure, the higher the risk that customers will perceive.	Pre- and post-questionnaires
	H1c	The higher the uncertainty and the riskiness of product choices, the higher risk customers will perceive.	Pre- and post-questionnaire and expected utility model
Percentage of Time Using Non-Compensatory Strategy	H2a	Customers will spend more time using a compensatory strategy while shopping for high involvement product (as opposed to non-compensatory strategy).	Time stamps of clickstream data and transcribed protocols
	H2b	The higher the time pressure, the greater the percentage of time using a non-compensatory strategy.	Time stamps of clickstream data and transcribed protocols
	H2c	The higher the riskiness of product choices, the greater the percentage of time using a non-compensatory strategy	Time stamps, expected utility model, and transcribed protocols
Percentage of Time in Breadth-first Search Mode	H3a	Customers will spend more time in depth-first search mode while shopping for a high involvement product (as opposed to breadth-first search mode).	Time stamps, clickstream data, and transcribed protocols
	H3b	The higher the time pressure, the greater the percentage of time using breadth-first search mode.	Time stamps, clickstream data, and transcribed protocols
	H3c	Customers will spend more time using depth-first search mode and reading product specifications in detail while shopping for high uncertainty and riskiness of product choice (as opposed breadth-first search mode).	Time stamps, clickstream data, expected utility model, and transcribed protocols

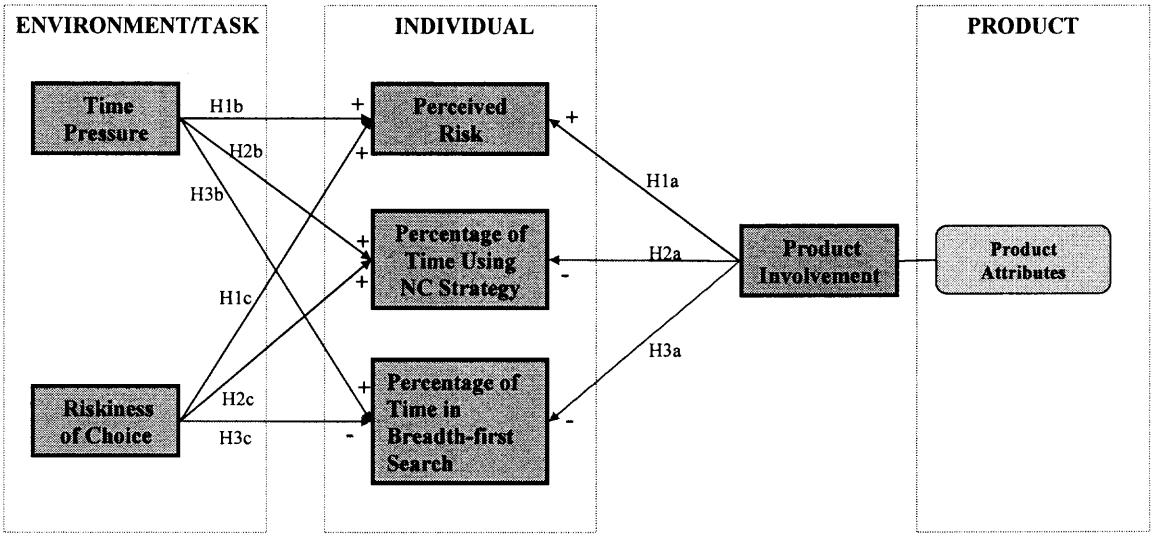

Figure 4.1 Research hypotheses.

4.1 Study Design

The design for this experiment is a complete 3-factor (2×2×2) factorial design. The dependent variables are search and decision strategies, perceived risk, and time on task. The factors and corresponding levels are time pressure, product involvement, and uncertainty and riskiness of choice. Order effect is counter-balanced by changing the order of two experiment tasks. Two scenarios contain: 1) the task of shopping for a low involvement product, either printer paper or blank CDR for daily use, and 2) the task of shopping for a high involvement product, either a digital camera as a gift for the subject's loved one or a television for the subject's own living room (see Appendix H). To achieve Power $1-\beta=.90$, $\alpha=.05$ and $\Delta / \sigma=1.0$, the sample size needed is 11 subject per cell (Kutner et al., 2005). Product involvement (I_i) is a random independent factor. Time pressure (T_j) and riskiness of choice (R_k) are fixed factors. The statistical model (mixed

effect model) of this design is written as follows, where μ is the overall mean effect of the model and NID represents a normal independent distribution.

$$Y_{ijkl} = \mu + I_i + T_j + R_k + (IT)_{ij} + (TR)_{jk} + (IR)_{ik} + (ITR)_{ijk} + \varepsilon_{ijkl}, \text{ where}$$

$$i = 1,2, j=1,2, k=1,2, l=1,2,...,5 \quad \sum T_j = 0, \sum R_k = 0, \sum_j (TR)_{jk} = \sum_k (TR)_{jk} = 0,$$

$$I_i \sim \text{NID}(0, \sigma_I^2),\ IT_{ij} \sim \text{NID}(0, \sigma_{IT}^2),\ IR_{ik} \sim \text{NID}(0, \sigma_{IR}^2),$$

$$ITR_{ijk} \sim \text{NID}(0, \sigma_{ITR}^2),\ \varepsilon_{ijkl} \sim \text{NID}(0, \sigma^2).$$

The dependent variable is a vector Y consisting of three elements: percentage of time in breadth-first search mode, percentage of time using non-compensatory strategy, and perceived risk. This research mainly focuses on the first order effect of three individual factors, but it would be beneficial to know whether interaction effects among these three factors occur.

4.2 Subjects

Subjects were recruited from various courses in Information Systems and Computer Science at New Jersey Institute of Technology. Screening was used to ensure that study subjects were reasonably homogenous (e.g., with similar level of computer skills and income, and all with prior online shopping experiences). Prior studies show that university students are active online shoppers, specifically those who not only have more experiences using web tools but also spend a fair amount of time online (Han & Ocker, 2002). IS677 "Information System Principles", IS350 "Computer, Society and Ethics,"

IS465 "Advanced Information Systems," and other equivalent-level classes were outlets for recruitment. Students voluntarily participated in an approximately 40 minutes study. To motivate realistic choices, participants choosing the product with best value later entered a draw for a winning prize (Morales et al. 2004). Twelve subjects were assigned to each experimental condition (Table 4.2), resulting in a total of 48 subjects.

Twenty-three percent of subjects reportedly shop about once a month and 58% of them shop several times a year. Books (87.5%), computers and peripherals (79%), and flight tickets and hotel deals (75%) are the most popular products to be shopped online among student subjects, following by electronic products (60%), media products such as CD, VCD and DVD (52%), and clothes, shoes and accessories (48%).

Table 4.2 Subject Assignment Table

		Riskiness of Choice			
		Low Riskiness of Choice		**High Riskiness of Choice**	
		Product Involvement		**Product Involvement**	
		Low	**High**	**Low**	**High**
Time Pressure	**No**	12 (a)	12 (b)	12 (c)	12 (d)
	Yes	12 (b)	12 (a)	12 (d)	12 (c)

4.3 Measures

The time pressure condition is simulated by reducing the available product choices over time (Sutter, Kocher, & Straub, 2003). In other words, the more time subjects spend on search, the fewer product choices are available. In order to verify that the time constraint

manipulation increased time pressure, two questions (Q10-Q11 shown in Appendix I) for each corresponding task in the post-experiment questionnaire are used.

A background questionnaire[3], which is used to collect information about demography, perceived risk, and product involvement, is shown as Appendix G. According to the survey results of product involvement, subjects are asked to shop on a pre-designed website for both a low- and a high-involvement product under assigned level of time pressure (with time pressure vs. without time pressure) and uncertainty and the riskiness of choice (high vs. low).

Uncertainty and the riskiness of a product choice is calculated using an expected utility model (Von Neumann & Morgenstern, 1944). The product database used in the website is constructed with nine product attributes for each of six product selections per product category. Information on the product includes text descriptions of approximate equal length and detail. Uncertainty and the riskiness of a product choice are obtained by omitting information about product attributes. Given K=9 attributes for a product L, the utility function U has an expected value if there is an assignment of probabilities $(u_1, u_2, ..., u_K)$ of missing attribute information for a product $L=(P_1, P_2, ..., P_K)$ and probabilities $u_K \geq 0$ with $\sum_1^k u_k = 1$. The expected utility function can then be written as:

$$U(L) = \sum_i^k u_i P_i .$$

Thus an optimal choice from the available product selections is accessible.

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[3] A background questionnaire regarding task assignments of product involvement was pre-tested with 6 subjects. Subjects did perceive television (average score: 5.7 on a 7-point semantic scale) and digital camera (average score: 5.1) as high involvement products, while blank compact disc (average score: 3.9) and printer paper (average score: 3.1) were perceived as low involvement products.

Subjects answer questions regarding their perceived risk before and after the shopping tasks. Perceived risk (PR) is measured by comparing the differences between pre- (Q8-Q12 shown in Appendix G) and post-experiment questionnaire responses (Q12-Q16 shown in Appendix I).

The percentage of time using a search mode or a decision strategy is calculated by adding up the time in one mode and then dividing by the total time on task. *Depth-first* search (denoted as "D") is defined as browsing information following a tree structure in finding product descriptions and detailed specifications. *Breadth-first* search (denoted as "B") is defined as exploring product selections without looking for detailed information. Each web page in the testing site has been carefully categorized with notations. Switching occurs either from mode D to mode B or vice versa. Total time spent and time spent per web page is computed by accessing time-stamps data. For example, a subject's navigation path may look like the figure shown in Figure 4.2. Navigation from P5 to Pn is considered as breadth-first search, while navigation starting from P5 and then browsing through detailed information of product attributes from P5A1 to P5A9 is identified as depth-first search. To enable identification of decision strategies from the protocols, the protocols are segmented then coded for content according to explicit rules (Ericsson & Simon, 1996). At least one additional independent coder is used to assess the reliability of the coding scheme. In order to further investigate which *Compensatory* (denoted as "C") and *Non-Compensatory* (denoted as "NC") strategy subjects actually use while performing shopping tasks, five questions (Q5-Q9 shown in Appendix I) for each corresponding task in the post-experiment questionnaire are used. Actual decision

strategies can also be obtained from keyword-coded protocols. Coding instructions are available in Appendix L.

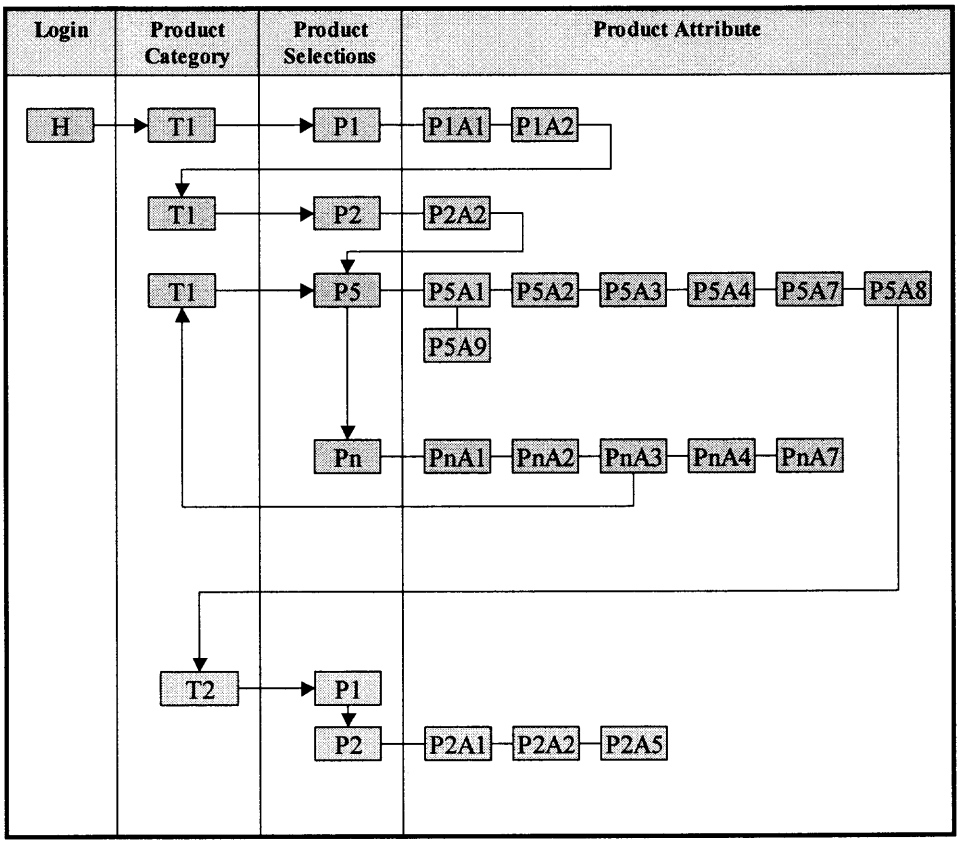

Figure 4.2 A sample of a subject's navigation path.

Contents of working memory are accessed through concurrent verbal protocols (Card et al. 2001; Lerch & Harter, 2001). Concurrent protocols require subjects to think out loud while performing a task (Biehal & Chakravarti, 1989; Ericsson & Simon, 1980). A post-experiment questionnaire (see Appendix I), is then used to collect information regarding whether subjects are confident with their purchase decisions (Q3) and which factors contribute to their degree of confidence (Q4). Methods of data collections and measures for each variable introduced in this study are summarized as Table 4.3.

Table 4.3 Summary of Data Collections and Measures for Each Variable

Variables	Data Source	Corresponding Questions	Scales
Product Involvement	Background questionnaire	Background (Q4-Q7) **(See Appendix G)**	Range: 4-28 (7-point scale)
Time Pressure	System manipulation with Post-experiment questionnaires	Post-experiment (Q10-Q11) **(See Appendix I)**	Range: 2-14 (7-point scale)
Uncertainty & Riskiness of Choice	System manipulation using expected utility model	Sample calculation is given in Table 4.4.	Range: 9-36 (7.7-30.8)
Perceived Risk	Difference between data collected from background and post-experiment questionnaires	Difference between Background (Q8-Q12) and Post-experiment (Q12-Q16). **(See Appendix G & I)**	Range: 0-35 (7-point scale)
Percentage of Time in Breadth-first Search	Time stamp in clickstream data	Sample clickstream data is given in Figure 4.4. E1= Time of B-First Search / Time of B-First + Time of D-First	Range: 0-100% 0.37003/0.60468 (min)=61.2% of time using breadth-first search
Percentage of Time in NC Strategy	Time stamp extracted from clickstream data and keywords in protocols	E2= Time of NC Strategy / Time of C Strategy + Time of NC Strategy	Similar calculation as above
	Post-experiment questionnaire (Note: to further investigate which C and NC strategy they used in detail)	Post-experiment (Q5-Q9) **(See Appendix I)**	Range: 5-35 (7-point scale)

4.4 Instrumentation

To better control factors manipulated in this work while sustaining the complexity of a shopping task, this research adopts an information display board (IDB) approach to collecting behavioral data (Lussier & Olshavsky, 1979; Payne, 1976; Weenig & Maarleveld, 2002). Information is shown in a matrix which consists of product alternatives (e.g., different models of digital camera) and product attributes (e.g., a camera's resolution in mega pixels, optical zoon, dimension, weight, etc.). Subjects move the mouse to the information they desire to know and then click on the circle button to view the information (Figure 4.3). When the cursor moves away from the cell, the information is hidden. As a result, the IDB approach enables effective collection of data that is heeded during the purchasing task (Cook & Swain, 1993).

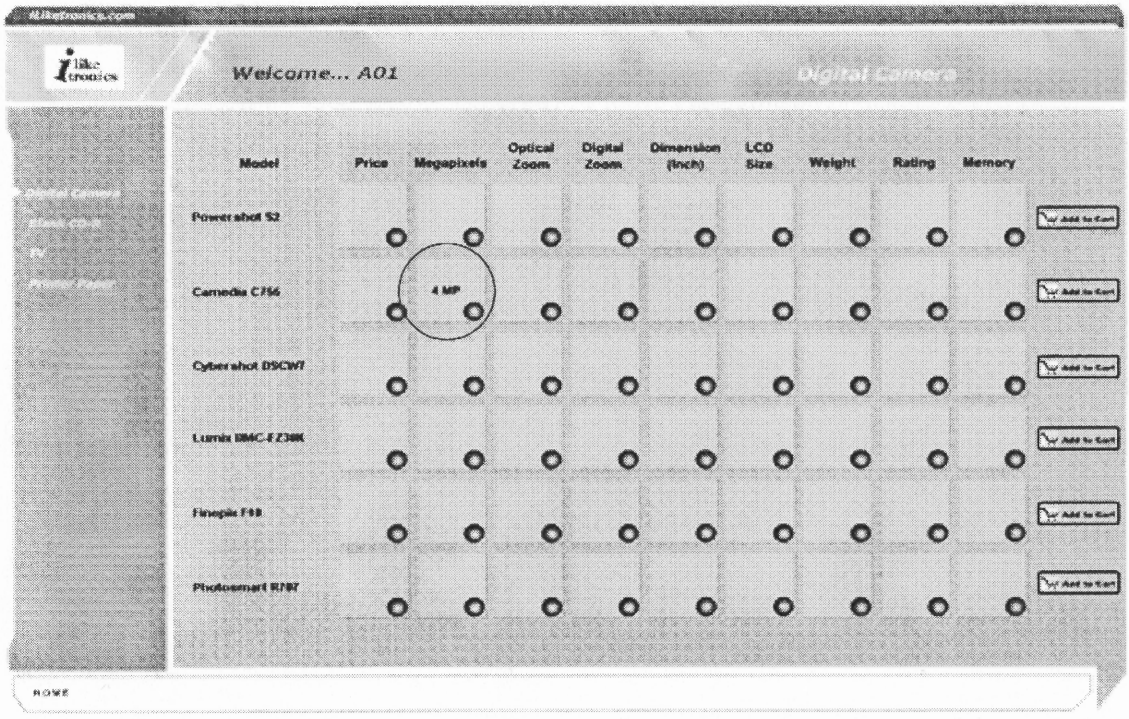

Figure 4.3 Information display board (IDB) sample of digital camera.

Complexity is controlled by holding the number of attributes constant across all four products, as follows. All four selected products, printer paper, blank CDR, digital camera and television, have the same number of attributes (9 attributes). Product choices in this study is based on considerations toward a targeted group of subjects, electronic products are better choices of high involvement product than jewelry or fashion products. The instrument for measuring product involvement is a 10-item 7-point scale adopted from McQuarrie and Munson (1992) (see attached background questionnaire as Appendix G).

As shown in Figure 4.4, behavioral data is recorded such as for which product category the user is currently seeking information (e.g., "Digital Camera"), who is the user (e.g., "A01"), which behavior the user is performing (e.g., "press" or "release" a cell button) at what time (e.g., "0.106216666666667" minutes after the task starts and the date and time for this behavior is "Mon Jan 30 16:30:54 Greenwich Mean Time-0500 2006"), which attribute of a model is currently being viewed (e.g., "r0205" meaning the 5^{th} attribute of product 2nd). Search modes are then identified based on the coding schema presented in Section 4.3 and the percentage of time using either breadth-first (denoted as "B") or depth-first (denoted as "D") are calculated as shown in Table 4.4. Source code of major functions in the study web site is available in Appendix M.

```
Digital Camera, A01.
press, 0.106216666666667 min. Mon Jan 30 16:30:54 GMT-0500 2006, r0205;
release, 0.126566666666667 min. Mon Jan 30 16:30:55 GMT-0500 2006, r0205;
press, 0.140316666666667 min. Mon Jan 30 16:30:56 GMT-0500 2006, r0102;
release, 0.156683333333333 min. Mon Jan 30 16:30:57 GMT-0500 2006, r0102;
press, 0.170316666666667 min. Mon Jan 30 16:30:58 GMT-0500 2006, r0301;
release, 0.192333333333333 min. Mon Jan 30 16:30:59 GMT-0500 2006, r0301;
press, 0.2102 min. Mon Jan 30 16:31:00 GMT-0500 2006, r0405;
release, 0.226533333333333 min. Mon Jan 30 16:31:01 GMT-0500 2006, r0405;
press, 0.239916666666667 min. Mon Jan 30 16:31:02 GMT-0500 2006, r0504;
release, 0.26005 min. Mon Jan 30 16:31:03 GMT-0500 2006, r0504;
press, 0.271516666666667 min. Mon Jan 30 16:31:04 GMT-0500 2006, r0307;
release, 0.286383333333333 min. Mon Jan 30 16:31:05 GMT-0500 2006, r0307;
press, 0.298316666666667 min. Mon Jan 30 16:31:06 GMT-0500 2006, r0208;
release, 0.3191 min. Mon Jan 30 16:31:07 GMT-0500 2006, r0208;
press, 0.33325 min. Mon Jan 30 16:31:08 GMT-0500 2006, r0505;
release, 0.360116666666667 min. Mon Jan 30 16:31:09 GMT-0500 2006, r0505;
press, 0.390033333333333 min. Mon Jan 30 16:31:11 GMT-0500 2006, r0409;
release, 0.4239 min. Mon Jan 30 16:31:13 GMT-0500 2006, r0409;
press, 0.455366666666667 min. Mon Jan 30 16:31:15 GMT-0500 2006, r0506;
release, 0.47625 min. Mon Jan 30 16:31:16 GMT-0500 2006, r0506;
press, 0.50735 min. Mon Jan 30 16:31:18 GMT-0500 2006, r0608;
release, 0.5256 min. Mon Jan 30 16:31:19 GMT-0500 2006, r0608;
press, 0.54935 min. Mon Jan 30 16:31:21 GMT-0500 2006, r0609;
release, 0.640616666666667 min. Mon Jan 30 16:31:26 GMT-0500 2006, r0609;
press, 0.6707 min. Mon Jan 30 16:31:28 GMT-0500 2006, r0605;
release, 0.68025 min. Mon Jan 30 16:31:29 GMT-0500 2006, r0605;
press, 0.693383333333333 min. Mon Jan 30 16:31:29 GMT-0500 2006, cart6;
release, 0.7109 min. Mon Jan 30 16:31:30 GMT-0500 2006, cart6;
```

Figure 4.4 Sample of clickstream obtained from the main experiment.

Table 4.4 Sample of Coded Clickstream Data

Act	Minutes	Date & Time	Cell	Mode	Switch	Time Lapse (Min)
press	0.1062	Mon Jan 30 16:30:54 GMT-0500 2006	r0205	B		
release	0.1266	Mon Jan 30 16:30:55 GMT-0500 2006	r0205	B		0.02
press	0.1403	Mon Jan 30 16:30:56 GMT-0500 2006	r0102	B		0.01
release	0.1567	Mon Jan 30 16:30:57 GMT-0500 2006	r0102	B		0.02
press	0.1703	Mon Jan 30 16:30:58 GMT-0500 2006	r0301	B		0.01
release	0.1923	Mon Jan 30 16:30:59 GMT-0500 2006	r0301	B		0.02
press	0.2102	Mon Jan 30 16:31:00 GMT-0500 2006	r0405	B		0.02
release	0.2265	Mon Jan 30 16:31:01 GMT-0500 2006	r0405	B		0.02
press	0.2399	Mon Jan 30 16:31:02 GMT-0500 2006	r0504	B		0.01
release	0.2601	Mon Jan 30 16:31:03 GMT-0500 2006	r0504	B		0.02
press	0.2715	Mon Jan 30 16:31:04 GMT-0500 2006	r0307	B		0.01
release	0.2864	Mon Jan 30 16:31:05 GMT-0500 2006	r0307	B		0.01
press	0.2983	Mon Jan 30 16:31:06 GMT-0500 2006	r0208	B		0.01
release	0.3191	Mon Jan 30 16:31:07 GMT-0500 2006	r0208	B		0.02
press	0.3333	Mon Jan 30 16:31:08 GMT-0500 2006	r0505	B		0.01
release	0.3601	Mon Jan 30 16:31:09 GMT-0500 2006	r0505	B		0.03
press	0.3900	Mon Jan 30 16:31:11 GMT-0500 2006	r0409	B		0.03
release	0.4239	Mon Jan 30 16:31:13 GMT-0500 2006	r0409	B		0.03
press	0.4554	Mon Jan 30 16:31:15 GMT-0500 2006	r0506	B		0.03
release	0.4763	Mon Jan 30 16:31:16 GMT-0500 2006	r0506	B		0.02
press	0.5074	Mon Jan 30 16:31:18 GMT-0500 2006	r0608	B		0.03
release	0.5256	Mon Jan 30 16:31:19 GMT-0500 2006	r0608	B		0.02
press	0.5494	Mon Jan 30 16:31:21 GMT-0500 2006	r0609	D		0.02
release	0.6406	Mon Jan 30 16:31:26 GMT-0500 2006	r0609	D	1	0.09
press	0.6707	Mon Jan 30 16:31:28 GMT-0500 2006	r0605	D		0.03
release	0.6803	Mon Jan 30 16:31:29 GMT-0500 2006	r0605	D		0.01
press	0.6934	Mon Jan 30 16:31:29 GMT-0500 2006	cart6			
release	0.7109	Mon Jan 30 16:31:30 GMT-0500 2006	cart6			
Total Task Time=0.71 minutes						

Mode	Time (minutes)	Percentage
B=	0.419383333	73.06%
D=	0.15465	26.94%

As described in Section 4.3, time pressure is simulated by reducing available product choices over time (see Figure 4.5). This approach has advantages over other approaches. For example, reducing available choices randomly may result in the order of product disappearances affecting the results. It would be inadvisable to eliminate the better choices at the beginning or the poorer choices at the very end. To overcome this problem, an incomplete block design is used to control the order of product eliminations. A SAS program (PROC OPTEX) is utilized to systematically generate 3 blocks of elimination orders out of 720 possible orders.

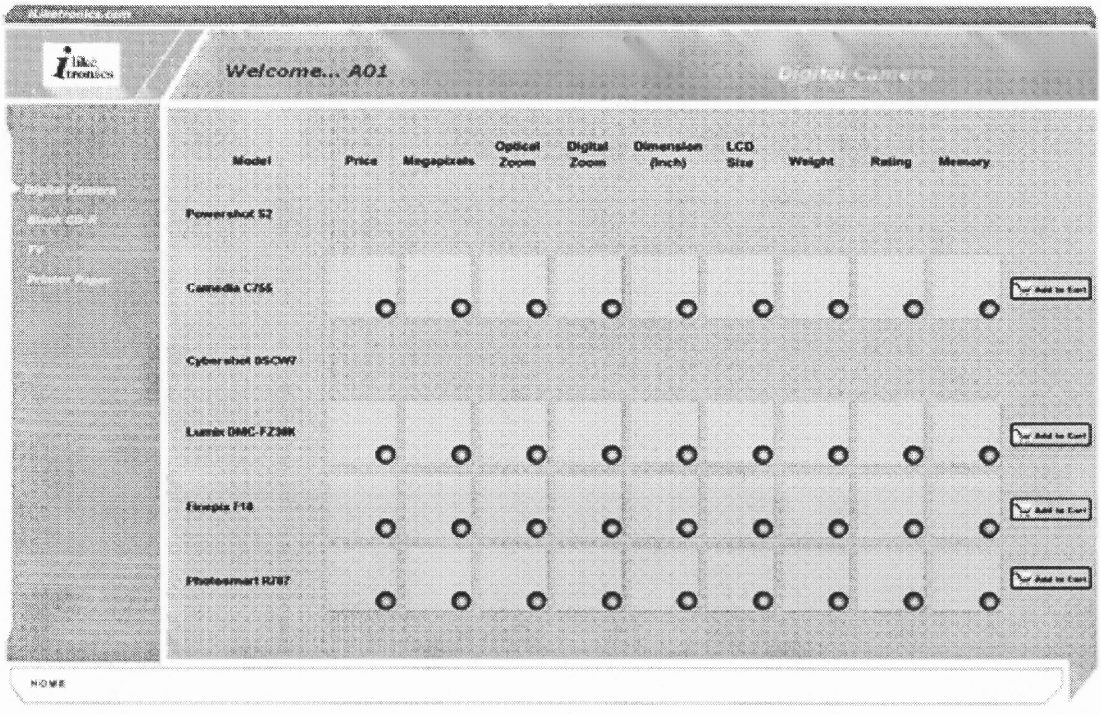

Figure 4.5 A sample of IDB simulated time pressure condition.

Uncertainty and the riskiness of a product choice are calculated using the expected utility model (Von Neumann & Morgenstern, 1944) discussed previously. Table 4.5 demonstrates detailed calculations of the expected utility for six digital camera

models. Each of the six digital cameras has at most nine attributes that describe it. Product 3 (Cybershot DSCW7) and product 5 (Finepix F10) are of best value among the bunch. By systematically assigning missing information to products, this study can control the riskiness of a product choice. In this study, full information represents low riskiness of choice, whereas missing information represents high riskiness of choice. In missing information conditions, values of those missing attributes are set to 0. Each of four products is of 10 cells missing information as shown in Table 4.6. Completed calculations for all four products are available in Appendix N.

Table 4.5 Expected Utility of Digital Camera with Complete Information

Product	Price	MP	Optical Zoom	Digital Zoom	Dimension	LCD Size	Weight	Rating	Memory		
Powershot S2	424	5	12x	4x	3.07x4.45x2.97"	1.8"	14.3 oz	8.3/10 (45)	32 MB memory card		
Camedia C755	299.99	4	10x	4x	2.60x4.20x2.70"	1.5"	10.4 oz	8.2/10 (11)	32 MB memory card		
Cybershot DSCW7	349.99	7.2	3x	2x	3.52x2.37x1.40"	2.5"	6.9 oz	9.2/10 (21)	32 MB internal memory		
Lumix DMC-FZ30K	599.94	8	12x	4x	5.54x3.37x5.44"	2"	23.84 oz	10/10 (1)	32 MB internal memory		
Finepix F10	322.84	6.3	3x	6.2x	3.62x2.30x1.07"	2.5"	5.5 oz	8.7/10 (21)	32 MB internal memory		
Photosmart R707	279.99	5.1	3x	8x	1.26x3.78x1.38"	1.5"	7.2 oz	6.8/10 (63)	32 MB internal memory		
Score 1-4	Expected Utility=Price*1+MP*1+OZ*1+DZ*0.8+Dimension*0.8+LCD*0.8+Weight*0.8+Rating*1+Memory*0.5										
Product	Price	MP	Optical Zoom	Digital Zoom	Dimension	LCD Size	Weight	Rating	Memory	Score	Expected Utility
Powershot S2	2	2	4	2	2	2	3	2	1	20	17.7
Camedia C755	4	1	3	2	2	1	3	2	1	19	16.9
Cybershot DSCW7	3	4	1	1	4	4	4	4	1	26	22.9
Lumix DMC-FZ30K	1	4	4	2	1	3	1	4	1	21	19.1
Finepix F10	3	3	1	3	4	4	4	3	1	26	22.5
Photosmart R707	4	2	1	4	4	1	4	1	1	22	18.9
	200-600	4-7+	12-Mar	8-Feb	6.57-100+	1.5-2.5	5.5-24	6.8-10			
	100	1	2+	1.5	23	0.25	4.6	0.8			
					40.57						
					29.48						
					11.68						
					101.56						
					8.91						
					6.57						

Table 4.6 Expected Utility of Digital Camera with Missing Information

Product	Price	MP	Optical Zoom	Digital Zoom	Dimension	LCD Size	Weight	Rating	Memory		
Powershot S2	424	5	12x	4x	3.07x4.45x2.97"	1.8"	14.3 oz	8.3/10 (45)	32 MB memory card		
Camedia C755	299.99	4	10x	4x	2.60x4.20x2.70"	1.5"	10.4 oz	8.2/10 (11)	32 MB memory card		
Cybershot DSCW7	349.99	7.2	3x	2x	3.52x2.37x1.40"	2.5"	6.9 oz	9.2/10 (21)	32 MB internal memory		
Lumix DMC-FZ30K	599.94	8	12x	4x	5.54x3.37x5.44"	2"	23.84 oz	10/10 (1)	32 MB internal memory		
Finepix F10	322.84	6.3	3x	6.2x	3.62x2.30x1.07"	2.5"	5.5 oz	8.7/10 (21)	32 MB internal memory		
Photosmart R707	279.99	5.1	3x	8x	1.26x3.78x1.38"	1.5"	7.2 oz	6.8/10 (63)	32 MB internal memory		
Score 1-4	Expected Utility=Price*1+MP*1+OZ*1+DZ*0.8+Dimension*0.8+LCD*0.8+Weight*0.8+Rating*1+Memory*0.5										
Product	Price	MP	Optical Zoom	Digital Zoom	Dimension	LCD Size	Weight	Rating	Memory	Score	Expected Utility
Powershot S2	2	2	4	2	2	2	3	2	0	19	16.8
Camedia C755	4	1	3	2	0	1	3	0	1	15	13.3
Cybershot DSCW7	3	4	0	1	4	0	4	4	1	21	17.9
Lumix DMC-FZ30K	1	4	4	2	1	3	1	0	1	17	15.1
Finepix F10	3	3	1	0	4	4	4	3	1	23	19.5
Photosmart R707	4	2	1	0	4	1	0	1	0	13	11.8
	200-600	4-7+	3x - 12x	2x -8x	6.57-100+	1.5-2.5	5.5-24	6.8-10			
	100	1	2+	1.5	23	0.25	4.6	0.8			
					40.57						
					29.48						
					11.68						
					101.56						
					8.91						
					6.57						

4.5 Experimental Procedure

Before the experiment, the subjects are asked to sign a consent form (Appendix D) and then to complete a background questionnaire, given in Appendix G. During each of the individual experimental sessions, the subjects work on an identically-equipped personal computer in the presence of an investigator. Next, the subjects complete a tutorial designed to familiarize them with the think-aloud method and the website (see Appendices E through F). After the tutorial, the subjects are informed that their objective is to shop for two products following the given task scenarios under assigned conditions (see Appendix H). The subjects are also informed that their shopping experiences and verbal protocols will be audio- and video-recorded along with mouse movements on the computer screen (see Appendix D). After completing each of their tasks, the subjects are asked to complete a questionnaire about their experiences and whether their perceived risk changed during the experiment (see Appendix I). Finally, they are debriefed.

4.6 Validity and Reliability

The analytic plan allows investigation of the major hypotheses and addresses issues of validity and reliability. Construct validity is enhanced by conducting the experiment using clearly defined procedures and scripts (Pandit, 1996), which are available in Appendix D through I. Internal validity is enhanced by building the theory and skeleton of the preliminary model from previous work (including the preliminary studies) and by clearly identifying all the variables in this study. External validity is enhanced by establishing the study domain through a series of literature reviews in e-commerce, consumer psychology, and information seeking fields. Thus critical factors of this study

are identified so that the results are expected to be applicable across the target domains. For example, Kivetz and Simonson's study (2000) deployed a matrix-like information presentation as the information display board (IDB). Many comparison shopping stores (e.g., Dell.com, HP.com, pricegrabber.com, etc.) also employ a matrix-like presentation of information as shown in Figure 4.6.

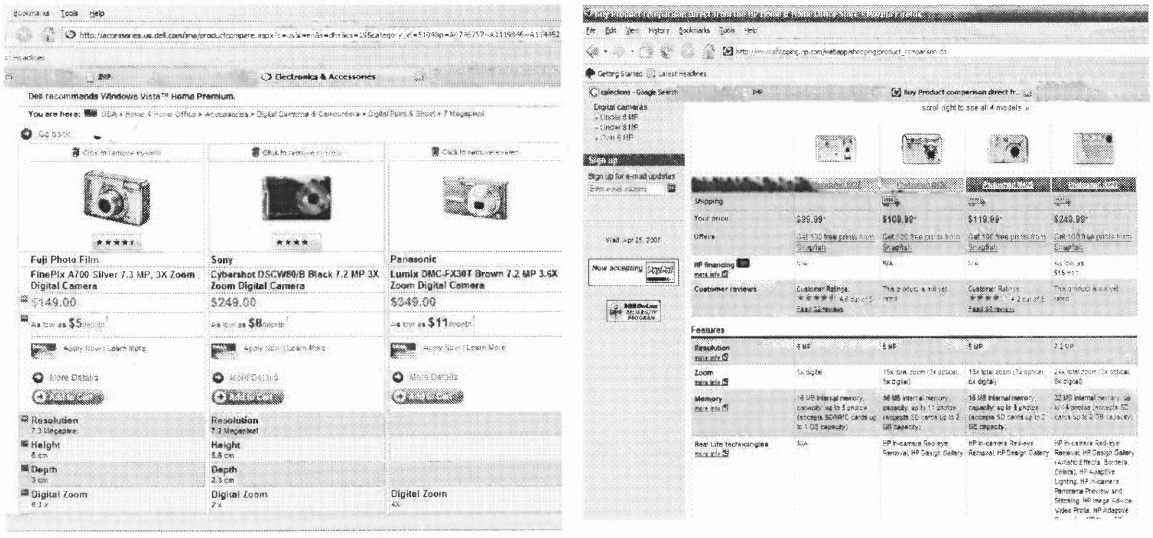

Figure 4.6 Samples of matrix-like information presentation (dell.com and hp.com).

Instruments designed for this research are adopted from prior studies and pre-tested with a small group of people so that validity and reliability of the measures employed are enhanced. Convergent and discriminant validity of measures is tested through Cronbach's alpha (α) loading (Cronbach & Meehl, 1955). A convergent validity test reveals that measures designed to be related are actually related; a discriminant validity test reveals that measures that are not supposed to be related are indeed not related. Assumptions of normality, homogeneity, and additivity are tested by calculating the Shapiro-Wilk (W) statistic and drawing normality and residual plots (Shapiro & Wilk, 1965; Montgomery, 2001) as illustrated in Appendix O.

All questions testing product involvement, perceived risk, time pressure and decision strategies are adapted from prior studies. All measures are reliable at 0.7180 or above (Cronbach & Meehl, 1955). The raw variable columns of Cronbach's alpha are used instead of the standardized columns since the variances showed a limited spread. Cronbach's alpha coefficient of reliability for product involvement averages 0.9483 across all 4 products. Specifically, 10-item 7-point-scale questions for printer paper is 0.9180; for blank CD-R is 0.9385; for digital camera is 0.9835; for television is 0.9674. Cronbach's alpha coefficient of reliability for perceived risk is 0.8935 and for time pressure is 0.7180.

Two transcribers keyword-coded all think-aloud protocols for further investigation of actual decision strategies made by subjects while shopping online. Thus testing inter-rater reliability is to have two transcribers determine which category each keyword regarding decision strategy falls into and then calculate the percentage of agreement between the transcribers. The inter-rater reliability for this study is 83%. The Cohen's Kappa correlation coefficient (Cohen, 1960) shows the agreement between two coders is 0.8, which indicates a high level of reliability in the coding operation (Landis & Koch, 1977). Table 4.7 shows the statistics of simple kappa coefficient for this study.

Table 4.7 Inter-Rater Reliability Between Two Coders

Simple Kappa Coefficient	
Percent Agreement	83%
Kappa	0.8
95% Confidence Interval for Kappa	0.4356 to 1
Z	2.5820
$p > Z$	0.0049

CHAPTER 5

MAIN STUDY RESULTS

The findings reported in this chapter are divided into three major sections. Section 5.1 describes and summarizes frequencies, descriptive statistics and hypothesis testing with respect to the results of the impact of the three independent variables (product involvement, time pressure, and uncertainty and riskiness of choice) on the dependent variables of time on task, search strategies and perceived risk. Multivariate analysis of variance (MANOVA) test criteria and exact *F* statistics are used to investigate overall effects. Section 5.2 discusses the findings collected from protocols that include the impact of three independent variables on the decision strategies. Table 6.1 describes the hypotheses discussed in each section. Section 5.3 compares the differences of findings discussed in the prior sections and summarizes the overall findings. Detailed results are given in Appendix P.

Table 5.1 Hypotheses Tested by Corresponding Analysis Methods

Hypothesis	Quantitative Methods (Part I)	Qualitative Methods (Part II)
H1a	√	
H1b	√	
H1c	√	
H2a	√	√
H2b	√	√
H2c	√	√
H3a	√	
H3b	√	
H3c	√	

5.1 Quantitative Study and Analysis

5.1.1 Manipulation Checks

Printer paper and blank CDR are indeed low involvement products compared to digital camera and television as shown in Figure 5.1. Time constraint manipulation is successful; subjects assigned to time pressure condition indeed feel pressure. Furthermore, time pressure manipulation, not product involvement or perceived risk, appears to be the sole factor which results in subjects' feeling pressure ($p<.0001$). Factorial ANOVA is used to justify this conclusion. No order effect is found between the two tasks (Wilks' Lambda=.9836; $p=.8580$). In addition, there is no significant within-factor difference between the two low-involvement products or between the two high-involvement products (Wilks' Lambda=.9231; $p=.3795$).

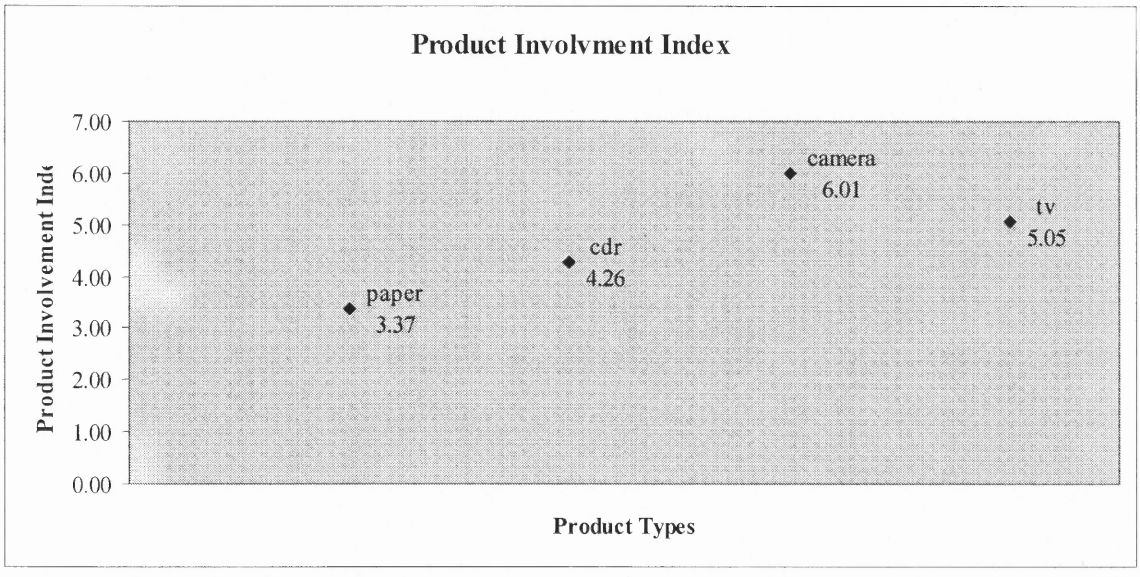

Figure 5.1 Product involvement index.

5.1.2 Results

According to the results of the MANOVA test, the respective effects are significant. Product involvement (Wilks' Lambda=0.2589; F=26.71, p<.0001), time pressure (Wilks' Lambda=0.7432; F=3.23, p<.01) and uncertainty and riskiness of choice (Wilks' Lambda=0.7931; F=2.43, p<.05) all contribute to the effect model. To further identify the specific dependent variable that contributed to the overall significant effect, the univariate F tests are then used to interpret the respective effect for each variable. The results show that product involvement, time pressure, and uncertainty and riskiness of choice all significantly affect subjects' total time on task. The higher the product involvement, the more time subjects spent on completing the task (F=11.99, p=0.0008). While uncertainty and riskiness of product choice increases the time subjects spend on making shopping decisions (F=9.27, p<0.01), the time pressure results in the opposite effect (F=18.21, p<.0001). Results also show an interaction effect between product involvement and time pressure (F=4.12, p<0.05). A complete data set of time on task is shown in Table 5.2 and the relationships among three factors are depicted in Figure 5.2.

Hypothesis H1a, which predicted a positive relationship between product involvement and perceived risk, was confirmed (F=142.71, p<.0001). Although not all aspects of perceived risk (psychological, financial, social and performance) resulted from various states of time pressure, Hypothesis H1b successfully predicted a relationship between time pressure and the performance aspect of perceived risk (F=3.07, p=0.0830), meaning that subjects shopping under time pressure worried that their purchases may not function as described. Hypothesis H1c, which predicted a positive relationship between riskiness of product choices and perceived risk, was confirmed on the psychological

aspect of risk (F=5.82, p=0.0178). It should be noted that there were interaction effects found between product involvement and each of the other independent variables – time pressure and riskiness of choice. The interaction effect between product involvement and time pressure is not statistically significant but is in the proposed direction (F=2.96, p=0.0877). The effect between product involvement and riskiness of choice was also found to be significant (F=5.53, p<.05).

Table 5.2 Total Task Times Across Three Factors (Minutes)

		Riskiness of Choice			
		Low Riskiness of Choice		High Riskiness of Choice	
		Product Involvement		Product Involvement	
		Low	High	Low	High
Time Pressure	No	3.37	3.67	4.79	7.69
		1.79	4.73	3.27	9.57
		0.92	3.54	2.48	2.39
		3.67	1.70	2.10	9.24
		2.09	3.96	2.33	2.58
		1.51	4.99	2.45	2.74
		1.03	1.62	2.07	3.92
		0.97	1.56	3.09	2.67
		2.94	2.49	2.90	4.67
		2.11	4.47	5.93	2.34
		2.23	5.45	3.13	3.64
		4.20	5.53	4.31	4.59
		Mean 2.24	3.64	3.24	4.67
	Yes	1.26	1.94	2.10	3.90
		1.99	2.99	2.74	3.16
		2.33	1.36	2.64	2.66
		1.85	2.27	3.17	2.92
		1.69	2.02	2.42	1.44
		2.05	2.14	0.95	1.87
		1.32	2.05	2.23	4.09
		2.10	1.29	1.82	2.80
		2.03	1.74	1.49	4.04
		1.76	1.61	1.31	3.39
		1.10	2.45	2.14	4.22
		3.22	2.66	3.65	1.42
		Mean 1.89	2.04	2.22	2.99

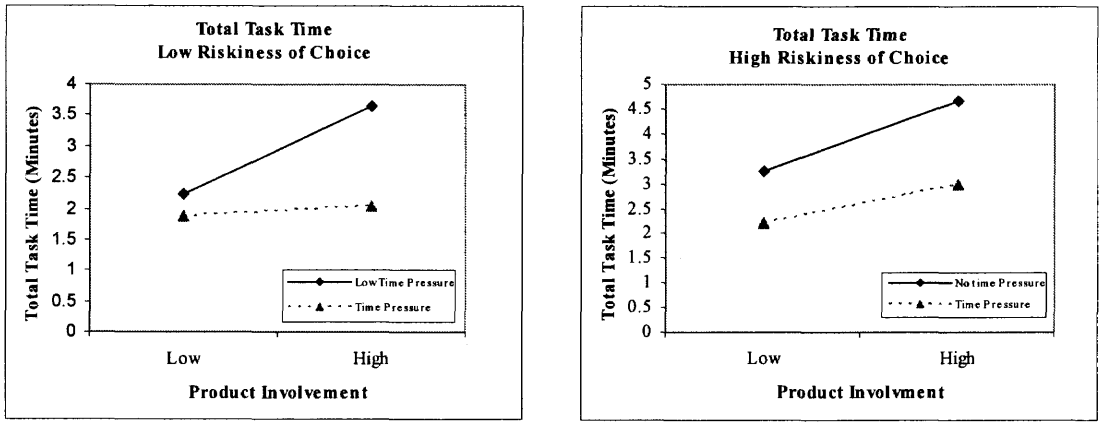

Figure 5.2 Graphical relationships among three factors on total task time.

Hypothesis 2 was tested using both quantitative and qualitative measures. Protocols were used to measure the actual time of execution of each decision strategy, while survey questions (Q5-Q9 in Appendix I) were used to measure its perceived proportion. Hypothesis H2c predicted that the higher the riskiness of product choice, the greater the percentage of time a non-compensatory strategy were used. Based on the survey results, the hypothesis was not statistically significant but in the proposed direction (F=3.44, p=0.0671). Finally, there was no support found for hypotheses H2a and H2b, in that product involvement (F=1.45, p=0.2324) and time pressure (F=0.02 p=0.8998) would negatively and positively affect the percentage of time subjects made use of non-compensatory decision strategy.

Although tendencies were shown (Figure 5.3), there was no support found for Hypotheses 3a, 3b and 3c, in that product involvement (F=0.08, p=0.7731), time pressure (F=0.40, p=0.5297) and riskiness of choice (F=0.50, p=0.4797), respectively would negatively, positively and positively affect the percentage of time subjects conducted breadth-first search. More detailed analysis and discussions are presented in the next section. In Figure 5.2, for low riskiness of choice and low product involvement

conditions, as time pressure increased the percentage of time on breadth-first search decreased, which is inconsistent with prediction of hypothesis H3b. The results also indicate an opposite phenomenon from what was predicted according to hypothesis H3c. Subjects increased the time using breadth-first search instead with one exception while they were shopping for high involvement product under pressure. A complete set of percentage of time on breadth-search strategy is shown in Table 5.3.

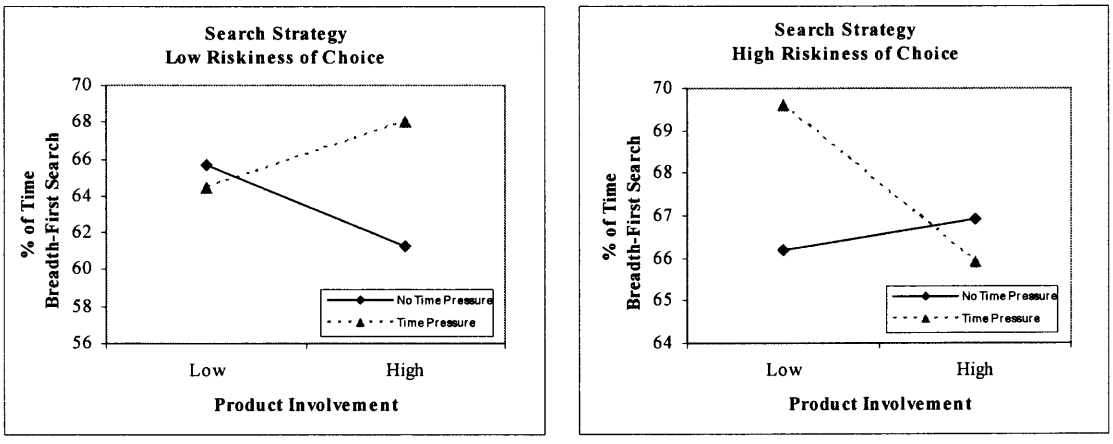

Figure 5.3 Graphical relationships among three factors on search strategy.

Table 5.3 Percentage of Time on Breadth-Search Strategy Across Three Factors (%)

		Riskiness of Choice			
		Low Riskiness of Choice		High Riskiness of Choice	
		Product Involvement		Product Involvement	
		Low	High	Low	High
Time Pressure	No	70	37	88	73
		88	63	48	77
		48	36	65	53
		42	69	47	53
		74	78	46	73
		89	58	73	63
		54	53	52	93
		65	64	70	58
		82	67	78	57
		50	64	90	87
		64	71	61	31
		62	76	75	85
		Mean 65.67	61.33	66.08	66.92
	Yes	36	59	90	47
		90	82	70	66
		53	72	67	86
		52	70	79	48
		75	65	48	76
		52	83	49	64
		62	72	89	68
		63	47	87	65
		56	89	52	85
		95	72	85	68
		82	57	34	60
		58	48	85	58
		Mean 64.5	68	69.58	65.92

5.1.3 Discussion Part I

This part discusses the results reported in the previous section using quantitative measures. The present research provides evidence of which product attributes or factors are the real dominant force resulting in changed behavior and cognition. Hypotheses H1a, H1b, H1c and H2c were supported. Although there was no significant support for hypotheses H3a, H3b and H3c, one interesting implication can be found by referring to protocols collected in this study and by comparing the results with preliminary findings. In preliminary runs, studies were conducted on Amazon.com, a website with unrivaled information length, unrivaled product specifications and unrivaled number of product selections. Although subjects started with breadth-first search and tended to explore as many alternative choices as possible, depth-first search was found as the dominant search mode that subjects used while they were shopping for high involvement products. In the present study such tendency still holds true but not significantly enough to support the prediction. One explanation is that the time amounted from the volume of product information to read, comparing information for high involvement product to that for low involvement product. Another explanation could be that customers shopping for high involvement products tended to spend time going through lengthy customer reviews and detailed specifications where time on depth-first search kept on accumulating rapidly. This assertion was concluded by investigating protocols and clickstreams collected in this study. Subjects expressed their willingness to review consumer reports and text reviews, not just numerical ratings, while shopping for high involvement products.

Information foraging theory (Pirolli, 2007) describes foraging as consisting the distinct activities of information-seeking and information-handling. Information-seeking is "purposive seeking for information as a consequence of a need to satisfy some goal" (Wilson, 2000). In the present study, information seeking has been denoted simply as *search*. Information-handling consists of behavioral and cognitive acts involved in incorporating found information into the person's existing knowledge base (Wilson, 2000).

An interesting finding is that an opposite relationship of hypothesis H3b was found, described in Section 5.1.2. As reported in Section 4.3, search strategy (i.e., *information-seeking*) mode D is defined as navigation through numerous attributes of a product choice, while mode B is defined as navigation through different product choices. Thus subjects were either in search mode D or mode B while they were clicking buttons to obtain product information. However, the time between each button click may represent the subjects' processing of the information they have just seen, considering what information they were going to seek next, evaluating product choices, or moving the mouse unconsciously. Such behaviors are considered as information-handling. By deducting time on such behaviors from previously coded search time, a relationship as predicted was then found (Figure 5.4). The information foraging in this study represents the collective behavior of seeking and handling (Pirolli, 2007; Qing, 2006). Although hypotheses H3a, H3b and H3c are still not significantly supported, the overall model on search strategy is dramatically improved (see Appendix P – Search vs. Minushandling). A complete modified data set of percentage of time spent on breadth-search strategy is shown in Table 5.4.

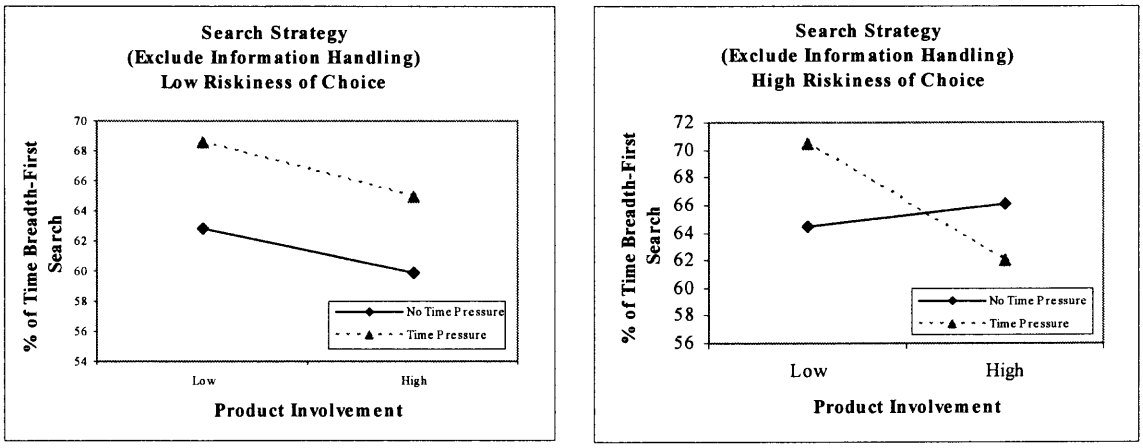

Figure 5.4 Graphical relationships among three factors on search strategy excluding information handling.

Table 5.4 Percentage of Time on Breadth-Search Strategy Excluding Information-Handling Across Three Factors (%)

		Riskiness of Choice			
		Low Riskiness of Choice		High Riskiness of Choice	
		Product Involvement		Product Involvement	
		Low	High	Low	High
Time Pressure	No	68	23	82	68
		76	63	58	72
		40	30	63	55
		40	66	48	50
		67	76	40	73
		96	48	60	60
		57	61	55	95
		58	64	62	59
		74	75	82	56
		57	65	89	88
		58	72	58	21
		63	76	66	96
		Mean 62.83	59.92	63.58	66.08
	Yes	87	51	87	43
		53	79	69	63
		54	79	65	87
		58	59	72	41
		78	47	53	75
		62	88	56	48
		64	67	89	53
		62	44	90	67
		71	83	59	91
		92	75	84	69
		83	63	31	54
		59	44	90	53
		Mean 68.58	64.92	70.42	62

5.2 Qualitative Study and Analysis

This section reports on the results of qualitative analysis associated with hypotheses H2a, H2b and H2c. Data to investigate the hypotheses is collected from open-ended questions of two post-questionnaires and from keyword-coded protocols. The focus of this study is to investigate the impacts of three independent variables (product involvement, time pressure, and uncertainty and riskiness of choice) on actual decision strategy – either compensatory (C) or non-compensatory (NC). In addition, questions regarding the subjects' shopping experiences were answered, which include what information was useful to them while shopping for a specific product, what information they wished they were given but did not have, which factors contributed to their final decisions and what concerns they had while shopping online, etc (see Appendix I).

5.2.1 Results

Based on the MANOVA results (see Appendix P – NC_Strategy with interaction effects), hypothesis H2a, which predicted a negative relationship between product involvement and percentage of time using NC-Strategy, was confirmed (F=11.89, p=.0019). Hypothesis H2b, which predicted a positive relationship between time pressure and the dependent variable (NC-Strategy) was not supported (F=2.03, p=.1578); meanwhile hypothesis H2c successfully predicted a relationship between riskiness of product choices and percentage of time using NC-Strategy but in the opposite direction (F=8.26, p=.0049). It should be noted that there was a significant interaction effect found between time pressure and riskiness of choice (F=6.71, p<.05). Two transcribers keyword coded the protocols using the coding scheme shown in Appendix L. A protocol analysis tool,

Transana 2.12, was employed. By identifying decision strategies and adding up elapsed time for each strategy, the percentage of time subjects spent on NC strategy is summarized in Table 5.5. The missing data points shown in the table resulted from inexplicit statements, unidentifiable protocols or defective recordings. Testing results show that the higher the riskiness of product choices, the lower the percentage of time subjects used a non-compensatory strategy. The interaction effect between time pressure and riskiness of choice was significant (F=6.71, p<.05).

Table 5.5 Percentage of Time on NC-Decision Strategy Across Three Factors (%)

		Riskiness of Choice			
		Low Riskiness of Choice		High Riskiness of Choice	
		Product Involvement		Product Involvement	
		Low	High	Low	High
Time Pressure	No	.	8	44	11
		56	33	36	3
		8	71	16	4
		35	62	8	30
		0	10	22	.
		54	17	17	20
		100	47	18	37
		63	45	18	0
		66	48	19	9
		53	45	22	0
		22	3	12	23
		28	55	21	20
		Mean 44.09	37	21.08	8.09
	Yes	80	0	59	58
		12	73	46	42
		24	77	35	.
		.	35	63	0
		51	9	0	0.2
		46	7	74	5
		14	0	72	4
		.	59	71	31
		38	53	45	0
		54	7	67	6
		57	22	31	27
		24	.	40	12
		Mean 40	31.09	50.25	16.84

For the digital camera task, subjects felt that information about price, megapixels, customer ratings, optical zoom and LCD size was most useful. In terms of customer ratings, not only the numerical rating but how many people had rated it are important. Subjects indicated that they would only trust the rating if at least 20 people had rated it; some used an even tougher criterion with double the number of people who had rated the product. They also expressed the need for information regarding brand, product appearance and customer reviews. For those who shopped with incomplete information (high riskiness of a choice), they either chose to eliminate the product as an alternative choice if the missing attribute information was critical or to evaluate the combination of multiple attributes. For example, some chose not to consider such a product if it lacked a promising customer rating; however, some chose to estimate overall value of such a product by compensating one attribute with another dominant attribute. Most frequently they switched between these two strategies to eventually come out with a satisfactory purchasing decision. For the other high-involvement product shopping task, subjects shopping for television expressed the opinions that information about price, diagonal screen size, customer rating, and dimension was helpful for their final decision. Similar to the digital camera task, subjects shopping for a television expressed the need to obtain information about brand, product image and customer text reviews.

> *"Basically it's one of the cheapest, you don't really need more than 4MP, she is not professional...decent size screen...the rating is good too....a good gift."*
>
> *- From subject B07 shopping for digital camera*

> *"Information is not available... these two are definitely out"*
>
> *- From subject C09 shopping for television*

"I will look at the price. The price for Superview is much higher than Killview. Screen size of Killview is bigger, but does not have HDTV. Superview has dimension available but killview doesn't. Aspect ratio....so my choice is either between the Killview or the Superview. Oh...the format is flatscreen...but the HDTV bothers me along with the dimension cause it maynot fit my space. But the price is very good. So I will go with the Killview"

- From subject D03 shopping for TV

For the printer paper and blank CD-R tasks, most of the subjects expressed that there wasn't much difference from one product to another. They wanted to buy the best value, most of the time meaning the cheapest price, with considerable quantities. Over 60% of subjects expressed that they didn't need more information than what was provided.

"It's just paper....I want the cheapest one."

- From subject C05 shopping for printer paper

The Goal of the task was also salient. For example, the scenario of the digital camera task is to purchase a camera for his/her loved one as a gift, many of them started with preferences of their loved one to evaluate alternative choices. For example, one subject was looking for a light-weight camera for his girlfriend; another was looking for a high-end camera for her technical savvy friend. For the printer paper task, some subjects were looking for inkjet paper to fit their printer while others were looking for paper of general purpose.

"I'm buying this for a loved one. I love my husband, so I want it to be a good one."

- From subject A09 shopping for digital camera

Among the 48 subjects, price and budgeting, quality of the product, transaction security, better deals online instead of in-store, and look and feel of a product ranked at the top of the list of concerns regarding online shopping. A complete list of concerns is summarized in Table 5.6. Web stores that address these concerns clearly will boost customers' trust and improve customers' overall experiences.

Table 5.6 Concerns for Shopping Online

Concerns for Shopping Online	No# out of 48	Percentage (%)
Price/budgeting	16	33.33
Quality	12	25.00
Security/fraud	9	18.75
Best value/good deals	9	18.75
Different from pictures/can't see actual product	7	14.58
Rating/reviews	6	12.50
Delivery date	5	10.42
Vendor reputation	5	10.42
Return policy	3	6.25
Hidden costs (tax or no tax, shipping cost)	2	4.17
Authenticity of a brand	2	4.17
Product description/specification	2	4.17
Talk to sales people	1	2.08

Finally, what subjects eventually purchased under assigned conditions was recorded in clickstream. This study assumes a linear relationship between the optimal choice and the actual one. With six product selections per product type, the distance ranges from zero to one, where zero indicates an optimal choice, and one indicates the worst choice of the bunch based on expected utility calculations shown in Appendix N. The complete results are summarized in Table 5.7. For further investigation, a more detailed calculation may be performed by identifying the distance between the values of each chosen product attribute and the values of each attribute of the optimal choice.

Given K=9 attributes for a product L, the utility function can be written as $U(L)=f(P_1, P_2, ..., P_K)$, and U_i is the utility of the chosen product while U^* is the utility of the optimal choice. The distance between the optimal choice and the chosen one can then be written as:

$$\left|U_i - U^*\right| = \sqrt{\sum_{j=1}^{9}\left[U(P_{ij}) - U(P_{*j})\right]^2}.$$

Due to the difficulties in identifying all utility contents and the complexities in conducting such calculation, the proposed investigation plan will be a part of the future work.

The current results presented in Table 5.7 show that time pressure and riskiness of choice didn't affect the subjects' final decisions. ANOVA/MANOVA results show no support that any of the three independent variable significantly impacted the final decisions (F=0.57, p=.6381).

Table 5.7 Distance between the Optimal Choices and the Actual Ones

		Riskiness of Choice			
		Low Riskiness of Choice		High Riskiness of Choice	
		Product Involvement		Product Involvement	
		Low	High	Low	High
Time Pressure	No	0.6	1	0.2	0.8
		0	0.4	0	0
		0.4	0.6	0.2	0.4
		0.6	0	0	0.4
		0	0	0	0.2
		1	1	0.4	0.4
		0.2	0.2	0	0.8
		0	0	0.4	0.2
		0.2	0	0	0
		0	0	0	0.2
		0.2	1	0.4	0.2
		0.4	0,2	0.8	0
		Mean 0.3	0.35	0.2	0.3
	Yes	0	0	0.8	0
		0	0	0.2	0
		0.4	1	0.2	0.2
		0.2	1	0.2	0.4
		0.2	0.2	0.4	0.8
		0.2	0	0.2	0
		0.8	0.2	0	0
		0.4	0.6	0	0.4
		0.6	0	0.8	0.2
		0	0	0.2	0.2
		0.2	0	0	0.4
		0	0.4	0.2	0.2
		Mean 0.25	0.28	0.27	0.23

5.2.2 Discussion Part II

In this present research, the study participants faced two complex shopping tasks with 6 alternative choices in each task that differed on 9 attributes, 54 cells overall. It was virtually impossible for them to process and memorize all information available. It was expected that subjects employed certain search and decision strategies to overcome the situation given. The findings indicate that product involvement negatively impacts the

use of non-compensatory strategy. More product attributes were sought after while the products were important and highly relevant to the subjects. The importance of attributes to participants was consistent to the experimental setup. It may suggest a reconfiguration on the order of product specifications based on customer preferences. Under time pressure, subjects did not change their pattern of strategies on information seeking and decision making. They either accelerated the processes or increased the selectivity of information processes. This is consistent with the findings from a prior study (Wennig & Maarleveld, 2002). Hence, time pressure did not worsen subjects' final decisions because they did not change decision strategy but made decisions faster. It was expected that uncertainty and riskiness of a product choice would positively impact the use of NC strategy. Surprisingly, the study results indicate otherwise. With missing information on certain product attributes, subjects tended to employ a compensatory strategy. The reason behind this may be due to equal importance of the missing information or the substitutability of one attribute to another.

Personal preferences and purchasing goals appeared to play important roles in online shopping. By giving control of customization to customers, overall shopping experiences may be improved and time spent on information seeking may be reduced. Some subjects expressed their preferences in comparison shopping. Matrix-like information display did enhance the visibility for participants to evaluate products. Some study participants suggested that such information display combined with multi-criteria sorting techniques would result in significantly improving shopping experiences in one online shopping store without making a lot of efforts to find deals elsewhere. These

results provide guidance for web stores on how to provide information that supports customer search and decision processes.

> *"I like this. I can easily compare price and other attributes."*
> *- From subject A10*

> *"This feature is nice. If I can sort on price, rating, lcd size and.... would be even better."*
> *- From subject C04 shopping for digital camera*

5.3 Overall Discussion and Summary

This present study supports main effects of hypotheses H1a, H2a and H2c, and partially supports predictions of hypotheses H1b and H1c. Although H3a, H3b and H3c are not significantly supported by study results, such tendencies are found. Comparing the results of hypotheses H2a, H2b and H2b between two different measures (Table 5.8), it appears that many subjects did not realize which decision strategy they used or how frequently. In summary, product involvement positively affects perceived risk and negatively affects the time for subjects using breadth-first search. While time pressure increases the performance aspect of perceived risk, it does not significantly alter customers' decision and search strategies. However, by distinguishing information-handling from information-seeking, subjects who shopped under low uncertainty and riskiness condition, time pressure appears to increase their time spent on breadth-first search. Finally, study results conclude that riskiness of a product choice psychologically increases customers' perceived risks and alters their search strategy in favor of

compensatory strategy. Figure 5.4 illustrates the testing results of study hypotheses on main effects.

Table 5.8 Hypotheses Supported by Corresponding Analysis Methods

Dependent Variable	Factor	Hypothesis	Clickstream & Questionnaire (Part I) *p*	Think-aloud Protocols (Part II) *p*
Perceived Risk	PI	H1a	<.0001	
	TP	H1b	.0830	
	RC	H1c	.0178	
NC Strategy	PI	H2a	.2092	.0019
	TP	H2b	.8998	.1578
	RC	H2c	.0671	.0049
BF Search	PI	H3a	.7731	
	TP	H3b	.5297	
	RC	H3c	.4797	

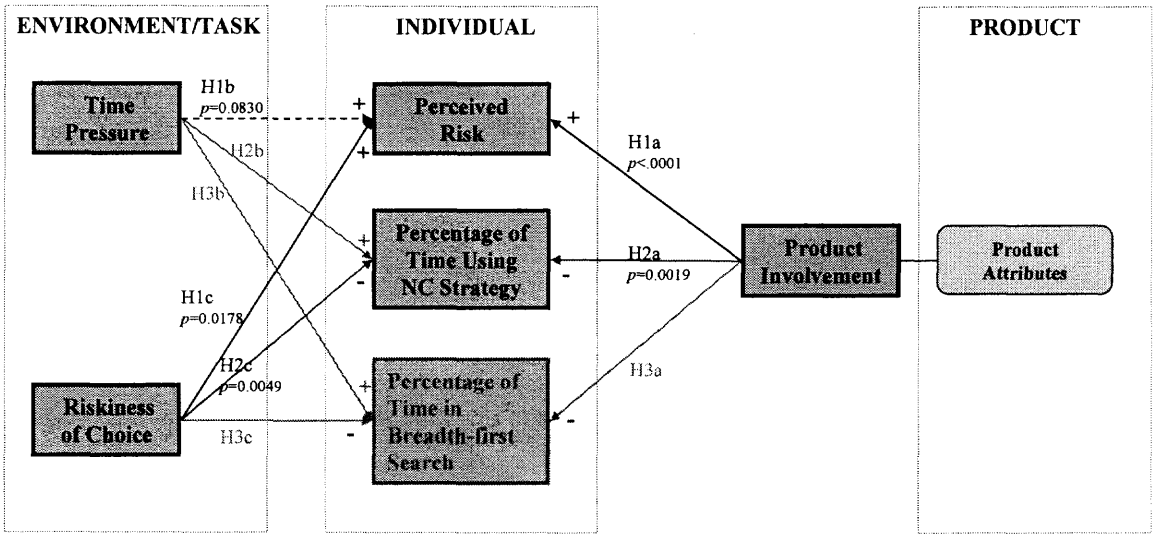

Figure 5.4 Testing results of research hypotheses (main effects).

5.4 Study Limitations

This study employs a multi-method approach. However, as discussed in the next chapter, it may advantageously collect data at a lower level. For example, eye tracker data can yield insights into eye fixation to specific information.

Subjects were drawn from a homogeneous pool, so the results can not be extrapolated to other population. The sample of participants is relatively small to online shopping population. However, without improvement of the instrumentation used for data collection, particularly for unobtrusive data collection, the approach taken in this research may be impractical.

Time pressure, risk and product involvement are all multifaceted concepts. To investigate the finer level effects of the impact of these factors, a more complex design may be necessary. For example, it may be worthwhile to investigate a wider range of time pressure conditions by inducing anxiety and stress through various methods (e.g., elimination of a product choice vs. limit of time with a ticking clock).

Furthermore, the way that information is displayed may influence the processes of search and decision strategies on multi-attribute choice, particularly affecting the ease of carrying out various decision processes (Schkade & Kleinmuntz, 1994). This study deployed a matrix-like presentation of information that is not a dominant information display style in existing web stores. It may be worthwhile to investigate various styles of information presentations.

CHAPTER 6

SUMMARY AND CONCLUSIONS

This work contributes to an understanding of how environmental, personal, product-related factors help shape customer choice in an online shopping environment. The implications of this work for research and practice are described below.

6.1 Contributions to Research

The specific research contributions are in five main areas. First, the research consolidates literature across multiple disciplines, taking the further step to incorporate time pressure and uncertainty of product choices, which are identified as important factors but are seldom investigated in the online shopping literature, into the research framework. Second, this multi-method research contributes to the understanding of the rich nature of customer behavior and cognition. Third, the experimental tools and the procedure designed for this study can also be further modified and extended for research in choice and judgment decision making. Fourth, it has yielded insights into the cognitive processes that inform the behavior. Finally, it has applied techniques from cognitive science to generate cognitive-level understanding of the online shopping experience. This knowledge is gleaned from the examination of working memory contents.

6.2 Contributions to Practice

The specific contributions to practice are in three main areas. First, this research is a step to develop more detailed, process-level models of the online shopping experience, thus contributing to knowledge of customer cognition and behavior. Models resulting from this work should therefore lead to improved information display and then to improved shopping experiences. The availability of matrix-like comparison shopping combined with multi-criteria sorting functions and value calculations will lead to better online shopping experiences and reduce the hustles of seeking and evaluating products from one site to another. Second, the instruments and analytic techniques may generate insights for marketing research and customization strategies. Online marketers may consider configuring the information presented to customers based on inferences about time pressure (Kim et al. 2005) and other salient variables. Finally, analysis of combined clickstream and protocol data helps our understanding of customer purchasing behavior and cognition down to the personal level.

6.3 Future Work

Principal extensions of the present study would further advance the contributions of this research program. First, products other than electronic and recording products may be chosen to increase the generalizability of the findings. Second, combining multi-criteria sorting techniques with a matrix-like presentation of information may further improve customers' overall shopping experiences. Third, the effect of multifaceted time pressure may be further investigated by inducing anxiety and stress through various methods (e.g., elimination of a product choice vs. limit of time with a ticking clock). Fourth, the impacts

of various forms of information displays on multi-attribute choice may be worth investigating. Future study beyond this dissertation is likely to involve more formal modeling of human cognition in online environments. Eye tracking data may be combined with log and verbal protocol data to create a richer model. Such a model may be built in tailoring information to the predicted needs of online shoppers. A purchase decision is sometimes a joint decision. Investigating behavioral and cognitive information regarding team shopping may be a novel extension for this present research. Video conferencing media may be utilized to conduct such an exploratory investigation.

APPENDIX A

THEORETICAL BACKGROUND (STATE OF THE ART PAPER)

A.1 Cognitive and Behavioral Processes in Online Shopping

A.1.1 Cognition in Online Shopping

In psychology, the term *cognition* is used to refer to the mental processes of an individual, with particular relation to a view that argues that the mind has internal mental states (i.e., beliefs, desires and intentions), that can be understood in terms of information processing.

Working memory (WM), which mediates between processes of perception and retrieval or recording to long-term memory, has in the past 15 years received considerable attention as key to understanding human cognition. WM can be defined as "a system for the temporary holding and manipulation of information during the performance of a range of cognitive tasks such as comprehension, learning and reasoning" (Baddeley, 1992). The dominant model of working memory was based on the assumption that working memory consists of a small number of fixed slots in which information could be temporarily held (Miller, 1956), but this model has been continually revised. Similarly, researchers have explored the role of external memory aids such a pencil and paper (Huguenard et al. 1997) in expanding WM capacity. At present, chunking theory (Chase & Ericsson, 1982) is itself being expanded, to consider the possibility that chunks may be highly complex and interrelated, thus creating a structure that is more a network than a number of (independent) slots. Effective WM capacity and structure influence online shopping in a number of ways. If a customer has been given

too much information in a short time period, overload may occur, leading to poor decision making and dissatisfaction (Malhotra, 1982). Thus consumer will process only a few alternatives or attributes to eliminate information load (Jacoby, 1977; Jacoby, Speller, & Berning, 1974; Jacoby, Speller, & Kohn, 1974).

The level of working memory capacity varies from person to person. The pioneering work by DeGroot in the 1940's (DeGroot, 1966), showed that the major difference between expert and novice chess players was not superior search moves or larger working memories, but instead, the experts enormous store of real game configurations held in long term memory (Chase & Simon, 1973).

Individuals are different in degree to which they engage in and enjoy effortful cognitive activities (Cacioppo, Petty, & Kao, 1984; Lerch & Harter, 2001; Li & Browne, 2004). The variation is generally defined as Need for Cognition (NFC). Studies found that people with different level of NFC have different attitude, cognition, and behavioral patterns in their daily life (Li & Browne, 2004; Ordonez & Benson III, 1997). People with higher NFC tend to depend on themselves for browsing, searching, retrieving, and processing information to understand and accommodate the world (Li & Browne, 2004), whilst people with lower NFC tend to depend on other people and social comparison process for information seeking and processing tasks (Cacioppo, Petty, Feinstein, & Jarvis, 1996).

To capture and to analyze customer's cognition and behavioral patterns, researchers and practitioners use three major groups of methods to obtain information: 1) pre-test and post-test survey questionnaire (Chu & Spires, 2003; Koufaris, 2002; Pedersen & Nysveen, 2003; Urbany, Dickson, & Wilkie, 1989; Yucelt, 2002), 2) think-

aloud protocol analysis (Card et al. 2001; Lerch & Harter, 2001; Payne, 1976), and 3) data mining techniques and web log analysis (Cooley et al. 1999; Moe & Fader, 2002). However, the first technique relies mostly on self-reported questionnaires and the third method fails to provide moment-by-moment consumer cognition (Card et al. 2001). Thus, this research determines to use think-aloud method to observe and to record the needed information. This technique requires subjects verbally describe everything passing through their mind while performing a task (Ericsson & Simon, 1980). Recording tools can be simply an audio or a video camera, and with sufficient budget, software and equipments for mouse movement recordings (P. Chang, Mendonça, & Im, 2004) and eye-tracking (Card et al. 2001; Tarasewich & Fillion, 2004) are preferred.

A.1.2 Search Strategies in Online Shopping

Several studies visualize online browsing/shopping behavior as a tree structure (Card et al. 2001; Foster, 2003; Liu, Hu, & Hsu, 2000; Zhong, Godoy, Shiaffino, & Amandi, 2004). Each node in a tree is an object containing attributes and methods, which could represent different types of web pages or different product attributes (Figure A.1). Customer may search information by depth-first, by breadth-first, or by switching between these two modes (Jenkins, Corritore, & Wiedenbeck, 2003). Depth-first search means that customer starts to look for product- or issue-related information; then goes through the tree branch by branch till reaching the bottom, whilst breadth-first search means that customer starts from exploring as many product selections as possible and then read detailed information later on.

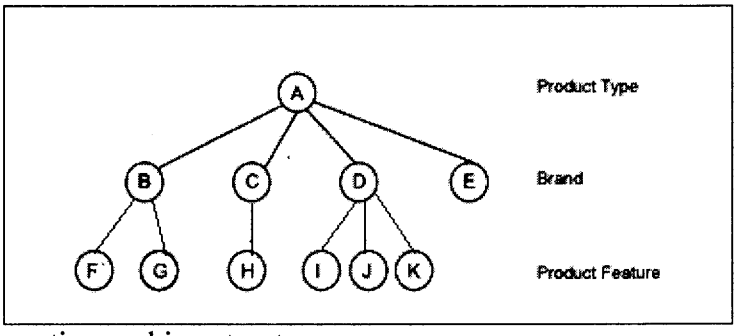

Figure A.1 Information seeking structure.

By investigating customer's information seeking behavior, online marketers can also observe number of pages a customer viewed, time duration for per-page visit, the decision point to stay or exit the site, and choices of which links to follow or which page to view (Bucklin et al. 2002).

The fact is that consumers do not remain in one particular seeking mode. Rather, they may and often do is to refine their strategies, approaches, and information requirements during the buying processes (Hodkinson, Kiel, & McColl-Kennedy, 2000; Rowley, 2000). Customers often start in an exploratory seeking mode and then gradually move towards goal-directed search with a progressively narrow focus (Detlor, Sproule, & Gupta, 2003; Shim et al. 2001). Inspired by those studies, keeping trace between mode switching by different product class would worth investigating.

Moreover, the decision aids, such as search engine and sorting capability provided by each site, may also affect customer's navigation style (C. H. Tan, 2003). We need to carefully control our experiment in which kind of information aid we provide to test subjects because that may result in different navigation results.

A.1.3 Decision Making

Decision rules are often characterized as either compensatory or non-compensatory (Chu & Spires, 2003) . In compensatory rules, a poor evaluation on one attribute may be compensated by a positive evaluation on another attribute, whilst in non-compensatory rules, poor evaluation on one attribute makes it an impossible choice. For example, in a TV purchasing task, the former rules show that high price may be compensated by a larger size of LCD flat panel screen, and the latter rules show that a non-flat panel screen is an impossible choice.

Payne et al. (Payne, Bettman, & Johnson, 1988) classify these two strategies into five types: 1) Compensatory strategy: weighted additive procedure (WADD), and equal weight method (EQW); 2) Non-compensatory strategy: satisficing method (SAT), lexicographic (LEX), and elimination-by-aspects (EBA). WADD uses a strategy of forming an overall score for each object by first multiplying the object's score on each attribute by an importance factor and then summing these products. Researchers believe this method leads to a nearly optimal choice (Kamis & Stohr, 2003). The EQW method uses a simple additive method – essentially ignoring any relative importance of the factors (Chu & Spires, 2003; Hayne & Smith, 1996; Smith, Arnold, & Sutton, 1997). LEX narrows the sets of alternatives by focusing one attribute at a time. The process of LEX starts from the most important attribute, which has been decided beforehand, and the alternative with highest value is chosen. If there is a tie, the process starts with the second most important attribute till find the highest value (Kamis & Stohr, 2003). EBA, a variant LEX, in which selections of attribute is probabilistic. SAT is frequently used by

individual. Alternatives are often evaluated one at a time and the rest of the processes are similar to LEX and EBA.

Combining the tree structure navigation modes introduced in previous section with the compensatory and non-compensatory strategies, this paper aims to observe how customer's behavior changes under different levels of time pressure and product involvement.

A.1.4 Perceived Risk in Online Shopping

When buyers plan to purchase a product or service, they often hesitate to take action because they cannot be certain that all of their buying goals will be achieved with the purchase (Roselius, 1971). In other words, buyers may perceive a certain degree of risk in most purchase decisions (Cox & Rich, 1967; Gupta, Su, & Walter, 2003). Studies of online shopping (Ko, Jung, Kim, & Shim, 2004; C. H. Tan, 2003; S. J. Tan, 1999) show that risk perceptions in purchasing differ both from individual to individual and from situation to situation.

Generally speaking, perceived risk is a consumer's perception of the overall negativity of a course of action based upon an assessment of the possible negative outcomes and on the likelihood that those outcomes will occur. It is viewed as resulting from uncertain and unanticipated consequences of a product purchase (Dholakia, 2001). For examples, John purchasing a MP3 player from an unknown manufacturer may consider its possibility of breaking down in less a year, while Jane buying a digital camera may concern about its memory capacity not being enough for storing high-resolution pictures.

Five dimensions of risk are identified: psychological, financial, performance, physical, and social risk (Jacoby & Kaplan, 1972). Psychological risk is the perception that a negative effect on a consumer's peace of mind may be caused by a defective product (Jacoby & Kaplan, 1972). Financial risk is the perception that a certain amount of money may be lost or required to make a product work properly (Garner, 1986). Performance risk is the perception that a product purchased may fail to function as originally expected (Kim & Lennon 2000). Physical risk refers to the perception that a product may be dangerous to health or safety when it does not work properly (Roselius, 1971). Finally, social risk refers to the perception that a product purchased may result in disapproval by family or friends (Dowling & Staelin, 1994).

Other risks, such as time and privacy, have been discussed occasionally. Time risk is the perception that time, convenience, or effort may be wasted when a product purchased is repaired or replaced (Bauer, 1967). In addition, privacy risk is the potential loss of control over personal information, such as invasion of privacy. This issue is actively discussed especially in virtual shopping environment.

Studies also show that risk perception is one of significant discriminators between those who purchased products online and those who did not (Jarvenpaa & Todd, 1997; Lowengart & Tractinsky, 2001; Pedersen & Nysveen, 2003). Consumers perceive a higher level of risk with non-store purchases (i.e., online shopping or catalog purchasing) than with "brick and mortar" stores or salespersons (Su, 2003; Akaah & Korgaonkar, 1988). This helps to explain why most consumers still use the Internet for browsing rather than purchasing (Wintrob, 1995).

A.2 Salient Contextual & Product Factors in Online Shopping

It is widely recognized by researchers and practitioners that customer behavior in a virtual environment is different from a store shopping environment (Alba et al. 1997; Degeratu, Rangaswamy, & Wu, 2000) due primarily to the constant introduction and adoption of new technologies (Zinkhan & Watson, 1998). Behavior like browsing and clicking online product information gradually replaces "window shopping" (Walker, 2003). Some known differences include the greater perceived risk, the means of obtaining product information, the greater importance of brand loyalty and high market share, and the ability for customer to repurchase the same product through the use of pre-stored personal shopping list (Danaher, Wilson, & Davis, 2003).

In following sections, this paper discusses four major factors: time pressure, product involvement, task complexity, and brand, which are considered to be critical in studying customer behavior and cognition in online shopping environment. In a traditional store shopping environment, time as a factor has been viewed as a known factor only occasionally studied or controlled by experimenters. With the capability of obtaining time-coded information online, adding time constraint and time pressure as factors in studies of online shoppers' cognition is feasible. Product involvement is a known term in marketing and consumer research sector. As for task complexity, this research considers it as a way to control how many product alternatives and attributes should be provided for experiment subjects and a way to measure information load. Details are discussed in order in sections A.3.2.1 to A.3.2.4.

A.2.1 Time Constraint & Time Pressure

First of all, there is a need to clarify the usually-mistaken terms between time constraint and time pressure (Fisher, Chengalur-Smith, & Ballou, 2003). While time constraint is the time available for the completion of a task, time pressure can be defined as the time constraint created some feeling of anxiety and stress and a need to cope with the limited time (Ordonez & Benson III, 1997). Experiment results show that some people may feel pressure in a long time constraint while others may not feel the pressure in a short time constraint.

In our daily life, people often feel stress that time is limited. Yet while most consumers feel severe time pressure especially during holiday seasons (Walker, 2003), only a few studies (Fisher et al. 2003; Walker, 2003) investigate online shopping behaviors under time pressure. Direct observation of behavior or cognition—either through experimentation or field studies—is rare, despite the potential insights that such approaches might yield.

Time constraint may have greater impact on decision making for novices than for the experiences decision makers (Dukerich & Nichols, 1991). Training in decision making helped to prevent the negative effects of time pressure on decision quality, but only when the time pressure was not severely high (Zakay & Wooler, 1984). Based on this discussion of the impact of time pressure, proposition 1 is now stated:

Proposition1: Levels of time pressure will affect consumer's decision making and behaviors online. Training may alleviate the impact of time pressure.

To simulate a time pressure condition, a gambling or a bargaining game is often used. For example, the number of available product choices (Sutter, Kocher, & Straub, 2003) may be reduced over time to increase the perception of time pressure. A post-

experiment survey may then be given to gather information about the participant's perception of time pressure under different levels of time constraint (Fisher et al. 2003). An alternative method, which needs to be confirmed with post-experiment survey of participant's perception of time pressure, is to give subjects exactly the same amount of time but to create the different level of anxiety by phrasing the task instruction differently. For example, in Mann & Tan's study (Mann & Tan, 1993), subjects in time-pressured condition were told: "You have 25 minutes to complete the tasks, so that's not much time. You need to hurry. Keep your eye on the clock to make sure you are keeping up." While subjects in no-time pressured condition were told: "You have 25 minutes, so that's plenty of time. Don't hurry, just take your time."

A.2.2 Product Involvement

Involvement may be defined as "a perceived relevance of the object based on their interest, needs, or values" (Zaichkowsky, 1985). Product involvement is a unique relationship between consumer and product that refers to "an unobservable state reflecting the amount of interest, arousal or emotional attachment evoked by the product in a particular individual" (Bloch, 1982). Hence "product involvement is a consumer-defined construct (Quester, Karunaratna, & Lim, 2003)."

The explanations for the diverse definitions and measures of involvement result from different applications of the term "involvement" (Park, Ekinci, & Cobanoglu, 2003; Sadarangani & Gaur, 2002). A customer can be involved with advertisements (Krugman, 1967), with purchase decisions (Clarke & Belk, 1978), or with products (Howard &

Sheth, 1969; Sadarangani & Gaur, 2002). This paper will mainly focus on involvement with products.

A distinction may be made between enduring involvement and situational involvement (Houston & Rothschild, 1978). The former reflects an individual's general and permanent concern with the product categories and the latter reflects concern aroused by a specific purchase occasion. For instance, an individual might usually purchase various low-price brands of wine at random because of low enduring involvement; while on a special occasion of a visit by the respected professor, a high situational involvement decision might be made to purchase a specific name brand (Laurent & Kapferer, 1985).

High involvement products can be roughly defined as those for which buyers prepared spending considerable time and effort in searching, while low involvement products are those which are bought with a minimum of thought and effort because they are not of vital concerns nor have any great impact on consumer's lifestyle (Laurent & Kapferer, 1985), leading to proposition 2. It may be argued that a product such as shampoo has high involvement for a female, but low involvement for a male. If so, how is involvement used to categorize products? To justify, online marketers only target the commercial campaign to female buyers, thus compared to a dress or a TV, shampoo is definitely a low involvement product for most of the consumer market.

Proposition 2: When product involvement is high, consumer tends to spend more time looking for product information and comparing alternatives.

Consumer Involvement Profiles (CIPs) may be used to measure product involvement (Laurent & Kapferer, 1985), but involvement should not be regarded as a unidimensional construct (Kapferer & Laurent, 1993). Rather, Kapferer and Laurent propose measuring product involvement through four dimensions: 1) perceived

importance of the product, 2) perceived risk associated with the product, 3) the symbolic or sign value attributed by the consumer to the product, and 4) the hedonic value of the product (i.e., its emotional appeal or its ability to provide pleasure). Validity of the measuring scales for these four dimensions has been tested. Based on the findings, detergent, oil, and other groceries are categorized as lower-involvement products; in contrast, electronic and fashion products are mostly categorized as higher-involvement products.

In addition, product involvement is interrelated with the consumer's prior knowledge of the product (C. H. Chang & Huang, 2002). Knowledge about a product indicates that customers intend to purchase a product (Pedersen & Nysveen, 2003), leading to proposition 3. Researchers either choose to design the experiment by testing groups of novices and experts based on their prior knowledge of a product (Fisher et al. 2003), or by educating and training subjects to an equivalent level of product knowledge. This research adopts the former method by distributing a background survey to participants.

Proposition 3: Product involvement is interrelated with the consumer's prior knowledge. Especially for online shopping, a novice will spend more time searching for product related information when s/he intends to shop for a high-involvement product than an experienced customer.

A.2.3 Task Complexity

Complexity may be defined as a function of the number of alternatives facing the decision maker and the number of attributes on which each alternative was compared (Payne, 1976). It has been examined in 1) information-processing and decision-making (Wood, 1986) literature, 2) in the task and job design literature, and 3) in the goal-setting

research literature (Campbell & Gingrich, 1986). Complexity can be treated as a psychological experience, an interaction between task and person characteristics, and a function of objective task characteristics (Campbell, 1988).

It is also useful to distinguish objective complexity of a task from subjective complexity that is experienced by a task doer. A person's familiarity with a task (i.e., task doer's short term memory and span of attention, time constraints, the availability of tools, and so forth) can moderate the relationship between these two types of complexity (Campbell, 1988).

A distinction between task complexity and task difficulty has also been made (Campbell & Gingrich, 1986; Tran, Lévesque, & Meunier, 2004). Complex tasks (i.e., are usually of a high degree of complexity) are often difficult, requiring a great deal of effort to perform; however, difficulty tasks are not necessary complex, leading to proposition 4:

Proposition 4: When task complexity is high (larger number of product alternatives and product attributes), consumers tend to spend more time and effort.

Some researchers (Lussier & Olshavsky, 1979; Payne, 1976; Weenig & Maarleveld, 2002) use an information display board (IDB) to control complexity. Information is shown in a matrix which consists of product alternatives (e.g., different models of digital camera) and product attributes (e.g., a camera's resolution (mega pixels), optical zoom, size, weight, etc.). IDB example is shown as Figure A.2 Information display board (IDB) sample. Computerized versions of IDB (Computerized Process Tracing Tools) (Cook & Swain, 1993; Lohse & Johnson, 1996) are introduced and continuously used by current consumer behavior scholars. Chief advantage of using an IDB is that data coding is much easier and thus statistical model testing is

comparatively enhanced via IDB (Cook & Swain, 1993). On the other hand, this approach demands higher time and effort to examine an information item (Arch, Bettman, & Kakkar, 1978; Cook & Swain, 1993).

As shown in Figure , different combinations of the number of alternatives and the number of attributes can produce different degrees of task complexity. Some studies name task complexity which consists of different levels of alternatives and attributes as information load (Hahn, Lawson, & Lee, 1992; C. H. Tan, 2003).

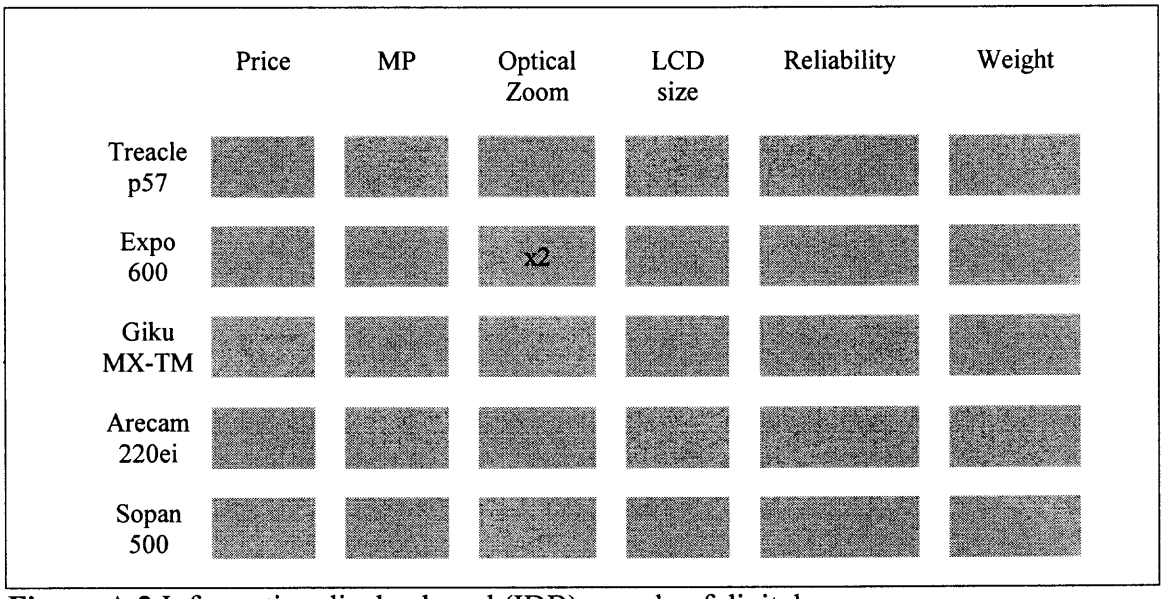

Figure A.2 Information display board (IDB) sample of digital camera.

A.2.4 Brand

Brand is one of important product attributes impacting customer shopping behaviors (Keller, 1993) and may be defined as "a name, term, sign, symbol, or design, or combination of them which is intended to identify the goods and services of one seller or group of sellers and to differentiate them from those of competitors" (Kotler, 1991). Branding has to do with what customers think about when they think of a company,

product or service. What do consumers think about when they see Kraft Philadelphia cream cheese in the supermarket? What do consumers think when they see a Sony TV right beside an Apex TV? And then it has been expanded to become a concept associated with customer experiences. Usually brands are registered as trademark with a regulatory authority and, therefore, cannot be used freely by other parties. "Brand equity," is the added valued by the brand to the product (Farquhar, 1989; Kamakura & Russell, 1993; Keller, 1993; Simon & Sullivan, 1993). There is some indication that brand impacts customer shopping behaviors in time spent and choice decision (Tyebjee, 1979), leading to proposition 5.

Proposition 5: Brand as a product attribute affects consumer's online shopping behaviors. If brand choice dominates other product attributes, customer will spend much less time to make product choice than if the customer has near equal preferences.

(Note: Since brand is hard to measure, this research inclines to use fictitious brand names to eliminate the brand effect or conduct a pre-test survey to understand subjects' brand preferences.)

There are numerous ways of measuring and estimating brand equity which are either financial or consumer-related (Myers, 2003). One of the financial measures uses the movements in stock price to capture the dynamic nature of brand equity (Simon & Sullivan, 1993). Another uses the potential value of brands to an acquiring firm as an indicator (Mahajan, Vithala, & Srivastava, 1994). Finally, one of the most publicized financial methods is used by Financial World (FW) in its annual listing of world-wide brand valuation. "FW's formula calculates net brand-related profits, then assigns a multiple based on brand strength defines as a combination of leadership, stability, trading environment, internationality, ongoing direction, communication support and legal protection (Myers, 2003). Similar reports have also been published by Interbrand, Damodaran, Houlihan Valuation Advisors, Market Facts, and CDB Research &

Consulting (Fernández, 2002). Customer-related measures can be involved with consumer perception (i.e., brand awareness, brand associations, or perceived quality) and with consumer behavior (i.e., brand loyalty and the focus on paying a price differential). Aaker (1991) incorporated both consumer perception and consumer behavior constructs and suggested a brand-earnings multiplier which is based on a weighted average of the brand on five key components of brand equity: 1) awareness, 2) associations, 3) perceived quality, 4) loyalty, and 5) other proprietary assets such as patents and trademarks. In this research, brand loyalty will be discussed in conjunction with product involvement in later section.

Furthermore, there are several aspects of brand that need to be considered for measurement: brand share (Danaher et al. 2003), brand consideration and preference (Aaker, 1991; Kapferer, 1998; Keller, 1998; Lussier & Olshavsky, 1979), brand loyalty (Danaher et al. 2003; Fournier & Yao, 1998; Quester et al. 2003), purchase intentions (Kim & Lennon 2000; Pedersen & Nysveen, 2003; Shim, Eastlick, Lotz, & Washington, 2001), use of Internet in purchase process, customer satisfaction (Kohli, Devaraj, & Mahmood, 2004), and so forth. Canadian Marketing Association (CMA) has proposed a measurement process applying different measurement to different audiences: measures to influence brand decisions, senior executives, and frontline staff and channels.

The desire to determine a brand's value is understandable, in fact, commendable. In the aftermath of dot-coms with sky-high market capitalization passed off as "brand value," brands are under the microscope as never before. But any large, mature brand is an enormously complex set of values, not a single value. Thus Brand is very difficult to

measure since a person's top brand choice of a certain product category might be different from another person's.

A.3 Impacts of Factor Combinations on Customer Cognition & Behavior

To discover customer's cognition and behavior further, there is a need to investigate combinations of factors which have been discussed individually in previous sections. Here, search and decision strategies, customer cognition, and perceived risk are explored with each of the followings: time constraint/pressure, product involvement, and brand. Then this paper moves on to examine the interrelationships among time constraint/pressure, product involvement, task complexity, and brand.

A.3.1 Impacts under Time Constraint/Time Pressure

Under time pressure conditions, following variables such as search strategies, consumer cognition, and perceived risks, may inter-relate with each other. Direct findings are presented first in order, then those containing more than one finding.

A.3.1.1 Search/Decision Strategies. An early study (Zakay, 1985) found that under time pressure, there was a more frequent use of non-compensatory strategies, and that postdecisional confidence was greater after non-compensatory decisions as compared to decisions with compensatory strategies.

There are three types of Macro-strategies to overcome time pressure: filtration, acceleration, and adapt to the situation by reframing the problem (Hayne & Smith, 1996). Filtration is a process to reduce time pressure by eliminating segments of the available information, hence ignoring certain piece of information. Acceleration is an alternative

approach that simply process information faster (Janis & Mann, 1977). The third method dealing with time pressure and information overload is for decision maker to adapt to the situation by reframing the problem or decomposing the larger problem into a sequence of smaller problems (Connolly & Deutch, 1980).

The by-far most influential early study of the effects of time pressure was published by Wright (Wright, 1974), who studied judgments under time pressure and noise distraction. Subjects were given descriptions of 30 hypothetical car models described on five attributes and judged each car according to the likelihood that they would purchase it. The levels of time pressure were manipulated by the instructions to the subjects. The results indicated that under high time pressure subjects changed their strategies and used more negative evidence that they gave relatively less weight to the positive and more to the negative information. In addition, subjects also seem to use fewer attributes under time pressure than when there was no time pressure. That is, under time pressure, people weigh negative information more heavily, which was also interpreted as more risk-avoidant behavior.

Several studies (Mann & Tan, 1993; Ordonez & Benson III, 1997; Svenson & Edland, 1987) have confirmed the result that under time pressure, people's choice decision may alter. For example, in Svenson and Edland's apartment experiment, it was found that in the no-time-pressure condition alternatives with greater size and longer traveling times were preferred most often, whereas in the time pressure condition the alternatives with the shorter traveling time and smaller size were preferred most often. The result indicates that subjects giving more weight to the most important attribute

(traveling time) under time pressure. It also indicates that greater weight giving to negative attributes to prune down the alternatives, leading to proposition 6:

Proposition 6: Time pressure will alter consumer's search strategies and behaviors. When time pressure is high, consumers tend to use non-compensatory strategy (negative information) to narrow down the alternatives and accelerate the choice process.

However, only a few of studies (Chu & Spires, 2003; Kamis & Stohr, 2003) investigate how customers use those rules to shop online, and none of them particularly investigate those strategies under different level of time pressure conditions. That's how this study will show a significant contribution to the field.

A.3.1.2 Consumer Cognition. Based on Lay Epistemic Theory (Kruglanski, 1989), it is hypothesized that "time pressure reduces motivation to process information systematically, and the time needed to negotiate an agreement, and that it produces greater reliance on cognitive heuristics when placing demands, and less integrative agreements". Cognitive Load increase when increasing the time pressure (Betsch, Haberstroh, Molter, & Glockner, 2004). In addition, time pressures leads to reduced effort based on a common explanation that time pressure creates psychological stress which interferes with the capacity for judgment and problem solving skills (Janis & Mann, 1977). Discussed with search strategies, findings suggest that compensatory rules and non-compensatory rules associated with different levels of information load (Billings & Marcus, 1983; Payne, 1976) and subjects use more non-compensatory rules under high information load. Under time constraint, subjects scoring low in need for cognition (NFC) appear to use more heuristic information search strategies than do high-NFC subjects (Verplanken, 1993), leading to 7 and 8:

Proposition 7: Customers feel stress when they are shopping under time pressure.

Proposition 8: Cognitive load increases when increasing the time pressure. Consumers use heuristic methods to reduce the cognitive load.

A.3.1.3 Perceived Risk. A prior research includes different deadline conditions when testing different models for making decisions between certain alternatives and uncertain risky alternatives (Busemeyer, 1985). The results indicate that the proportion of choices of the risky alternatives may not affected by time pressure in a low-variance condition. However, when the expected value was negative in the high-variance condition, time pressure tended to increase uncertain alternative choices.

Another study (Benzur & Breznitz, 1981) test three time pressure conditions in gambling game. The results indicated that subjects made less risky choices under high time pressure. In other words, they preferred alternatives with high probabilities of small gains among alternatives with the same expected value, proposition 9 is now stated:

Proposition 9: Under high time pressure, people tend to make less risky choices than under no/moderate pressure.

A.3.2 Impacts by Product Involvement

A.3.2.1 Search/Decision Strategies. Customers' involvement in product categories is believed to influence their information seeking behavior and decision-making process (Laurent & Kapferer, 1985; Quester & Smart, 1996; Kotler, 2000). "People become avid seeker to obtain knowledge when they are highly involved with the product, but they do not actively seek information when they are less involved (Laurent & Kapferer, 1985)." Thus, depending on the level of involvement, customer's decision process indicated by the length of the choice process and the number of product attributes used to compare brands will differ greatly (Kotler, 2000; Krugman, 1967). Customers with high product involvement are more goal-oriented in their search for information

(refer to situational involvement in section 2.2) than customers with low product involvement (Pedersen & Nysveen, 2003), leading to proposition 10 and 11:

Proposition 10: Consumers with high product involvement will try to explore and research more product related information in details. That means more time on each product pages and more time overall in searching.

Proposition 11: Consumers with high product involvement are more goal-oriented in their search for information than customers with low product involvement.

A.3.2.2 Cognitive Load/Information Load. While discussing about the navigation modes of online customers, many of those researchers also emphasize on the importance of understanding human's limitation of memory load and information load. Human have limited short-term memory (Miller, 1956). To overcome this limitation and to reduce customers' information searching time, researchers grow interests in measuring time that customers spend on each page and investigating the effectiveness of decision aids (i.e., sorting function) (C. H. Tan, 2003). One interesting finding shows that online customers tend to search for a small number of the best alternatives because of the short-term memory limitation (Montgomery, Li, & Liechty, 2003). Author's prior study (Chang et al. 2004) shows that customers tend to search more alternatives (average three to four alternatives) for high involvement product than one or two alternatives for low involvement product. That confirms with Montgomery's conclusion about customer's searching for a maximum of four alternatives in online shopping environment.

Proposition 12: Consumers will not search or compare more than four product alternatives for both low- and high-involvement products.

Proposition 13: Consumers tend to search more alternatives for high involvement product than for low involvement product.

A.3.2.3 Perceived Risk. Some researchers have typically analyzed the effects of product involvement on customers' risk perceptions. Combining enduring and situational involvement (introduced in section A.3.2) with different types of risk perceptions, a motivational process model (Figure A.3) explicates the processes of which involvement and consumer risk perceptions are caused, influence one another, and customer's behavioral responses (Dholakia, 2001). The results suggest that, while enduring involvement positively and significantly influences the customer's situational involvement (goal-oriented) with the product class prior to a purchase occasion, perceived psychological risk do not have a significant impact on situational involvement. Interestingly, the reversed causal relationship between psychological risk and situational involvement is found to be significant. Results also suggest that the paths from situational involvement to all four dimensions of risks are all positive and highly significant. In addition, this study suggests that customer may not evaluate or not experience risks associated with low-involvement product class, leading to proposition 14:

Proposition 14: Consumers may not perceive or experience risks associated with low-involvement products.

Finally, in most of the cases, high involvement products represent higher risk of a customer than a low involvement product (Zaichkowsky, 1985). Customers are willing to spend more time learning product features and compare differences between products, proposition 15 is now stated:

Proposition 15: Consumers perceive higher risk for a high involvement product than a low involvement product.

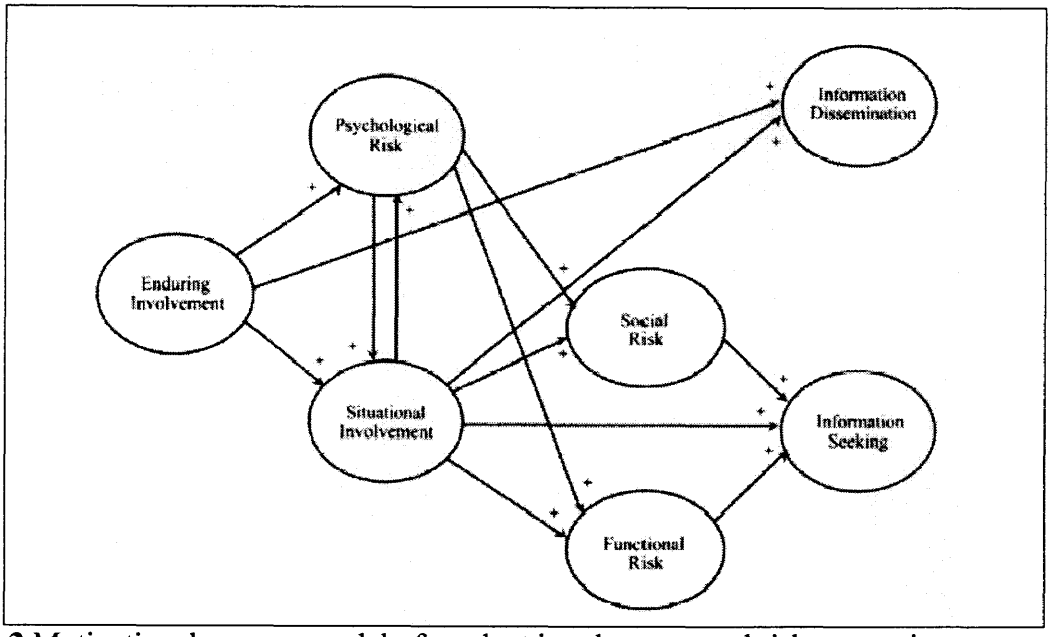

Figure A.3 Motivational process model of product involvement and risk perception.

A.3.3 Impacts of Time Pressure and Product Involvement

Existing literatures rarely investigate customer behaviors under controls of both time pressure and product involvement. A study (McCall, Trombetta, & Nattrass, 2002) shows interests in this subject. But instead of investigating product involvement, they paid attention to the involvement with decision and decision outcome. In addition, the experiment requested store clerks under different level of time pressure to determine customer's likelihood of purchasing alcohol that is neither a direct analysis of consumer behaviors nor an online study. Possible reasons to explain this phenomenon are difficulty to obtain dynamic data, or difficulty in designing instruments to measure both perceived construct of time pressure and product involvement.

A.3.4 Impacts of Product Involvement and Brand

Brand is interrelated with product involvement. Researchers are typically interested in the relationships between brand loyalty (also called brand commitment) and product involvement (Betty, Kahle, & Homer, 1988; Coulter, Price, & Feick, 2003). Brand loyalty or brand commitment is "an emotional or psychological attachment to a brand within a product class (Fournier & Yao, 1998). Prior research has typically specified that the origins of brand loyalty (or commitment) as an outcome of product involvement (Betty et al. 1988), leading to proposition 16.

Proposition 16: Brand loyalty is interrelated with product involvement. Product involvement often leads to brand loyalty or brand commitment.

In contrast with the former research stream, Fournier (1998) argues that the idea of the origins of brand commitment may have no relevance with product involvement but related to people's daily life experiences. Social Context including social network (i.e., family, friends, acquaintances, employers or colleagues) and macro-environmental factors (i.e., culture and economies) is identified as an activating factor between product involvement and brand commitment (Coulter et al. 2003). For example, in the developed-market economies, consumers are well familiar with the concept of branded products (denote as brand awareness), but in countries marking transition to a market economy, consumers know little about brands.

Reports also show that brand loyalty could be identified when customer make a repeat purchase for a high-involvement product, whereas a simply habitual purchase could be indicated when customer make a repeat purchase for a low-involvement product (Lin & Chang, 2003; Quester et al. 2003). Studies show if brand choice dominates other

product attributes, customer will spend much less time to make product choice than if the customer has near equal preferences (Hoyer, 1984; Tyebjee, 1979).

A.3.5 Impacts of Task Complexity and Time Constraint/Time Pressure

The degree of task complexity is constructed by a matrix of decision choices (alternatives) and decision criteria (product attributes) (See Figure). Prior research has indicated that 20 cells represent a relatively simple task, while complex tasks may have as many as 40, 60, or 80 cells (Payne, Bettman, & Johnson, 1993). Study found that a simple task, performed by experts given a short time period, leads to general consensus. However, providing data quality information (i.e., consumer rating as one of the product attributes) along with longer time period to perform a simple task leads to a decrease in consensus, leading to proposition 17. In contrary, time constraint is not a factor for experts performing a complex task (Fisher et al. 2003).

Proposition 17: Customer rating or third-party opinions can be a dominant attribute while consumers are shopping under time pressure. In traditional store shopping, customer rating (as one of product attribute) is harder to get compared to online shopping.

A.4 Implications & Discussions

Appendix C briefly summarizes each article with its experiment methodologies and analyzed findings. The studies discussed thus far may be summarized in a matrix which consists of both critical factors (i.e., time pressure, product involvement, task complexity, and brand) and observation interests (i.e., search/decision strategies, cognition and behaviors, perceived risks). Such a matrix is presented in Appendix B.

Time-related methods received relatively little attention from model builders and users. However, Internet databases make it possible to easily integrate transactional and attitudinal data and to quickly create frequency data not only at the aggregate level but at the individual-consumer level (Dekimpe & Hanssens, 2000). There is no study analyzing the relationships between time pressure and product involvement in details. But several researchers did recognize the importance of time pressure as a factor in consumer behaviors and plan to conduct further research. Furthermore, may literatures listed here are studies of traditional store shopping, and only a few studies (Moe, 2003; Pedersen & Nysveen, 2003) investigate variation in cognition and behavior during online shopping. Yet there are practical and theoretical needs for this type of research, particularly in developing and validating methods for the discovery and comparison of online shopping behavior patterns under different needs and goals. This research is motivated by a belief that modeling customers' thinking patterns is likely to lead to knowledge about customers that is both accurate and generalizable.

This research also interests in using product involvement with selections of product attributes to construct a product database for investigating types of products which may lead to variation in the time people search product-related information before making a purchase and variation in information search behavior. How to construct such a database with mixed products attributes and various levels of risky choices is identified as a critical issue in this research. In summary, the propositions presented in previous sections are integrated in Table A.1.

Table A.1 Proposition Table

Topics	Propositions
Time Constraint/Time Pressure	*Proposition1: Levels of time pressure will affect consumer's decision making and behaviors online. Training may alleviate the impact of time pressure.*
Product Involvement	*Proposition 2: When product involvement is high, consumer tends to spend more time looking for product information and comparing alternatives..*
	Proposition 3: Product involvement is interrelated with the consumer's prior knowledge. Especially for online shopping, a novice will spend more time searching for product related information when s/he intends to shop for a high-involvement product than an experienced customer.
Task Complexity	Proposition 4: When task complexity is high (larger number of product alternatives and product attributes), consumers tend to spend more time and effort.
Brand	*Proposition 5: Brand as a product attribute affects consumer's online shopping behaviors. If brand choice dominates other product attributes, customer will spend much less time to make product choice than if the customer has near equal preferences.*
Search/Decision Strategies under Time Pressure	*Proposition 6: Time pressure will alter consumer's search strategies and behaviors. When time pressure is high, consumers tend to use non-compensatory strategy (negative information) to narrow down the alternatives and accelerate the choice process.*
Consumer Cognition under Time Pressure	*Proposition 7: Customers feel stress when they are shopping under time pressure.*
	Proposition 8: Cognitive load increases when increasing the time pressure. Consumers use heuristic methods to reduce the cognitive load.
Perceived Risks under Time Pressure	*Proposition 9: Under high time pressure, people tend to make less risky choices than under no/moderate pressure.*
Search/Decision Strategies Affected by Product Involvement	*Proposition 10: Consumers with high product involvement will try to explore and research more product related information in details. That means more time on each product pages and more time overall in searching.*
	Proposition 11: Consumers with high product involvement are more goal-oriented in their search for information than customers with low product involvement.
Cognitive Load/Information Load affected by Product Involvement	*Proposition 12: Consumers will not search or compare more than four product alternatives for both low- and high-involvement products.*
	Proposition 13: Consumers tend to search more alternatives for high involvement product than for low involvement product.
Perceived Risk Affected by Product Involvement	*Proposition 14: Consumers may not perceive or experience risks associated with low-involvement products.*
	Proposition 15: Consumers perceive higher risk for a high involvement product than a low involvement product.
Product Involvement & Brand	*Proposition 16: Brand loyalty is interrelated with product involvement. Product involvement often leads to brand loyalty or brand commitment.*
Task Complexity & Time Constraint/Time Pressure	*Proposition 17: Customer rating or third-party opinions can be a dominant attribute while consumers are shopping under time pressure. In traditional store shopping, customer rating (as one of product attribute) is harder to get compared to online shopping.*

APPENDIX A REFERENCES

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APPENDIX B

CLASSIFICATIONS OF REVIEWED ARTICLES

Prior studies discussed in Appendix A may be summarized in a matrix which consists of both critical factors (i.e., time pressure, product involvement, task complexity, and brand) and observation interests (i.e., search/decision strategies, cognition and behaviors, perceived risks). Table B.1 illustrates such matrix.

I Independent Variable
D Dependent Variable
* Online Study

Table B.1 Matrix of Classifications of Reviewed Articles

Concepts		Product Involvement		Time Pressure		Task Complexity		Brand		Perceived Risk		Search Decision Strategy		Customer Behaviour		Cognition	
				I	D	I	D	I	D	I	D	I	D	I	D	I	D
Product Involvement	I							Tyebjee, 1979	Coulter, 2003 Quester, 2003 Sadarangani*, 2002	Dholakia, 2000 Laurent, 1985 Lichtenstein, 1988 Lowengart *, 2001 Park*, 2003 Pedersen *, 2003 Quester, 2003			Chang *, 2004 Chang, 2002 Pedersen *, 2003		Chang *, 2004 Dholakia, 2000 Gury, 2000 Koufaris *, 2002 Laurent, 1985 Park*, 2003 Sadarangani*, 2002	Chang, 2002 Lichtenstein, 1988 Park*, 2003 Pedersen *, 2003 Sadarangani*, 2002	Chang *, 2004 Lowengart *, 2001
	D							Laichowsky, 1985		Laurent, 1985						Laichowsky, 1985	
Time Pressure	I					Fisher, 2003 Weenig, 2002				Busemeyer, 1985	Benzur, 1981 Ordonez, 1997		Betsch, 2004 Busemeyer, 1985 Fisher, 2003 Foster *, 2002 Hayne, 1996 Mann, 1993 Ordonez, 1997 Payne, 1988 Weenig, 2002 Wright, 1974		Mann, 1993		Betsch, 2004 Fisher, 2003 Mann, 1993 Ordonez, 1997
	D																

Table B.1 Matrix of Classifications of Reviewed Articles (Continued)

Concepts		Product Involvement		Time Pressure		Task Complexity		Brand		Perceived Risk		Search Decision/Strategy		Customer Behaviors		Cognition	
		I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D
Task Complexity	I							Lussier, 1979 Rossi, 1996					Card *, 2001 Cook, 1993 Fisher, 2003 Lohse *, 1996 Lussier, 1979 Mukherjee, 2001 Payne, 1976 Tarasewich *, 2004 Weenig, 2002			Cook, 1993	Fisher, 2003 Lohse *, 1996 Tarasewich *, 2004
	D																
Brand	I										Rossi, 1996 Urbany, 1989		Lussier, 1979		Bockenholt, 2000 Lin, 2003 Rossi, 1996	Lin, 2003 Zaichowsky, 1985	Myers, 2003
	D									Quester, 2003					Sadarangani*, 2002	Lin, 2003	
Perceived Risk	I											Pedersen *, 2003	Busemeyer, 1985 Ford, 2003 Pritchard, 2003 Pritchard, 2003 Taylor, 2000 Urbany, 1989		Campbell, 2001 Dholakia, 2000 Featherman*, 2004 Gupta*, 2003 Ko*, 2004 Liu *, 2003 Tan *, 1999 Yucelt *, 2002	Featherman*, 2004 Ford, 2003 Lichtenstein, 1988 Park*, 2003 Pedersen *, 2003 Taylor, 2000	Lowengart *, 2004
	D												Ordonez, 1997		Rossi, 1996		Ordonez, 1997
Search Decision/ Strategies	I														Detlor *, 2003 Montgomery *, 2003 Pedersen *, 2003		Chu, 2003
	D												Cooley *, 1999 Kwon, 2003		Chang *, 2004 Mann, 1993	Chang, 2002 Cook, 1993 Ford, 2003 Lerch, 2001	Chang *, 2004 Fisher, 2003 Lohse *, 1996 Mann, 1993 Tarasewich *, 2004
Customer Behaviors	I																
	D														Davenport, 2001 Walker *, 2003 Zhang *, 2004	Featherman*, 2004 Koufaris *, 2002 Sadarangani*, 2002 Silberschatz, 1996	Mann, 1993
Cognition	I																
	D																

APPENDIX C

SUMMARY TABLE OF REVIEWED ARTICLES

Appendix C briefly summarizes each article with its experiment methodologies and analyzed findings. Table C.1 summarizes all articles which continue for 10 pages.

CPT	Computerized Process Tracing Tools	*	Online Study	**C**	Covariate
IDB	Information Display Board	*	Online Shopping & Customer Behavior Study		
HB	Hierachical Bayes Probability Model	**I**	Independent Variable		
CRM	Customer Relationship Management	**D**	Dependent Variable		

Table C.1 Summary Table of Reviewed Articles

Articles	Concepts										
	Involvement	Time Pressure	Perceived Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Benzur, 1981		I	D								Relationship between Time Pressure and Risk: The results indicated that subjects made less risky choices under high time pressure. In other words, they preferred alternatives with high probabilities of small gains among alternatives with the same expected value.
Betsch, 2004		I		D (Routine Maintenance vs. routine deviation)				D (creative learning and memory)		choices between trains in a fictitious subway system. 80 participates (60 female, mean age=21) in 60 fiticitous cities. They were randomly assigned to one of four groups resulting from a 2x2x2 factorial design with two factors, time pressure (1400 vs 700ms) and order of intentionformation and routine strength (high vs. low)	1) Error Rate; Decision Routine; 2) multiple strategy models: individual can employ different kinds of decision rules. Routine can be viewed as an anchor of choice processes or as a heuristic strategy.
Bockenholt, 2000						I	D		C (past four weeks; after trial)	Model proposing: first model captures individual heterogeneity by a latent class structure (LC); second model captures individual heterogeneity by postulating that the brand-choice probabilities follow a Dirichlet Distribution (DM). Monte Carlo simulations are performed toward assessing whether individual transition probability can be captured from knowledge of only aggregated brand choices.	1) Latent brand dependencies; 2) Brand switching

Articles	Concepts										
	Involvement	Time Pressure	Perceived Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Busemeyer, 1985		I	I	D							The results indicated that the proportion of choices of the risky alternatives may not affected by time pressure in a low-variance condition (pay-off; of the uncertain alternatives). However, when the expected value was negative in the high-variance condition, time pressure tended to increase uncertain alternative choices.
Campbell, 2001			I				D			1) Study1: 2 (low/high risk) x 2 (congruent/moderately incongruent) between subjects (ANCOVA) design. 67 managers in a fully employed MBA program are recruited to perform two wine purchase tasks. 2) 3 (no/low/high risk) x 2 (congruent/moderately incongruent) between subjects factorial design. 171 undergraduate studnets perform Soft Drink tasks. 3) 2 (no/hih risk) x 2 (congruent/moderately incongruent) between subjects design. 147 MBA students were asked to evaluate a new soft drink.	Product Incongruent effect: when there is no risk associated with the evaluated product, a moderately incongruent option is evaluated more positively than a congruent option. However, when risk is high, the moderately incongruent option is evaluated less positively than the congruent option. Risk leads consumers to prefer what looks "like it should".
Card *, 2001				D	I (information scent: low, medium, or high)					1) Protocol Analysis and Eyetracking resulsts. 14 members of the Standford University community, mean age 23, half female. Nearly all participants reported using the Web daily. 2) Post-Questionnare survey is to idenify finding information as one of the three primary reasons for search on the web. 3) Two tasks: City task and Antz task.	1) Informaiton Scent; 2) Information Foraging Theory; 3) Problem Space Structure and Web Bahavior Graph (WBG); 4) GOMS-like or non-GOMS like behavior.
Chang *, 2004	I			D			D	D (memory load, information load)	I	Protocol Analysis (4 graduate students) in 2 x 2 factorial design experiment. Mouse movement recording and web log file history.	1) Customer switch more times between depth search mode and breath search mode while shopping for high involvement products. 2)Consumers tend to search 3-4 alternatives while shopping for high involvement products. Consumers tend to search only 1 or 2 alternatives while shopping for low involvement products.

Articles	Concepts										
	Involvement	Time Pressure	Perceived Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Chang, 2002	I			D				I (prior knowledge)		N/A	When customers have little prior knowledge of the product, the external information sources utilized by the consumers will show a dominant influence over the decision making process in spite of high/low product involvement they
Chu, 2003				I				D (accuracy, knowledge, care, motivation)		156 undergraduate students from four classes. 119 questoins under 17 questions	1) Compensatory vs. Noncompensatory; 2) EIPs (Elementary Information Processes)
Cook, 1993				D (Compensatory strategies, additive info search strategy); I (choice task vs. judgement task)	I (information load, 3 x 3 vs. 7 x 7 IDB)			I (personality measures)		12 subjects were presented with a series of six capital budgeting choice taks in ISLand environment; verabl protocol analysis; personality measure using Myers-Briggs Type Indicator	Protocol Analysis; Information Boards; Computerized Process Tracing Tools (CPT); Eye movement recordings
Cooley *, 1999				D						IP address with auxiliary-content transactions classification (reference length, time window, mfr)	Path, mining, mental model
Coulter, 2003	I					D				Depth interview 28 women who represent varying socioeconomic conditions and ages (22-40) and different levels of cosmetics involvement. Interviews were conducted in two cities in Hungary and two citiesin Romania.	1) The relationship between product involvement and brand commitment: Involvement most likely proceeded or lead to commitment. 2) Political-cultural discourses, cultural intermediaries, social influence, and life themes and projects collectively prompt product involvement
Davenport, 2001							D			Using Mental maps to capture customer's thinking about various products	Mental maps; Knowledge; Training
Dekimpe, 2000		Time-Series								Meta data analysis and literatures reviews (study, sample length in years, temporal aggregation using Granger-causality tests, entity aggregation, and contribution)	1) Time-series Model (Span of time length); 2) Internet databases allow to easily integrate transactional and attitudinal data and to quickly create high-frequency data at the individual-consumer level. 3) Forcasting purpose and determing over-time impact of marketing variables.

Articles	Concepts										
	Involvement	Time Pressure	Perceived Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Detlor *, 2003				I			D		I	Ezploratory study with 31 undergraduate business students with two online shopping tasks on five well-known online retailing sites; content analysis	1) Goal-directed; Exploratory mode to goal-directed searching mode; 2) Task Fit Theory (TFT) - information systems have a positive impact on user performance with the system only when there is correspondence between the functionality of the system and the task requirements of users.
Dholakia, 2000	I		I				D			122/188 completed a survey voluntarily. In addition, an identical survey were also distributed to 33 undergraduate students at a southern US university. Total 155 subjects. Factor Analysis is conducted. After performing an oblique OBLIMIN rotation, 15 items split into 5 factors.	Motivational process model
Featherman*, 2004			I				D	I (Mentaly Intangibility)		First sample (N=154) for theory development and then confirm with second sample (N=253). A computer survey was controlled in a computer lab of a large US university. Subject performed a 25 minutes shopping trial with provided vendor information. Confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) were performed.	Intangibility of e-services: mental intangibility facet was found to be the most salient 'causal' determinant of perceived artificiality and resultant risk concerns. Risks (privacy and security) concerns affect consumer's e-service adoption intention.
Fisher, 2003		I		D	I			D		2 experiments: 1 expt. (2 groups, 118 novices and38 experts)	1) DQI (data quality information to be meta data addresses the data's quality), 2) Knowledge, 3) Customer Rating
Ford, 2003			I (Uncertinty)	D				I (knowledge, memory & information need)		Framework Building based on prior work from Popper (model of the communication process) to Pask (conversation theory)	1) Uncertainty; 2) Pask's Conversation Theory
Foster *, 2002		Time (I)		D						Indepth Semi-structure interviews of 45 academics	Tree Structure; Problem Solving Model
Guiry, 2000	I						D			1) Study1: 561 MBA students survey questionnaire to develop an improved measure of recreational shopping (RSI); 2) Study 2: Informal depth interviews of 15 female consumers who enjoy shopping for clothing.	1) Segments of recreational shoppers is identified using Recreational Shopper Identity Scale; 2) Types of shopping trip: mission shopping, window shopping, mood shopping.

Articles	Concepts										
	Involvement	Time Pressure	Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Gupta*, 2003			I				D			An economic model that captures consumer hsopping channel choices based on shopping channel characteristics and consumer risk profiles (risk-neutral or risk-averse) was proposed. Based on literatures, two observations were reported.	1) Compare traditional vs. online shopping; 2) Consumer Channel switching behavior
Hayne, 1996		I		D						3 separate sets of experiments: college students engaged in business decision-making experiments while experiencing time pressure. Expl: 14 general business student groups of 5 students each produced a set of 26 decisions. Expt3: 18 accounting student groups of 4 or 5 students each determined the materiality judgment for forms.	1) Business Decision; GSS; 2) Macro-strategy: filtration, acceleration vs. Micro-strategy: 5 types (Payne); 3) The greater media richness of face-to-face communication, and the more structured decision process used by GSS groups.
Ko*, 2004			I				D			A self-administrated survey was conducted at universityies in both Korea (155/167 are usable) and the United States (192/201 are usable).	1) Cross-culture differences: Korean Internet users felt a higher level of social risk toward online shopping, while American Internet users had a higher level of perceived risk in terms of financial, time, and psychological risk. 2) Online shoppign still considered a risky propostion in spite of its numerous purported benefits.
Koufaris *, 2002	I						D (intend to return)	I (flow)		directly survey Booksamillion.com; new customers (280/300 subjects)	Flow theory; TAM model; Return Intention
Kwon, 2003				D							Collaborative filtering; Graphical context
Laurent, 1985	I		I				D			literature review and in-depth interviews of 207 housewives.	1) Consumer Involvement Profiles (CIPs); 2) When consumers are involved, they should engage in a number of behaviors (active search, extensive choice process, active information processing, etc.); when consumers are not involved, they should not engage in these behaviors.

Articles	Concepts										
	Involvement	Time Pressure	Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Lerch, 2001				D				I (working memory capacity)		An animation tool that reproduces one mail-sorting factory of the United States Postal Service (USPS) was designed and tested. This is a 3-year study of the sorting factory with the 14th highest mail volume in the contry. 1) Expt1: 2 (high/low working memory capacity) x 2 (on/off browsing conditions) x 3 (on/off/browse) facotrial between-subjects design. 2) Expt2: 2 (feedback) x 2 (feedforward) x 3 factorial with two between-subjects factors and three repeated measures. 24 participants were recruited.	1) Decision Strategy: Monitoring vs. Control; 2) Providing support for real-time dynamic decision making may be very difficult, and that designing effective decision aids requires a detailed understanding of the underlying cognitive processes. 3) High working memory participants had few split assignments in the browsing condition, but the number of splits increased in the no-browsing condition. 4) Performance feedback did not speed up learning.
Lichtenstein, 1988	I		I					I (perceived product quality; knowledge)	D	questionnaires were mailed to 1800 (25.1% reponse rate; 452/1800) recent participants in a popular reginal road run.	1) Price and product quality inferences; 2) Price acceptance ; 3) Product involvement should not be confused with the temporary purchase-dependent interest in a product that results from risk perceptions. 4) Product involvement is postively correlated to price-quality inferences and price acceptability level.
Lin, 2003						I	D (habitual behavior)	I (Awareness, perceived quality)	I	Personal interviews with Chinese customers of the Chung-Shing Texitle Group in two metropolitan areas in China. 1284 data are included in the sample.	Consumers do not make repeat purchase basedon simple heuristic factors such as brand awareness. Channel convenience, perceived quality, price all have significant influence on habitual behavior.
Liu, 2000 *				D						Number of Decision Tree Leaves	If, then rules; Tree Structure
Lohse *, 1996		D (Total Time)		D (within-attribute-transitions vs. within-alternative-transitions)	I (information load, 2x2, 2,7, 7x2, 7 x 7 IDB)			D (EIPs to measure cognitive effort)		MouseLab and Eyegaze tools are used. 26447 eyegaze fixations and 16992 mouselab fixation over all 36 subjects. 2 choice tasks (gambles and apartment selection)	CPT, EIPs (Elementary information processes), IDB
Lowengart *, 2001	I	D (Total Time)	I					D (beliefs and perceptions about various internet stores)		1) 114 first-year engineering students volunteered to participate in the study. 72 are male and 42 are female. The participants' average age is 23.75%. 2) Participants were asked to access web sites of three online Israeli bookstores and three onlin Isareli computer stores.	1) Probability modeling; 2) Attitude; 3) lack of information increase risk; 4) time-related factor; 5) Factor Analysis using VARIMAX method to rotates four factors.

Articles	Concepts										
	Involvement	Time Pressure	Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Lussier, 1979				D	I	I				27 MBA students on a voluntary basis were recruited. Portable manual typewriters were selected for study. A 3 (3, 6, 12 brands) x3 (5, 10, 15 product attribues) fixed effect factorial design was used for the experiment. 3 subjects were randomly assigned to each cell. Protocol Analysis for each subjects is conducted, transcribed, and coded.	Brand choice strategy: Stronger two step elimination model (phase1: non-compensatory strategy; phase2: compensatory strategy) with larger number of alternatives.
Mann, 1993		I		D			D	D		two experiments on a sample of 162 university students who were assigned to a time-pressure condition or a non time-pressure condition.	1) Cognitive Closure; 2) Filtration Effect - narrow the range of information search; 3) Motivational Model; 4) Measures of vigilance: number of objectives, number of alternatives, number of consequences, number of pages read, information assimilation (number of items taken), number of changes made, and number of contingency plans.
Montgomery *, 2003				I (browsing)			D (Intention to purchase)			1160 users who visited barnsandnoble.com (or also books.com or bn.com) between 4/1/02 and 4/30/02. Simulation has been performed to predict the probability the user will order (O) on the next page if the user has visited the category (C) and shopping cart (S) pages.	1) Multinominal probability model of web browsing with memory component, clickstream data, Path Analysis; 2) Path Analysis is quite helpful to predict purchase conversion. 3) Changes are proposed to make on a website for users who are browsing-oriented: delete price information, add promotion image, delete banner ads, reduce the number of links to home pages by half, double the links to product, account, and information pages.
Mukherjee, 2001				D	I				C (high price)	1) 140 undergraduate students at a Canadian university participated in the study for a course credit and a chance to win four prizes of $50. 2) The hypotheses were tested using a 2x2x2 product complexity bynovel attribute by search design.	1) Negative learning cost, third opinion; 2) Negative effect of novel attributes on the evaluation of high-complexity products can persist even after consumers are given explicit information about the benefits of novel attributes. Novel attributes may contribute to consumer resistance toward technological innovation.

Articles	Concepts										
	Involvement	Time Pressure	Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Myers, 2003						I		D (awareness, perceived quality, preferences)		43 participants (23 female, 20 male) measure brand equity of 9 top market-share brand in soft drink category.	1) To measure brand equity: perceived value, brand dominance, and intangible value. 2) Conjoint Analysis to measure the importance of brand name relative to other brand attributes.
Ordonez, 1997		I (Time Constriant)	D	D (strategy switching)				D (mood related questions)	I	1) Exp1: 50 undergraduate business stydebts at the University of Arizona. (2x2x2 time constrint by task by task order) factorial design - gambles were displayed as pie chart; 2) Exp2: subjects rated the attractiveness of the 25 gambles used in Expt1 under either time-unconstrained or time-constrained condition. They also needs to complete NFC questionnaire and a few aditional demographic questions. 3) Exp3: 56 undergraduate business students participate - testing the hypothesis of changed decision strategy purely in responsed to time constraint.	1) Need for Cognition (NFC), 2) Gamble Experiment; 3) Price Tasks; 4) Additive multiplicative strategy; 5) subjects may have been attempting to reduce their cognitive effort by continuing to use the decision strategy they had been using in the previous task, assuming that there is a cognitive cost to changing strategies.
Park*, 2003	I		I				D (Intention to purchase)	I (attitude towards purchasing)		Questionnaire: measurement of constructs and variables: personal involvement, motivational involvement, attitude towards purchasing and behavioral intentions.	Intention to Buy; Attitude
Payne, 1976				D	I					Protocol Analysis	Subjects use more non-compensatory rules under high information load
Payne, 1988		I		D							Classified compensatory and non-compensatory strategies into 5 types: WADD, EQW, SAT, LEX and EBA.
Pedersen *, 2003	I		I	I & D			D (Intention to purchase)	I (Knowledge)		A quasiexperimental 13- group posttest only design was setup. Subjects were recruited at 13 different web shops. A banner ads and a text link of equal wording, which provided stimuli settings, were put at similar locations of the front page of the sites. And online questionnaire is filled and collected.	1) Search modes: goal-oriented search mode and exploratory search mode. 2) Search mode and purchase intention are related. When product risk or involvement is low, a low degree of goal-oriented search mode gives the highest purchase intention, but when product risk or involvement is high, a high degree of goal-oriented search mode gives the highest purchase intention.
Pritchard, 2003			I	D							1) Choice vs. Judgmental Tasks; 2) people tend to avoid risky situations when gains are involved and they tend to be risk seeking when losses are involved; 3) St. Petersburg Paradox

Articles	Concepts										
	Involvement	Time Pressure	Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Quester, 2003	I		I			D				1) Focus group discussions (Involvement): 13 male and 14 female second year university students; 2) Factor Analysis (brand loyalty): TAFE students enabled a reduction of the initial 31 items to 16; 3) Self-administered questionnaire to a convenience sample of 253 university students (56% female; 90% age 18-25)	1) Ego involvement and brand loyalty; 2) Use Customer Involvement Profile (CIP) scale to measure involvement
Rossi, 1996			D (uncertainty measured by the expected value of brand, price & other product attributes)		I (feature and display variables)	I	D		I	1) Bayesian analysis of hierarchical model and Markov Chain simulation methods. 2) The data used in the analysis is an A. C. Nielsen scanner panel dataset of tuna purchases in Springfield, MO. 5 brands of tuna packaged in 6-ounce cans are included in the analysis. 400 are selected at random from the 775 households who remained in the panel at least 1.5 years.	1) Consumer Segments by analyzing historial purchase data; 2) Target Marketing - point-of-purchase couponing and royal/frequent shopper program
Sadarangani* , 2002	I					D (attitude toward brand)	D (needs, desire stage to action stage of purchasing)	I (attitude, emotion)		Model proposing based on literal reviews (Work in Progress)	1) Emotion intensity, attitude toward brand; 2) proposition1: emotional intensity of a web site will change brand attitudes to a greater extent under low involvement as opposed to moderate involvement. 3) emotional intensity of a web site has a greater impact on brand attitudes under high rather than moderate involvement conditions. 4) emotional intensity web sites have a greater impact on brand attitudes than low emotional intensity websites.
Silberschatz, 1996							D	I (beliefs, knowledge)			Beliefs, Knowledge
Su *, 2003			I				D			107 business major undergraudates and MBA students particpate in a paer-pencil survey on a voluntary base. Non-student sample (18988/50000 responded the survey) was collected via a web survey. 4 product categories: book, flight tickets (search goods), wine and stero systems (experience goods) were chosen and available in both online and offline channels.	1) For books, nonstudent subjects are more risk-averse online than offline. 2) In non-student sample, result indicates a consistency between the financial risk-aversion attitudes and price search intentions in flight tickets, wine and stereo systems.

Articles	Concepts										
	Involvement	Time Pressure	Risk	Search/Decision Strategies	Task Complexity	Brand	Customer Behaviors	Cognition	Price	Method	Notes
Tan *, 1999			I				D			1) Pilot: 2 (in store vs. Internet shopping) x 3 (low/medium/high risk) factorial design.Eightproducts, two for each risk category, were selected for the study. A pilot study was then undertaken on a random sample of 18 National University of Singapore business undergraduates, who had to rate the products on perceived risks and familiarity with the products. Final list of three products, inkjet printer, watch, and blank video-cassette tapes (representing high, medium and low risk products, respectively) were selected. 2) Main expt: 3x2x2x2 factorial design. The final sample size was 179, with an average of 30 subjects per treatment cell. There were 129 (71.9 percent) female and 50 (28.1 percent) male respondents.	1) Risk reduction strategy; 2) Consumers use reference group as a guide to specific behaviors. 3) Consumers perceive higher risk for Internet shopping than in-store shopping. 4) Regardless of the types of product involved, the use of an expert as a reference group appeal yields higher utility as a risk reliever than the use of a common man appeal. 4) The use of brand image as a risk reliever also yielded the same utility reactions as the use of retailer's reputation.
Tarasewich *, 2004				D	I			D (Attention)		19 subjects (17 male, 2 female) participated in an controlled experiment. Each task generated a set of web page images with paths of the cursor movement). Task complexity is manipulated by the web site design complexity and usability metrics.	1) Enhaced Rstricted Focus Viewer (ERFV) has been developed to track user's attention - eye tracking software. 2) Blurriness levels should be further investigated.
Taylor, 2000			I	D				I (Individual Attitude)		1) 42 undergraduate students, comprising 6 focus groups, participated in partial fulfillment of a subject pool rquirement for an exploratory marketing study. Each group was Video- and audio-taped. 2) 2 tasks: internal ambiguity (trivia question) vs. external ambiguity (new product choices).	1) Utility of product attribute and probability model. 2) Proposition1: Internally and externally generated ambiguity indice different reasoning process. 3) Proposition2: The most important determinants of choices under internally generated ambiguity willl be commitment to ownership of estimates, probablity shifts, and credit/blame attributions. 4) Proposition3: The most important determinants of choices under externally generated ambiguity will be risk attitudes, accountability, and perceptions of controls.
Tyebjee, 1979	I	D (Choice Time)				I				Computer-controlled laboratory experiment: self-selected sample of 47 college students (21-29 age). Nine trands of beer comprised the stimulus set. The task was forced, pairwise choice between two brands of beer.	1) Choice time; Brand Choice. 2) If brand dominates other product attributes in the preference structure, choice time will be less than if the consumer has near equal preferences.

APPENDIX D

STUDY CONSENT FORM

Official study consent form approved by Institutional Review Board (IRB) is attached in this section. 4-page document contains information about the purpose of the study, study duration, procedure, participants, risk and discomfort involved, confidentiality, video- and audio-taping, study incentives, benefits to participants and contact information of study investigator.

NEW JERSEY INSTITUTE OF TECHNOLOGY
323 MARTIN LUTHER KING BLVD.
NEWARK, NJ 07102

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY:
Sifting Customers from the Clickstream: Behavior Pattern Discovery in Virtual Shopping Environment

RESEARCH STUDY:
I,_____, have been asked to participate in a research study under the direction of Peishih Chang (Investigator) of New Jersey Institute of Technology. Other professional persons who work with them as study staff may assist to act for them.

PURPOSE:
Purpose of this study is to understand people's cognition while purchasing online and then create a cognitive model to predict customer behavior. Providing the right information at the right time is what online marketers and researchers like us are keen to achieve.

DURATION:
My participation in this study will last for an hour including performing think-aloud protocol and answering post-questionnaire.

PROCEDURES:
I have been told that, during the course of this study, the following will occur:

1) Filling in background questionnaire before experiment.

2) Taking tutorials and training about the procedures of this study.

3) Carrying out two online-shopping tasks.

4) Filling out post-questionnaire or answering interview questions.

5) All communications during the online-shopping tasks will be recorded, and later analyzed.

6) Receiving debriefing after data are integrated and analyzed.

PARTICIPANTS:
I will be one of about 50 participants in this experiment.

RISKS/DISCOMFORTS:
There is no known risk involved in this study. There may be risks and discomforts that are not yet known. I fully recognize that there are risks that I may be exposed to by volunteering in this study which are inherent in participating in any study; I understand that I am not covered by NJIT's insurance policy for any injury or loss I might sustain in the course of participating in the study.

CONFIDENTIALITY:
I understand confidential is not the same as anonymous. Confidential means that my name will not be disclosed if there exists a documented linkage between my identity and my responses as recorded in the research records. Every effort will be made to maintain the confidentiality of my study records. If the findings from the study are published, I will not be identified by name. My identity will remain confidential unless disclosure is required by law.

VIDEOTAPING/AUDIOTAPNG:
I understand that I will be video and audio taped during the course of this study. Video and audio tapes will be stored for (insert time frame) after the end of this project (12/31/06). After that time, the tapes will be erased by recording over my recorded sessions. The tapes will be stored in a locked office at NJIT and will not be made available to anyone except (Peishih Chang and Dr. David Mendonça) who are involved in this research.

PAYMENT FOR PARTICIPATION:
I have been told that I will receive no compensation for my participation in this study.

PARTICIPATION BENEFITS:
1) An opportunity to learn about experimental design and procedure of Protocol Analysis.

2) This proposed research will enhance the ability of giving shoppers the right information at the right time while shopping online.

RIGHT TO REFUSE OR WITHDRAW:
I understand that my participation is voluntary and I may refuse to participate, or may discontinue my participation at any time with no adverse consequence. I

also understand that the investigator has the right to withdraw me from the study at any time.

INDIVIDUAL TO CONTACT:
If I have any questions about my treatment or research procedures, I understand that I should contact the principal investigator at:

Peishih Chang
Ph.D. Candidate in IS Department
New Jersey Institute of Technology (GITC 4323)
Newark, NJ 07102
(973) 596-5422
peishih.chang@njit.edu

If I have any addition questions about my rights as a research subject, I may contact:

Dawn Hall Apgar, PhD, IRB Chair
New Jersey Institute of Technology
323 Martin Luther King Boulevard
Newark, NJ 07102
(973) 642-7616
dawn.apgar@njit.edu

SIGNATURE OF PARTICIPANT
I have read this entire form, or it has been read to me, and I understand it completely. All of my questions regarding this form or this study have been answered to my complete satisfaction. I agree to participate in this research study.

Subject Name:_____ Signature:_____

Date:_____

SIGNATURE OF READER/TRANSLATOR IF THE PARTICIPANT DOES NOT READ ENGLISH WELL

The person who has signed above, _____, does not read English well, I read English well and am fluent in (name of the language) _____, a language the subject understands well. I have translated for the subject the entire content of this form. To the best of my knowledge, the participant understands the content of this form and has had an opportunity to ask questions regarding the consent form and the study, and these questions have been answered to the complete satisfaction of the participant (his/her parent/legal guardian).

Reader/Translator Name:_____

Signature:_____

Date:_____

SIGNATURE OF INVESTIGATOR OR RESPONSIBLE INDIVIDUAL

To the best of my knowledge, the participant, _____, has understood the entire content of the above consent form, and comprehends the study. The participants and those of his/her parent/legal guardian have been accurately answered to his/her/their complete satisfaction.

Investigator's Name:_____

Signature:_____

Date:_____

APPENDIX E

INTRODUCTION PROCEDURE

- Self introduction of the investigator
- You are invited to help us evaluate the online shopping website using Protocol Analysis method.
- Protocol Analysis method requires you to "THINK OUT LOUD" during the process in using the online shopping website to achieve the tasks we ask you to do.
- Think Out Loud means you need to speak out your strategies, feelings, judgments, plans, and so on in every step of your work. We'll show you a simple demo later on before you start your experiment.
- When you begin the tasks, we will record the whole process (using both screen recorder and audio recorder) for afterward analyses, and we will not answer any questions about how to achieve the tasks. All your information will be kept confidential, and only the investigator has the accessibility to these records. The audio (or video) records will be erased after the analyses.
- Please pretend that you are making purchase decision for yourself and let it be as real as possible. In addition, we are here to evaluate the online shopping website, not your computer skills. If there is any difficulty in carrying out the tasks, it is the system's fault, not yours.
- The estimated time for completing the tasks is around forty minutes.
- After you complete the tasks, you are invited to answer a questionnaire concerning to the evaluated system and the experiment itself.
- Please read the Consent Form carefully, and sign it. If you have any questions on it, please do not hesitate to ask us.

APPENDIX F

PROTOCOL ANALYSIS PROCEDURE

Setup Session Check List

Form:

- ✓ Pre-questionnaire (Background and Involvement/Risk Perception)
- ✓ Consent Form
- ✓ Tasks scenarios
- ✓ Post-Questionnaire

Equipment:

- ✓ Online E-commerce Website with subject account [assign each participant an unique account]
- ✓ Database linkage with the website
- ✓ Web logs are automatically generated by website
- ✓ Camtasia for screen/mouse movement recording
- ✓ Audio Recorder
- ✓ Microphone for participant
- ✓ Turn on Camtasia

Welcome & Introduction Session

Hi… [Subject's first name] How are you doing?
Thank you for coming. [Wait for subject sitting down and be comfortable]
[Then read the following…]
"Today you will be shopping online. As you shop, we will ask you to think out loud. I will briefly explain what I mean THINK OUT LOUD later.

When you begin the tasks, I will record what you say and do. Please be assured that all your information will be kept confidential.

Once you are done shopping, I will ask you some questions about the experience.

Any question so far? [Wait for answer]
OK!
Consent Form Session

[Hand out the consent form]
"Please read the Consent Form, and sign it. If you have any questions on it, please ask me."
[After the subject sign her/her consent form, hand out the background (pre-) questionnaire.
Pre-Questionnaire (maybe online?)

Before we begin, please answer this questionnaire. If you have questions, please ask me. Thank you.
[After the subject fill in the pre-questionnaire, see if they choose digital camera as high-involvement and printer-paper as low involvement. If yes, choose these two tasks for them to perform; otherwise, choose alternative Blank-CD and …]
Warm-up Session

OK!
Now I am going to explain what I mean "THINK ALOUD."

In this experiment I am interested in what you say to yourself as you perform some tasks that I give you. In order to do this I will ask you to THINK ALOUD as you work on the tasks. What I mean by think aloud is that I want you to tell EVERYTHING you are thinking from the time you first see the question until you give an answer. I would like you to talk aloud COSNTANTLY from the time I present this problem until you have given your final answer to the question. I don't want you to try to plan out what you say or try to explain to me what you are saying. Just act as if you are alone in the room speaking to yourself. It is most important that you keep talking. If you are silent for any long period of time I will ask you to talk. Do you understand what I want you to do?
[Wait for response.]

Good, before we turn to the real experiment, we will start with practice problems. I want you to think aloud while you do this problem. I will ask you to add two numbers in your head.

1) So think aloud while you add 24 to 38!
[Remind the subject if he/she did not think aloud. "Keeping talking", "Think, reason in a loud voice, tell me everything that passes through your head."]

2) Good. Let's try another one. Now I want you to tell me "how many windows are there in your parent's house?"

Good.
Tasks/Protocol Session

[Open the experiment website and give subject a unique id to login.]

Now you are going to shop for 2 items. Please remember to think, reason in a loud voice, tell me everything that passes through your head during your work searching for the solution to the tasks.

[Hand in Task Scenarios.] Now you may begin.

Note: When subject lapses into silence, using

- ✓ "keep talking"

- ✓ "what are you thinking about?" to reminder him/her to think aloud after 15 sec to 1 min pauses (the interval being different in different studies)."
- ✓ "Try to think aloud. I guess you often do so when you are alone and working on a problem."
- ✓ "tell me everything that passes through your head"
- ✓ "I am not primarily interested in your final solution, still less in your reaction time, but in your thinking behavior, in all your attempts, in what ever comes to your mind, no matter whether it is good or a less good idea or a question." (Duncker, 1926)

Post-Experiment

[Give Subject the post-questionnaire once he/she completes each task.]
Please fill this out. Let me know if you have any question. Thank you.
Debriefing

Thank you for participating in this experiment. Now your job has completed. I would like to debrief to you that how this experiment has been setup. And what research questions we are interested in. [Or maybe send them email about this experiment.]

The End

Thank you very much. [Big Smile]
Escort the subject to the door.

- ✓ Saved subject's log file
- ✓ Save subject's digital video files with ID.
- ✓ Turn off video and audio.
- ✓ Turn off Camtasia.

APPENDIX G

BACKGROUND QUESTIONNAIRE

ID#_____
Date: _____

BACKGROUND QUESTIONNAIRE

1. Have you ever shopped online?
___Yes
___No

2. How often do you make a purchase online?
___Never
___Once a year
___2-6 times a year
___Once a month
___Once a week
___Several times a week

3. What kinds of products have you purchased online? (Choose all items that apply)
___Books
___CD, VCD, DVD
___Clothes, Shoes, Accessories
___Computer and Peripherals
___Software and Computer/Video Games
___Flight Tickets, Hotels, and Vacation Deals
___Electronics
___Others (Please specify)_____

---

4. We would like to know how interested you are in printer papers. Please use the series of descriptive words listed below to indicate your level of interest in printer papers.

Important	O O O O O O O	Unimportant
Irrelevant	O O O O O O O	Relevant
Means a lot to me	O O O O O O O	Means nothing to me
Unexciting	O O O O O O O	Exciting
Dull	O O O O O O O	Neat
Matters to me	O O O O O O O	Doesn't matter to me
Boring	O O O O O O O	Interesting
Fun	O O O O O O O	Not fun
Appealing	O O O O O O O	Unappealing
Of no concern to me	O O O O O O O	Of concern to me

5. We would like to know how interested you are in blank CD-R. Please use the series of descriptive words listed below to indicate your level of interest in blank CD-R.

Important	O O O O O O O	**Unimportant**
Irrelevant	O O O O O O O	**Relevant**
Means a lot to me	O O O O O O O	**Means nothing to me**
Unexciting	O O O O O O O	**Exciting**
Dull	O O O O O O O	**Neat**
Matters to me	O O O O O O O	**Doesn't matter to me**
Boring	O O O O O O O	**Interesting**
Fun	O O O O O O O	**Not fun**
Appealing	O O O O O O O	**Unappealing**
Of no concern to me	O O O O O O O	**Of concern to me**

6. We would like to know how interested you are in digital cameras. Please use the series of descriptive words listed below to indicate your level of interest in digital cameras.

Important	O O O O O O O	**Unimportant**
Irrelevant	O O O O O O O	**Relevant**
Means a lot to me	O O O O O O O	**Means nothing to me**
Unexciting	O O O O O O O	**Exciting**
Dull	O O O O O O O	**Neat**
Matters to me	O O O O O O O	**Doesn't matter to me**
Boring	O O O O O O O	**Interesting**
Fun	O O O O O O O	**Not fun**
Appealing	O O O O O O O	**Unappealing**
Of no concern to me	O O O O O O O	**Of concern to me**

7. We would like to know how interested you are in televisions. Please use the series of descriptive words listed below to indicate your level of interest in televisions.

Important	O O O O O O O	**Unimportant**
Irrelevant	O O O O O O O	**Relevant**
Means a lot to me	O O O O O O O	**Means nothing to me**
Unexciting	O O O O O O O	**Exciting**
Dull	O O O O O O O	**Neat**
Matters to me	O O O O O O O	**Doesn't matter to me**
Boring	O O O O O O O	**Interesting**
Fun	O O O O O O O	**Not fun**
Appealing	O O O O O O O	**Unappealing**
Of no concern to me	O O O O O O O	**Of concern to me**

Please indicate the extent to which you agree or disagree with the following statements by selecting the description that applies.

8.

	It is a big deal for me to make a mistake when purchasing this product.						
	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Printer Paper	1	2	3	4	5	6	7
Blank CD	1	2	3	4	5	6	7
Digital Camera	1	2	3	4	5	6	7
Television	1	2	3	4	5	6	7

9.

	It is hard for me to make a good purchasing choice for this product.						
	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Printer Paper	1	2	3	4	5	6	7
Blank CD	1	2	3	4	5	6	7
Digital Camera	1	2	3	4	5	6	7
Television	1	2	3	4	5	6	7

10.

	I am worried what I paid may exceed the true value of this product.						
	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Printer Paper	1	2	3	4	5	6	7
Blank CD	1	2	3	4	5	6	7
Digital Camera	1	2	3	4	5	6	7
Television	1	2	3	4	5	6	7

11.

	I am worried that this product may have defects or not function as required.						
	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Printer Paper	1	2	3	4	5	6	7
Blank CD	1	2	3	4	5	6	7
Digital Camera	1	2	3	4	5	6	7
Television	1	2	3	4	5	6	7

12.

	This product is a subject of discussion in my group of friends.						
	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Printer Paper	1	2	3	4	5	6	7
Blank CD	1	2	3	4	5	6	7
Digital Camera	1	2	3	4	5	6	7
Television	1	2	3	4	5	6	7

Demographic:

1) Your gender: ___Male ___Female
2) Your age:
___16-25 ___26-35 ___36-45 ___46-55 ___56 and Over
3) Current degree program:
___Undergraduate ___Master ___Ph.D. ___Post Graduate
4) Your major: _____
5) What is the dollar amount of your biggest online purchase:$_____
What is the dollar amount of your smallest online purchase:$_____
6) Number of Computers at Home:
___None ___One ___Two or more

Thank You Very Much! ☺

Questions extracted and modified from articles:

i) McQuarrie, E.F. and Munson, J.M. (1992) A Revised Product Involvement Inventory: Improved Usability and Validity. In *Advances in Consumer Research*, J. F. Sherry and B. Sternthal (eds.), 19, Association for Consumer Research, Provo, UT, pp. 108-115.

ii) Spiekermann, S. (2004). Product context in EC website: How consumer uncertainty and purchase risk drive navigational needs. Proceedings of the 5th ACM conference on electronic commerce, New York, NY. Originally adopted from Murray, K. B. and Schlacter, J. L. (1990). The impact of services versus goods on consumers' assessment of perceived risk and variability. *Journal of the Academy of Marketing Science*, 18(1), 51-65.

APPENDIXT H

TASK SCENARIOS

All the tasks should be completed within the provided website. The tasks are considered completed once you add a product to the shopping cart. Please perform these tasks as you shopped for yourself.

Scenario 1:

You are almost out of blank CD-R. You consider to buy some more for daily use.

Or

You are almost out of printer paper. You consider to buy some more for daily use.

Scenario 2:

Your loved one's birthday is approaching. You think a digital camera will be a great gift for him or her.

Or

You consider buying a new TV for your living room, so you browse online to see if you can find a good deal.

(Note: For time pressure conditions, subjects are informed that they have limited time to shop. Some of the deals may disappear from screen once they are out of stock or unavailable any more.)

APPENDIX I

POST-EXPERIMENT QUESTIONNAIRE

ID#_____

Post-Experiment QUESTIONNAIRE 1

1. **In selecting the product, what information was most useful to you?**

_____

_____

2. **In selecting the product, what information did you want but did not have?**

_____

_____

3. **I am confident that my choice is satisfying.**

:___1___:	___2___:	___3___:	___4___:	___5___:	___6___:	___7___:
Strongly Disagree	**Disagree**	**Slightly Disagree**	**Neutral**	**Slightly Agree**	**Agree**	**Strongly Agree**

4. **The factors that contribute to my degree of confidence (or lack of) in the task are:**

_____

_____

_____

The following questions concern your overall views about your experiences in selecting this product.

	Never						Always
5. Did you compare alternatives two at a time and then compare that one to the next one and so on until only one was left standing?	1	2	3	4	5	6	7
6. Did you focus on single characteristic (attribute) and compare across all alternatives?	1	2	3	4	5	6	7

7. Did you tend to compare a sum of all attribute values multiplied by their weights and derive a single score for each alternative?	1	2	3	4	5	6	7
8. Did you establish minimal acceptable values for critical attributes of each alternative and then see if each alternative met the "cutoff?"	1	2	3	4	5	6	7
9. Did you use a combination of the above techniques?	1	2	3	4	5	6	7

10. I felt that I needed to make a decision faster in this task.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

11. I experienced time pressure to complete this task.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

---

Based on your experience during the experiment, please indicate the extent to which you agree or disagree with the following statements by selecting the description that applies.

12. It is a big deal for me to make a mistake when purchasing this product.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

13. It is hard for me to make a good purchasing choice for this product.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

14. I am worried what I paid may exceed the true value of this product.

: 1	: 2	: 3	: 4	: 5	: 6	: 7 :
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

15. I am worried that this product may have defects or not function as required.

: 1	: 2	: 3	: 4	: 5	: 6	: 7 :
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

16. This product is a subject of discussion in my group of friends.

: 1	: 2	: 3	: 4	: 5	: 6	: 7 :
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

Thank You Very Much!

ID#_____

Post-Experiment QUESTIONNAIRE 2

1. **In selecting the product, what information was most useful to you?**

_____

_____

2. **In selecting the product, what information did you want but did not have?**

_____

_____

3. **I am confident that my choice is satisfying.**

:___1___:	___2___:	___3___:	___4___:	___5___:	___6___:	___7___:
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

4. **The factors that contribute to my degree of confidence (or lack of) in the task are:**

_____

_____

_____

The following questions concern your overall views about your experiences in selecting this product.

	Never						Always
5. Did you compare alternatives two at a time and then compare that one to the next one and so on until only one was left standing?	1	2	3	4	5	6	7
6. Did you focus on single characteristic (attribute) and compare across all alternatives?	1	2	3	4	5	6	7
7. Did you tend to compare a sum of all attribute values multiplied by their weights and derive a single score for each alternative?	1	2	3	4	5	6	7

8. Did you establish minimal acceptable values for critical attributes of each alternative and then see if each alternative met the "cutoff?"	1	2	3	4	5	6	7
9. Did you use a combination of the above techniques?	1	2	3	4	5	6	7

10. I felt that I needed to make a decision faster in this task.

: 1	: 2	: 3	: 4	: 5	: 6	: 7 :
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

11. I experienced time pressure to complete this task.

: 1	: 2	: 3	: 4	: 5	: 6	: 7 :
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

---

Based on your experience during the experiment, please indicate the extent to which you agree or disagree with the following statements by selecting the description that applies.

12. It is a big deal for me to make a mistake when purchasing this product.

: 1	: 2	: 3	: 4	: 5	: 6	: 7 :
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

13. It is hard for me to make a good purchasing choice for this product.

: 1	: 2	: 3	: 4	: 5	: 6	: 7 :
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

14. I am worried what I paid may exceed the true value of this product.

: 1	: 2	: 3	: 4	: 5	: 6	: 7 :
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

15. I am worried that this product may have defects or not function as required.

:___1___:	___2___:	___3___:	___4___:	___5___:	___6___:	___7___:
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

16. This product is a subject of discussion in my group of friends.

:___1___:	___2___:	___3___:	___4___:	___5___:	___6___:	___7___:
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

---

Rate the experiment instructions:

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
17. The vocabulary of the experiment prevented me from participating.	7	6	5	4	3	2	1
18. The amount of specialized instruction that was given to me was sufficient.	1	2	3	4	5	6	7
19. The practices that were given to me prior experiment were useful.	1	2	3	4	5	6	7
20. I acted differently because I knew I was in an experiment.	7	6	5	4	3	2	1

21. What are the major concerns when you are making a purchase online?

Thank You Very Much!
Have a Nice Day! ☺

Questions extracted and modified from articles:

i) Fisher, C. W., Chengaour-Smith, I., Ballou, D. P. (2003). The impact of experience and time on the use of data quality information in decision making. *Information Systems Research*, 14(2), 170-188.

ii) Spiekermann, S. (2004). Product context in EC website: How consumer uncertainty and purchase risk drive navigational needs. Proceedings of the 5th ACM conference on electronic commerce, New York, NY. Originally adopted from Murray, K. B. and Schlacter, J. L. (1990). The impact of services versus goods on consumers' assessment of perceived risk and variability. *Journal of the Academy of Marketing Science*, 18(1), 51-65.

APPENDIX J

INSTITUTIONAL REVIEW BOARD APPROVAL

NJIT NEW JERSEY INSTITUTE OF TECHNOLOGY

Institutional Review Board: HHS FWA 00003246
Notice of Approval
IRB Protocol Number: C4-04

Principal Investigators: Peishih Chang, Information Systems

Title: Sifting Customers from the Clickstream: Behavior Pattern Discovery in Virtual Shopping Environments

Performance Site(s): NJIT Sponsor Protocol Number (if applicable):

Type of Review: FULL [ ] EXPEDITED [X]

Type of Approval: NEW [ ] RENEWAL [X] MAJOR REVISION [ ]

Approval Date: February 20, 2006 Expiration Date: February 19, 2007

1. **ADVERSE EVENTS:** Any adverse event(s) or unexpected event(s) that occur in conjunction with this study must be reported to the IRB Office immediately (973) 642-7616.

2. **RENEWAL:** Approval is valid until the expiration date on the protocol. You are required to apply to the IRB for a renewal prior to your expiration date for as long as the study is active. Renewal forms will be sent to you; but it is your responsibility to ensure that you receive and submit the renewal in a timely manner.

3. **CONSENT:** All subjects must receive a copy of the consent form as submitted. Copies of the signed consent forms must be kept on file with the principal investigator.

4. **SUBJECTS:** Number of subjects approved: 50.

5. The investigator(s) did not participate in the review, discussion, or vote of this protocol.

6. **APPROVAL IS GRANTED ON THE CONDITION THAT ANY DEVIATION FROM THE PROTOCOL WILL BE SUBMITTED, IN WRITING, TO THE IRB FOR SEPARATE REVIEW AND APPROVAL.**

Dawn Hall Apgar

Dawn Hall Apgar, PhD, LSW, ACSW, Chair IRB February 20, 2006

APPENDIX K

COMPLETE PRELIMINARY RESULTS (AMCIS2004 PAPER)

Inside the Customer:
Modeling Cognition during Online Shopping

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ABSTRACT

Online marketers want to present potential customers with the right information at the right time. Decisions about what information to present are typically made before the customer has visited a web site, using data such as purchase histories and logs of web pages visited (i.e., clickstream data). An alternative approach is to develop predictions about what information to present based on inferences made from cognitive models of the customer. This research presents one approach to collecting and analyzing data that could be used to construct such models. Two studies are presented on how differences in product type may impact customer cognition and browsing behavior. The results suggest that differences in product type may lead to differences in waiting time before making a purchase. Product type may also influence the types of information people consult before making a purchase.

Keywords

Cognitive modeling, online shopping, customer behavior, clickstream data

INTRODUCTION

Online marketers want to present the right information at the right time to potential customers. Decisions about what information to present to potential customers are typically made before the customer has visited a web site, using data such as purchase histories and logs of web pages visited (i.e., clickstream data). This research explores an alternative cognitive approach to investigate how differences in types of products customers are looking for may impact customer cognition and browsing behavior. To produce the data used in this study, shoppers followed given scenarios to make purchases and then thought-aloud retrospectively while watching recorded mouse movements. Analysis of the think-aloud and clickstream data suggests that variation in product type leads to variation in the time people wait before making a purchase and variation in their browsing behaviors.

A brief review of related prior research is followed by a series of pilot studies concerning how product types may impact online customers' shopping behaviors. The results of the studies are then presented, followed by analyses of clickstream data and statements in protocols. A discussion of directions for future work is then concluded in this paper.

RELATED WORK

To investigate customers' online shopping behaviors, researchers and online marketers mainly collects huge amount of clickstream data to find possible behavior patterns within. Clickstream is a record of the mouse clicks executed by the customer in the company's information space, typically the web (Chatterjee et al., 1998). Clickstreams of e-customers in virtual shopping malls are traces of behavior over time – much like footprints of shoppers in physical shopping malls – that may give evidence of browsing and buying behaviors. Clickstream shows information such as how long a customer spends with various products, what products the customer browsed through and the path that led to these products. Logs of clickstream data can be comprehensive, large and therefore unwieldy, making extraction of valuable information from them a difficult task (Davenport et al., 2001). All of those online marketers' efforts are based on the assumption that similar behaviors imply similar preferences or purchase occasions. However, customer's needs and goals, which are founded to be an important factor affecting customer's online shopping behavior (Chen et al., 1998; Cooley et al., 1999; Silberschatz and

Tuzhilin, 1996), are left out at most studies. Card especially states that clickstream is informative but fails to provide any moment-by-moment cognition occurred between customer clicks that is how people's goal evolved (Card et al., 2001).

Types of Products

In addition to customer's needs and goals, online marketers and researchers are also interested in finding factors that affect customer behaviors. Customers' involvement in products is believed to influence their information seeking behavior and decision-making process (Laurent and Kapferer, 1985; Quester and Smart, 1996). "People become avid seeker to obtain knowledge when they are highly involved with the product, but they do not actively seek information when they are less involved (Laurent and Kapferer, 1985)." Some researchers have typically analyzed the effects of product involvement on customers' risk perceptions. Risk perception is viewed as resulting from uncertain and unanticipated consequences of a product purchase (Dholakia, 2001). For examples, John purchasing a MP3 player from an unknown manufacturer may consider its possibility of breaking down in less than a year, while Jane buying a digital camera may be concerned about its memory capacity of not enough space for storing high-resolution pictures. In most of the cases, high involvement products represent higher risk for a customer than a low involvement product (Zaichkowsky, 1985). Customers are willing to spend more time learning product features and compare differences between products. Study also shows that risk perception is one of significant discriminators between those who purchased products online and those who did not (Jarvenpaa and Todd, 1997; Lowengart and Tractinsky, 2001; Pedersen and Nysveen, 2003).

Price is considered to be another important factor related to product class. Price is viewed as a perception construct that means one person's high-priced product could be another person's low-priced product. Price conscious consumers may not pay the lowest price available but tend to pay a lower price when more expensive alternatives do not provide distinguishing product features (Lichtenstein et al., 1988).

Brand is one of the important product attributes that impacts customer shopping behaviors (Keller, 1993). It can be defined as "a name, term, sign, symbol, or design, or combination of them which is intended to identify the goods and services of one seller or group of sellers and to differentiate them from those of competitors" (Kotler, 1991). Researchers are typically interested in the relationships between brand loyalty and product involvement. Reports show that brand loyalty could be identified when customer make a repeat purchase for a high-involvement product, whereas a simply habitual purchase could be indicated when customer make a repeat purchase for a low-involvement product (Quester et al., 2003). Study also shows that if brand choice dominates other product attributes, customers will spend much less time to make product choice than if the customer has near equal preferences (Tyebjee, 1979).

The interest of this research is using product involvement and price to construct a product matrix for investigating types of products may lead to variation in the time people search product-related information before making a purchase and variation in information search behavior.

Customer Search Behaviors

Another way for analyzing customer online shopping behavior is to find unique information-seeking strategies related to product class. Several studies visualize online customer's behavior as a tree structure (Card et al., 2001). Each node in a tree is an object containing attributes and methods, which could represent different types of web pages or different product attributes (See Figure 1). Customer may search information by depth-first, by breadth-first, or by switching between these two modes (Jenkins et al., 2003). Depth-first search means that customer starts to look for product- or issue-related information, then goes through the tree branch by branch till reaching the bottom, whilst breadth-first search means that customer starts from exploring as many product selections as possible and then read detailed information later on.

By investigating customer's navigation style, online marketers can also observe number of pages a customer viewed, time duration for per-page visit, the decision point to stay or exit the site, and choices of which links to follow or which page to view (Bucklin et al., 2002). Moreover, the decision aids, such as search engine and sorting capability provided by each site, may also affect customer's navigation style (Tan, 2003). We need to carefully control our experiment in which kind of information aid we provide to test subjects because that may result in different navigation results.

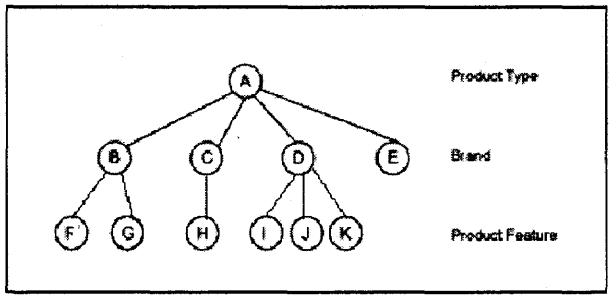

Figure 1. Information-Seeking Structure

Customer Cognition

While discussing about the navigation modes of online customers, many of those researchers also emphasize on the importance of understanding human's limitation of memory load and information load. Human have limited short-term memory (Miller, 1956). To overcome this limitation and to reduce customers' information searching time, researchers grow interests in measuring time that customers spend on each page and investigating the effectiveness of decision aids (i.e. sorting function) (Tan, 2003). One interesting finding shows that online customers tend to search for small number of the best alternatives because of the short-term memory limitation (Montgomery et al., 2003).

TWO STUDIES OF COGNITION IN ONLINE SHOPPING

Few studies (Moe, 2003; Pedersen and Nysveen, 2003) investigate variation in cognition and behavior during online shopping. Yet there are practical and theoretical needs for this type of research, particularly in developing and validating methods for the discovery and comparison of online shopping behavior patterns under different needs and goals. This study is motivated by a belief that modeling customers' thinking patterns is likely to lead to knowledge about customers that is both accurate and generalizable. Two rounds of pilot experiments have been completed in order to identify salient features of cognition in online shopping. The constructs of two studies aim to measure time spent before making a purchase, customers' search strategies, and information source (i.e. third-party opinions such as customer reviews) by controlling the variation in product involvement and price.

Pilot Study 1: Self-Protocol

In Pilot Study 1, a single subject (one of the authors) shopped online for four different types of products under different time pressure conditions.

Design and Procedure

Pilot Study 1 was used to discover factors that might impact online shopping behavior and to provide a preliminary evaluation of the feasibility of the experiment method. Experimental factors of product involvement and price were used, each at a low and high level, thereby yielding the four classifications of product type shown in Table 1. Note that a high involvement product is not necessary a high price product. One product or class of products was chosen for each of the four classifications. Two different types of web sites were used because customer behavior may vary depending on the type of web site he or she is visiting. Clickstream data were collected as the subject thought out loud while accomplishing the following four tasks:

> *You can't wait to get "Harry Potter V: the Order of the Phoenix." However, it is out of stock from most of the bookstore. You decide to purchase it online now.*
>
> *Your mother's birthday is at the end of next month. You think a digital camera will be a great gift for her. She is an amateur in photography. Therefore, a high-resolution (maybe 5 megapixel) camera would be good enough for her. Also, it will be ideal if the camera has better zooming capability. You expect to spend $700-$1,000 for this gift. Some memory expansion and accessories are considerable.*
>
> *You decide to buy a photo editing software to edit your personal/ family photos. You know Adobe is quite a brand name in this industry. You know you can get a better price online.*

You want to find an earring or a necklace to match your black evening dress. Products pricing around $50 or less are considerable.

		Product Involvement	
		Low	**High**
Price	**Low**	Harry Potter V	Fashion Accessories
	High	Photo Editing Software	Digital Camera

Table 1. Product Types

Results

The subject used various price comparison sites either to begin searches or evaluate search results. The subject spent much more time in finding information (such as reviews) and looking for alternatives for the high involvement and high price product than for the low involvement and low price product. If the subject had insufficient knowledge of a product, both expert and objective opinions were sought. The results suggest that a higher product price leads to more price comparisons.

For both high price products, product brand was used to narrow down the number of alternatives. For example, in the digital camera task, the subject visited the sites of three prominent vendors to obtain more detailed technical information. Finally, when time pressure was high (task 1) or moderate (task 3), the subject requested third-party opinions to enable the decision to be made sooner. Finally, more time was spent shopping for high involvement than for low involvement products.

Discussion

One effect of time pressure may be seeking help from third-party opinions. The results begin to suggest a further investigation of how customers under same time pressure will react while purchasing different types of products. It may also be advantageous to apply prior research in online information-seeking modes and users' expertise to investigate customers' online shopping (Jenkins et al., 2003). Finally, it should be noted that some refinements were made to the experimental protocol. Allowing the subject to use different sites introduced an unnecessary factor into the design, which was then incorporated into the design of a second pilot study.

Limitation

In this study, only one subject who is one of the authors has been recruited. However, for an exploratory study like this, our goal is to find possible factors that would impact customer shopping behaviors and to find possible results for the study as well. We recognize the advantages of using one subject, who is always available and can go deeply through all four tasks, without worrying about how to motivate the subject sustaining his/her energy throughout a long experiment. Another limitation of the study is that time pressure has not been clearly controlled. Future experimental design needs to address this issue.

Pilot Study 2: 4 Subjects

In Pilot Study 2, four subjects were given two online shopping tasks to complete.

Design and Procedure

This study was used to gather information on cognition during a high time-pressure purchase. Only one site (amazon.com) could be used for browsing and purchasing. Four subjects, of approximately the same level of computer skill and frequency of online shopping, took part in the study (see Table 2 for subjects' characteristics).

Subjects were first instructed in how to give a retrospective verbal protocol then were each given two tasks, described to them as follows:

All the tasks should be completed within the provided web site (amazon.com). The tasks are considered completed once you place the order.

You can't wait to get "Harry Potter V: the Order of the Phoenix." However, it is out of stock from most of the bookstore. You decide to purchase it online now.

Your mother's birthday is approaching. You need to make a purchase now to make sure your gift can be delivered in-time. You think a digital camera will be a great gift for her. She is an amateur in photography. Therefore, a high-resolution (maybe 5 megapixel) camera would be good enough for her. Also, it will be ideal if the camera has better zooming capability. You expect to spend $700-$1,000 for this gift. Some memory expansion and accessories are considerable.

Subject	Sex	Age	Frequency of Online Shopping Experiences	Level of Computer Skills	Knowledge level of Digital Camera	Products purchased online before
S1	Female	26-35	2-6 times a year	Expert	Serious Amateur	Book, Clothes/Shoes/ Accessories, Electronics, and Toy
S2	Female	26-35	2-6 times a year	Expert	Advanced Amateur	Book & Computer
S3	Female	26-35	2-6 times a year	Expert	Beginner Amateur	Book, CD/VCD/DVD, and Computer peripherals
S4	Male	36-45	2-6 times a year	Expert	Novice	Book

Table 2. Subjects' Characteristics

As subjects searched for a product, the contents of the computer screen were recorded to a file. Once they completed a task, they watched the video while recalling, out loud, what they had been thinking. They were then asked to explain how they came up with their product selections and how they made their final decision. These responses were audio- and video-taped. Subjects were then debriefed. All protocols were transcribed. Finally, an annotated file that summarized the clickstream and protocol data was then created, as shown in Figure 2.

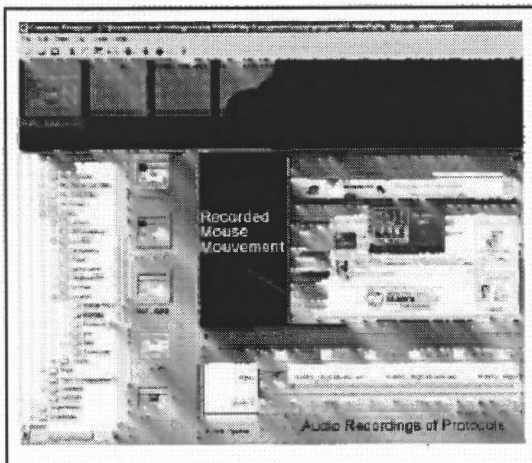

Figure 2. Screen Shot

4. (5:11:30) [Scroll down & up] "S2: But it only gives me three choices at the first shot. It seems that there are not many choices for me. Ex: It's very weird that it didn't give you choices of digital camera. S2: yeah…it only gives me PDA and video software… "

5. (5:12:17) [Click on the picture of Canon EOS 6.3MP…] "S2: I click on Canon to see the details if it matches my expectation."

6. (5:12:21) [Scroll down to read the product descriptions.] "S2: I need to buy camera with very large zoom, but this camera only has 18-55 mm. So I think the zoom range is not so big. What did I do now?"

7. (5:12:48) [Click on "Digital Camera" from the menu at the top] "S2: I want to see more product selections."

8. (5:12:57) [Click on Browse digital camera by 5 megapixel & up.] "S2: Actually, I try to find if it has feature which can rank all the digital cameras by their zoom, but there is no such feature. So I have to browse through all the cameras."

Figure 3. Sample of Protocol

Results

For Task 1, purchasing the book *Harry Potter V* (low price and low involvement product), all four subjects directly typed in either "harry potter" or "Harry Potter: the order of the phoenix" to search within the book category. They all expressed that they were familiar with the book and had an acceptable price in mind. They did not read the product description and customer reviews. Two of them checked the price of used & new books, then bought the least expensive one in either new or like-new condition. According to the recordings of their mouse movements and their protocols, they all started to search this product in depth-first search mode. They went directly to the book they were looking for, checked the price, read shipping and discount information, and then make a purchase. Two of them checked alternative vendors for cheaper price; therefore, they switched from a depth-first search to a breadth-first search mode. The average number of search-mode switching for Task 1 is 0.5 times and the average completion time of Task 1 was 1.7 minutes (see Table 3 for results).

For Task 2, purchasing a 5MP digital camera as a gift for mother (high price and high involvement product), all subjects except subject 1 looked up for three or four alternatives. The result is quite matched to Montgomery's finding that people tend to search among a small number of the best alternatives—usually less than four—in order to reduce short-term memory loads (Montgomery et al., 2003). The subjects then read and re-read related information several times. Two of them used the "Back" button to retrieve the best alternatives; the other subject opened each alternative in a new window, thereby using a sort of external memory aid. The average completion time of Task 2 is 9.72 minutes – considerably higher than Task 1 (see Table 3).

The results suggest that repeatedly switching between depth-first and breadth-first search may indicate that the shopper has searched for a high-involvement and high price product. They began to explore product selections in breadth-first search until finding one product for which they looked up detailed information. They then switched to depth-first search to read through the product descriptions, product features, editor reviews, customer reviews, and technical specification. After they gained more knowledge about digital camera, they began to search for alternatives, bringing them back to breadth-first search. Repeating this process several times, they decided to compare major features and price for the best two products. Results of Task 2 show that shopper switching between two search-modes around 5 times (See Table 3).

Measures	Low Price/Low Involvement	High Price/High Involvement
Product	Harry Potter V (Decided Goal)	Digital Camera (Partially-Decided Goal)
Average Task time	1.7 minutes	9.72 minutes (excluding subject S1)
Average alternatives lookup	1	3 (excluding subject S1)
Search Mode	Depth-first Search	Breadth-first Search
Average Search-mode Switching	0.5 times	5 times (excluding subject S1)

Table 3: Results by Product Type

Price and brand also seem very important for electronics purchasing. They used their perceived best digital camera brands to narrow down their search. For example, Subject 1 expressed her preference for Sony brand early on. Moreover, she said that she owned and was pleased with a Sony digital camera. Thus she chose not to look for other (brand) alternatives, and went straight to a Sony model. Subject 2 stated that "15. I use one Fujifilm digital camera before. Actually I like this brand, brand is very important, at least for me. I have one camera which is made by Nikon, Nikon is good too." This result confirms a previous study's finding that choice time would be reduced if customer has strong preference in brand (Tyebjee, 1979).

Four questions were asked of each subject once the study was completed:

What are the main features of the web site (amazon.com) that you use most?

What kind of feature(s) do you think should be added to the web site to improve your online shopping experience?

Do you think the setup of this experiment close to your true online shopping experiences? If not, please specify the reasons.

What are the major concerns when you are making a purchase online?

The questionnaire responses, summarized in Table 4, suggest some insights into shopper behavior and cognition. Subjects all wanted to consult more sites while performing the second task than the first task. They indicated that they wanted more product-related information. Most importantly, they also wanted to compare price and then chose a vendor with great reputation and relatively good return policy. Memory aids were used to keep the information about alternatives that had been looked up.

All four subjects said that they wanted the search engine to provide only the information they were looking for. For example, while searching product selections for digital camera, Subject 2 said that "...it only gives me PDA and video software?" and Subject 4 stated that "a lot of phone come out, not what I want." They spent a considerable time to reach certain amount of product selections they were looking for. That suggests a measure for the number of alternatives and information length of each page could help explain variation in choice time between high-involvement-high-price product and low-involvement-low-price product.

Questions	Subject 1	Subject 2	Subject 3	Subject 4
Q1	Search price and product. Similar product comparison and used product information.	Search function. Sort, and product details	Search function, and customer reviews	Search function, product category, and sort by price.
Q2	N/A	Sort by product features (e.g. Camera with zoom)	Clear product category	Price and product comparison.
Q3	"Yes, especially for books. However, for camera, I would like to search from other sites instead of only one site. (e.g. I like Sony camera, so I would like to search it from Sony web site.)"	"Yes. But I would like to compare products and see product reviews from different web site for digital camera."	"Yes, very close. But I want to switch site and look for more information for digital camera."	"It's a working web site, so it's pretty close to true online shopping experiences. But you need to remind me that I have to pretend that I will shop for myself as I usually do."
Q4	Price, Brand, and my own budget.	Product features, services (return policy), and price.	Price, return policy, detailed description of the product, customer reviews/rates about the vendor	Price, condition (e.g. New or used product), vendor.

Table 4. Summary of Answers to Interview Questions

DISCUSSIONS AND CONCLUSIONS

The results of both studies suggest that variation in product type leads to variation in shopping behavior and cognition. Additionally, customer information-seeking behavior may also switch between breadth- and depth-first search depending on product involvement. The findings may enable variation in clickstream data regarding (i) time spent on one product and its alternatives and (ii) in information-seeking behavior to lead to predictions about the types of product a customer is seeking.

Further study should address additional factors. For instance, based on the findings from the previous two studies, subjects' knowledge and as well as their attitudes about brand could be confounding factors. Since brand is important to customers, especially in buying electronic products, a refined experiment needs to either address brand directly or eliminate it as a factor (e.g., by using fictitious brands). It may be possible to assess subject knowledge about products, or to train subjects so that their product knowledge is roughly equivalent. Extra attentions are needed for constructing task scenarios because different description of a scenario may result in different perception of a product's involvement. Buying a kids book for your nephew's birthday may require more search time than buying a Harry Potter book in the study. The uncertainty risk associated with a purchase (Dholakia, 2001) may be also worth investigating. In keeping with some prior research (Moe and Fader, 2002;

Montgomery et al., 2003), it may also be appropriate to assess the correctness of the customer's purchase given the information shown to them.

Finally, the results suggest that the efficacy of predictions about customer needs and goals may be improved by analyzing cognitive-level data, as well as behavioral data such as clickstreams. Models resulting from this work should have both theoretical and practical significance. The chief benefits to theory may be in the development of models which may be tuned in real-time through the use of clickstream data analysis, then compared for their similarity to the behavior and thinking processes of actual online shoppers. A benefit to online merchants should be that improved customer models lead to improved information displays, and then to improvements in the shopping experience. The integration of protocol and clickstream data is anticipated to provide a powerful source of information to predict customer behaviors and enable greater efficiency in online shopping.

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APPENDIX L

INSTRUCTIONS FOR CODING PROTOCOLS IN ONLINE SHOPPING

L.1 Overview

This document provides the instructions for coding the content of protocols by individual shoppers making online shopping decisions in an experiment. The complete coding instruction consists of two parts. In part I, you will code the transcripts by identifying keywords, i.e., what are keywords in terms of decision strategies (e.g., whether it concerns a goal according to task scenario and a decision strategy to eliminate some product choice at what time, etc.).

The experiment environment is presented first, followed by directions for coding the keywords in transcripts.

L.2 Experimental Environment

This section provides background on the experimental task done by an individual. This is done to familiarize you with the task, but you should also do the task yourself so that you really get to know it.

During each of the individual experimental sessions, subjects work on an identically-equipped personal computer in the presence of an investigator. Next, subjects complete a tutorial designed to familiarize them with the think-aloud method and the website (see Figure L.1). After the tutorial, subjects are informed that their objective is to shop for two products following the given task scenarios under assigned conditions (see

Table L.1). Each subject is given 2 task scenarios. One is for low-involvement product (printer paper or blank CD-R); the other is for high-involvement product (digital camera or television). Each product category contains 6 selections, each of 9 attributes (see Figure L.1). Subjects are also informed that their shopping experiences and verbal protocols will be audio- and video-recorded along with mouse movements on the computer screen. Each subject is assigned a unique ID. For example, if the subject is assigned to condition a, his/her ID will be AXX (XX is any number from 01 to 12).

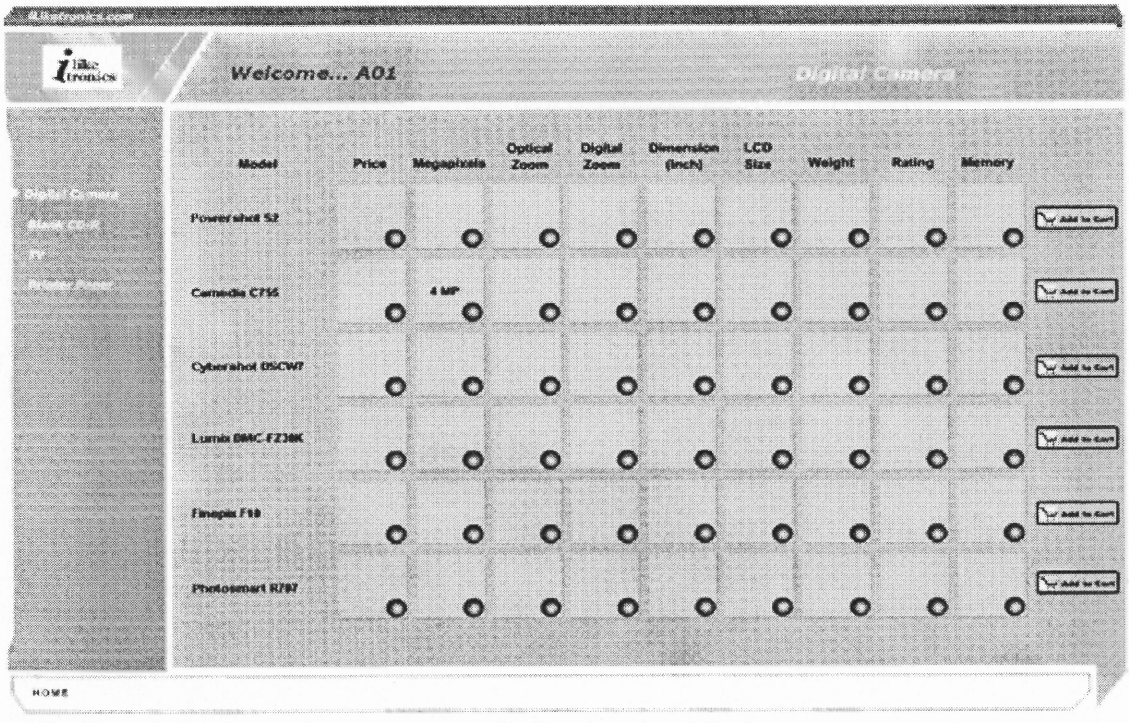

Figure L.1 Information display board (IDB) sample of digital camera.

Table L.1 Subject Assignment Table

		Riskiness of Choice			
		Low Riskiness of Choice		High Riskiness of Choice	
		Product Involvement		Product Involvement	
		Low	High	Low	High
Time Pressure	No	12 (a)	12 (b)	12 (c)	12 (d)
	Yes	12 (b)	12 (a)	12 (d)	12 (c)

L.3 Keyword Coding the Videos

This section provides the instructions for how to keyword code the content of the video clips. Each video clip corresponds to think-aloud with mouse movements of a subject on a single task. You want to identify decision strategies that subjects use while performing the tasks. Decision strategies can be described as either compensatory (denoted as C) or non-compensatory (denoted as NC). With compensatory rules, a poor evaluation on one attribute (e.g., size) may be compensated by a positive evaluation on another attribute (e.g., price). With non-compensatory rules, poor evaluation on one attribute makes that attribute an impossible choice. A freeware Transana 2.12 is used to help coders on keyword coding, video playback and other coding related tasks.

L.3.1 Compensatory Strategy (denoted as C)

A keyword protocol is being sought when it appears in the following list:

- Statements about comparing several attributes across at least two models, like "I want it to be a good one", "I want the best value among those", "so far I like this one better" ;

- Statements indicating that one attribute may be compensated by another attribute, like "xx attribute is good but its another attribute is just ok or bad", "I'm willing to pay more for better features", "reasonable price with decent features", "so cheap and larger size", "this one is more expensive but does not mean it will not have what I want";
- Statements indicating the difference between two products without a clear favor, like "the rating difference is just 3 points, "these two have similar memory....let me look at LCD size"

L.3.2 Non-Compensatory Strategy (denoted as NC)

A keyword protocol is being sought when it appears in the following list:

- Statements indicating a cut-off point for a specific attribute, like "I want a LCD flat panel TV", "I want a bigger screen", " 3x digital room is enough";
- Statements about eliminating a product choice, like "I don't want this one", "I won't consider...", "it doesn't seem enough", "this won't work", "so heavy", "this is too...", "this is expensive";
- Statements indicating interests in the best offer regarding a specific attribute, like "This one has the best rating", "this is the cheapest", "this is much better", "this rating is relatively high and more people rate it"

A decision strategy is either compensatory or non-compensatory. Once a decision strategy is being identified, insert a time stamp with keywords and coded information.

L.4 Illustration

This section illustrates how the coding environment is like and how the actual keyword coding looks like. Figure L.2 shows the screen snapshot of the Transana coding environment. Image on the upper right is a file of a video recording; image on the upper left is the corresponding audio file reproduced from the video recording; image on the lower left is a transcript editor; lastly image on the lower right shows the organization of a complete project with a series videos, groups of keywords, and search functions on keywords playback. Table L.2 shows the sample keyword-coded transcript zooming out from Figure L.2.

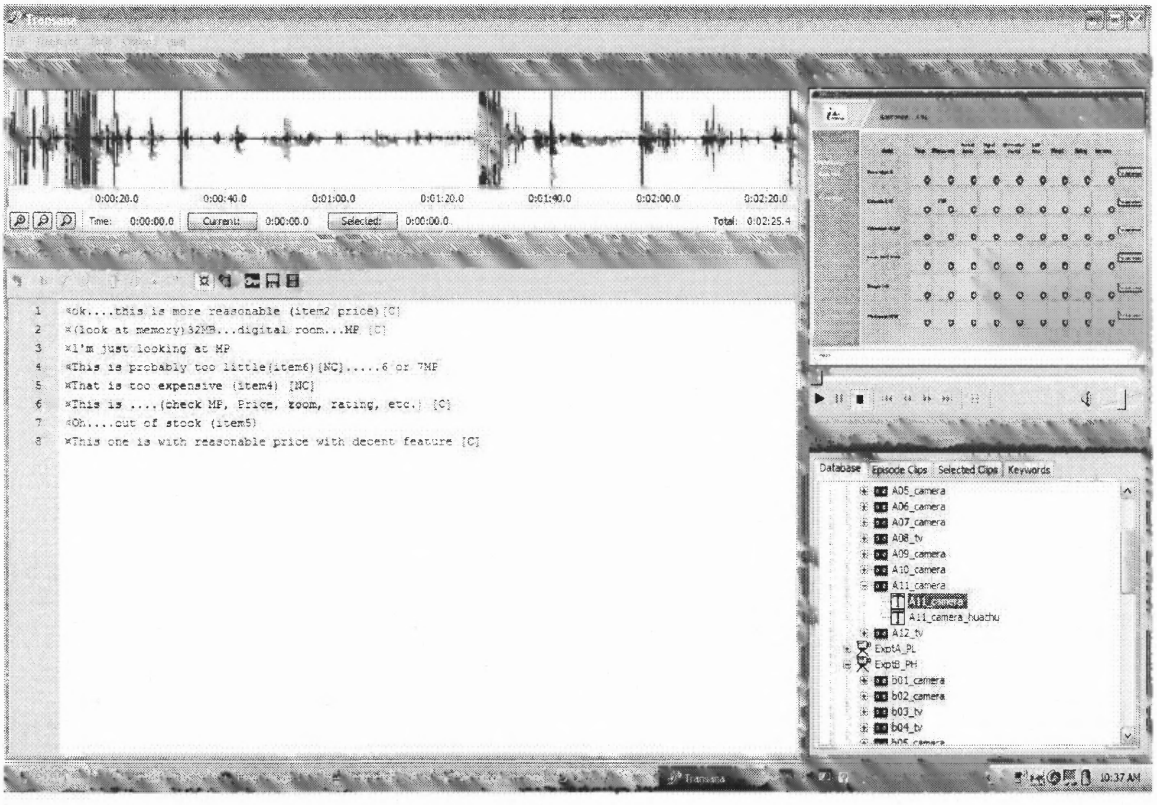

Figure L.2 Transana coding environment.

Table L.2 Example of A Keyword-Coded Transcript extracted from Figure M.2

¤<23461>ok....this is more reasonable (item2 price) [C]
¤<37369>(look at memory)32MB...digital room...MP [C]
¤<91510>I'm just looking at MP
¤<94332>This is probably too little(item6)[NC].....6 or 7MP
¤<100477>That is too expensive (item4) [NC]
¤<105047>This is ... (check MP, Price, zoom, rating, etc.) [C]
¤<120325>Oh....out of stock (item5)
¤<131961>This one is with reasonable price with decent feature [C]

L.5 Questions

Please keep a logbook with your hours and comments if you have any questions concerning the coding. I thank you for the work you're doing and urge you to contact me if you have any questions (Office: 973-596-5422; email:peishih.chang@njit.edu).

APPENDIX M

SOURCE CODE FOR MAJOR FUNCTIONS IN STUDY WEB SITE

```
//setup time pressure simulation to eliminate a product choice every 1.5 minutes– digital
camera
disappear4=2;
disappear3=3.5;
disappear2=5;
disappear1=6.5;
disappear6=8;
disappear5=20;
//end of setup time pressure condition

str="Digital Camera, "+_root.username+ " . ";
_root.welcome="Welcome... "+_root.username;
stop();
//setup product array
var products=new Array();
products[0]=new product("Bigeye
S2","424","5","12x","4x","3.07x4.45x2.97","1.8","14.3 oz","8.3/10 (45)","32 MB
memory card");
products[1]=new product("Camedia
C755","299.99","4","10x","4x","2.60x4.20x2.70","1.5","10.4 oz","8.2/10 (11)","32 MB
memory card");
products[2]=new product("Vfocus
W7","349.9","7.2","3x","2x","3.52x2.37x1.40","2.5","6.9 oz","9.2/10 (21)","32 MB
internal memory");
products[3]=new product("Eagleye
FZ30K","599.94","8","12x","4x","5.54x3.37x5.44","2","23.84 oz","10/10 (1)","32 MB
internal memory");
products[4]=new product("Slimboy
F10","322.84","6.3","3x","6.2x","3.62x2.30x1.07","2.5","5.5 oz","8.7/10 (21)","32 MB
internal memory");
products[5]=new product("Smartshot
R707","279.99","5.1","3x","8x","1.26x3.78x1.38","1.5","7.2 oz","6.8/10 (63)","32 MB
internal memory");
//end of setup product array

//Retreive Model Name from the Array
_root.model1=products[0].model;
_root.model2=products[1].model;
_root.model3=products[2].model;
```

```
_root.model4=products[3].model;
_root.model5=products[4].model;
_root.model6=products[5].model;
//End of retrieving Names of Models
function product(model,price,mp,oz,dz,dimension,lcd,weight,rate,memory){
        this.model=model;
        this.price=price;
        this.mp=mp;
        this.oz=oz;
        this.dz=dz;
        this.dimension=dimension;
        this.lcd=lcd;
        this.weight=weight;
        this.rate=rate;
        this.memory=memory;
}//Product Array includes 10 variables of price, megapixel, optical zoom and digital
zoom

//setup time pressure simulation to eliminate a product choice per minute – blank CD-R
disappear5=1.5;
disappear4=2.5;
disappear3=3.5;
disappear2=4.5;
disappear1=5.5;
disappear6=20;
//end of setup time pressure condition

str="CD-R,  "+_root.username+ " . ";
_root.welcomecdr="Welcome... "+_root.username;
stop();
var products=new Array();
products[0]=new product("TFK","9.99","50pk","52x","700Mb","80","2.5","6 oz","8.3/10
(9)","32 MB memory card");
products[1]=new product("Memomax","21","100pk","48x","700MB","80","2","6
oz","8.1/10 (78)","32 MB memory card");
products[2]=new product("Primera","9.99","25pk","48x","700MB","80","2.5","6
oz","8.3/10 (9)","32 MB memory card");
products[3]=new
product("Verbatimex","18.86","100pk","650MB","74","2.24x3.37x1.04","2","6
oz","8.1/10 (78)","32 MB memory card");
products[4]=new product("Ridata","16.99","50pk","16x","185MB","21","2.5","6
oz","8.3/10 (9)","32 MB memory card");
products[5]=new product("Jukebox","17.99","50pk","16x","700MB","80","2","6
oz","8.1/10 (78)","32 MB memory card");
```

```
//Retreive Model Name from the Array
_root.brand1=products[0].brand;
_root.brand2=products[1].brand;
_root.brand3=products[2].brand;
_root.brand4=products[3].brand;
_root.brand5=products[4].brand;
_root.brand6=products[5].brand;
//End of retrieving Names of Models
function product(brand,price,pack,oz,dz,dimension,lcd,weight,rate,memory){
        this.brand=brand;
        this.price=price;
        this.pack=pack;
        this.speed=speed;
        this.capacity=capacity;
        this.minutes=minutes;
        this.weight=weight;
        this.sfcolorq=sfcolorq;
        this.rate=rate;
        this.storage=storage;
}//Product Array includes 10 variables of price, megapixel, optical zoom and digital
zoom

function showPrice(brand){
        var str="";
        for (var i=0;i<products.length;i++){
                if(brand==products[i].brand){
                        str+= "$" + products[i].price;
        _root.price=str;
          }//end of if
        }//end of for loop
}//end of function showPrice
function showPack(brand){
        var str="";
        for (var i=0;i<products.length;i++){
                if(brand==products[i].brand){
                        str+= products[i].pack;
        _root.pack=str;
           }//end of if
        }//end of for loop
}//end of function showPack

//Set text format
pageDesign=new TextFormat();
pageDesign.bold=true;
_root.price.setTextFormat(pageDesign);
```

```
//setup time pressure simulation to eliminate a product choice every 1.5 minutes -
television
disappear5=2;
disappear4=3.5;
disappear3=5;
disappear2=6.5;
disappear1=8;
disappear6=20;
//end of setup time pressure condition


str="Television, "+_root.username+ " . ";
_root.welcometv="Welcome... "+_root.username;
stop();
var products=new Array();
products[0]=new product("KillView FS120","299.94","27","Flat Screen
CRT","No","19.6 x 30.2 x 23.2","2.5","6 oz","8.3/10 (9)","32 MB memory card");
products[1]=new product("KillView HS420","699.99","30","Flat Screen
CRT","HDTV","35.38 x 23.75 x 22.25","2","6 oz","8.1/10 (78)","32 MB memory card");
products[2]=new product("Superimage B8","698.64","20","LCD Flat Panel
TV","HDTV","25.1 x 3.6 x 15.3","2","23.84 oz","10/10 (1)","32 MB internal memory");
products[3]=new product("CyberView R50","549.94","20","LCD Flat Panel
TV","EDTV","18.6 x 8.5 x 22.6","1.5","10.4 oz","8.2/10 (11)","32 MB memory card");
products[4]=new product("PicturePerfect FS120","467.99","32","Flat Screen
CRT","No","35.4 x 22.7 x 27.4","2","6.3 oz","8.4/10 (47)","32 MB internal memory");
products[5]=new product("SuperView R238W","848.99","23","LCD Flat Panel
TV","HDTV","23 x 17.4 x 3.5","1.8","10.1 oz","8.8/10 (17)","32 MB internal memory");



//Retreive Model Name from the Array
_root.model1=products[0].model;
_root.model2=products[1].model;
_root.model3=products[2].model;
_root.model4=products[3].model;
_root.model5=products[4].model;
_root.model6=products[5].model;
//End of retrieving Names of Models
function product(model,price,mp,oz,dz,dimension,lcd,weight,rate,memory){
        this.model=model;
        this.price=price;
        this.screensize=screensize;
        this.format=format;
        this.dimension=dimension;
        this.weight=weight;
        this.input=input;
```

```
        this.output=output;
        this.rate=rate;
        this.ratio=ratio;
}//Product Array includes 10 variables of price, megapixel, optical zoom and digital
zoom

//setup time pressure simulation to eliminate a product choice per minute – printer paper
disappear4=1.5;
disappear2=2.5;
disappear1=3.5;
disappear6=4.5;
disappear5=5.5;
disappear3=20;
//end of setup time pressure condition
str="Printer Paper, "+_root.username+ " . ";
_root.welcomepaper="Welcome... "+_root.username;
stop();

var products=new Array();
products[0]=new product("OfficeEx","29.99","8.5 x 11","500","No","19.6 x 30.2 x
23.2","2.5","6 oz","8.3/10 (9)","32 MB memory card");
products[1]=new product("OfficeEx","9.09","8.5 x 14","500","HDTV","35.38 x 23.75 x
22.25","2","6 oz","8.1/10 (78)","32 MB memory card");
products[2]=new product("WistOffice","4.19","8.5 x 11","500","HDTV","25.1 x 3.6 x
15.3","2","23.84 oz","10/10 (1)","32 MB internal memory");
products[3]=new product("WistOffice","7.99","8.5 x 11","500","EDTV","18.6 x 8.5 x
22.6","1.5","10.4 oz","8.2/10 (11)","32 MB memory card");
products[4]=new product("Eaton","5.29","8.5 x 11","500","No","35.4 x 22.7 x
27.4","2","6.3 oz","8.4/10 (47)","32 MB internal memory");
products[5]=new product("Universe","6.36","8.5 x 11","500","HDTV","23 x 17.4 x
3.5","1.8","10.1 oz","8.8/10 (17)","32 MB internal memory");



//Retreive Model Name from the Array
_root.model1=products[0].model;
_root.model2=products[1].model;
_root.model3=products[2].model;
_root.model4=products[3].model;
_root.model5=products[4].model;
_root.model6=products[5].model;
//End of retrieving Names of Models
function product(model,price,mp,oz,dz,dimension,lcd,weight,rate,memory){
        this.model=model;
        this.price=price;
        this.screensize=screensize;
```

```
        this.format=format;
        this.dimension=dimension;
        this.weight=weight;
        this.input=input;
        this.output=output;
        this.rate=rate;
        this.ratio=ratio;
}//Product Array includes 10 variables of price, megapixel, optical zoom and digital
zoom



//Function of each attribute button with time pressure control and mouse effect – sample
//of printer paper
on(rollOver, rollOut, press, release, releaseOutside){
        if (getTimer()/60000>disappear1){
                _root.r0101._visible=false;
                _root.r0102._visible=false;
                _root.r0103._visible=false;
                _root.r0104._visible=false;
                _root.r0105._visible=false;
                _root.r0106._visible=false;
                _root.r0107._visible=false;
                _root.r0108._visible=false;
                _root.r0109._visible=false;
                _root.cart1._visible=false;
        }
        if (getTimer()/60000>disappear2){
                _root.r0201._visible=false;
                _root.r0202._visible=false;
                _root.r0203._visible=false;
                _root.r0204._visible=false;
                _root.r0205._visible=false;
                _root.r0206._visible=false;
                _root.r0207._visible=false;
                _root.r0208._visible=false;
                _root.r0209._visible=false;
                _root.cart2._visible=false;
        }
        if (getTimer()/60000>disappear3){
                _root.r0301._visible=false;
                _root.r0302._visible=false;
                _root.r0303._visible=false;
                _root.r0304._visible=false;
                _root.r0305._visible=false;
                _root.r0306._visible=false;
```

```
                _root.r0307._visible=false;
                _root.r0308._visible=false;
                _root.r0309._visible=false;
                _root.cart3._visible=false;
        }
        if (getTimer()/60000>disappear4){
                _root.r0401._visible=false;
                _root.r0402._visible=false;
                _root.r0403._visible=false;
                _root.r0404._visible=false;
                _root.r0405._visible=false;
                _root.r0406._visible=false;
                _root.r0407._visible=false;
                _root.r0408._visible=false;
                _root.r0409._visible=false;
                _root.cart4._visible=false;
        }
        if (getTimer()/60000>disappear5){
                _root.r0501._visible=false;
                _root.r0502._visible=false;
                _root.r0503._visible=false;
                _root.r0504._visible=false;
                _root.r0505._visible=false;
                _root.r0506._visible=false;
                _root.r0507._visible=false;
                _root.r0508._visible=false;
                _root.r0509._visible=false;
                _root.cart5._visible=false;
        }
        if (getTimer()/60000>disappear6){
                _root.r0601._visible=false;
                _root.r0602._visible=false;
                _root.r0603._visible=false;
                _root.r0604._visible=false;
                _root.r0605._visible=false;
                _root.r0606._visible=false;
                _root.r0607._visible=false;
                _root.r0608._visible=false;
                _root.r0609._visible=false;
                _root.cart6._visible=false;
        }
}

on (press) {
        now=new Date();
        //strmin=now.getMinutes();
```

```
        //strsec=now.getSeconds();
        str+="press, "+Math.round(getTimer()/600)/100+" min. "+now+",
"+getProperty(_root.r0206, _name)+"; ";
        _root.timepaper=str;
}
on (release) {
        now=new Date();
        //strmin=now.getMinutes();
        //strsec=now.getSeconds();
        str+="release, "+Math.round(getTimer()/600)/100+" min. "+now+",
"+getProperty(_root.r0206, _name)+";\n ";
        _root.timepaper=str;
}//system time is reformatted from milliseconds to minutes
```

APPENDIX N

COMPLETED CALCULATIONS OF UNCERTAINTY AND RISKINESS OF CHOICE FOR FOUR PRODUCTS

Table N.1 – N.8 shows complete calculations of expected utilities of uncertainty and riskiness of choices for four products including printer paper, blank CD-R, digital camera, and television.

Table N.1 Expected Utility of Digital Camera with Complete Information

Product	Price	MP	Optical Zoom	Digital Zoom	Dimension	LCD Size	Weight	Rating	Memory		
Powershot S2	424	5	12x	4x	3.07x4.45x2.97"	1.8"	14.3 oz	8.3/10 (45)	32 MB memory card		
Camedia C755	299.99	4	10x	4x	2.60x4.20x2.70"	1.5"	10.4 oz	8.2/10 (11)	32 MB memory card		
Cybershot DSCW7	349.99	7.2	3x	2x	3.52x2.37x1.40"	2.5"	6.9 oz	9.2/10 (21)	32 MB internal memory		
Lumix DMC-FZ30K	599.94	8	12x	4x	5.54x3.37x5.44"	2"	23.84 oz	10/10 (1)	32 MB internal memory		
Finepix F10	322.84	6.3	3x	6.2x	3.62x2.30x1.07"	2.5"	5.5 oz	8.7/10 (21)	32 MB internal memory		
Photosmart R707	279.99	5.1	3x	8x	1.26x3.78x1.38"	1.5"	7.2 oz	6.8/10 (63)	32 MB internal memory		
Score 1-4	Expected Utility=Price*1+MP*1+OZ*1+DZ*0.8+Dimension*0.8+LCD*0.8+Weight*0.8+Rating*1+Memory*0.5										
Product	Price	MP	Optical Zoom	Digital Zoom	Dimension	LCD Size	Weight	Rating	Memory	Score	Expected Utility	
Powershot S2	2	2	4	2	2	2	3	2	1	20	17.7	5
Camedia C755	4	1	3	2	2	1	3	2	1	19	16.9	6
Cybershot DSCW7	3	4	1	1	4	4	4	4	1	26	22.9	1
Lumix DMC-FZ30K	1	4	4	2	1	3	1	4	1	21	19.1	3
Finepix F10	3	3	1	3	4	4	4	3	1	26	22.5	2
Photosmart R707	4	2	1	4	4	1	4	1	1	22	18.9	4
	200-600	4-7+	3x - 12x	2x -8x	6.57-100+	1.5-2.5	5.5-24	6.8-10				
	100	1	2+	1.5	23	0.25	4.6	0.8				
					40.57							
					29.48							
					11.68							
					101.56							
					8.91							
					6.57							

Table N.2 Expected Utility of Digital Camera with Missing Information

Product	Price	MP	Optical Zoom	Digital Zoom	Dimension	LCD Size	Weight	Rating	Memory		
Powershot S2	424	5	12x	4x	3.07x4.45x2.97"	1.8"	14.3 oz	8.3/10 (45)	32 MB memory card		
Camedia C755	299.99	4	10x	4x	2.60x4.20x2.70"	1.5"	10.4 oz	8.2/10 (11)	32 MB memory card		
Cybershot DSCW7	349.99	7.2	3x	2x	3.52x2.37x1.40"	2.5"	6.9 oz	9.2/10 (21)	32 MB internal memory		
Lumix DMC-FZ30K	599.94	8	12x	4x	5.54x3.37x5.44"	2"	23.84 oz	10/10 (1)	32 MB internal memory		
Finepix F10	322.84	6.3	3x	6.2x	3.62x2.30x1.07"	2.5"	5.5 oz	8.7/10 (21)	32 MB internal memory		
Photosmart R707	279.99	5.1	3x	8x	1.26x3.78x1.38"	1.5"	7.2 oz	6.8/10 (63)	32 MB internal memory		
Score 1-4	Expected Utility=Price*1+MP*1+OZ*1+DZ*0.8+Dimension*0.8+LCD*0.8+Weight*0.8+Rating*1+Memory*0.5										
Product	Price	MP	Optical Zoom	Digital Zoom	Dimension	LCD Size	Weight	Rating	Memory	Score	Expected Utility	
Powershot S2	2	2	4	2	2	2	3	2	0	19	16.8	3
Camedia C755	4	1	3	2	0	1	3	0	1	15	13.3	5
Cybershot DSCW7	3	4	0	1	4	0	4	4	1	21	17.9	2
Lumix DMC-FZ30K	1	4	4	2	1	3	1	0	1	17	15.1	4
Finepix F10	3	3	1	0	4	4	4	3	1	23	19.5	1
Photosmart R707	4	2	1	0	4	1	0	1	0	13	11.8	6
	200-600	4-7+	3x - 12x	2x -8x	6.57-100+	1.5-2.5	5.5-24	6.8-10				
	100	1	2+	1.5	23	0.25	4.6	0.8				
					40.57							
					29.48							
					11.68							
					101.56							
					8.91							
					6.57							

Table N.3 Expected Utility of Printer Paper with Complete Information

Product	Price	Size	Ream of Sheets	Case of Reams	Weight	Brightness	Quality	Rating	Paper Finish		
OfficeEx	29.99	8.5 x 11"	500	10	50 lbs	104	Envirocopy recycled copy paper	7.9/10 (1)	Standard		
OfficeEx	9.99	8.5 x 14"	500	1	7 lbs	113	Inkjet paper	7.6/10 (3)	Standard		
WistOffice	4.19	8.5 x 11"	500	1	6 lbs	87	Business copy paper	6/10 (2)	Standard		
WistOffice	7.99	8.5 x 11"	500	1	6 lbs	108	Inkjet paper	10/10 (7)	Rich feel of coated paper		
Eaton	5.29	8.5 x 11"	500	10	52 lbs	96	Multi-purpose	7.5/10 (9)	Standard		
Universe	6.36	8.5 x 11"	500	10	60 lbs	96	Premium inkjet paper	6.9/10 (2)	Standard		
Score 1-4	Expected Utility=Price*1+Size*1+RS*1+CR*1+Weight*0.5+Brightness*0.8+Quality*1+Rating*1+PF*0.5										
Product	Price	Size	Ream of Sheets	Case of Reams	Weight	Brightness	Quality	Rating	Paper Finish	Score	Expected Utility	
OfficeEx	3	4	4	4	3	3	4	3	3	31	27.4	1
OfficeEx	1	1	4	1	4	4	3	3	3	24	19.7	5
WistOffice	2	4	4	1	4	1	3	1	3	23	19.3	6
WistOffice	1	4	4	1	4	3	3	4	4	28	23.4	4
Eaton	4	4	4	4	3	2	3	3	3	30	26.6	2
Universe	4	4	4	4	2	2	4	2	3	29	26.1	3
	4.19-29.99	8.5x11" -14"	500	1-10	6-60	87-113	multiformat papers	6-10				
	0.004	8.5 x 11"	100	2.5	10	6	premium	1				
Price per sheet	0.0060											
	0.0200											
	0.0084											
	0.0160											
	0.0011											
	0.0013											

Table N.4 Expected Utility of Printer Paper with Missing Information

Product	Price	Size	Ream of Sheets	Case of Reams	Weight	Brightness	Quality	Rating	Paper Finish		
OfficeEx	29.99	8.5 x 11"	500	10	50 lbs	104	Envirocopy recycled copy paper	7.9/10 (1)	Standard		
OfficeEx	9.99	8.5 x 14"	500	1	7 lbs	113	Inkjet paper	7.6/10 (3)	Standard		
WistOffice	4.19	8.5 x 11"	500	1	6 lbs	87	Business copy paper	6/10 (2)	Standard		
WistOffice	7.99	8.5 x 11"	500	1	6 lbs	108	Inkjet paper	10/10 (7)	Rich feel of coated paper		
Eaton	5.29	8.5 x 11"	500	10	52 lbs	96	Multi-purpose	7.5/10 (9)	Standard		
Universe	6.36	8.5 x 11"	500	10	60 lbs	96	Premium inkjet paper	6.9/10 (2)	Standard		
Score 1-4	Expected Utility=Price*1+Size*1+RS*1+CR*1+Weight*0.5+Brightness*0.8+Quality*1+Rating*1+PF*0.5										
Product	Price	Size	Ream of Sheets	Case of Reams	Weight	Brightness	Quality	Rating	Paper Finish	Score	Expected Utility	
OfficeEx	3	4	4	4	3	0	4	3	0	25	23.5	2
OfficeEx	1	1	4	0	4	4	3	3	3	23	18.7	4
WistOffice	2	0	4	1	0	1	3	1	3	15	13.3	6
WistOffice	1	4	4	0	4	3	3	0	4	23	18.4	5
Eaton	4	4	4	4	0	2	3	3	3	27	25.1	1
Universe	4	4	4	4	2	0	4	0	3	25	22.5	3
	4.19-29.99	8.5x11" -14"	500	1-10	6-60	87-113	multiformat papers	6-10				
	0.004	8.5 x 11"	100	2.5	10	6	premium	1				
Price per sheet	0.0060											
	0.0200											
	0.0084											
	0.0160											
	0.0011											
	0.0013											

Table N.5 Expected Utility of Blank CD-R with Complete Information

Product	Price	Pack	Speed	Capacity	Minutes	Weight	Quality	Rating	Storage		
TFK	9.99	50 pk	52x	700 MB	80	2.1 lbs	Silver	7.2/10 (69)	Spindle		
Memomax	21	100 pk	48x	700 MB	80	4 lbs	Gold	6.5/10 (9)	Spindle		
Primera	9.99	25 pk	48x	700 MB	80	1.5 lbs	Multicolor vinyl	9.1/10 (19)	Jewel case		
Verbatimex	18.86	100 pk	52x	650 MB	74	4.2 lbs	Audio & imaging	9.2/10 (10)	Spindle		
Ridata	16.99	50 pk	16x	185 MB	21	0.86 lbs	Mini CDR	8.6/10 (3)	Pocket spindle		
Jukebox	17.99	50 pk	16x	700 MB	80	1.5 lbs	Music recording only	10/10 (2)	Music cakebox		
Score 1-4	Expected Utility=Price*1+Pack*1+Speed*1+Capacity*1+Minutes*1+Weight*0.5+Quality*1+Rating*1+PF*0.5										
Product	Price	Pack	Speed	Capacity	Minutes	Weight	Quality	Rating	Storage	Score	Expected Utility	
TFK	4	3	4	4	4	2	3	2	4	30	27	2
Memomax	4	4	3	4	4	1	4	1	4	29	26.5	3
Primera	2	2	3	4	4	3	4	4	3	29	26	4
Verbatimex	4	4	4	3	3	1	3	4	4	30	27.5	1
Ridata	3	3	1	1	1	4	2	3	4	22	18	6
Jukebox	3	3	1	4	4	3	2	4	3	27	24	5
	9.99-21	25-100	16x - 52x	185-700	21-80	0.86-4.2		6.5-10				
	0.15	25	16x	50	6	0.8						
Price per cd	0.1998											
	0.21											
	0.3996											
	0.1886											
	0.3398											
	0.3598											

Table N.6 Expected Utility of Blank CD-R with Missing Information

Product	Price	Pack	Speed	Capacity	Minutes	Weight	Quality	Rating	Storage		
TFK	9.99	50 pk	52x	700 MB	80	2.1 lbs	Silver	7.2/10 (69)	Spindle		
Memomax	21	100 pk	48x	700 MB	80	4 lbs	Gold	6.5/10 (9)	Spindle		
Primera	9.99	25 pk	48x	700 MB	80	1.5 lbs	Multicolor vinyl	9.1/10 (19)	Jewel case		
Verbatimex	18.86	100 pk	52x	650 MB	74	4.2 lbs	Audio & imaging	9.2/10 (10)	Spindle		
Ridata	16.99	50 pk	16x	185 MB	21	0.86 lbs	Mini CDR	8.6/10 (3)	Pocket spindle		
Jukebox	17.99	50 pk	16x	700 MB	80	1.5 lbs	Music recording only	10/10 (2)	Music cakebox		
Score 1-4	Expected Utility=Price*1+Pack*1+Speed*1+Capacity*1+Minutes*1+Weight*0.5+Quality*1+Rating*1+PF*0.5										
Product	Price	Pack	Speed	Capacity	Minutes	Weight	Quality	Rating	Storage	Score	Expected Utility	
TFK	4	3	4	4	0	2	3	2	4	26	23	2
Memomax	4	4	3	0	4	1	0	1	0	17	16.5	5
Primera	2	2	0	4	4	3	4	0	3	22	19	4
Verbatimex	4	4	4	3	3	1	0	4	4	27	24.5	1
Ridata	3	3	1	1	1	0	2	3	4	18	16	6
Jukebox	3	3	0	4	4	3	2	4	3	26	23	2
	9.99-21	25-100	16x - 52x	185-700	21-80	0.86-4.2		6.5-10				
	0.15	25	16x	50	6	0.8						
Price per cd	0.1998											
	0.21											
	0.3996											
	0.1886											
	0.3398											
	0.3598											

Table N.7 Expected Utility of Television with Complete Information

Product	Price	Diagonal Screen Size	Format	HDTV/EDTV	Dimension	Inputs S-video/Composite/Component	AV Jack Front/Side	Rating	Aspect Ratio		
KillView FS120	299.94	27"	Flat Screen CRT	No	19.6x30.2x23.2"	1/ 2/ 1	Yes/ No	8.0/10 (42)	4:3		
KillView HS420	699.99	30"	Flat Screen CRT	HDTV	35.38x23.75x22.25"	3/ 4/ 2	Yes/ No	7.5/10 (43)	16:9		
Superimage B8	698.64	20"	LCD Flat Panel	HDTV	25.1x15.3x3.6"	1/ 1/ 1	No/ No	7.9/10 (5)	4:3 (1024x768 pixels)		
CyberVuew R50	549.94	20"	LCD Flat Panel	EDTV	18.6x22.6x8.5"	1/ 1/ 1	No/ No	5.2/10 (3)	4:3 (1024x768 pixels)		
PicturePerfect FS12	467.99	32"	Flat Screen CRT	No	35.4x22.7x27.4"	1/ 3/ 1	Yes/ No	6.9/10 (12)	4:3		
SuperView R238W	848.99	23"	LCD Flat Panel	HDTV	23x17.4x3.5"	1/ 2/ 2	No/ No	8.5/10 (8)	16:9 (1366x768 pixels)		
Score 1-4	Expected Utility=Price*1+DSS*1+Format*1+HDTV*1+Dimension*1+SCC*0.8+AV*0.5+Rating*1+AR*0.8										
Product	Price	Diagonal Screen Size	Format	HDTV/EDTV	Dimension	S-video/Composite/Component Inputs	AV Jack Front/Side	Rating	Aspect Ratio	Score	Expected Utility	
KillView FS120	4	3	2	1	2	2	3	3	2	22	19.7	4
KillView HS420	2	4	2	4	1	4	3	3	3	19	23.1	2
Superimage B8	2	1	4	4	4	1	1	3	3	26	21.7	3
CyberVuew R50	3	1	4	3	4	1	1	1	3	21	19.7	4
PicturePerfect FS12	3	4	2	1	1	3	3	2	2	26	18.5	6
SuperView R238W	1	2	4	4	4	3	1	4	4	22	25.1	1
	300-848.99	20-32		No-Yes	1383-22018	1-4	No-Yes	5.2 - 8.5	4:3 - 16:9			
	150	3			5160	1		0.825				
Dimension (inch^3)					13732.544							
					18680.26563							
					1382.508							
					3573.06							
					22018.092							
					1400.7							

Table N.8 Expected Utility of Television with Missing Information

Product	Price	Diagonal Screen Size	Format	HDTV/EDTV	Dimension	Inputs S-video/Composite/Component	AV Jack Front/Side	Rating	Aspect Ratio		
KillView FS120	299.94	27"	Flat Screen CRT	No	19.6x30.2x23.2"	1/ 2/ 1	Yes/ No	8.0/10 (42)	4:3		
KillView HS420	699.99	30"	Flat Screen CRT	HDTV	35.38x23.75x22.25"	3/ 4/ 2	Yes/ No	7.5/10 (43)	16:9		
Superimage B8	698.64	20"	LCD Flat Panel	HDTV	25.1x15.3x3.6"	1/ 1/ 1	No/ No	7.9/10 (5)	4:3 (1024x768 pixels)		
CyberVuew R50	549.94	20"	LCD Flat Panel	EDTV	18.6x22.6x8.5"	1/ 1/ 1	No/ No	5.2/10 (3)	4:3 (1024x768 pixels)		
PicturePerfect FS12	467.99	32"	Flat Screen CRT	No	35.4x22.7x27.4"	1/ 3/ 1	Yes/ No	6.9/10 (12)	4:3		
SuperView R238W	848.99	23"	LCD Flat Panel	HDTV	23x17.4x3.5"	1/ 2/ 2	No/ No	8.5/10 (8)	16:9 (1366x768 pixels)		
Score 1-4	Expected Utility=Price*1+DSS*1+Format*1+HDTV*1+Dimension*1+SCC*0.8+AV*0.5+Rating*1+AR*0.8										
Product	Price	Diagonal Screen Size	Format	HDTV/EDTV	Dimension	S-video/Composite/Component Inputs	AV Jack Front/Side	Rating	Aspect Ratio	Score	Expected Utility	
KillView FS120	4	3	2	1	0	2	3	3	2	20	17.7	3
KillView HS420	2	4	2	0	1	4	0	3	3	19	17.6	4
Superimage B8	2	1	4	4	4	0	1	0	3	19	17.9	2
CyberVuew R50	3	1	4	3	0	1	1	1	3	17	15.7	5
PicturePerfect FS12	3	4	2	0	1	3	3	0	2	18	15.5	6
SuperView R238W	1	2	4	4	4	0	1	4	0	20	19.5	1
	300-848.99	20-32		No-Yes	1383-22018	1-4	No-Yes	5.2 - 8.5	4:3 - 16:9			
	150	3			5160	1		0.825				
Dimension (inch^3)					13732.544							
					18680.26563							
					1382.508							
					3573.06							
					22018.092							
					1400.7							

APPENDIX O

TESTING ASSUMPTIONS OF NORMALITY, HOMOGENEITY AND ADDITIVITY

This section explains the normality assumptions necessary for estimating the points of the linear models that are anticipated to be used for testing the hypotheses. Symbols contain in this report are listed as Product Involvement (PI), Time Pressure (TP), Unvertainty and Riskiness of Choice (RC), Perceived Risk (PR), Low (1), and High (2).

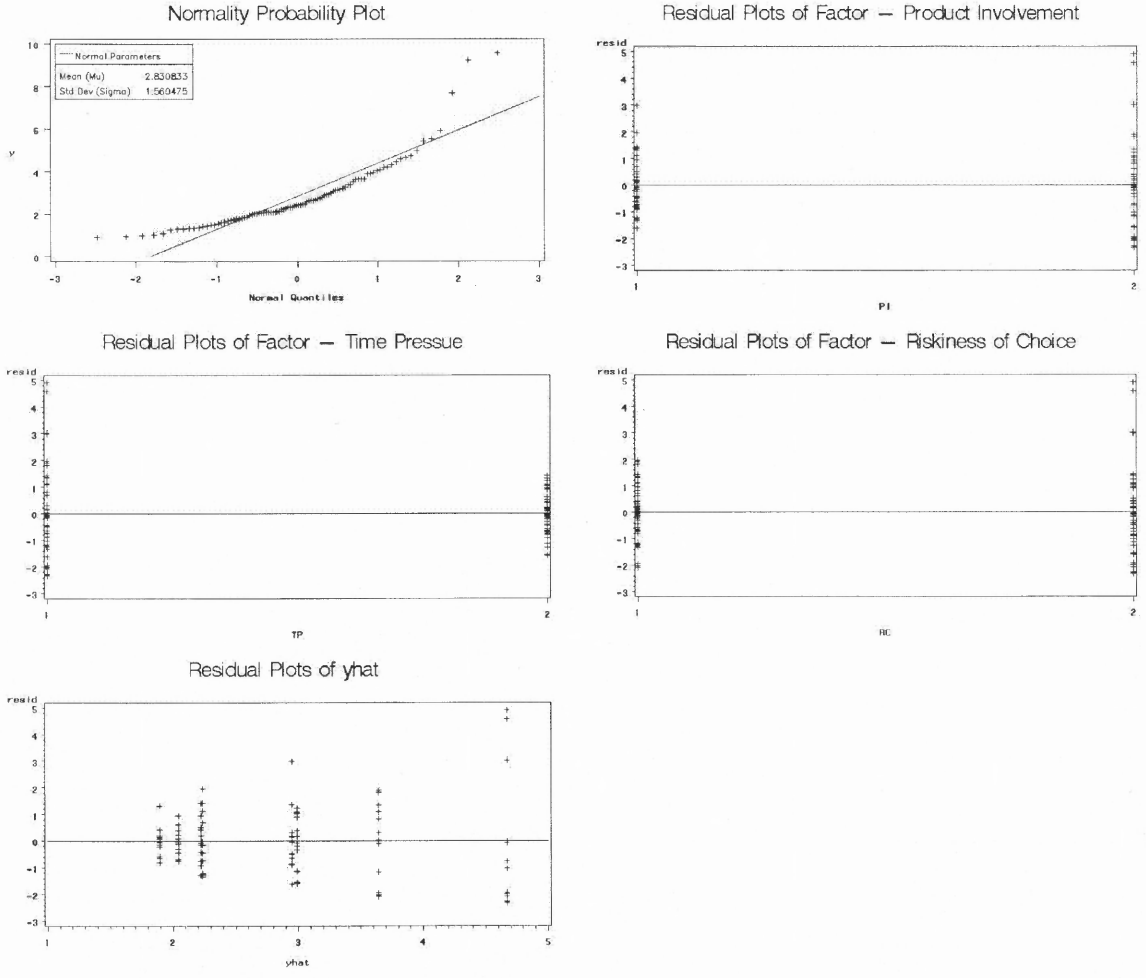

Figure O.1 Normality probability plot and residual plots of total task time.

Figure O.1 shows the testing assumptions for total task time. The upper left image of normality probability plot does not seem normally distributed. Therefore, Kolmogorov-Smirnov and Shapiro-Wilk normality tests are used to further investigate whether the distributions in each of the groups are normal. Normality assumption has been met based on the testing results shown in Table O.1.

Table O.1 Two Normality Test Results of Total Task Time

Group1:	Shapiro-Wilk	W	0.935385	Pr < W	0.1287
TP 1 & RC 1	Kolmogorov-Smirnov	D	0.144279	Pr > D	>0.1500
Group2:	Shapiro-Wilk	W	0.930597	Pr < W	0.3865
TP 1 & RC 2	Kolmogorov-Smirnov	D	0.168637	Pr > D	>0.1500
Group3:	Shapiro-Wilk	W	0.959888	Pr < W	0.4362
TP 2 & RC 1	Kolmogorov-Smirnov	D	0.12214	Pr > D	>0.1500
Group4:	Shapiro-Wilk	W	0.962585	Pr < W	0.4925
TP 2 & RC 2	Kolmogorov-Smirnov	D	0.08565	Pr > D	>0.1500

Figure O.2 shows the normality, homogeneity, and additivity assumptions for search strategy. According to the plot results, all assumptions hold true. Figure O.3 shows testing assumptions for decision strategy.

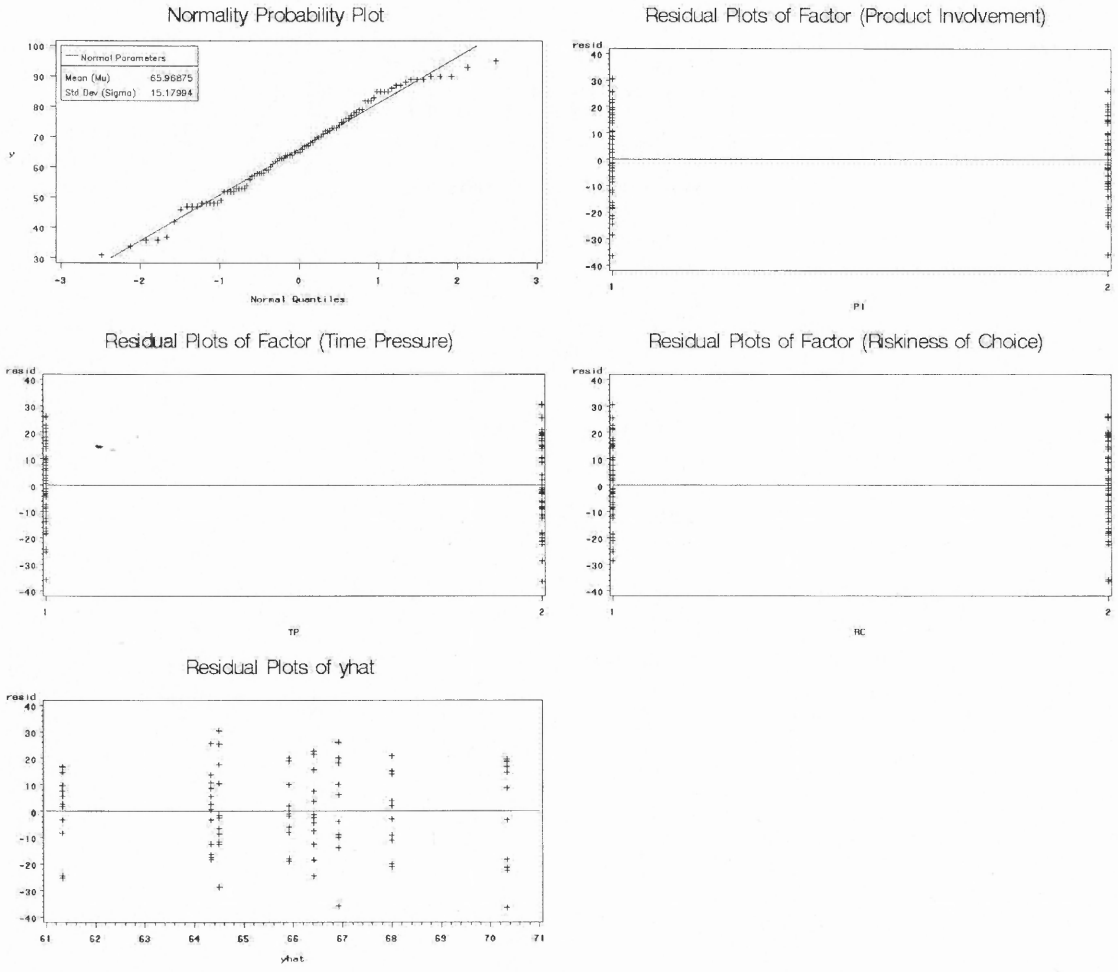

Figure O.2 Normality probability plot and residual plots of percentage of time on breadth-first search.

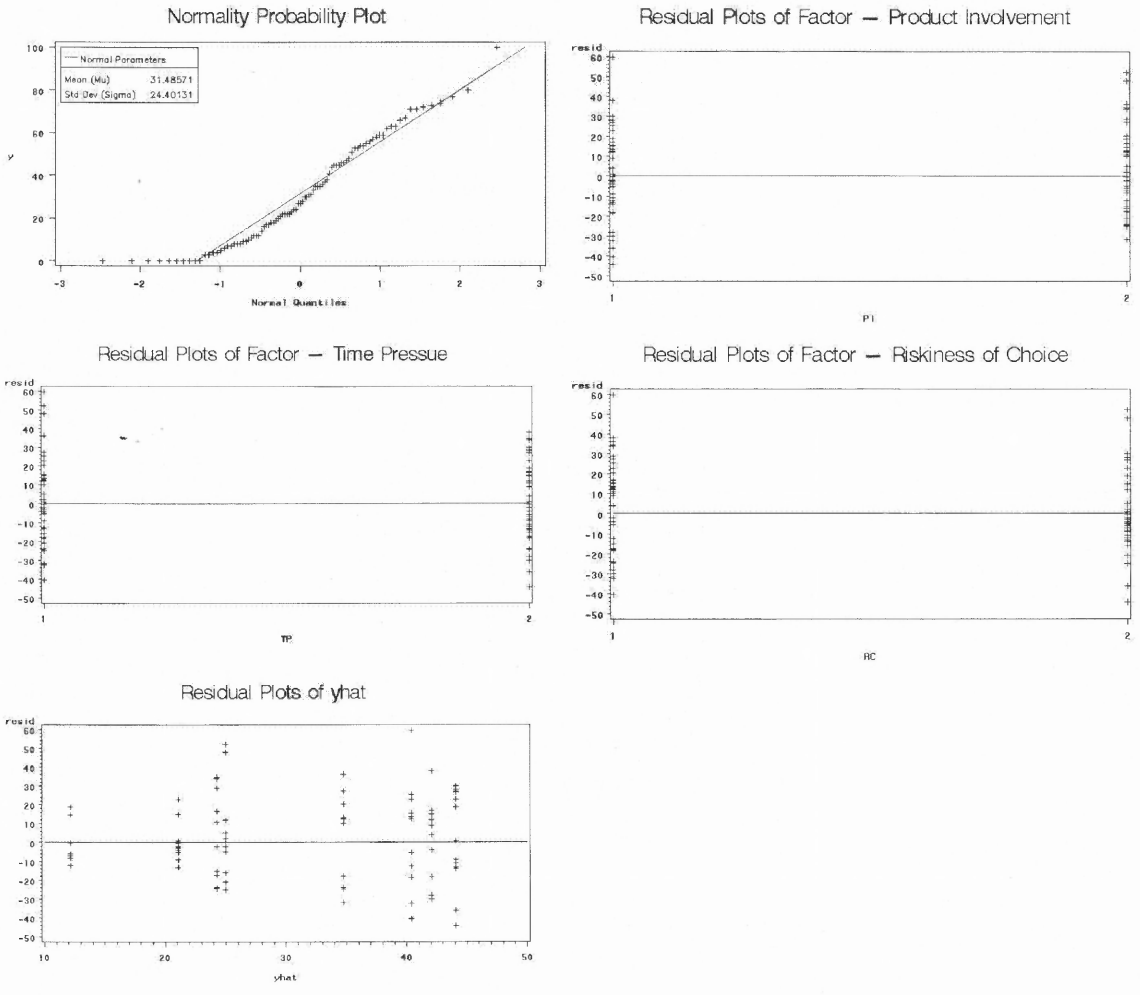

Figure O.3 Normality probability plot and residual plots of percentage of time on non-compensatory (NC) decision strategy.

APPENDIX P

MANOVA SAS OUTPUT

This section provides all SAS MANOVA results and Bootstrap codes and outputs.

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The GLM Procedure
Class Level Information

Class	Levels	Values
PI	2	High Low
TP	2	High Low
RC	2	High Low

Number of Observations Read	97
Number of Observations Used	96

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The GLM Procedure

Dependent Variable: totaltasktime totaltasktime

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	69.8938674	23.2979558	13.16	<.0001
Error	92	162.8949885	1.7705977		
Corrected Total	95	232.7888560			

R-Square	Coeff Var	Root MSE	tasktime Mean
0.300246	46.41508	1.330638	2.866823

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	21.22990651	21.22990651	11.99	0.0008
TP	1	32.24222109	32.24222109	18.21	<.0001
RC	1	16.42173984	16.42173984	9.27	0.0030

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	21.22990651	21.22990651	11.99	0.0008
TP	1	32.24222109	32.24222109	18.21	<.0001
RC	1	16.42173984	16.42173984	9.27	0.0030

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The GLM Procedure

Dependent Variable: Search Search

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	237.66667	79.22222	0.33	0.8048
Error	92	22190.33333	241.19928		
Corrected Total	95	22428.00000			

R-Square	Coeff Var	Root MSE	Search Mean
0.010597	23.53120	15.53059	66.00000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	20.1666667	20.1666667	0.08	0.7731
TP	1	96.0000000	96.0000000	0.40	0.5297
RC	1	121.5000000	121.5000000	0.50	0.4797

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	20.1666667	20.1666667	0.08	0.7731
TP	1	96.0000000	96.0000000	0.40	0.5297
RC	1	121.5000000	121.5000000	0.50	0.4797

The GLM Procedure

Dependent Variable: SwitchSearch SwitchSearch

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	865.50000	288.50000	1.95	0.1265
Error	92	13587.83333	147.69384		
Corrected Total	95	14453.33333			

R-Square	Coeff Var	Root MSE	switch Mean
0.059882	63.68350	12.15294	19.08333

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	416.6666667	416.6666667	2.82	0.0964
TP	1	368.1666667	368.1666667	2.49	0.1178
RC	1	80.6666667	80.6666667	0.55	0.4618

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	416.6666667	416.6666667	2.82	0.0964
TP	1	368.1666667	368.1666667	2.49	0.1178
RC	1	80.6666667	80.6666667	0.55	0.4618

The GLM Procedure

Dependent Variable: PerceivedRisk PerceivedRisk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	170.4602865	56.8200955	48.45	<.0001
Error	92	107.8828125	1.1726393		
Corrected Total	95	278.3430990			

R-Square	Coeff Var	Root MSE	PerceivedRisk Mean
0.612411	27.48366	1.082885	3.940104

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	167.3496094	167.3496094	142.71	<.0001
TP	1	2.9225260	2.9225260	2.49	0.1178
RC	1	0.1881510	0.1881510	0.16	0.6897

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	167.3496094	167.3496094	142.71	<.0001
TP	1	2.9225260	2.9225260	2.49	0.1178
RC	1	0.1881510	0.1881510	0.16	0.6897

The GLM Procedure

Dependent Variable: PerceivedRisk_Q1 PerceivedRisk_Q1

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	263.2500000	87.7500000	42.41	<.0001
Error	92	190.3750000	2.0692935		
Corrected Total	95	453.6250000			

R-Square	Coeff Var	Root MSE	PerceivedRisk_Q1 Mean
0.580325	32.41699	1.438504	4.437500

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	247.0416667	247.0416667	119.38	<.0001
TP	1	4.1666667	4.1666667	2.01	0.1593
RC	1	12.0416667	12.0416667	5.82	0.0178

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	247.0416667	247.0416667	119.38	<.0001
TP	1	4.1666667	4.1666667	2.01	0.1593
RC	1	12.0416667	12.0416667	5.82	0.0178

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The GLM Procedure

Dependent Variable: PerceivedRisk_Q2 PerceivedRisk_Q2

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	128.0833333	42.6944444	17.16	<.0001
Error	92	228.8750000	2.4877717		
Corrected Total	95	356.9583333			

R-Square	Coeff Var	Root MSE	PerceivedRisk_Q2 Mean
0.358819	42.29543	1.577267	3.729167

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	126.0416667	126.0416667	50.66	<.0001
TP	1	2.0416667	2.0416667	0.82	0.3673
RC	1	0.0000000	0.0000000	0.00	1.0000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	126.0416667	126.0416667	50.66	<.0001
TP	1	2.0416667	2.0416667	0.82	0.3673
RC	1	0.0000000	0.0000000	0.00	1.0000

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The GLM Procedure

Dependent Variable: PerceivedRisk_Q3 PerceivedRisk_Q3

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	94.5312500	31.5104167	10.51	<.0001
Error	92	275.8750000	2.9986413		
Corrected Total	95	370.4062500			

R-Square	Coeff Var	Root MSE	PerceivedRisk_Q2 Mean
0.255210	45.79593	1.731659	3.781250

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	94.01041667	94.01041667	31.35	<.0001
TP	1	0.26041667	0.26041667	0.09	0.7689
RC	1	0.26041667	0.26041667	0.09	0.7689

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	94.01041667	94.01041667	31.35	<.0001
TP	1	0.26041667	0.26041667	0.09	0.7689
RC	1	0.26041667	0.26041667	0.09	0.7689

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The GLM Procedure

Dependent Variable: PerceivedRisk_Q4 PerceivedRisk_Q4

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	74.0312500	24.6770833	8.65	<.0001
Error	92	262.4583333	2.8528080		
Corrected Total	95	336.4895833			

R-Square	Coeff Var	Root MSE	PerceivedRisk_Q4 Mean
0.220011	45.16615	1.689026	3.739583

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	65.01041667	65.01041667	22.79	<.0001
TP	1	8.76041667	8.76041667	3.07	0.0830
RC	1	0.26041667	0.26041667	0.09	0.7632

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	65.01041667	65.01041667	22.79	<.0001
TP	1	8.76041667	8.76041667	3.07	0.0830
RC	1	0.26041667	0.26041667	0.09	0.7632

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The GLM Procedure

Dependent Variable: PerceivedRisk_Q5 PerceivedRisk_Q5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	285.3750000	95.1250000	40.78	<.0001
Error	92	214.5833333	2.3324275		
Corrected Total	95	499.9583333			

R-Square	Coeff Var	Root MSE	PerceivedRisk_Q5 Mean
0.570798	39.62539	1.527229	3.854167

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	280.1666667	280.1666667	120.12	<.0001
TP	1	0.1666667	0.1666667	0.07	0.7898
RC	1	5.0416667	5.0416667	2.16	0.1449

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	280.1666667	280.1666667	120.12	<.0001
TP	1	0.1666667	0.1666667	0.07	0.7898
RC	1	5.0416667	5.0416667	2.16	0.1449

The GLM Procedure

Dependent Variable: DecisionStrategy (From Survey Questionnaire)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	20.1222133	6.7074044	1.63	0.1878
Error	83	340.7973270	4.1059919		
Corrected Total	86	360.9195402			

R-Square	Coeff Var	Root MSE	Q7 Mean
0.055753	62.07403	2.026325	3.264368

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	5.94226750	5.94226750	1.45	0.2324
TP	1	0.04396859	0.04396859	0.01	0.9178
RC	1	14.13597716	14.13597716	3.44	0.0671

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	6.57634544	6.57634544	1.60	0.2092
TP	1	0.06552989	0.06552989	0.02	0.8998
RC	1	14.13597716	14.13597716	3.44	0.0671

The GLM Procedure

Dependent Variable: NC_Strategy NC_Strategy (From Protocols)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	9590.95524	3196.98508	6.65	0.0004
Error	83	39906.57396	480.80210		
Corrected Total	86	49497.52920			

R-Square	Coeff Var	Root MSE	NC_Strategy Mean
0.193766	66.32593	21.92720	33.05977

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	4691.905009	4691.905009	9.76	0.0025
TP	1	878.569729	878.569729	1.83	0.1801
RC	1	4020.480501	4020.480501	8.36	0.0049

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	4945.930181	4945.930181	10.29	0.0019
TP	1	925.348830	925.348830	1.92	0.1691
RC	1	4020.480501	4020.480501	8.36	0.0049

The GLM Procedure

Dependent Variable: Minushandling Minushandling

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	698.13875	232.71292	0.81	0.4896
Error	83	23720.20608	285.78562		
Corrected Total	86	24418.34483			

R-Square	Coeff Var	Root MSE	minushandling Mean
0.028591	25.95292	16.90519	65.13793

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	266.0805570	266.0805570	0.93	0.3374
TP	1	427.4918541	427.4918541	1.50	0.2248
RC	1	4.5663405	4.5663405	0.02	0.8997

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	255.9150874	255.9150874	0.90	0.3467
TP	1	426.3391837	426.3391837	1.49	0.2254
RC	1	4.5663405	4.5663405	0.02	0.8997

The GLM Procedure

Dependent Variable: ConfidenceInChoice ConfidenceInChoice

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	12.4166667	4.1388889	3.19	0.0275
Error	92	119.5416667	1.2993659		
Corrected Total	95	131.9583333			

R-Square	Coeff Var	Root MSE	Satisfaction Mean
0.094095	20.19006	1.139897	5.645833

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	12.04166667	12.04166667	9.27	0.0030
TP	1	0.37500000	0.37500000	0.29	0.5924
RC	1	0.00000000	0.00000000	0.00	1.0000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	12.04166667	12.04166667	9.27	0.0030
TP	1	0.37500000	0.37500000	0.29	0.5924
RC	1	0.00000000	0.00000000	0.00	1.0000

The GLM Procedure
Multivariate Analysis of Variance

Characteristic Roots and Vectors of: E Inverse * H, where
H = Type III SSCP Matrix for PI
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 totaltasktime	Search	SwitchSearch
PerceivedRisk	PerceivedRisk_Q1	PerceivedRiskQ2	PerceivedRisk_Q3	
PerceivedRisk_Q4	PerceivedRisk_Q5	ConfidenceInChoice		
2.86205058	100.00	0.03523771	0.00029939	-0.00269703
0.19213628	-0.00942864	-0.04215514	0.01725357	-0.05865051
0.00000000	-0.00787257			
0.00000000	0.00	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000			
0.00000000	0.00	0.00570327	-0.00051663	0.00193595
0.02902603	-0.01181880	0.02198601	0.00232258	-0.02245195
0.00000000	0.09975741			
0.00000000	0.00	-0.00934581	0.00123962	0.00027637
-0.01330819	0.00054710	-0.04911417	0.07663409	0.00184893
0.00000000	0.00000000			
0.00000000	0.00	-0.06026994	0.00353133	0.01154921
0.00719274	-0.00038261	-0.00126996	0.00030700	-0.00222536
0.00000000	0.00000000			
0.00000000	0.00	-0.00588425	0.00677975	-0.00003427
0.00724842	-0.00038557	-0.00127979	0.00030937	-0.00224259
0.00000000	0.00000000			
0.00000000	0.00	-0.00824599	-0.00043458	0.00102858
-0.10907665	0.02187693	0.09867398	0.00052400	-0.00379837
0.00000000	0.00000000			
0.00000000	0.00	-0.01068237	0.00071392	-0.00091056
0.13080535	0.10986924	0.00073535	-0.00057491	0.00416738
0.00000000	0.00000000			
0.00000000	0.00	0.01063846	0.00157332	0.00070759
0.14055227	0.05560949	0.01799326	-0.01406732	0.10197103
0.00000000	0.00000000			

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall PI Effect
H = Type III SSCP Matrix for PI
E = Error SSCP Matrix

S=1 M=3.5 N=41

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.25892980	26.71	9	84	<.0001
Pillai's Trace	0.74107020	26.71	9	84	<.0001
Hotelling-Lawley Trace	2.86205058	26.71	9	84	<.0001
Roy's Greatest Root	2.86205058	26.71	9	84	<.0001

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The GLM Procedure
Multivariate Analysis of Variance

Characteristic Roots and Vectors of: E Inverse * H, where
H = Type III SSCP Matrix for TP
E = Error SSCP Matrix

Root	Percent	totaltasktime	Search	SwitchSearch
PerceivedRisk	PerceivedRisk_Q1	PerceivedRiskQ2	PerceivedRisk_Q3	
PerceivedRisk_Q4	PerceivedRisk_Q5	ConfidenceInChoice		
0.34560414	100.00	0.08707624	-0.00210417	-0.00324227
0.01660381	0.00482651	0.00801109	-0.02405875	0.02087674
0.00000000	0.01842915			
0.00000000	0.00	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000			
0.00000000	0.00	-0.00249228	0.00087683	-0.00123496
-0.10531246	0.11061645	0.00005626	-0.00016896	0.00014662
0.00000000	0.00012943			
0.00000000	0.00	-0.00034940	-0.00100307	0.00078086
-0.12991638	0.01973609	0.10354667	-0.00310889	0.00269771
0.00000000	0.00238143			
0.00000000	0.00	-0.01334379	-0.00013060	0.00277045
0.01423800	-0.01276405	0.02167159	0.00555974	-0.02206111
0.00000000	0.09832699			
0.00000000	0.00	-0.02675755	0.00156847	0.00242173
-0.22504944	0.05529528	0.02920743	-0.01490675	0.11600615
0.00000000	0.00000000			
0.00000000	0.00	0.01047755	0.00642029	-0.00069563
0.00663622	-0.00007331	0.00256495	-0.00372177	0.00000000
0.00000000	0.00000000			
0.00000000	0.00	0.02079153	0.00099315	-0.00112924
0.01252976	0.00146339	-0.05119904	0.07429037	0.00000000
0.00000000	0.00000000			
0.00000000	0.00	-0.03436646	0.00339165	0.01089140
0.01134283	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000			

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall TP Effect
H = Type III SSCP Matrix for TP
E = Error SSCP Matrix

S=1 M=3.5 N=41

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.74316061	3.23	9	84	0.0021
Pillai's Trace	0.25683939	3.23	9	84	0.0021
Hotelling-Lawley Trace	0.34560414	3.23	9	84	0.0021
Roy's Greatest Root	0.34560414	3.23	9	84	0.0021

The GLM Procedure
Multivariate Analysis of Variance

Characteristic Roots and Vectors of: E Inverse * H, where
H = Type III SSCP Matrix for RC
E = Error SSCP Matrix

Root	Percent	totaltasktime	Search	SwitchSearch
PerceivedRisk	PerceivedRisk_Q1	PerceivedRiskQ2	PerceivedRisk_Q3	
PerceivedRisk_Q4	PerceivedRisk_Q5	ConfidenceInChoice		
0.26084104	100.00	0.06170659	0.00082543	-0.00320621
-0.10664025	0.08658268	0.00394671	-0.01253593	0.03874843
0.00000000	-0.00328461			
0.00000000	0.00	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000			
0.00000000	0.00	0.00494147	-0.00051177	0.00203799
0.01032544	-0.00820283	0.02537753	0.00054682	-0.01650520
0.00000000	0.10001365			
0.00000000	0.00	-0.00040427	0.00137463	-0.00021565
-0.00768401	0.00853937	-0.05209278	0.07669061	0.00246786
0.00000000	0.00000000			
0.00000000	0.00	-0.01391980	0.00670583	0.00022109
0.00748856	-0.00609362	-0.00003740	0.00043889	-0.00268984
0.00000000	0.00000000			
0.00000000	0.00	-0.00912548	-0.00060510	0.00104359
-0.14229826	0.02715170	0.10208340	-0.00048961	0.00300066
0.00000000	0.00000000			
0.00000000	0.00	-0.00063838	0.00103122	-0.00030936
0.12197106	-0.01580886	-0.00186653	0.00111318	-0.00682233
0.00000000	0.00000000			
0.00000000	0.00	-0.04940421	0.00366754	0.01127683
-0.03063723	0.01926459	0.00227454	-0.00135651	0.00831365
0.00000000	0.00000000			
0.00000000	0.00	-0.02601107	0.00081386	0.00191650
-0.18429938	0.02676186	0.03055833	-0.01822467	0.11169335
0.00000000	0.00000000			

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall RC Effect
H = Type III SSCP Matrix for RC
E = Error SSCP Matrix

S=1 M=3.5 N=41

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.79312139	2.43	9	84	0.0164
Pillai's Trace	0.20687861	2.43	9	84	0.0164
Hotelling-Lawley Trace	0.26084104	2.43	9	84	0.0164
Roy's Greatest Root	0.26084104	2.43	9	84	0.0164

```
/*Bootstrap collated data with n=100 and n=500 using SAS PROC multtest
procedure*/

data number1;
set Number;
if PI=1 and TP=1 and RC=1 then sp=1;
if PI=1 and TP=1 and RC=2 then sp=2;
if PI=1 and TP=2 and RC=1 then sp=3;
if PI=1 and TP=2 and RC=2 then sp=4;
if PI=2 and TP=1 and RC=1 then sp=5;
if PI=2 and TP=1 and RC=2 then sp=6;
if PI=2 and TP=2 and RC=1 then sp=7;
if PI=2 and TP=2 and RC=2 then sp=8;
run;
proc freq data=number1;
tables PI*TP*RC*sp/ list;
run;

proc multtest data = number1 boot n = 100 s = 12345 bon notables pvals;
class sp;
contrast 'using an interaction' 0 1 0 -1 0 -2 0 -3;
test mean(totaltasktime search perceivedrisk NC_strategy);
run;

proc multtest data = number1 boot n = 500 s = 12345 bon notables pvals;
class sp;
contrast 'using an interaction' 0 1 0 -1 0 -2 0 -3;
test mean(totaltasktime search perceivedrisk NC_strategy);
run;
```

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The FREQ Procedure

PI	TP	RC	sp	Frequency	Percent	Cumulated Frequency	Cumulated Percent
1	1	1	1	12	12.50	12	12.50
1	1	2	2	12	12.50	24	25.00
1	2	1	3	12	12.50	36	37.50
1	2	2	4	12	12.50	48	50.00
2	1	1	5	12	12.50	60	62.50
2	1	2	6	12	12.50	72	75.00
2	2	1	7	12	12.50	84	87.50
2	2	2	8	12	12.50	96	100.00

Frequency Missing = 1

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The Multtest Procedure

Model Information

Test for continuous variables	Mean t-test
Tails for continuous tests	Two-tailed
Strata weights	None
P-value adjustment	Bonferroni
P-value adjustment	Bootstrap
Center continuous variables	Yes
Number of resamples	100
Seed	12345

Contrast Coefficients

	Sp							
Contrast	1	2	3	4	5	6	7	8
using an interaction	0	1	0	-1	0	-2	0	-3

p-Values

Variable	Contrast	Raw	Bonferroni	Bootstrap
totaltasktime	using an interaction	0.0273	0.1091	0.2100
Search	using an interaction	0.7469	1.0000	1.0000
PerceivedRisk	using an interaction	<.0001	<.0001	<.0001
NC_Strategy	using an interaction	0.0140	0.0561	0.1000

The Multtest Procedure

Model Information

Test for continuous variables	Mean t-test
Tails for continuous tests	Two-tailed
Strata weights	None
P-value adjustment	Bonferroni
P-value adjustment	Bootstrap
Center continuous variables	Yes
Number of resamples	500
Seed	12345

Contrast Coefficients

	Sp							
Contrast	1	2	3	4	5	6	7	8
Using an interaction	0	1	0	-1	0	-2	0	-3

Contrast Coefficients

p-Values

Variable	Contrast	Raw	Bonferroni	Bootstrap
totaltasktime	using an interaction	0.0273	0.1091	0.1380
Search	using an interaction	0.7469	1.0000	0.9980
PerceivedRisk	using an interaction	<.0001	<.0001	0.0020
NC_Strategy	using an interaction	0.0140	0.0561	0.0640

The GLM Procedure (With interaction Effects)

Dependent Variable: NC_Strategy NC_Strategy (From Protocols)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	14610.35761	2435.05960	5.58	<.0001
Error	80	34887.17159	436.08964		
Corrected Total	86	49497.52920			

R-Square	Coeff Var	Root MSE	NC_Strategy1 Mean
0.295173	63.16668	20.88276	33.05977

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	4691.905009	4691.905009	10.76	0.0015
TP	1	878.569729	878.569729	2.01	0.1597
RC	1	4020.480501	4020.480501	9.22	0.0032
PI*TP	1	1163.755992	1163.755992	2.67	0.1063
TP*RC	1	2966.520662	2966.520662	6.80	0.0109
PI*RC	1	889.125715	889.125715	2.04	0.1572

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	5185.762927	5185.762927	11.89	0.0009
TP	1	886.738427	886.738427	2.03	0.1578
RC	1	3600.413125	3600.413125	8.26	0.0052
PI*TP	1	1023.524160	1023.524160	2.35	0.1295
TP*RC	1	2924.917728	2924.917728	6.71	0.0114
PI*RC	1	889.125715	889.125715	2.04	0.1572

The GLM Procedure

Dependent Variable: Performance Performance (Distance between the optimal choices and the actual ones)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	1767.76900	589.25633	0.57	0.6371
Error	83	85993.15054	1036.06205		
Corrected Total	86	87760.91954			

R-Square	Coeff Var	Root MSE	Performance Mean
0.020143	112.0140	32.18792	28.73563

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PI	1	1418.424826	1418.424826	1.37	0.2453
TP	1	1.126732	1.126732	0.00	0.9738
RC	1	348.217443	348.217443	0.34	0.5637

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PI	1	1367.250902	1367.250902	1.32	0.2540
TP	1	0.691416	0.691416	0.00	0.9795
RC	1	348.217443	348.217443	0.34	0.5637

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