FLOW IN INTERNET SHOPPING:

A VALIDITY STUDY AND AN EXAMINATION OF A MODEL

SPECIFYING ANTECEDENTS AND CONSEQUENCES OF FLOW

A Dissertation

by

YI GUO

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2004

Major Subject: Information and Operations Management

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Approved as to style and content by:

Marshall Scott Poole (Chair of Committee)	
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ABSTRACT

Flow in Internet Shopping:

A Validity Study and an Examination of a Model

Specifying Antecedents and Consequences of Flow. (December 2004)

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This dissertation studies the antecedents and consequences of the flow experience in online retailing environments. Flow is the enjoyable and engrossing experience that people feel when acting with total involvement. A review of previous studies suggests that applying the notion of flow to understand the online consumer experience is a promising but underdeveloped field with several conceptual and methodological issues.

This dissertation attempts to contribute to our understanding of flow in online shopping in three ways. First, a three-part validity study was carried out using different approaches to construct validity and involving two sets of two flow measures: the Flow State Scale (FSS, Jackson and Marsh 1996) and the Internet Flow Scale (IFS). The first study related flow to behavioral criteria in online shopping. The second conducted a traditional construct validity study in which we developed and tested a "nomological network" of relationships between flow measures and other logically-related constructs. This study also included a Multitrait-Multimethod validity study. The third was a

factorial validity study of the flow construct. These studies provided evidence of construct validity for flow and suggested that the FSS had advantages over the IFS in terms of validity.

Second, this dissertation tested a comprehensive model of flow that included the underlying dimensions of flow, the mediating effects of perceived challenge and skill on flow, and antecedents and consequences of flow. Consequences of flow include perceived usefulness, affective responses to the site, and intentions to revisit and purchase. Overall, results based on data collected by a controlled experiment supported our model, suggesting that flow is a second-order construct and positively related to outcome variables.

Thirdly, we studied the effect of Web site complexity on flow. Perceived site complexity was found to effect flow negatively. Investigating the effects of it on inducing flow in online shopping may eventually lead us to guidelines for improving the shopping experience by designing more capable Web sites.

DEDICATION

To my parents, Guo Tianquan and Xiong Weirong, for their never ending love, support and encouragement.

To my husband, Zhe Xu, for always being there for me.

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First of all, I want to express my deepest gratitude to my advisor, Dr. Poole. I would not have been able to finish this dissertation without him. Dr. Poole is the kind of advisor every Ph.D. student dreams for. He guides you through each step with inspiration, encouragement, and patience. He is the kind of researcher you want to be and work with: knowledgeable, dedicated, and open-minded. He touched and changed my life by being my mentor. Words are just too limited and pale to describe my gratitude. I guess, the best thing I can do to pay him back is to work harder and hopefully someday I myself will become a researcher and teacher of his kind.

I want to send special thanks to my committee members for their time, attention, and support through this complicated and challenging process: Dr. Tretter for her support throughout the years and her great help on statistics; Dr. Choobineh for his many valuable comments; Dr. Yadav for offering helpful insights and for his pursuit of excellence. Their constructive critiques made the dissertation better.

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CHAPTER I

INTRODUCTION

It is obvious that the Internet has affected how we shop. This dissertation studies one specific aspect of Business-to-Consumer (B2C) Electronic Commerce (EC) -- online consumer behavior. It is focused on the flow experience in online retailing environments. The flow experience is often described as engrossing and intrinsically rewarding (Csikszentmihalyi 1975). Normally when people are in flow, they act with a sense of total control, concentration, and deep involvement. This study attempts to tackle questions such as "What are the factors contribute to flow in online shopping?" and "What are the antecedents and consequences of this optimal shopping experience?"

These are important issues for two reasons. First of all, the Internet is a different medium and a distinct distribution channel in its own right (e.g., Hoffman and Novak 1996; Butler and Peppard 1998; Schlosser 2003), and thus it is important to study its impact on consumer behavior (Barwise et al. 2002). In online commerce, shopping is mediated by the interactive Internet. Shoppers behave as both consumers and computer/Internet users (Koufaris 2002). Hoffman and Novak (1996) proposed that it was important to study flow in interactive, computer-mediated environments to understand this dual role of online consumers. We attempt to address this call with a study of the impact of the Internet on consumer behavior through the lens of flow theory.

This dissertation follows the style and format of *MIS Quarterly*.

Second, contrary to the early prediction of large increases in online spending and changes in consumers' buying habits, overall EC has proven to be merely satisfactory in terms of growth and volume. Despite the anticipated incentive and customer value of utilizing online technology, customer acceptance of the Internet as a major and routine shopping place is still not "revolutionary" (Barwise et al. 2002). Studying online consumer behavior may help us understand why. In particular, flow, as an optimal experience, is posited to lead to exploratory behavior and intentions to return to a site, both of which seem likely to contribute to utilization of online shopping sites (Hoffman and Novak 1996; Wan and Nan 2001). By understanding the mechanism by which Web sites affect the flow experience, we may be able to contribute some insights into why EC can be made more rewarding for consumers. Although online shopping is not yet as commonplace as it promised to be, it still holds potential to increase rapidly in the next few years (Barwise et al. 2002). Studying online consumer behavior, especially optimal shopping experience, will help to better realize this potential.

Several researchers have applied flow theory to online environments in the study of consumers' shopping experience, e.g., Novak et al. (2000) and Koufaris (2002). Flow is a "peculiar dynamic state—the holistic sensation that people feel when they act with total involvement" (Csikszentmihalyi 1975, p. 36) and an "ordered, negentropic state of consciousness" (Csikszentmihalyi 1988). Flow is engrossing and enjoyable and people want to repeat experiences that lead to flow. Hoffman and Novak (1996) note that flow is "the process of optimal experience preceded by a set of antecedent conditions necessary for this experience to be achieved and followed by a set of consequences that

occurs as a result of the process." Studying such experiences and their antecedents and consequences in leisure, work, and everyday-life events helps us construct activities to "maximize flow involvement in as many people as possible" (Csikszentmihalyi 1975, p.203).

It is evident that people undergo this "optimal experience" in a range of situations, including various online activities (Chen et al. 1999). Several studies have assessed the flow experience and its antecedent factors in using computers and the Internet (e.g., Ghani 1995; Nel et al. 1999; and Skadberg and Kimmel 2004). However, there has been little detailed research on flow in online shopping settings, as will be subsequently demonstrated. Especially lacking are experimental studies that systematically vary antecedents of flow.

1.1 Research Objectives

Originally, we focused our effort primarily on constructing and testing a structural model of flow in online shopping environments that included both antecedents and outcomes of flow. However, research is an interactive learning process, especially in an area of limited understanding, such as this one. It took several pilot studies and modifications of the initial plan to arrive at the final plan for the dissertation. At the outset, when we had a rough idea of what we wanted to do, we conducted an initial pilot study. In this study we experimented with the Experience Sampling Method and used screen-capture software to record subjects' mouse movements as they shopped. This study led to the conclusion that the flow measure adapted from the original Experience Sampling Form (Csikszentmihalyi and Csikszentmihalyi 1988) was not satisfactory. We

then conducted a second pilot study using a flow measure compiled from previous studies of flow in the fields of Information Systems and Marketing. We called this measure the Internet Flow Scale (IFS). Results of the second pilot study suggested that this measure was far from perfect. We extended our literature review effort to other fields and discovered another flow measure in sports psychology, the Flow State Scale (FFS) (Jackson and Marsh 1996). This measure had a good deal of validity evidence and had been employed in a number of studies, suggesting it might be more adequate than existing measures of flow employed in IS and Marketing. However the FSS had never been applied in IS, and it was unclear that it would transfer well. This suggested that a full-fledged construct validity study of the various measures would be useful. This validity study consisted of three parts: (1) Study 1-A assessed the validity of flow measures by identifying behavioral correlates of flow in Internet contexts and assessing the relationships between the flow measures and behavioral correlates; (2) Study 1-B was a classic construct validity study of IFS and FSS in which we tested a nomological network of constructs related to IFS and FSS, and conducted a mutlitrait-multimethod (MTMM) validation study; and (3) Study 1-C assessed the factorial validity of the IFS and FSS. These studies were related and complementary to each other. They examined the validity issue of flow measures from three different angles. Study 1-A related subjective flow measures to observable behaviors. If the flow measures correspond to expected behaviors, this provides evidence for their construct validity. In Study 1-B, assessing the MTMM matrix would provide evidence of (or lack of) convergent and discriminant validity. A nomological network including flow and other related

constructs addressed the validity issue using a between-network approach by establishing a logical, theoretically consistent pattern among constructs (Marsh 1990). Finally, Study 1-C, using the factorial approach, evaluated within-network issues related to internal structure of flow (Marsh 1990). In combination, these studies provided a comprehensive examination of validity of flow measures.

Following the validity study and selection of appropriate flow measures, the dissertation conducted a test of a comprehensive model of flow (Study 2). This model included key antecedents of flow, a broad measure of flow as it relates to online shopping, and outcomes of flow. The antecedents fell into two types. The first type was the direct preconditions of the flow experience that are suggested by flow theory. The preconditions leading to the flow experience are theorized to be (1) the balance between the perceived challenge presented by the activity and the skills possessed by the actor, (2) a clear goal, and (3) a quick and unambiguous feedback mechanism. The second type of antecedent was external factors, such as Web site complexity, which affects flow via its impact on perceived challenge and skill.

The broad measure of flow used in the comprehensive model was adapted mainly from the FSS since it demonstrated a better performance in our validation study. The outcomes were customers' cognitive evaluation of the usefulness of the site, affective responses to the site, and behavioral intentions to revisit and purchase in future.

1.2 Expected Contributions

The dissertation attempts to make several contributions to research on flow in the online context. It (1) includes a multi-part validity study of flow measures using

multiple approaches, (2) tests a comprehensive model of flow including all underlying dimensions of flow as well as the mediating variables of perceived challenge and skill, (3) examines the applicability of the channel model of flow in online environments, and (4) investigates the effects of site complexity on flow in online shopping. The ultimate goal is to provide information that will enhance our understanding of flow in online shopping and facilitate the design of Web environments that provide an optimal online shopping experience.

These studies attempted to address both conceptual and methodological challenges in studying flow in Information Systems field. First, it tried to formally address the validity issue of flow measures in IS research, an issue considered only indirectly in previous research. The validity studies employed both behavioral and subjective measures to assess construct validity in multiple studies, thus providing a multi-perspective view of validity of flow measures rooted in different fields: Information Systems and Sports Psychology. We believed this effort would contribute to the literature by addressing measurement challenges faced by researchers in this field, helping in development of measures more tailored to the IS field.

Second, the current study utilized a full set of underlying dimensions of flow in the context of online shopping. This represents an advance over previous studies that have used only a partial operationalization of flow. We were able to study those dimensions that have been left out of IS and Marketing research, such as mergence of awareness and activity and loss of self-consciousness. Furthermore, by testing this comprehensive model of flow using validated measure we were able to overcome the

conceptualization issues in previous work, such as inconsistent flow models and incomplete operationalization of the flow construct.

Third, using the channel models to compare and contrast experience in different segments enabled us to determine the role of flow in the online shopping context in a more definitive fashion than previous research has done, addressing a call by Chen et al. (1998). To our knowledge this was the first controlled laboratory experiment that has examined the mediating effects of perceived challenge and skill on flow in the online environment, which is the essence of flow theory and has been neglected by researchers in IS and Marketing. If it could be established that perceived challenge and perceived skill were indeed the direct antecedent of experiencing flow in online shopping, this would simplify future endeavors in that the extension of the model could focus on external factors thought to have impacts on these two factors.

Fourth, the study incorporated external factors and consequences of flow that have both research and practical significance. The external factor of site complexity is an information technology-centered variable that represents unique aspects of Internet interaction. Results from these studies have the potential to deepen our understanding of flow in online shopping and extend our knowledge of online consumer behavior by including the Internet as a distinctive medium. Furthermore, the results of this research have the potential to provide a basis for future research on site usability and development of technologies that make Web sites more "flowable." It would also supply guidelines for site design and shed light on optimal Web retailer strategies. It would help designers create online shopping environments that are capable of

maximizing people's flow experience. The study also investigated the relationship between flow and consequent outcomes which are of significant and practical value to retailers. Positive associations would indicate that flow is a desirable state and that online retailers should develop plans to facilitate flow in their site based on their overall business strategies.

The contributions of this study are not restricted to online shopping. The study would also provide general guidance for other kinds of Web sites as well. For example, if this study found that unfamiliar content presents a major part of perceived challenge to users, an information intensive site should balance the overwhelming amount of domain knowledge by employing a simpler structure or presenting the content in a way easier for visitors to grasp, so that the perceived challenge and skill could somehow in balanced.

In addition to theory and practice, this research also experimented with multiple data collection methods to address the uniqueness of the interaction between a Web site and its clients. The Experience Sampling Method was used to collect on-the-spot data of participants' internal states and feelings. This represents a new approach in data collection in online environments. We examined the applicability and experimented with the manner in which to adapt this method to online environments. We also developed a set of methods to transcribe and code mouse movement data captured by software.

1.3 Organization of the Dissertation

This dissertation is organized into chapters as follows: The next chapter provides a theoretical foundation by introducing the main points of flow theory and reviewing

previous work on flow in Information Systems and EC. The literature review revealed certain conceptual and methodological issues and challenges in flow research, some of which we tried to address in our research. This led to Chapter III, in which a series of research studies to further flow research in online shopping is proposed based on the evaluation of previous research. The effort is targeted to two aspects of flow research: the validity issue of flow measures and investigation of a comprehensive flow model in online shopping. In Chapter IV, the procedures used in those studies are discussed. Chapter V and Chapter VI present the results of this research project. Chapter V reports the results of the validity study (Study 1), and Chapter VI reports the results of the investigation of the proposed flow model (Study 2). Chapter VII discusses the results of the studies and their significance.

CHAPTER II

LITERATURE REVIEW

In this section, we first introduce the basis of the theory of flow briefly by presenting its main points and describing data collection techniques that have been used in previous research. Flow is an optimal state of experience. People feel flow in various leisure and everyday activities. Since the theory developed, it has been used in various fields to examine people's subjective experience in different situations, such as playing chess, composing music, and performing surgery. Since the late 1980s, researchers have used the flow concept to explain the usage of information technology, e.g., spreadsheet software (Webster 1989), email (Trevino and Webster 1992), and the Internet (Agarwal and Karahanna 2000). When online shopping became a phenomenon, researchers tried to use the theory to study people's online shopping experience in order to investigate what affected their behavior. This chapter presents a review of related studies in Information Ssystems and other fields that applied the flow concept to study online behavior. At the end of the chapter, we discuss the limitations of previous research, which is the motivation for the current study.

2.1 Introduction to Flow Theory

When trying to understand enjoyment, Csikszentmihalyi (pronounced chick-sent-me-high-ee) developed the concept of flow. Flow "is the crucial component of enjoyment" (Csikszentmihalyi 1975, p. 11). Flow represents a "peculiar dynamic state—the holistic sensation that people feel when they act with total involvement" (p. 36) and

an "ordered, negentropic state of consciousness" (Csikszentmihalyi 1988, p. 34). In this state, actions transit seamlessly into another, displaying an inner logic of their own. The term "negentropic" refers to being in harmony and a lack of chaos. The actor experiences a smooth transition and total control of his/her actions without distraction. The term "flow" was coined by the informants themselves who participated in those studies when they refer to this "autotelic experience."

In order for flow to occur, the task should have a clear goal and a quick, unambiguous feedback mechanism. That is why people often experience flow when playing games (e.g., chess and basketball). The first model of flow presented by Csikszentmihalyi states that the perceived balance of challenge and skill leads to *flow*. If challenges exceed skills, people feel overwhelmed and *anxious*; on the other hand, if the activity is too easy, people get *bored*. Empirical data suggested both challenges and skills had to pass a certain threshold for flow to occur; otherwise the person showed *apathy* towards the activity, even when challenges and skills were in balance (Csikszentmihalyi and Csikszentmihalyi 1988). This discovery led to the development of the four-channel model of flow (Figure 2.1).

A more complex, 8-channel model was developed by Massimini and Carli (1988). The 8 channels (Figure 2.2) are the results of three levels in challenge and skills, listed below. Only in the case of high challenge and high skill does flow occur.

1. High challenges and average skills (arousal)
2. High challenges and high skills (flow)
3. Average challenges and high skills (control)
4. Low challenges and high skills (boredom)
5. Low challenges and average skills (relaxation)
6. Low challenges and low skills (apathy)

7. Average challenges and low skills (worry)
8. High challenges and low skills (anxiety)

The dimensions of the flow experience include focused concentration, "merging of activity and awareness", perceived control, time distortion, and loss of self-consciousness ("a transcendence of self") (Csikszentmihalyi 1988). As a result, "consciousness is in harmony and the self – invisible during the flow episode – emerges strengthened" and "the negentropic quality of the flow experience makes it autotelic, or intrinsically rewarding" (Csikszentmihalyi 1988). The term "autotelic" (from Greek auto=self and telos = goal, purpose) means with one's own purposes. In other words, the activity "required formal and extensive energy output on the part of the actor, yet provided few if any conventional rewards" (Csikszentmihalyi 1975, p. 10). A summary of the characteristics of flow is listed in Table 2.1.

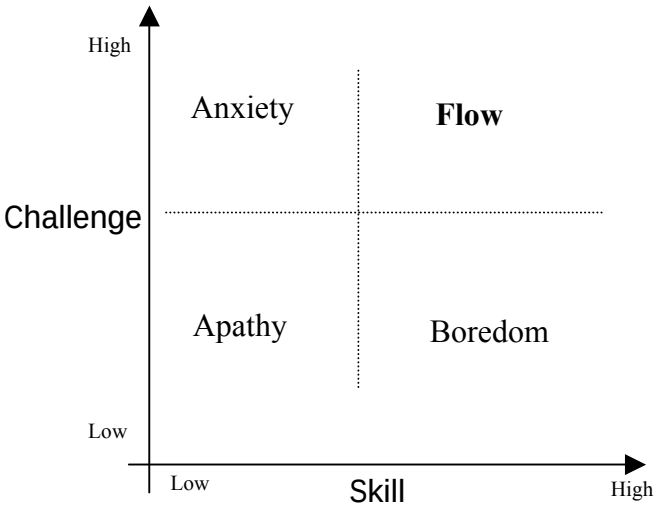

Figure 2.1 The 4-Channel Flow Model

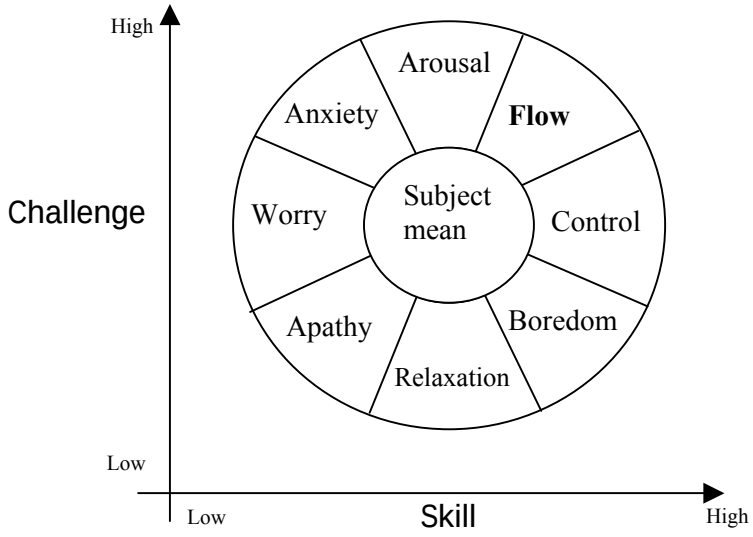

Figure 2.2 The 8-Channel Model of Flow

Table 2.1 General Characteristics of Flow Experience

	Construct	Type of Construct	Definition
1	Challenge and skill balance	Precondition	"A balance between the challenges perceived and the skills a person brings to" (Csikszentmihalyi 1988) "A challenging activity that requires skills" (Csikszentmihalyi 1990, p. 49)
2	A clear goal	Precondition	"The activity must have relatively clear goals." (Csikszentmihalyi 1988)
3	Feedback	Precondition	"Provide rather quick and unambiguous feedback" (Csikszentmihalyi 1988)
4	Concentration	Dimension	"A centering of attention on a limited stimulus field" (Csikszentmihalyi 1975, p. 40) "Concentration on the task at hand" (Csikszentmihalyi 1990, p. 58)
5	Mergence of activity and awareness or Mergence of action and awareness	Dimension	"The merging of activity and awareness: transcendence of ego boundaries" (Csikszentmihalyi 1975, p. 85) "merging of activity and awareness so typical of enjoyable activities" (Csikszentmihalyi 1988) "People become so involved in what they are doing that the activity becomes spontaneous, almost automatic; they stop being aware of themselves as separate from the actions they are performing." (Csikszentmihalyi 1990, p.53)
6	Sense of control	Dimension	"There is the sense that the outcomes of the activity are, in principle, under the person's own control." (Csikszentmihalyi 1988) "Lacking the sense of worry about losing control" (Csikszentmihalyi 1990, p.59) "The sense of exercising control in difficulty situations" (Csikszentmihalyi 1990, p.61)
7	Time distortion	Dimension	"Distorted sense of time" (Csikszentmihalyi 1988) "The transformation of time", "Time no longer seems to pass the way it ordinarily does (Csikszentmihalyi 1990, p.66)
8	Loss of self-consciousness	Dimension	"Lose temporarily the awareness of self" (Csikszentmihalyi 1988) "There is not enough attention left over to allow a person to consider either the past or the future, or any other temporarily irrelevant stimuli." (Csikszentmihalyi 1990, p.61) "The loss of the sense of a self separate from the world around it is sometimes accompanied by a feeling of union with the environment." (Csikszentmihalyi 1990, p.63)
9	Autotelic experience	Outcome /dimension	"The key element of an optimal experience is that it is an end in itself." (Csikszentmihalyi 1990, p.67)

Csikszentmihalyi introduced the concepts of flow (or autotelic) personality and flow activity, which refer to a personality that has the ability to experience flow easily and an activity that is easy for people to achieve flow experience, respectively. Both will influence the occurrence of flow. Furthermore, flow is a dynamic, evolving force. It is hard to be in flow for a substantially long period of time since the perceived level of challenge and skill change over time. In most cases, a person with ever increasing skills will eventually become bored unless the activity becomes more challenging at the same time.

In order to study activities that people enjoyed a lot, researchers initially used personal interviews to collect first-hand data. Subjects' descriptions of their subjective experiences were used to extract the common features and structure of such enjoyable experiences. The results confirmed the theoretical model of flow. Later, two quantitative methods for determining the presence or lack of flow were tested in a study of rock dancing. The first method was to code and count "the number of elements of the flow experience a person derives from an activity" and the second one was "the ratio of skills to challenges perceived by a person in a given activity" (Csikszentmihalyi 1975, p.102). Still, the majority of earlier studies in various contexts relied on self-reported, personal reminiscence through interviews and questionnaires. The data from these studies were qualitative and not fully definitive.

To find a way to record flow experience in the stream of consciousness of everyday life, the Experience Sampling Method (ESM) was developed in the mid-1970s

(Csikszentmihalyi and Csikszentmihalyi 1988). It used electronic pagers as the stimulus for participants to report their on-the-spot thoughts and feelings. Once prompted, participants answered a set of questions (on the "Experience Sampling Form", ESF) regarding the activities they were participating in and their subjective states at the time. In a typical study, participants were prompted six to eight times a day for a period of one to two weeks. Each ESF had over 30 questions regarding the emotional and situational state of the participants. Flow was determined by the ratio of challenges and skills. It was found that in order for flow to occur both challenges and skills have to pass a threshold. The 4-channel model of flow was thus developed. The scales made statistical testing of hypothesized relationships possible. Several studies subsequently used this measurement approach to closely examine flow experience in everyday life, to compare experiences in different cultures (Carli et al. 1988), and to investigate relationship between flow experience and other factors, such as self-esteem (Wells 1988) and family context (Rathunde 1988).

2.2 Studying Flow in Information System Use

Before flow was introduced to study subjective experience in online environments, it was integrated into studies on computer mediated communications (CMC) (Trevino and Webster 1992) and human-computer interaction (Webster et al. 1993; Ghani and Deshpande 1994). In these studies, flow is considered as a multidimensional complex construct, characterized by a set of underlying constructs. In this section, we provide a brief review of selected literature focusing on studies that

provided a basis for further investigation by conceptualization and operationalization of flow in CMC environments. A summary is presented in Table 2.2.

Table 2.2 Literature of Studying Flow in Human Computer Interaction

	(Csikszentmihalyi 1975, 1988)	**(Trevino and Webster 1992)**	**(Webster et al. 1993)**	**(Ghani and Deshpande 1994)**	**(Ghani 1995)**
Domain		Email vs. voice mail systems	Use of Lotus 1-2-3	Computer usage in the workplace	Computer use
Data collection method		Field survey	Study 1: student survey Study 2: field survey	Field survey	Experiment
Sample		154 respondents	1. 133 respondents 2. 43 respondents	149 respondents	Pilot: 450 students, Main: 130 students
Technological factors	Flow activity	Ease of use	Flexibility		
			Modifiability		
Contextual factors				Job characteristics	
Individual factors	Flow personality				Cognitive spontaneity
Precondition	Challenge and skill			Perceived challenge	Skill, perceived challenge
	Clear goal				
	Feedback				
Flow Dimension	Concentration	Attention	Attention focus	Concentration	
	Mergence				
	Control	In control	Control	Perceived control	Perceived control
	Time distortion				
	Loss of self-consciousness				
		Curiosity	Aroused curiosity		
Results	Autotelic experience	Intrinsic interest	Intrinsic interest	Enjoyment	Enjoyment
		Attitudes	Experimentation behavior	Exploratory use	Learning
		Communication effectiveness	Expected voluntary use		Creativity
		Quantity of communication	Communication effectiveness		Focus on process
		Communication barrier reduction	Quantity of communication		

Trevino and Webster (1992) applied both flow theory and the Technology Acceptance Model to study the effects of multiple variables on user evaluation and perceived impacts of electronic mail and voice mail systems. This field survey found that flow, which was operationalized in terms of four dimensions of control (attention focus, curiosity, and intrinsic interest), was affected by technological factors (email vs. voice mail) and by perceived ease of use. Flow was found to be positively associated with user attitudes, communication effectiveness, and quality of communication. Similarly, in Webster et al. (1993), flow was found to be associated with perceived characteristics of the computer software as well as with relevant performance outcomes. However, the proposed 4-dimensional flow construct was found to be three-dimensional in that curiosity and intrinsic interest seemed to make up one dimension (called cognitive enjoyment) when using computers (Webster et al. 1993).

Ghani and Deshpande (1994) reported that flow experiences were linked with exploratory use behavior, which in turn led to the extent of computer usage in terms of number of hours of use. The antecedents of flow were perceived control and challenge. Job characteristics also played a moderating role in the relative influence of those antecedents on flow experiences. In another study, students used computer software to complete an assignment and answered a questionnaire (Ghani 1995). Flow (in terms of enjoyment and concentration) was found to be positively related to learning, creative behavior, and process focus. On the other hand, flow was also positively related to individual cognitive spontaneity and perceived control. In addition, the term of "fit" was

defined as the difference between skills and perceived challenges and was positively related to perceived control. Contrary to the theory, no direct relation was found between "fit" and flow. In explaining this, Ghani introduced the notion of "optimal challenge" which reflected the curvilinear relationship between "fit" and flow, arguing that the perceived challenge was relative to one's skills. Thus, flow was empirically showed to be negatively related to the square of the difference between skills and challenge.

2.3 Studying Flow in Online Environments

Table 2.3 highlights major studies with special relevance to our research. They focus on flow experience in Internet usage and online shopping. Some of them are conceptualizations and others are empirical investigations, and some of them use qualitative methods and others use quantitative methods. From the summary, we can see that flow is a useful concept in understanding people's behavior in engaging and interactive activities, including human computer interaction and online environments. However, research in this stream is far from cohesive and still in its initial stages. Several challenges can be observed in this literature (Finneran and Zhang 2002). In this section each study is discussed briefly; critiques will be presented in the next section. The table lists studies chronologically, although discussion of the studies in this review may not follow this sequence, as we try to discuss closely related papers together.

Table 2.3 Summary of Literature Studying Flow in the Internet

Authors	Main points and Limitations
1. Hoffman and Novak (1996)	• Application the concept of flow to Internet usage • It defined flow in computer mediated communication • It proposed a process model of Web navigation with antecedents and consequences of flow
2. Chen et al. (1998)	• An empirical test of the validity and the possibility of applying notion of flow to Internet surfing • 100 students, Experience sampling method (ESM), 201 data points • Results partially supported flow theory. • More work is needed to examine applicability of flow in Internet surfing. • Time interval of 5 to 7 minutes was naturalistic.
3. Chen et al. (1999)	• Report of "Web users' optimal flow experience in the Web environment" • Content analytic procedures, 304 Web users' open-ended questionnaires • The flow feeling (internal experience when in flow) reported were very similar to those described by original works in flow. Factors and activities for challenge, control, and enjoyment were extracted too. o Based on previous experience of flow in Web activities
4. Nel et al. (1999)	• Investigation of distinguishable patterns of flow in different Web sites • Experimental evaluation of different kinds of Web sites grouped by their content and audience focus • Web sites acting as domestic communication tool had the highest flow score. • Flow score were positively related to return intention and overall rating. o Omission of perceived challenges and skills o Intention of user was excluded.
5. Novak et al. (2000)	• Development of a structural model that "embodies the components of what makes for a compelling online experience" • Constructs included: Web usage, arousal, challenge, control, exploratory behavior, flow, focused attention, interactivity, involvement, playfulness, positive affect, skills, telepresence, and time distortion, total 75 items • Based on a large-scale online survey, 1654 respondents o Self selected sample o Bases on memory of previous experience o Not taking a situated perspective o Congruence of challenge and skill was not treated as dynamic process as it should be. o No repeated measures on same individual
6. Agarwal and Karahanna (2000)	• Use of a multidimensional construct "cognitive absorption" to explain information technology usage. • Cognitive absorption (CA) is a state of deep involvement with software; it is mainly based on flow theory. • Five dimensions of CA: temporal dissociation, focused immersion, heightened enjoyment, control, and curiosity. • World Wide Web as the target technology • Playfulness and personal innovativeness were important determinants of CA. o Only personal traits are included as determinants for CA, no other contextual factors are considered.
7. Wan and Nan (2001)	• Examination of "whether a congruency effect exists if Web features and surfing motives match up." • A 2 by 2 (dynamic vs. static Web site designs and information seeking vs. entertainment seeking motives) online experiment using an actual e-commerce Web site. • Interaction effect of surfing motive and Web design was significant on facilitating positive emotion and experience and resulting in high evaluation and behavioral intention, but the congruency effect was not symmetric. o No investigation of the impacts of balance of perceived challenges and skills on those variables

Table 2.3 Continued

Authors	Main points and Limitations
8. Finneran and Zhang (2002)	• Study intended to "enhance the understanding of flow and how to study it within computer-mediated environments by reviewing past studies. • Listing conceptual and methodological challenges • Proposing a conceptual framework including task and artifact characteristics and individual traits
9. Koufaris (2002)	• The Technology Acceptance Model and flow theory, along with environmental psychology, were used to form an integrated theoretical framework of online consumer behavior. • Shopping enjoyment and perceived usefulness were found to impact intention to return. • Product involvement, Web skills, and challenges had impacts on shopping enjoyment and concentration, while value-added search mechanisms only affected shopping enjoyment.
10. Novak et al. (2003)	• An investigation of "whether flow occurs during both experiential and goal directed activities" • A series of quantitative analyses of over 1000 Web users' open-ended questionnaires • More evidence is found for flow occurring in goal-directed activities although there is evidence for flow happening in both kinds of activities. o Based on previous experience of flow in Web activities
11. Smith and Sivakumar (2004)	• Development of a model to study impacts of flow on different aspects of online shopping • Consumer individual difference, product and purchase characteristics are included. • A conceptualization paper
12. Skadberg and Kimmel (2004)	• An empirical evaluation of visitor's experience while browsing a Web site using flow model • Interrelationships among elements of a Web site were closely related to flow experience. • Flow experiences leaded to increased learning, and eventually changes of attitude and positive actions.
13. Huang (2003a)	• An investigation of Web attributes' effect on flow, and direct or indirect impacts on the Web performance • Web attributes: complexity, novelty, interactivity • Flow: attention, control, interest, curiosity • Web performance: utilitarian and hedonic • Web attributes affected flow differently • Flow was found to enhance both utilitarian and hedonic performance.
14. Finneran and Zhang (2003)	• Development of a component-based model that consists of person, artifact, and task, as well as the interactions of these components.

Directly applying flow concepts in the study of online shopping was pioneered by Hoffman and Novak (1996). First, flow experience in a hypermedia computer mediated environment (CME) has been defined as a cognitive state that is a seamless sequence of responses facilitated by machine interactivity, which is the extent to which users can participate in modifying the form and content of the mediated environment in real time. Machine interactivity is inherent to the Web to some extent, but it is different in levels determined by ease of use, speed, technology use by the site, as well as other

factors. In addition, this particular flow state is intrinsically enjoyable, accompanied by a loss of self-consciousness, and self-reinforcement. A process model of network navigation in CME was proposed based on conceptualization and previous empirical studies. The authors argue that flow consists of a process state that requires a set of antecedents to occur and results in a set of consequences. In this model, antecedents of flow are three sets of variables. They are: (1) control characteristics, including skills and challenges; (2) content characteristics, including interactivity and vividness; and (3) process characteristics, whether the shopping task is an experiential one or a goal-directed one. They found that the relationship between skills and challenge, and interactivity directly affect flow. Interactivity and vividness affect telepresence and focused attention, and process characteristics affect involvement, which in turn impacts focused attention. Also, telepresence and focused attention influence on flow. Thus the authors differentiate primary and secondary antecedents of flow. Primary antecedents are skills, challenges, focused attention, and involvement, while secondary antecedents are interactivity and telepresence, which are not sufficient alone, but increase the subjective intensity of the flow state. Major consequences of flow are increased learning, an exploratory mind-set, a positive subjective experience, and perceived behavioral control. In their proposed model, flow is the centerpiece gluing antecedents (i.e., content characteristics, process characteristics, and control characteristics) and consequences together.

In summary, for a sufficiently motivated user to experience flow when interacting with the Web, focused attention and perceived balance between their skill

and the challenge posed by the Web site are needed. During flow, (1) action and awareness are merged; (2) concentration is so intense that little attention is left for anything else; (3) self-consciousness disappears; and 4) sense of time is distorted. In this optimal, gratifying, intrinsically enjoyable state, people feel control and respond positively. As a result, consumers show better learning and more exploratory and participatory behaviors. However, the way they conceptualization of characteristics of flow experience in Web navigation is slightly different from the original structure proposed by Csikszentmihalyi (1988). A contrast of these two is in Table 2.4.

In their subsequent work (Novak et al. 2000), researchers collected data on flow in conjunction with the ninth WWW User Survey, which was a large-scale online consumer survey at the Georgia Institute of Technology. The flow survey was one of the ten surveys given. Key constructs related to flow were modeled and empirically measured. These constructs included interactivity, involvement (importance), playfulness, focused attention, skill, control, challenge, arousal, telepresence, time distortion, positive affect, and exploratory behavior. Flow was measured as a yes-no variable by self-assessment questions, such as "Did you have flow in the past when using the Web?" A total of 1962 respondents completed the flow survey.

Table 2.4 Contrast of Original Flow Theory and Flow in Computer-Mediated Communication

(Csikszentmihalyi 1988)		**(Hoffman and Novak 1996)**	
Conceptualization	*Characteristics*	*Characteristics*	*Conceptualization*
	Flow activity	Goal-directed vs. experiential activities	Process characteristics
		Interactivity	Content characteristics, secondary antecedent
		vividness	Content characteristics
		telepresence	Secondary antecedent
	Flow personality	Autotelic personality	
		Optimal stimulation level	
Precondition	Balance of challenge and skill	(perceived) Balance of challenge and skill	Control characteristics, Primary Antecedent
Precondition	Clear goal	Embedded in the activity of Web navigation	
Precondition	Feedback	Embedded in the interactivity of Web communication	
		Involvement	Factor to primary antecedent
Dimension	Concentration	Focused attention	Primary Antecedent
Dimension	Mergence	Mergence	Experience
Dimension	Control	Perceived control	Consequences/effect
Dimension	Time distortion	Time distortion	Experience
Dimension	Loss of self-consciousness	Loss of self-consciousness	Experience
Result	Autotelic experience	Intrinsically enjoyable	Experience
		Positive subjective experience	Consequences/effect
		Increased learning	Consequences/effect
		Exploratory and participatory behavior	Consequences/effect

Based on their early work (Hoffman and Novak 1996), the authors proposed a set of hypotheses to examine relationships among these constructs and a structural model, called base model. The base model was purified and revised using statistical procedures, resulting in a revised model. The base and revised model supported most parts of the hypotheses. First, the study found that greater skill/control and greater challenge/arousal were related to greater flow experience. This finding was in accordance with the preconditions of flow. Experiencing flow was found to be associated with time distortion and telepresence. Focused attention was thought to be a direct influence of flow too; however, it only affected time distortion and telepresence, not flow. Second, indirect influences included speed of interactivity and involvement. Speed of interactivity affected flow but not focused attention, time distortion, nor telepresence; and involvement (importance of the activity) affected focused attention. Intuitively, the longer a user had been using the Internet, the higher his/her skill was. Thirdly, in the study exploratory behavior and positive affect were investigated as consequences of experiencing flow when using the Web; however, a conclusion remained elusive. The relationship between exploratory behavior and flow were more complex than thought. In the base model, the relationship was significant, but not in the revised model. Further investigation is needed. Positive affect was dropped during the purification process, so the hypothesis involving this variable was not testable.

More data was collected by the "Web and Internet Usage Survey", which was part of GVU WWW survey as well. The authors used data from 1654 respondents who filled out both flow and Web usage surveys to obtain insights to online consumer

behavior. It was found that people experience greater flow (including greater time distortion, telepresence, and focused attention) in experiential activities (such as chatting) than in task-oriented activities (such as working or specific reference searching). The length of time people had been using the Web was negatively related to experiential usage of the Web and experiencing flow.

This study was the first of only a few to use empirical data and a complex process model to examine online user/consumer experience, and the results were very informative. However, it was a cross-sectional study that only examined the users' past Web experience in general. This raises three main concerns. First, the congruence of challenge and skill was not treated as a dynamic process as it should be. In other words, the study did not take a situated and dynamic perspective, which is presumed in flow experience when studying the phenomenon (Chen et al. 1999). For example, questions about skills and challenges were related to the respondents' current levels of skills and perceived challenges in using the Web. Secondly, it treated Web use as one monologue activity. Again, the skill and challenge questions assessed the current, average levels and did not take into account the variety of Web activities and Web sites. The questions about flow and its closely related constructs tended to be an average of past experience (e.g., "Interacting with the Web is slow and tedious" and "Most times I use the Web I feel that I am in flow"). There were no context-based questions to gather information about circumstance under which the participants experienced flow. Data collected in this manner were not "on-the-spot" as they should be. The on-the spot data normally refers to information collected by Experience Sampling Forms (Csikszentmihalyi and

Csikszentmihalyi 1988). Survey data might produce a systematic measurement error due to memory loss and distortion, and cause concerns regarding measurement validity. Repeated, on-the-spot measures on the same individual would have provided data on studying subjective experience, which is characterized by perceived condition. At first these two concerns seem merely methodological and related only to data collection. However, the resulting one-shot data is not only subject to memory loss and distortion, but also raises theoretical concerns because it contradicts the belief that flow is a process state, not a constant state (Hoffman and Novak 1996).

Third, in Hoffman and Novak's structural model, the effects of skill and challenge on flow were treated separately, ignoring the critical precondition that the balance between the two is the key. Furthermore, their study was not targeted to the shopping context in particular, although an online information search can be thought of as the part of the shopping process. Thus, it would be hard to pinpoint in which exact situation, in which activity, and in which stage of the shopping process, Web users experienced the optimal, flow state. Nevertheless, this study is a good starting point.

Nel et al. (1999) found that flow experience varied among different kinds of Web sites. Web sites were classified into four categories (or four cells) based on two axes: Web site content (communication tool vs. transaction site) and audience focus (international vs. domestic). These four categories of Web sites corresponded to the four quadrants: domestic communication tool (Q1), domestic transaction site (Q2), international communication tool (Q3), and international transaction site (Q4). In a simulated experimental setting, each student subject was asked to surf twenty Web sites

(five for each category) and to evaluate them based on their experience. Web sites acting as a domestic communication tool (Q1) had the highest flow score, followed by Q2, Q3, and Q4, in that order. Also, there was a significant positive relationship within each quadrant/cell between flow on a Web site and the likelihood of that site being visited again. It was found that when overall ratings of individual sites varied from good to bad, flow mean scores correspondingly deteriorated.

This study showed a distinguishable pattern in flow experience among Web site categories. However, it failed to identify the causes of differences in flow experience. In our opinion, omitting perceived challenge and skill from their model is the primary reason leading to this inadequacy, because there is then no way to tell whether or not Web sites in different quadrants presented different levels of challenges due to the selected factors. Also, without a hypothesized mediating effect of challenge and skill along with selection of factors in terms of their effects on challenge and skill, the choice of factors (site content and audience focus) seems unjustified and ill conceived. Thinking of factors in terms of perceived challenges and skills would yield more reasonable and relevant choices, making the selection process more systematic and efficient. Also, the intention of the user was excluded from the study. In other words, when users tried to make a transaction they would find an information provider site frustrating. "It is the task and the context that create the flow experience, not merely the Web site type" (Finneran and Zhang 2002).

Chen et al. (1998) took a microphenomena approach to study the flow experience during interaction with the Web. A computer application was developed to implement

the Experience Sampling Method (ESM) in a computer interaction environment. It recorded the users' navigation activities and prompted a questionnaire at random times with intervals of 5 to 7 minutes. One hundred students participated in the study while browsing the Web and generated 201 data points. The subjects were classified as being in flow if 1) differences between the skills and challenges were less than 2 on an 11-point Likert scale and 2) both of them were above 5. Other flow dimensions measured included a clear goal, enjoyment, attention, and time distortion. Results were mixed. People in flow enjoyed less and paid less attention, in addition to not likely having a clear goal, which contradicted the fundamental elements of flow theory. On the other hand, the associations of the dimensions were as expected. It was also found that the sequences of actions in Web navigation affected the flow experience. The authors called for re-examination the applicability of flow theory and its dimensions in online environments by using ESM technique.

Chen et al. (1999) reported baseline data on the existence of flow phenomenon in the Web environment. Using standard qualitative content analytic procedures on 304 Web users' descriptions of perceived flow experience, the authors categorized contextual and situational factors, as well as conditions relating to flow experience. The Web is a multi-activity medium; it is not surprising to find flow occurring in several Web activities. Research on the Web, including information retrieval, was the activity with the highest frequency in which people felt flow. Other activities included participating in newsgroups and communicating by email or chatting. The feelings of flow (internal experience when in flow) reported were very similar to those described by original work

in flow, such as inspired involvement, lost self-consciousness, excitement, timelessness, and so on. Factors and activities related to challenge, control, and enjoyment were extracted too. The most reported sources for challenges were surfing (locating information), looking for information to solve a problem, and building research strategies and queries. Their study provides the groundwork for future model and instrument building.

In trying to understand consumer experience in different activities, Novak et al. (2003) investigated whether flow occurred during both experiential and goal-directed activities, which are two distinct categories of consumer behavior. This time, they performed a series of quantitative analyses on qualitative descriptions of flow experiences provided by Web users. Web users were asked to answer three open-ended questions about their flow experience when using the Web. Over one thousand user verbatims (short descriptive answers to open-ended questions) were collected through a Web survey and coded according to ten coding rules. Contrary to earlier research, more evidence was found for the occurrence of flow in goal-directed activities, although there was evidence that flow happened in both kinds of activities. Flow on the Web seemed to occur across a broad range of consumer involvement with goals, processes, products, and content. Study results also showed distinguishable flow experiences defined by types of activities: goal-oriented as opposed to experiential. It was evident that the context was important in inducing subjective experiences. The authors suggested an important future research area to study different kinds of flow, namely experiential and task-oriented flow.

In an experimental study, the effects of Web design and user motivation on experiencing flow were put under investigation (Wan and Nan 2001). A 2 (Web site design feature: dynamic vs. static Web design) by 2 (user motivation: information seeking vs. entertainment seeking motives) online experiment was conducted. It was posited that a match between Web features and surfing motives would result in an optimal experience. This proposition implied that the matching situations (static Web site with information seeking motives, dynamic Web site with entertainment seeking motives) would facilitate positive emotions and experience, resulting in high evaluation and high behavioral intention. Although the interaction between the two factors (Web feature and user motivation) was significant, the congruency effect was not symmetric. The combination of dynamic Web site and entertainment seeking motivation was more capable of inducing optimal experience than the combination of static Web site and information seeking motive. The authors attributed the lack of symmetry to the too-appealing dynamic Web design. Although it was thought that the Web as a shopping channel lacked the ability to evoke the emotional aspect of a shopping experience, this study found certain features of Web site design could induce affective responses, both positive and negative. However the underlying mechanism needs further investigation since this study did not model the perceived challenges and skills at all.

Smith and Sivakumar (2004) tried to explore conditions under which flow experience would facilitate different aspects of online shopping by proposing a conceptual model. The model incorporated consumer-related factors (such as perceived risk, willingness to buy, and self-confidence), the nature of products involved (goods vs.

services), and the nature of the purchase occasion (planned vs. impulse). In this conceptualization paper, it was the first time that individual factors besides skills were included, and it was also the first time shopping-specific factors were systematically considered in a model; this moved one step further to studying flow in online shopping.

In another study (Koufaris 2002), online consumers were treated as both shoppers and computer users. The Technology Acceptance Model and flow theory, along with environmental psychology, were used to form an integrated theoretical framework of online consumer behavior. The two consumer behavioral variables looked at were unplanned purchases and intention to return. Five factors were thought to have impacts on them. They were: perceived control, shopping enjoyment, concentration, perceived usefulness, and perceived ease of use. Furthermore, product involvement, Web skills, value-added search mechanisms, and challenges were hypothesized to affect perceived control, shopping enjoyment, and concentration. Three hundred actual online shoppers were recruited to visit a fairly unknown Web bookstore and to answer online questionnaires. Shopping enjoyment and perceived usefulness were found to impact the intention to return. Product involvement, Web skills, and challenges had impacts on shopping enjoyment and concentration, while value-added search mechanisms only affected shopping enjoyment.

Another study (Skadberg and Kimmel 2004) attempted to empirically evaluate visitors' experience while browsing a Web site. A complex model of flow was proposed and tested using structural equation modeling. It was found that flow experience was characterized by time distortion, enjoyment, and telepresence. There was adequate

evidence to conclude that the interrelationships among the elements of a Web site—design attractiveness, speed, and ease of use—were closely related to people's flow experience. This research also found that flow experience while browsing a Web site influenced a number of important outcomes that are typically expected by Web site developers. First, when people were in a state of flow they tended to learn more about the content in the Web site. Second, the increased learning led to changes in attitude and behavior, including taking positive actions, e.g. revisits.

In addition to examining both antecedents and consequences of flow, two strengths of the study were (1) situated definitions of skill and challenge, and (2) including multiple contextual antecedents. First, skill and challenge were conceptualized and measured in terms of the situation. That is, skill was the domain knowledge of the visitors and challenge was the content of the Web site. Although we can argue the specifics, measuring skill and challenge by other means than a general question is a step forward, which was called for by Ellis et al (1994). Second, the study incorporated multiple items as antecedents to flow: site design, performance, prior Web experience and knowledge, and Web site content. However, this study was not without drawbacks. The first weakness was the incomplete measurement of flow dimensions. Only telepresence, enjoyment, and time distortion were assessed. Second, some relationships between constructs were arguable. For example, experience with Web sites can also relate to skill and challenge, not only perceived ease of use and attractiveness as posited by the study.

Huang (2003a) studied impacts of Web attributes (complexity, interactivity, and novelty) on flow experience (in terms of attention, control, curiosity, and intrinsic interest) and investigated consequences of flow (utilitarian and hedonic Web performance) using a structural model based on data collected by a Web survey. It was found that those attributes impacted flow differently and could meet both goal-oriented and experiential needs directly. Complexity distracted attention; novelty excited curiosity; interactivity increased control, curiosity, and interest. Furthermore, flow was found to contribute to both utilitarian and hedonic aspects of Web performance. Attention was more utilitarian related; curiosity was both utilitarian and hedonic; control and intrinsic interest were more hedonic.

Another study worthy of mentioning is by Agarwal and Karahanna (2000). In the study, cognitive absorption, a concept very similar to flow, was posited as one of two influences on perceived usefulness and perceived ease of use, and eventually affects behavioral intention to use. Personal innovativeness and playfulness were two individual characteristics thought to affect cognitive absorption. In this study, contextual factors, perceived challenge, and perceived skill were excluded for no good reason. However, the measures of cognitive absorption were robust. Cognitive absorption has five dimensions, which echo the counterparts of flow. Thus, they can be used readily as subset of measures for the dimensions of flow.

2.4 Evaluation of Previous Work

In this section, we discuss the conceptual and methodological issues found in previous work. While we try to separate them, it is clear that conceptual and

methodological issues are related. For example, ambiguous definitions normally lead to inconsistent methods of operationalization and measurement.

2.4.1 Conceptual Issues

Issues related to the conceptualization of flow are manifested as (1) inconsistent and incomplete flow models and (2) inconsistent and inadequate definitions of core constructs. We will discuss each of these issues in detail below. Table 2.5 summarizes selected empirical research in terms of the flow models used. The majority of the studies included in this table involve Internet usage and online shopping. For a similar summary of studies on general information technology, please refer to Agarwal and Karahanna (2000).

Table 2.5 Summary of Selected Research on Flow

Authors	Construct	Dimensions	Antecedents	Consequences
1. Csikszentmihalyi (1988)	Flow	Concentration; Mergence; Control; Time distortion; Loss of self-consciousness	Balance of challenges and skills; Clear goal; Clear feedback	Autotelic experience
2. Csikszentmihalyi and LeFevre (1989)	Flow	In flow vs. not in flow	Balance of challenges and skills; Work vs. leisure	Affect; Potency; Concentration; Motivation; Satisfaction
3. Hoffman and Novak (1996)	Flow	Mergence; Time distortion; Lost of self-consciousness; Telepresence; Gratifying state	Balance of skills and challenges; Interactivity; Focused attention	Positive subjective experience; Increased learning; Exploratory and participatory behavior; Perceived control
4. Chen et al. (1998)	Flow	Enjoyment; Attention; Time distortion	Challenges vs. skills; Clear goal	
5. Nel et al. (1999)	Flow	Control; Attention focus; Curiosity; Intrinsic interest	Web site type (content, audience focus)	Return intention; Overall site rating

Table 2.5 Continued

Authors	Construct	Dimensions	Antecedents	Consequences
6. Agarwal and Karahanna (2000)	Cognitive Absorption	Temporal dissociation; Focused immersion; Heightened enjoyment; Control; Curiosity	Personal innovativeness; Playfulness	Perceived usefulness; Perceived ease-of-use
7. Novak et al. (2000)	Flow	One-dimensional	Telepresence; Time distortion; Challenge/arousual; Skill/control; Interactivity	No conclusive results for consequences of flow
8. Wan and Nan (2001)	Optimal online experience	Web excitement (flow); Other dimensions: Positive emotions; Negative emotions; Evaluation of Web site structure and efficiency; Negative Web experience	Surfing motive; Web site design	Web actions; Change of brand attitude
9. Koufaris (2002)	Flow	Shopping enjoyment	Product involvement; Web skill; Challenge; Value-added search	return intention
		Concentration	Product involvement; Web skill; Challenge	
10. Novak et al. (2003)	Flow	Flow; Flow verbatim	Goal directed vs. experiential activities; Skill; Challenge Novelty; Importance	
11. Skadberg and Kimmel (2004)	Flow experience	Enjoyment; Lost track of time; Telepresence	Interactivity; Attractiveness; Proposed but dropped: Domain knowledge/skill; Information in the Web site/challenge	Increased learning, in turn it leads to changes of attitude and behavior
12. Huang (2003a)	Flow	Attention; Control; Curiosity; Interest	Complexity; Novelty; Interactivity	Utilitarian; Hedonic
13. Finneran and Zhang (2003)	Flow		People: trait and states Task; Artifact	

2.4.1.1 Flow Models

First of all, from the table, it clear that there are discrepancies among flow models used in these studies. This inconsistency can be found in two aspects. One inconsistency is the total number of flow core constructs examined in a given study. It varies from thirteen (Novak et al. 2000) to two (e.g., Koufaris 2002). For example, the requirements for a clear goal and interactivity are examined in some studies, but are assumed to be embedded in Web activities or technology in other studies. This assumption might be worthy of reexamination. The second inconsistency resides in the theorization of those constructs: the antecedents and consequences of flow are modeled differently. The same constructs are placed in different stages in different studies. For instance, perceived control has been treated as a part of flow experience in some studies (e.g., Trevino and Webster 1992) but as an antecedent in others (Ghani 1995; Novak et al. 2000). In addition, with the help of structural equation modeling, some studies further differentiate antecedents of flow into direct and indirect factors, while others treat them the same. Although inconsistency is not necessarily deficient, it is a sign of lack of cohesiveness in theorization and maybe an indicator of the immaturity of the field.

More seriously, not all dimensions in the Csikszentmihalyi's flow theory have been investigated. Few have studied time distortion and balance of challenges and skills; fewer have looked into either the merging of action and awareness or the loss of self-consciousness. Some studies omitted important constructs. For example, perceived challenges and skills are sometimes excluded (e.g., Nel et al. 1999; Wan and Nan 2001),

and we see this as a major flaw. In summary, none of the models is a complete model. More research is needed to answer questions such as what flow experiences are associated with Web activities, including Internet shopping, and what antecedents and consequences of flow are relevant to online environments.

2.4.1.2 Flow Constructs.

The second conceptual issue is related to the definition of core constructs. The operationalization of the most important constructs – flow and the ratio of perceived challenges and skills – is troublesome. First, although researchers agree on the underlying multidimensionality of flow, it seems they cannot agree on the number of dimensions. This issue is the direct result of the inconsistent models used in the studies and can be seen in Table 2.5.

Secondly, measures of perceived challenges and skills are also a concern. Ellis et al. (1994) point out that unidimensional scales of challenges and skills may not serve as valid measures. Although at first this appears to be a measurement issue, it is also rooted in conceptualization of the situated challenge and skill perception. It is especially true when collecting everyday-life data using the Experience Sampling Method, because challenges and skills can be context-based. Merely asking whether it is hard to carry out an activity will not yield enough information on that particular situation. In the case of Internet activities, challenges and skills are multi-faceted and activity-specific, because Internet activities consist of a wide range. For example, shopping online requires the skills of using a computer and the Internet, knowledge of the site and product in question, and payment ability (such as possessing a credit card). Failing to incorporate

challenges and skills, along with not recognizing this contextual aspect of challenges and skills, leads to unjustified research models and results that go astray.

Third, the ratio of perceived challenges and skills is thought of as the determinant of flow in many studies in other fields. However, when studying flow in online and computer environments, the concept of this crucial balance is lost in some studies. For example, except for Ghani (1995) and Chen et al. (1998), other studies have treated the impact of perceived challenges and skills separately instead of using the balance of these two (e.g., Novak et al. 2000; Koufaris 2002).

2.4.2 Methodological Issues

In addition to the conceptualization problems aforementioned, there are issues related to methodology and measurement as well. First, there are some problems with data collection. The data collection method employed in a study determines what kind of data is collected. It also determines how close the data collected is to the phenomenon we are trying to study and measure. In studies of flow in the Internet, data collection methods are dominantly self-reported surveys (Novak et al. 2000) and retrospective questionnaires after experiments (Nel et al. 1999). Results from those studies may be informative, but are not adequate for studying flow, which is a situated, conditioned, dynamic, individual experience (Chen et al. 1999). Major limitations of the survey method in studying flow are (1) ignoring the situated, dynamic nature of flow and (2) memory loss and distortion. "Surveying non-situated, generalized factors does not account for the dynamism of each factor and how its fluctuation influence flow" (Finneran and Zhang 2002).

Experiments with questionnaires quickly following them enable researchers to observe the situation more closely and to collect data with less memory loss and distortion, but are not without drawbacks of their own. Although experiments raise concerns of external validity in general, it is especially so in the study of flow, for two reasons. First, there is little consensus on the underlying structure and operationalization of flow and related constructs. Second, flow is such a context-specific phenomenon that the design of the experiments (selected factors, task, and the site used) may have a compound effect. Thus, we may reach an incorrect conclusion by using an experimental approach before we have obtained a clearer understanding of flow using other research methods. For example, Nel et al. (1999) concluded that the Web site type was the leading factor of flow. This result is misguided at best, since the context considered in that study was mainly in terms of site type, ignoring the fact that context consists of so many other uncontrolled and unconsidered factors, such as user intention and site design. Thus, without a solid theoretical foundation and a systematic plan to investigate contextual factors, any experimental design would appear arbitrary. Only one study made an attempt to use the ESM to examine flow in the context of Web surfing (Chen et al. 1998); however why used 5 to 7 minutes as the time interval was not explained. In regard to data collection issues, Hoffman and Novak (1996) called for a comprehensive measurement procedure to include flow, antecedents, consequences, and other related psychological experiences via both qualitative and process tracing measures. Finneran and Zhang (2002) have suggested using qualitative techniques to enhance our

understanding of flow and to ensure validity. In our study we will try to overcome those conceptual and methodological challenges.

Another issue is lack of consistent measurement. We can see researchers tried to build on previous work by reusing scales when it was possible. However, there is still an inconsistency, which can be traced back to inconsistent operationalization of constructs.

2.4.3 Additional Observations

The next two observations are of special relevance to our study. First, in terms of results, although most findings are consistent with the original flow theory, there are a few inconsistencies and contradictions among them. For example, Chen et al. (1998) reported contradictory results. In their study, in-flow surfers enjoyed less and paid less attention than those not in flow. No fully satisfying explanation was given for this result. It was suggested to reexamine the applicability of flow in Internet activities, which is one of the objectives of our study.

Second, there is no comprehensive understanding of the specific activities during which people actually experience flow on the Web (Novak et al. 2003). Some empirical studies of flow in Internet usage only investigated the general experience of Web usage and treated Web activities as one whole activity. This approach warrants reexamination. There are so many different online activities and although these activities share a certain commonality, they are totally different in terms of intention, expectations, challenges, people's skills, and so on. Chen et al. (1999) shows that people experience flow more in certain Web activities than in others. Treating those activities as though they were the

same neglects the contextual nature of flow. Therefore, studying individual activities may yield more specific guidelines for different kinds of sites. We chose to start with Internet shopping because (1) there is little empirical study done on flow experience in Internet shopping; (2) Internet shopping is a contextually rich activity; and (3) it is quite different from its counterpart in conventional shopping.

In summary, studying flow in online environments is still underexplored, both because flow theory itself is still under development and it is only relatively recently that flow has been introduced into Information Systems research. In response to the call for an extension on their work by going "beyond a retrospective general evaluation of customer experience on the Web to its modeling in specific online situations" (Novak et al. 2000), this dissertation is going to look into online shopping experience in particular and in a close-up manner using both qualitative and quantitative methods.

CHAPTER III

RESEARCH OBJECTIVES AND QUESTIONS

The literature review showed that applying flow to understand the online consumer experience was promising, but that this area of research was in need of further development. This research effort was spent in two aspects of flow research. In Study 1 we conduct a validity study of flow. Study 2 tests a comprehensive flow model in online shopping. By conducting those studies this dissertation continue the endeavor and deepen the inquiry regarding flow in IS and Internet research in several ways, which will be discussed within the next section of Overview. Detailed discussion of sub-studies will follow.

3.1 Overview

First of all, one of the most urgent issues in flow research was a lack of validated measure. Study 1 is a validity study of flow measure. It has three parts: examining behavioral correlates of flow using mouse movement data captured by screen-capture software (Study 1-A), testing nomological networks of flow via survey data (Study 1-B), and factor analysis of flow measurement models (Study 1-C). Behavioral patterns discovered from subjects' mouse movement provided evidence of construct validity of flow measures. A survey study testing a nomological net of flow and related construct provides another piece of evidence for construct validity of two available flow measures, the Internet Flow Scale (IFS) and the Flow State Scale (FSS). The third piece of validation effort is using factorial analytic approach to compare a set of alternative

models of flow measurement with the aim to choose a more suitable one for later study. These three studies try to address the limitation of current flow studies: a lack of validated measures.

The second part (Study 2) of the project tests a comprehensive model. This model includes key antecedents of flow, outcomes of flow, and flow, which is modeled in terms of a broad range of theoretical dimensions. The antecedents fall into two types. First type is the direct determinants suggested by flow theory. One of the preconditions leading to such an experience is the balance between the perceived challenge presented by the activity and the skills possessed by the actor. Other two preconditions are having a clear goal and a quick and unambiguous feedback mechanism. The second type is external factors, such as Web site complexity, which affects flow via the perceived challenge and skill. The broad measure of flow is adapted mainly from FSS since it had demonstrated a better performance in our validation studies. The outcomes are assessed in terms of cognitive evaluation, affective responses, and behavioral intentions. Hoffman and Novak (1996) argue that including the antecedents, consequences, and psychological experience of flow is important for a comprehensive flow measurement procedure. By testing this comprehensive model of flow we will be able to overcome some of the conceptualization issues in previous work, such as inconsistent flow models and incomplete operationalization of the flow construct.

Another aspect is to study IT-related and design-related external factors. The external factor, which we manipulate, was Web site complexity, a variable directly relevant to IT. The site complexity is one of the unique aspects of a Web site as an IT

artifact. Also, site complexity is an important variable to take into account in designing Web sites. Investigating the effects of it on inducing flow in online shopping may eventually lead us to guidelines for improving the shopping experience by designing more capable Web sites.

Thus, this dissertation is a broad study of flow, addressing both conceptual and methodological issues of flow research and using multiple research methods. Study information is summarized in Table 3.1. In the remaining of this chapter, each sub-study is discussed in detail, while methodologies are in the next chapter.

Table 3.1 Objectives and Contributions of This Dissertation

Study and Objective	Contributions
Study 1: validity study of flow measures	• investigate all known underlying dimensions of flow • validate two flow measures from different fields
Study 2: study of a comprehensive model of flow	• examine a comprehensive model specifying both antecedents and consequences of flow • test channel model of flow, investigate relationship between challenge/skill and flow explicitly • study IT-related, design-related external factors using a randomized experimental design

3.2 The State of Flow: Instrument Validation (Study 1)

The synopsis of prior work in psychology and individual interactions with information technology suggested that the holistic experience – flow – is an important explanatory variable. Flow is posited as the mediating mechanism and is the center focus of this research effort. The review presented in the last section indicated that while researchers acknowledged the importance of this concept and its multi-

dimensionality, no consistent underlying dimensions had been agreed upon. Although some validity evidence existed, we saw the need for further investigation of flow measures in Information Systems context. This study consists of three parts: Study 1-A seeks to relate flow to behavioral criteria in online shopping; Study 1-B conducts a traditional construct validity study in which we develop a "nomological network" of predictions about how flow measures should relate to other constructs and assess the relationship of flow measures to other logically related constructs. In this study we also conduct a Multitrait-Multimethod validity study. Study 1-C is a factorial validity study that assesses the validity of the flow construct via factor analysis. Details are described in the following paragraphs.

3.2.1 Existing Measures of Flow

We conducted a review of about 20 flow studies in the IS, Marketing, and related literature. This review indicated a number of different operationalizations and measures of flow. None of the studies reviewed included all nine preconditions and dimensions associated with flow. The most common dimensions in these studies are concentration, enjoyment, and sense of control (e.g., Webster et al. 1993; Ghani 1995; Agarwal and Karahanna 2000; Novak et al. 2000; Koufaris 2002). Time distortion has been also been examined (Agarwal and Karahanna 2000; Novak et al. 2000). The two dimensions of flow that have not been investigated in this research stream are loss of self-consciousness and mergence of action and awareness. Telepresence (Steuer 1992) has been added as another dimension to capture the uniqueness of computer mediated environment (Hoffman and Novak 1996). These measures, comprised of different but

partially overlapping items, all exhibit reasonable levels of reliability, and clear face and factorial validity. They use different response formats, ranging from a 5-point Likert scale to a 9-point Likert scale (Table 3.2).

For the purposes of this study, we select the scale with the highest reliability for each dimension from the reviewed studies and created items for the two unstudied dimensions. Preconditions of flow, except perceived challenge and perceived skill (Koufaris 2002) are not normally included in flow models in the IS and Marketing literature, since they are often presumed to be present in computer-mediated environments (Hoffman and Novak 1996). At first, trying to be consistent with these work, we do not include these two preconditions in the validity study either. The resulting measure of flow for this research is composed of the seven of nine dimensions in Table 2.1 and with an additional telepresence dimension and is called the Internet Flow Scale (IFS) (Figure 3.1).

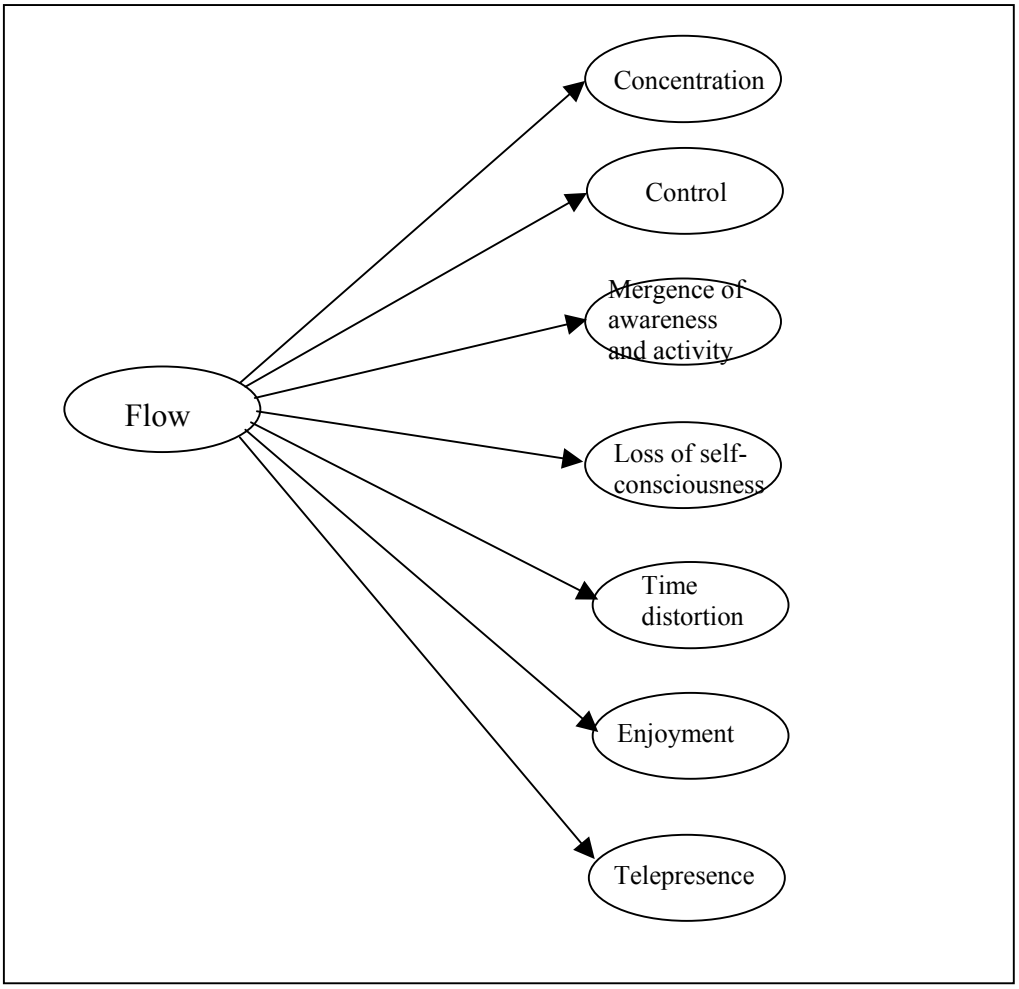

Figure 3.1 Flow Construct and its Underlying Dimensions

Table 3.2 Definitions and Measurements of Flow Dimensions

Dimensions	Definitions	Measurements			
		measures	***alpha***	***Study***	***Source***
Concentration	"focused concentration" (Csikszentmihalyi 1988, p.32) "a centering of attention on a limited stimulus field" (Csikszentmihalyi 1975, p.40)	10-point 1-item scale		Csikszentmihalyi and LeFevre (1989)	
		7-point 4-item scale	0.910	Koufaris (2002)	Ghani et al. (1991)
		7-point 1-item scale		Trevino and Webster (1992)	Csikszentmihalyi (1975)
		7-point 3-item scale	0.72-0.82	Webster et al. (1993)	Trevino and Webster (1992)
		5-item scale	0.68	Ghani (1995)	Csikszentmihalyi (1975); Csikszentmihalyi (1988); Webster (1989)
		5 point 3-item scale		Nel et al. (1999)	Webster et al. (1993)
		7-point 5-item scale (two items for mergence)	0.88	Agarwal and Karahanna (2000)	
		11-point 1-item scale		Chen et al. (1998)	
		9-point 4-item scale	0.638, 0.83	Novak et al. (2000)	Ghani and Deshpande (1994)
		7-point 3-item scale	0.82	Huang (2003a)	Webster et al. (1993)

Table 3.2 Contitued

Dimensions	Definitions	Measurements			
Enjoyment /intrinsic interest	"the negentropic quality of the flow experience makes it autotelic, or intrinsically rewarding." (Csikszentmihalyi 1988, p. 33) "extremely gratifying state" (Hoffman and Novak 1996)	7-point 1-item scale		Trevino and Webster (1992)	Csikszentmihalyi (1975)
		7-point 3-item scale	0.72-0.82	Webster et al. (1993)	Trevino and Webster (1992)
		4-item scale	0.90	Ghani (1995)	Csikszentmihalyi (1975); Csikszentmihalyi (1988); Webster (1989)
		11-point scale		Chen et al. (1998)	
		5-point 3-item scale		Nel et al. (1999)	Webster et al. (1993)
		7-point 4-item scale	0.93	Agarwal and Karahanna (2000)	Webster et al. (1993); Davis et al. (1992)
		7-point 4-item scale	0.944	Koufaris (2002)	Ghani et al. (1991)
		7-point 3-item scale	0.72	Huang (2003a)	Webster et al. (1993)
Feeling of control	"under the person's own control" (Csikszentmihalyi 1988, p. 33) "in control of his actions and of the environment" (Csikszentmihalyi 1975, p.44)	7-point 1-item scale		Trevino and Webster (1992)	Csikszentmihalyi (1975)
		7-point 3-item scale	0.72-0.82	Webster et al. (1993)	Trevino and Webster (1992)
		5-item scale	0.92	Ghani (1995)	Csikszentmihalyi (1975); Csikszentmihalyi (1988); Webster (1989)
		5-point 3-item scale		Nel et al. (1999)	Webster et al. (1993)
		7-point 3-item scale	0.83	Agarwal and Karahanna (2000)	Webster et al. (1993)
		7-point 4-item scale	0.813	Koufaris (2002)	Ghani et al. (1991)
		7-point 3-item scale	0.68	Huang (2003a)	Webster et al. (1993)
		9-point 4-item scale	0.685	Novak et al. (2000)	Havlena and Halbrook (1986)

Table 3.2 Contiued

Dimensions	Definitions	Measurements			
Mergence	"merging of activity and awareness" (Csikszentmihalyi 1988)	No studies used this construct			
Time distortion	"a distorted sense of time" (Csikszentmihalyi 1988, p. 33)	7-point 5-item scale	0.93	Agarwal and Karahanna (2000)	
		11-point scale		Chen et al. (1998)	
		9-point 2-item scale	0.703	Novak et al. (2000)	
Loss of self-consciousness	"loses temporarily the awareness of self", "a transcendence of self" (Csikszentmihalyi 1988, p. 33) "What is usually lost in the flow is not the awareness of one's body or one's functions, but only the self *construct*, the intermediary which one learns to interpose between stimulus and response." (Csikszentmihalyi 1975, p.45)	No studies used this construct			
Telepresence	"the mediated perception of an environment" (Steuer 1992) "compelling sense of being present in a mediated virtual environment" (Kim and Biocca 1997)	9-point 7-item scale		Novak et al. (2000)	Kim and Biocca (1997)
		5-point 2-item scale		Skadberg and Kimmel (2004)	
Flow	as a uni-dimensional construct	9-point 3-item scale		Novak et al. (2000)	Chen et al. (1999)
		5-point 2-item scale		Skadberg and Kimmel (2004)	
		5-point 12-item scale	0.95	Wan and Nan (2001)	

Later, a second carefully developed measure of flow, the Flow State Scale (FSS) was located in the sports psychology literature. Developed by Jackson and Marsh (1996), it exhibits reasonable reliability (average alpha=0.83) and external validity (Marsh and Jackson 1999). This scale has been used for a dozen studies in the sports context (e.g., Doganis et al. 2000; Marsh and Jackson1999; Vlachopoulos et al. 2000). The FSS is a 36-item scale measuring all nine preconditions and dimensions of flow: a clear goal, feedback, the balance of challenge and skills, concentration, mergence of activity and awareness, sense of control, transformation of time, loss of self-consciousness, and autotelic experience. Each factor is measured by four items. Confirmatory factor analyses supported both the nine-factor structure and a hierarchical model with one global flow factor as a second-order factor. We have two concerns with this scale. First, it treats the preconditions (balance of challenge and skill, feedback, and clear goal) as the same type of construct as the dimensions of flow. Secondly, the questions measuring balance of challenge and skill are compound questions, which may lead to nonequivalent responses from subjects. So we decided to include this as a second measure in our construct validation study.

3.2.2 Study 1-A: Behavioral Correlates of Flow

In this study we examine actual behavioral indicators of flow and to determine whether people in flow and not in flow behave differently. According to flow theory, people in flow concentrate on the task at hand and are deeply involved in task related activity. In order to achieve flow, preconditions include perceived balance of skill and challenge, having a clear goal, and a unambiguous feedback mechanism. Thus, people

who are in flow surfing a Web site would display smooth navigation patterns, stay on pages longer reading, and/or look for products in a systematic fashion without run into troubles. On the hand, if people encounter certain navigational problems and are disoriented or confused, they probably will not get into flow. Furthermore, if visitors are interrupted consistently by pop-up advertisements, it would be harder for them to experience flow. In this validity study, we capture both subjects' mouse movements and measure their subjective experience using sampling forms. We will code behavioral patterns and associate those patterns to subjective flow measures will be able to provide validity evidence for flow theory and measurement. No study that we are aware of has examined actual visitor behavior using mouse movement data. In addition to its innovative approach the study will provide some objective data on the validity of the flow construct.

3.2.3 Study 1-B: Test a Nomological Network of Flow

The objective of Study 1-B is to validate two flow measures (IFS and FSS), comparing and contrasting them so that we would be able to choose or modify one for later use. The approach that we take involved two construct validation tests: (a) a test of a nomological network that included the flow measures and (b) a multitrait-multimethod validity study. We study the scales in two contexts, Internet shopping and game playing. In this section, we first introduce the nomological network and MTMM approach before presenting the nomological network and data collection methods used in our study.

The nomological network is at the heart of the concept of construct validity (Cronbach and Meehl 1955). A nomological network has three components: a

theoretical framework, an empirical framework, and a set of linkages within and between these two frameworks. The theoretical framework includes the constructs we are developing measures for and theoretically related constructs; linkages among this set of constructs are posited based on existing theories that we have confidence in. Constructs in the theoretical framework include correlates of the measured constructs and variables on which the measured constructs should clearly differ. The empirical framework is composed of the proposed measures of the constructs of interest and well-validated measures of the related constructs in the nomological net. After collecting data, we can test whether those predicted linkages hold and whether predicated nonrelationships are absent, thus providing evidence of construct validity. At the center of the idea of the nomological network is the attempt to link the unobservable conceptual realm with the observable realm. Although this idea provides a philosophical foundation for construct validity, it has been criticized in that it does not immediately suggest a practical and usable methodology for actually assessing construct validity. The range of constructs related to those being measured is quite broad and it is unclear which to include and when to stop testing relationships in the nomological network.

The multitrait-multimethod (MTMM) matrix (Campbell and Fiske 1959) was developed to provide a more practical and formal process to assess construct validity of a set of measures. It involves measuring a set of different traits (hence multitrait) using a set of different methods (hence multimethod). Then the matrix of correlations between these different measures is analyzed to diagnose construct validity issues. The MTMM method introduced the concepts of convergent validity and discriminant validity.

Convergent validity is founded on the expectation that measures of theoretically similar constructs should be highly intercorrelated. On the other hand, discriminant validity is founded on the expectation that measures of theoretically different constructs should not correlate highly with each other. Analysis of the MTMM correlation matrix provides evidence of (or lack of) convergent validity and discriminant validity.

This study is designed to test a nomological network and to conduct a MTMM analysis in two different contexts in order to assess the construct validity of two flow measures, the Internet Flow Scale (IFS) and the Flow State Scale (FSS). The two contexts are playing computer/video games and shopping online, both utilized in prior IS studies of flow. Other constructs included in the nomological network are love for the activity, skill for the activity, computer anxiety, and computer playfulness. The nomological network is depicted in Figure 3.2.

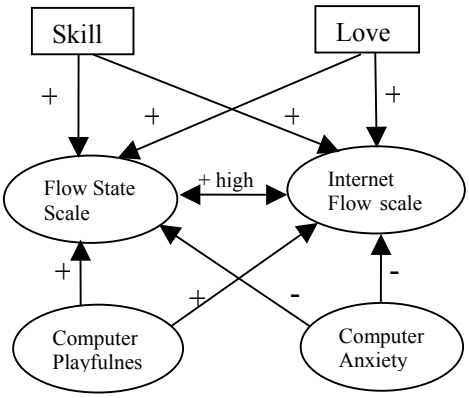

Figure 3.2 A Nomological Net for Flow

In both computer/video gaming and online shopping contexts, we expect that people with higher skill in a particular game or skill in Internet shopping would report higher flow scores when recalling the last time they engaged in such an activity than those who do not have high skills. Similarly, we expect that people who like gaming or shopping would report higher flow score than people who do not like these activities. These predictions are straightforward. Computer anxiety and computer playfulness should also correlate to flow experience. Computer playfulness should positively correlate with flow, while computer anxiety should correlate negatively. We also expect that the IFS and FSS would correlate more highly with each other than with any other constructs, such as computer anxiety and computer playfulness.

3.2.4 Study 1-C: Factor Analytic Approach

An effort to validate constructs should incorporate two approaches: within- and between-network studies (Marsh 1990). While the objective of between network studies (e.g., Study 1-B) is to establish a logical, theoretically consistent pattern among constructs, a within-network study explores the internal structure of a construct. Within-network studies examine the dimensionality of a construct and often take a factor analytic approach.

Factor analysis (FA) is a statistical technique applied to a data set to discover groups of variables in the set that form coherent subsets. Those subsets are relatively independent from one another. Variables in a subset are typically combined into a factor. FA can be used to summarize patterns of correlations among observed variable and to reduce a large number of observed variables to a smaller number of factors. It

can also be used to operationalize an underlying process and to study the nature of the underlying processes. There are two kinds of factor analysis different in the nature of inquiry: exploratory and confirmatory. Confirmatory Factor analysis (CFA) is to test specific theoretical expectations about the structure of a set of measures. Normally, a strong theoretic suggestion about underlying factorial structure is available and can be used to specify a model if using structural equation modeling (SEM) procedure to conduct the analysis. The goal is to see how close the data "confirm" to the proposed factorial structure. On the other hand, exploratory factor analysis is often used to discover unfamiliar or less known structures, with the goal of exploring. This approach allows an underlying structure to emerge. However, the distinction between the two is not determined by the software used, but rather the purpose of a study. For example, if we are only interested in whether an expected factorial structure exists in a data set or not and without adding/dropping items, it is confirmatory in nature. Also, it is very easy to across the line between these two. For instance, using SEM to test models (including CFA models) is confirmatory, but once we start to modify and respecify the models, we step into the realm of exploratory analysis (Byrne 2001, p. 91). CFA is an important part of validation and is suggested to be used to establish construct validity, namely, discriminant validity, convergent validity, and factorial validity (Straub et al. 2004).

Hence the purpose of this study is to use FA to evaluate within-network issues related to internal structure of flow responses. Both exploratory and confirmatory techniques will be used in our study. First, we use the exploratory approach to examine whether the expected factorial structure of flow construct can be found in collected data;

then CFA will be used to compare the ability of alternative measurement models of flow to explain flow responses

3.3 Effects of Web Site Complexity on Flow (Study 2)

Figure 3.3 represents the overall research model. In this section we will describe the model and hypotheses in detail. This model incorporates the basic flow theory in which perceived balance of challenge and skill determines the occurrence of flow as the key mediating factor. Antecedents and consequences of flow are also included in the model. Each part will be presented in this section.

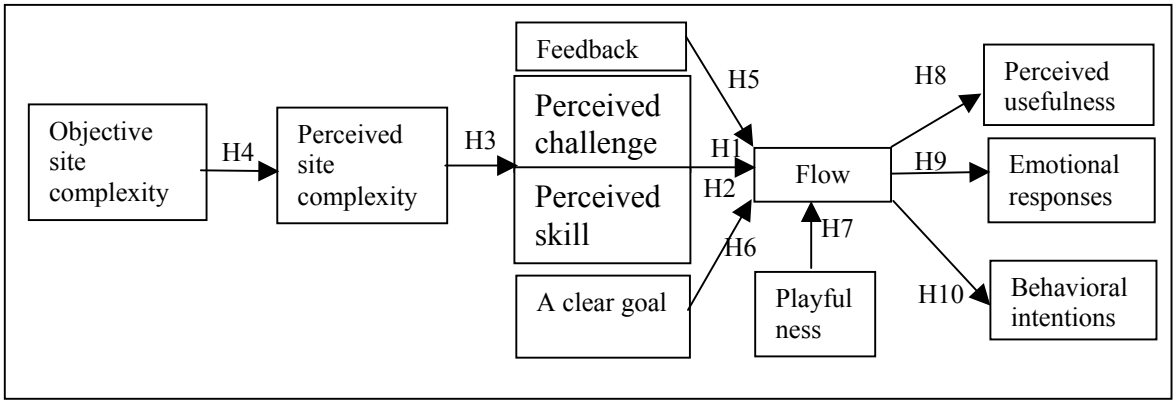

Figure 3.3 Research Model

3.3.1 Flow – Optimal Experience

The first goal of Study 2 is to determine whether the quality of the flow experience is better than the quality of experience in any of the other channels in online shopping. It has been found that the quality of experience (in terms of concentration, affect, potency, creativity, motivation, satisfaction, and so on) is strongly, positively

influenced by whether a person is in flow or not, regardless of whether the activity is working or leisure (Csikszentmihalyi and LeFevre 1989). Studies have also found supporting evidence for this using the 4-channel model (Massimini and Carli 1988) and the 8-channel model (Carli et al. 1988). However, Chen et al. (1998) used a dual model (in flow vs. not in flow, determined by the difference of challenge and skill ratings) to compare in-flow and non-flow experiences for people surfing the Web, and obtained mixed results. In pilot studies we conducted before, mixed results were also found (Please refer to later chapters for discussion). Thus, it is not obvious that flow will lead to a pleasant experience. Although studies on flow in computer and Internet usage have included perceived challenge and skill as key determinants, they have often treated the effects of these two separately and rarely examined channel model, except Chen et al. (1998). Thus, in the current study, a comparison of the quality of experiences among channels should be useful as the first step. Using the 4-channel model (please refer to Figure 2.1.), we will test the following hypothesis:

Hypothesis 1. People in flow have a higher quality of experience than those not in flow (namely, in the boredom, anxiety, and apathy channels).

Besides having a clear goal and feedback, the third critical precondition for flow to occur is the balance of perceived challenge and skill. According to channel models of flow, only the channel with high challenge and high skill (the upper right channel in Figure 2.1) will result in flow. Therefore, the relativity of perceived challenge and skill is the major determinant. Thus, we will test:

Hypothesis 1a. Flow score will be highest when challenge and skill are

simultaneously at moderate to high levels.

Hypothesis 1b. Flow score will be moderate when either challenge or skill is high and the other is not.

Hypothesis 1c. Flow score will be lowest when challenge and skill are simultaneously at low levels.

Although studies in flow in computer and Internet usage have included challenge and skill as key determinants, they have often treated the effects of these two separately. In this study we will employ the balance between the subjective assessments of challenge and skill to predict flow. Thus, besides using channel model to examine effect of perceived challenge and skill on flow, we will also investigate the nomological relationships between perceived challenge and skill and flow experience. In the context of Web surfing and online shopping, Novak et al. (2000), Koufaris (2002), and Novak et al. (2003) found both relationships positive, while Skadberg and Kimmel (2004) did not find direct effects between skill and flow nor between challenge and flow. On the other hand, according to the theory, the effect of the balance between skill and challenge on flow is one of the key determinants of flow, instead of perceived challenge and perceived skill separately. This balance is also called "fit" in Ghani (1995). In a study of learning software, it was found that the relationship between this "fit" and flow is a curvilinear one. In other words, rather the square of the difference between skill and challenge was hypothesized and found to affect flow. It was explained that skill and challenge both had an effect on flow directly and indirectly, via perceived control. However, the mediating effect of perceived control was inconclusive, since only few studies had supported it. We used a structural model to study the relationships among

balance of challenge and skill, perceive challenge, perceive skill, and flow by testing following alternative hypotheses:

Hypothesis 2a. The balance of challenge and skill has positive effect on flow.
Hypothesis 2b. Perceived challenge has positive effect on flow.
Hypothesis 2c. Perceived skill has positive effect on flow.

Among these hypotheses, 2a is our primary interest because it is suggested by theory. Due to the complex nature and inconclusive results from previous research, we will explore the other two hypotheses in supplementary analysis.

3.3.2 External Influential Factors

In our model of flow, we distinguished external influential factors from the preconditions of flow including the perceived balance of challenge and skill. In discussion of perceived challenge and skill, we have to note that they are multi-faceted constructs in online shopping context, as in other contexts (Ellis et al. 1994). People use mental models, cognitive constructs derived from knowledge and experience, to interpret the world (Brandt and Uden 2003). A mental model for Internet searching includes searching and IT skills, and knowledge about the subject being searched. General computer and Internet skills are included as individual factors in our model. In the context of shopping in an online store, subject knowledge involves at least knowledge of both the site and product in question. Expectations from an activity also present challenges, and therefore affect people's perception of challenge and skill. Thus, challenge and skill concerning online shopping are influenced by three aspects: the site, the product, and the nature of the shopping task at hand. Site complexity is the focal

point of our study, which is discussed in detail in this section. In other words, external factors influence flow via perceived challenge and skill.

Studies have investigated technological factors, contextual factors, and individual factors regarding flow (Trevino and Webster 1992). The major external factor in our study is site complexity, which is related to Web site design. Other external factors related to our study include product factors, task factors, and individual factors. We controlled those factors in light of their documented effects on flow. We wanted to study those factors related to site design as our main focus because (1) they have major impacts on perceived challenge and skill; (2) they are among the most important and unique aspects of the online shopping context and are in line with the Person-Artifact-Task model proposed by Finneran and Zhang (2002) and with the contingency model (Smith and Sivakumar 2004); and (3) they are associated with the IT aspect of a Web site and can be improved from a Web design perspective. By studying them, we will generate knowledge that may enable designers to make online shopping enjoyable.

Aspects of Web sites thought to be important and studied in the context of Internet usage, are speed (Novak et al. 2000), interactivity (Skadberg and Kimmel 2004), and attractiveness (Skadberg and Kimmel 2004). Site design features also have been investigated, such as search mechanism (Koufaris 2002) and page format (Wan and Nan 2001). While these factors and features are important, most studies have ignored the mediating effect of perceived challenge and skill on their ability of inducing flow. The choice of complexity as an independent variable is grounded in our assumption that Web sites affect people as more holistic entities than in terms of their parts. The approach we

take is to focus on the factors representing a holistic effect and directly relating to perceptions of challenge and skill. The factor we choose is Web site complexity. Only one study has investigated the effect of perceived site complexity on flow experience (Huang 2003a).

3.3.2.1 Web Site Complexity

Complexity can be roughly defined as the "amount of variety or diversity" in a stimulus (Berlyne 1960 p.38). Complexity can be measured both objectively and subjectively (Campbell 1988; Germonprez and Zigurs 2003). Campbell (1988) distinguishes the objective complexity of a task and the subjective complexity that is experienced by people. These two are related but not necessarily identical. Several factors, such as familiarity (prior knowledge), short-term memory, and mood moderate the relationships between objective and subjective complexity. In this study, the approach will be to manipulate objective complexity and to measure subjective complexity. In the next few paragraphs, we introduce the concept of complexity based on general complexity theories, and then define complexity in terms of Web comprehension.

Based on the information processing literature, if a task is high in information load, information diversity, and rate of information change, a task is complex because it is high in cognitive demand. The complexity of a stimulus pattern depends on several properties: number of distinguishable elements, the level of dissimilarity between elements, and the level of unity among elements (Geissler et al. 2001). Similarly, objective task complexity can be described by the number of potential alternatives,

number of outcomes, conflicting interdependence, and the uncertainty of correct paths to a solution. And for a choice task, complexity is determined by the number of alternatives in a consideration set, number of attributes of alternatives, variation in values, and trade-offs of those attributes. A purchasing task such as those Web shopper engage in is normally a choice task.

Researchers have extended theories of information complexity into the Web context to study Web site complexity and its relations to communication effectiveness (Geissler et al. 2001), usability (Tarasewich in press), traffic (Bucy et al. 1999), shopping behaviors (Huang 2000), and flow (Huang 2003a). Two aspects of site complexity have emerged as common themes in these studies and in media research: structural complexity and content complexity. We will discuss each of them in detail below.

3.3.2.1.1 Site Structural Complexity

When we try to comprehend a Web site, two things are involved. First we try to figure out the structure and functionality of the site, including what the pages look like, where the links lead, and the relationship among the pages. Basically, this is concerned with the design aspect of a site and the way in which information is presented and organized in the site. The second part is to understand the content of the site itself. We use the term "structural complexity" to refer to the cognitive demand required by the first task in comprehending a site. It also has been referred to page complexity (Bucy et al. 1999; Geissler et al. 2001), design complexity (Tarasewich in press), and form (Germonprez and Zigurs 2003). We use "structure" to echo the "information space"

metaphor of hyper documents. In this space, there is an interconnected Web of nodes/pages (Marshall and Shipman 1995). People "travel", "navigate", "orientate", and "disorientate" in this space (Thuring et al. 1995; Otter and Johnson 2000). The structure of the space affects the cognitive overhead required by comprehension. One study showed that the text structure (hierarchical, nonlinear, and mixed) and prior knowledge affected the ease with which hypertext can be used (McDonald and Stevenson 1998). However, a different study argues that a visitor's mental representation reflects more of a conceptual (i.e., semantic) relationship, and not the nature of the interconnections among pages of a site (Farris et al. 2002).

This structural complexity is a result of three factors: individual page structure, overall site structure, and links. Page structure concerns the design of page elements. Bucy et al. (1999) examined features such as banners, page structures (e.g. using frames or not), dynamic elements, graphic elements, both asynchronous and real-time interactive elements, and background colors. It found that the page structure (e.g., graphical elements and asynchronous interactive elements) of a Web page corresponded to increased traffic for the Web site. In studying home pages, Geissler et al. (2001) found that perceived complexity resulted from the number of links, number of graphics, home page length, and use of animation on the page. They found a quadratic relationship (inverted U-shape) between complexity and attention. Tarasewich (in press) investigated how to use complexity metrics in improving Web site usability. He classified Web site design complexity into two parts: page layout and Web specific. In page layout, he considered aspect ratio, percentage of white space, horizontal and

vertical balances, and horizontal symmetry. Web specific metrics include the number of graphics and graphic size, number of words, number of links, number of pages, and average depth of pages. Better usability was found for a redesigned web site according to the rules of reducing complexity. However, only two versions of a same-content site were used. It was hard to probe any other relationships between complexity and usability other than the mean difference.

Page structure concerns the design of individual pages, while overall site structure concerns the relationships between those pages. The last two Web specific metrics of Tarasewich (in press), the total number of pages and average depth of pages, are actually in this category. Additionally, coherence is one quality we should strive for in order to reduce complexity (Thuring et al. 1995). It can be achieved by applying a similar formatting style throughout the site or through groups of pages, using consistent navigation tools and cues, and/or a uniform interface for similar tasks on the site.

In addition to page design and site design, another important aspect is related to links (Germonprez and Zigurs 2003). Although it is not normally pointed out, intelligently designed links make a difference when navigating through a site. Besides having a meaningful text for the link, some methods of using links to reduce complexity are showing the destination of the link and/or providing knowledge about the interrelationships between information units (Oinas-Kukkonen 1998).

3.3.2.1.2 Site Content Complexity.

The nature of the content of a Web site is just as important as its structure. We use the term “content” to differentiate between two types of related information on a

site: business-related information (such as product information and company information) and structural information (such as navigational links and buttons). We discussed the complexity of structural information in the last section. In this section our focus is content, i.e., business-related information.

The actual content provided by the site is the second major cause of information overload (Thuring et al. 1995). In a study of information overload in organizations, Schneider (1987) listed several characteristics of information that contribute to overload, including: uncertainty, ambiguity, novelty, complexity, and intensity. Uncertainty refers to the amount of information needed versus the amount of information available. Contrary to the claim of Germornprez and Zigurs (2003) that uncertainty was not relevant in regard to Web complexity, if a piece of critical information is missing or just hard to find on the site, it will increase the mental load of visitors who are trying to find that piece of information in order to understand the entire content. In shopping contexts, missing price information or shipping information definitely is a large obstacle to making purchase decision. Ambiguity refers to the number of alternative ways to interpret information, or just a lack of clarity in the information from the users' perspective. A similar characteristic is information equivocality, which is the ability of information to be interpreted in multiple ways. Ambiguity and equivocality have been treated as the same (Schneider 1987) or as different properties (Germornprez and Zigurs 2003), but we treat them as one. Of course, unclear information makes it hard for users to comprehend a Web site, thus increasing its complexity.

Novelty of information is the inability to fit it into any exiting schema. It is somewhat related to the domain knowledge of users. For example, a person new to digital cameras will find it hard to understand their product descriptions, and this will make it difficult for them to make comparisons and a final purchase decision. Complexity of information is the degree of the interrelatedness among units of information; it is how related groups of information are, or the logical relationships among pieces of information. Complexity of an information net increases when a piece of information relates to many other pieces of information, and the same is true in a Web site since the content presented on a Web site can be thought of as an information net too. Highly interrelated content presents a bigger challenge for readers since it places more cognitive load on readers. In Web sites, pages and links relating these pages are the physical form of the content provided to visitors. Visitors will feel much more challenged when the physical form matches the logical relationship among pieces of information well.

Intensity refers to an increase in rate/arrival of information and/or importance of the information, according to Schneider (1987). We separate it into two properties: intensity and importance. In the study of Web site complexity, intensity can be conceptualized as the way content is being presented, whether all cluttered into one long page or broken down into pieces. Thus it is part of structural complexity. Importance, as one independent property, refers to the relevance of a piece of information to the shoppers' decision-making. That is how critical a piece of information is. In addition to all these, the volume of information plays a role in complexity as well, since it presents a

major cognitive demand. In a commercial Web site, the amount of content depends on the complexity of the products, number of products available, level of detail, breadth of product information provided, and so on. It is correlated with the number of pages to some extent.

3.3.2.2 Perceived Site Complexity

As discussed above, these two complexity factors are related in some respects, but, basically they represent two distinct aspects of web site complexity. There is a third aspect of Web site complexity: the cognitive dimension (Germanprez and Zigurs 2003). It addresses how individuals retrieve and use information (both structural and content) on a Web site. Constructs that have been examined include mental model development (Thuring et al. 1995; Dalal et al. 2000; Brandt and Uden 2003), prior knowledge and familiarity (Otter and Johnson 2000), and human cognitive capacity (memory, attention, strategy formation, and so on). Normally, cognitive factors are mediating effects involved in the transformation of the objective complexity to subjective complexity.

Taking this integrated approach, Nadkarni and Gupta (2003) define perceived site complexity as "the degree to which the users find the form and content of the website difficult to understand, process and interact with in the performance of online tasks." This definition provided a broad and holistic conceptualization of perceived site complexity that captures not only the structural and content complexity, but also objective and psychological views. They developed a measure with three dimensions: component complexity, coordinative complexity, and dynamic complexity. Component complexity is "the degree to which users find the form and content cues of the web

pages dissimilar and visually complicated." Coordinative complexity is "the degree to which users find the organization of the web pages and the interrelatedness of form and content across web pages incoherent, illogical, and constraining in the process of navigation." Dynamic complexity refers to "the degree to which users find the relationship between the navigation actions and the outcomes resulting from the actions ambiguous, uncertain and unpredictable."

In our study, we deemed that subjective or perceived complexity was more appropriate as an independent variable. Perceived complexity is the subjective feeling of complicatedness when visiting a Web site, is influenced by objective site complexity and reflects the cognitive aspects of individuals. It discounts the effects of familiarity and meaningfulness, and reflects real factors that impact other subjective experiences (Huang 2000). In regard to flow experience on the Internet, no study has examined the effects of Web site complexity on perceived challenges and skills, except a single study that examined the effect of perceived complexity (in terms of information load) on the occurrence of flow (Huang 2003a). Thus, in regard to the relationships between perceived complexity and perceived challenge and between perceived complexity and perceived skills, we tested the following hypotheses:

Hypothesis 3a. As perceived site complexity increases, the balance of perceived challenge and skill decreases.

Hypothesis 3b. As perceived site complexity increases, perceived challenge increases.

Hypothesis 3c. As perceived site complexity increases, perceived skill decreases.

Compared to the multi-aspect conceptualization of Web site complexity, the information load approach taken by Huang (2000, 2003a) seems too simplistic in that it only focuses on structural aspect of a site. The approach in our study is more comprehensive. First, the underlying multi-dimensional structure of perceived site complexity is investigated. However, results from our pilot studies did not support the three-dimensional structure of perceived site complexity proposed by Nadkarni and Gupta (2003). For discussion please refer to Appendix B. Secondly, in manipulating objective characteristics of complexity, we follow the methods by Nadkarni and Gupta (2003) and Nadkarni (2004). Both structural and content complexities are taken under consideration when selecting Web sites to be as the treatment with high and low objective complexity. For discussion of Web site selection and operationalization of objective site complexity, please refer to later Section 4.4. In data analysis, the following hypothesis will be tested as manipulation check.

Hypothesis 4. Perceived complexity is higher for Web sites with high objective site complexity.

3.3.3 Other Factors

There are other important factors involved in shopping, such as the product and the nature of the shopping task. In this section, we discuss their impacts and how we treated them in our research.

3.3.3.1 The Product

There is no doubt that the product at hand impacts consumers' perceptions of the challenge and skill. Two aspects related to the product are the complexity of the product

and shoppers' prior knowledge about the product. Although the product is not included in our model as an independent variable, actually the two aspects of it have been at least partially indirectly modeled or captured through content complexity, especially by the volume and novelty of content. Below is a brief discussion of the reasons.

Because shopping for a product is also a "choice task", how difficult this choice task is depends on task variables and context variables. Thus, from the consumers' perspective, the complexity of a product is related to how difficult it is to make a shopping decision about the product. Similar to any other kind of complexity, "the difficulty of the choice problem faced by the consumer will increase with more options and attributes, with increased uncertainty about the values of the attributes, if there are more attributes that are difficult to trade off, and if the number of shared attributes is smaller, among other factors" (Bettman et al. 1998). More mental effort and knowledge is required to make (1) a choice in a bigger choice set with more alternatives; (2) a choice involving products with a larger number of attributes; and (3) a choice in a product category with more variations in product attributes (Johnson and Payne 1985). Thus, people will feel a more complex choice task is more difficult than a less complex one, and will feel quite capable of making a decision in the less complex cases. We argue the content complexity of a commercial Web site includes the complexity of the products. For example, a more complex product may need more description than a simpler product. Furthermore, the presentation of variable attributes of a complex product is more critical for a customer to make a purchase decision.

On the other hand, consumer knowledge about certain products is an important aspect of consumer decision making (Bettman and Park 1980; Park et al. 1988). There is a distinction between objective knowledge and subjective (or self-assessed) knowledge (Park et al. 1994). Objective knowledge is the accurate information about the product stored in long-term memory, and subjective knowledge is the perceptions people have of what or how much they know about a product class. Both of them affect the way people process information when making a decision, but differently. Prior knowledge will affect the way we perceive how hard the decision is and how skillful we are. This prior knowledge can be measured by product familiarity. A three-level assessment of familiarity has been used in studies (Park and Lessig 1981). Low familiarity is defined as no information-search and use experience, and no ownership of the product; moderate familiarity is with information-search and/or use experience; and high familiarity is with information-search and/or use experience, and ownership of the product. The relationship between familiarity of the product and novelty of content of a Web site is evident.

Although product was not an independent variable in our study and was controlled for experimentation purposes, we were still faced the choice of an appropriate product in designing our study. We have to consider these two aspects of a product (that is, the familiarity of a product and prior knowledge of the product) in addition to the other attributes of site complexity in order to design a reasonable experiment that will invoke certain level of interest from subjects. To control familiarity in the study, the products selected are products of high familiarity among students. Also, prior

knowledge of the product is captured as a part of individual difference and can be controlled statistically if needed.

3.3.3.2 The Shopping Activity

The concept of "flow activity" refers to "those sequences of action that make it easy for people to achieve optimal experiences" (Csikszentmihalyi 1988). Of course, this does not mean that engaging in a flow activity guarantees the occurrence of flow. Csikszentmihalyi (1975, p.21) concluded that "activities are located on an autotelic continuum," based on the data collected for a variety of activities. This implies that activities are different in terms of their ability to induce flow. Chen et al. (1999) have studied Internet activities and found that some activities are easier for people to experience flow in than others.

Two broad categories of activities in which consumers engage during shopping are experiential and goal-directed. The distinctions are summarized in Novak et al. (2003). Goal-directed and experiential activities differ in terms of motivation (extrinsic versus intrinsic), benefits (utilitarian versus hedonic), orientation (instrumental versus ritualized), involvement (situational versus enduring), search mode (directed, prepurchase versus non-directed, browsing, ongoing), choice (goal-directed versus navigational), and results (planned purchases, repurchasing versus compulsive shopping, impulse buys). Goal-directed activities are thought of as more cognitive and "work"-oriented, while experiential activities are more affective and fun. What is noteworthy is that both experiential and goal-directed activities have goals, which is one of the preconditions of flow.

The nature of the shopping activity was posited and found to impact flow experience (Hoffman and Novak 1996; Novak et al. 2000; Wan and Nan 2001; Novak et al. 2003). It has been found that the interaction of Web site design features (static vs. dynamic) and motivations (information-seeking vs. entertainment) on flow experience was significant (Wan and Nan 2001). The shortcoming of their study is the omission of perceived challenge and skill, so that it is unclear how these two activities affect the occurrence of flow. Novak et al. (2003) found more evidence of flow for goal-oriented rather than experiential activities, although flow occurs under both scenarios. This finding was contrary to previous findings (Novak et al. 2000). Both studies could not assess perceived challenge and skill for different activities due to their designs. Thus, the question of how different types of activities affect flow remains unanswered. The findings are inconsistent because the differentiation of these two categories of shopping tasks is not as clear-cut as it initially appears. Consumers reap both hedonic and utilitarian rewards at the same time (Babin et al. 1994). There are situations when we engage in both experiential and goal-directed behaviors during shopping. For example, a grocery shopping trip, which is normally considered as a goal-directed shopping activity, can result in unplanned purchases too.

On the other hand, other factors of an activity need to be studied. According to flow theory, having a clear goal is one of the preconditions of flow in addition to the balance of skill and challenge. A clear goal can be found in both of the two modes of shopping. Here, goal has a broader meaning. It can be to make a purchase or to browse and gather information for a product. Having a clear goal or not is also situational, in

that it is related to individual visits. We may have clear goals during one visit but not during another.

The third precondition of flow is fast and clear feedback from the activity. Flow theory states that it is important the activity has a mechanism to provide people with quick and unambiguous feedback in order for people to have flow experience. Hoffman and Novak (1996) assume this feedback mechanism to be embedded in computer-mediated communication environments (including the Internet) because of its interactive nature. That is, the display of a Web page after a click on a link is the feedback the site provides to the visitor. Although their assumption is correct to some extents, we think more is needed to provide clear and fast feedback to Web site visitors than mere interactivity. From a visitor's point of view, a clear and quick feedback is the information provided by the site after an action, based on which she or he can easily make a judgment on whether her or his previous action is correct or not. Whether a site can provide such kind of feedback depends on several things, including the clarity of information on the page, whether the site design is logic, and the downloading speed. Normally, it is part of the characteristics of a Web site; however, we emphasize the situational and subjective nature of this factor. That is, whether a visitor feels getting quick and clear feedback during a particular visit to the site will affect her or his experiencing flow.

Thus we claim that types of shopping activities may not be as important as situational factors of activities, such as a clear goal and feedback, unless we can find solid evidence that those types of shopping activities require different sets of skills and

present different challenges. Little research in IS and Marketing has studied the effects of having a clear goal and feedback as antecedents of flow. Therefore we test the following hypotheses:

Hypothesis 5. Having a clear goal has a positive effect on flow experience.
Hypothesis 6. Having quick and unambiguous feedback has a positive effect on flow experience.

3.3.3.3 Individual Characteristics

In additional to characteristics of site, product, and task, another category of factors, characteristics of individuals, has been proposed and investigated for its impact on people's flow experience. Two aspects of individual characteristics which have been thought to be particularly pertinent, are (1) the individual's skills and knowledge in regard to the activity in question and (2) the personal disposition to feel flow and get involved.

In the context of online shopping, prior knowledge of computers and the Web, and product domain knowledge are definitely influential for perceived challenge and skill, thus in turn influencing flow experience. Web user experience (in terms of years of using the Web) has been found to be positively related to skills and negatively related to challenge (Novak et al. 2000). However, their study was just a general assessment. Skadberg and Kimmel (2004) investigated two relationships regarding challenge and skill. The first was the relationship between flow and skill, part of which was prior experiences with similar Web sites, and the second relationship was between flow and challenges, which was related to domain knowledge. We included prior experience and knowledge as an individual difference to be measured and statistically controlled.

Csikszentmihalyi (1975) defines "an autotelic person" as "one who is able to enjoy what he is doing regardless of whether he will get external rewards for it" (p.22). The ability to experience flow is part of an "autotelic personality", which is due to individual differences that are in part inborn, but certainly can be learned. We used this concept to claim that the disposition to feel flow would certainly affect the occurrence of flow in a particular situation. In order to account for the effect of this individual disposition as an important antecedent of flow, researchers have used several constructs, for example, microcomputer playfulness (Webster and Martocchio 1992; Agarwal and Karahanna 2000; Novak et al. 2000), personal innovativeness (Agarwal and Karahanna 2000), novelty (Novak et al. 2003), and cognitive spontaneity (Webster 1989; Ghani 1995). All of them have been found to have a positive relationship with flow. Since there is no established direct measure for "autotelic personality", in our study, we include microcomputer playfulness into the model to study its effect on flow. The hypothesis we will test is:

Hypothesis 7. Microcomputer playfulness is positively correlated with flow experience.

3.3.4 Consequences of Flow

In addition to clarifying the process by which Web site structure influences flow, we are also interested in the consequences of flow that serve as the dependent variables. We investigate (1) what value a flow experience in online shopping can bring; and (2) what implications we can draw for site designers and retailers. Although flow experience is "autotelic" and "provides few if any conventional rewards"

(Csikszentmihalyi 1975, p.10), the same activity may provide strong extrinsic rewards (Csikszentmihalyi 1975, p.21). However, sometimes it is difficult to draw a clean line between intrinsic and external rewards. Flow in online shopping provides both intrinsic rewards and external rewards. For example, finding useful information and making a purchase are two external rewards, while having a good time browsing is one of the intrinsic rewards. In relation to Babin at el.'s (1994) dual-dimensional measure for consumer shopping values (hedonic and utilitarian), the internal rewards of flow are more related to hedonic values while external rewards are related to utilitarian values. People benefit from both. Huang (2003a) showed that flow enhanced both utilitarian and hedonic performance.

We examine the consequences in terms of three aspects -- cognition, affectivity, and behavior (Wan and Nan 2001), and the relationships among those aspects. Although we list the consequences of flow below in three separate groups, those variables might be correlated. Relationships among those aspects are discussed as well.

3.3.4.1 Cognitive Evaluation

Web-based activities have both cognitive and affective aspects (Wan and Nan 2001). Flow itself is a cognitive state. The high concentration and involvement that people feel during flow and the reinforced self that people feel afterwards are rewarding. In addition to those, researchers have investigated post-flow evaluation of the site, the experience, and the technology involved in order to evaluate the external rewards of flow. Studying this aspect makes it possible to assess how flow influences the opinion that a visitor has.

Cognitive absorption, a concept similar to flow, was found to positively influence the perceived usefulness of the web technology (Agarwal and Karahanna 2000). Web excitement, which consists of 12 items measuring respondent's flow experience on the Web, is correlated with the cognitive evaluation of the site (i.e., Web structure and Web efficiency) (Wan and Nan 2001). Particularly, attention was found to be a significant facilitator of utilitarian performance (Huang 2003a). So we propose the following hypothesis:

Hypothesis 8. Flow experiences cause perceived usefulness of the site.

3.3.4.2 Affectivity

Emotions, such as pleasure and arousal, are important components of intrinsically valuable time and consumer hedonic value. Since flow is an engrossing, highly enjoyable experience, it is only natural for people to develop a positive emotion when in flow (Csikszentmihalyi and LeFreve 1989; Hoffman and Novak 1996; Huang 2003b). Therefore, positive emotions are a major part of the intrinsic reward for an individual visitor. It has been found that affect, potency, creativity, satisfaction, and motivation are all higher in flow states than in non-flow states, no matter whether the activity was for work or leisure (Csikszentmihalyi and LeFreve 1989). Wan and Nan (2001) found a significant interaction effect of Web design and surfing motive on positive emotions. They found that Web excitement generated positive emotions. Another study found that control and intrinsic interest dimensions of flow have a greater impact on hedonic performance than on utilitarian performance (Huang 2003a).

Emotional responses can be sorted into three dimensions: pleasure, arousal, and dominance (PAD) (Mehrabian and Russell 1974, p.8; Donovan and Rossiter 1982). Although there are competing typologies of emotions in consumer behavior research, it has been demonstrated that PAD is better in terms of reliability, internal validity, and external convergent validity (Havlena and Holbrook 1986). Several studies have used part of this measure (e.g., Novak et al. 2000). Csikszentmihalyi and LeFreve (1989) used a similar measure for affect and potency. Originally, all three dimensions were included in the model and corresponding hypotheses were derived. The data from pilot studies, however, did not support the dimensions of arousal and dominances, in that they had low reliability and no proper factor structures emerged. Therefore, in current study, only pleasure will be included in data analysis.

Hypothesis 9. Flow experiences cause positive emotional responses, pleasure.

3.3.4.3 Behavioral Intentions

This aspect is of special importance to online retailers and has been the most common outcome in previous research. Applying the notion of flow, Hoffman and Novak (1996) listed increased learning and exploratory and participatory behavior as the behavioral results of flow in computer mediated environments. Novak et al (2000) found that exploratory behavior was associated with telepresence, and increased learning was found to be positively associated with flow when browsing a Web site (Skadberg and Kimmel 2004).

Intention to return is also a behavioral indicator of interest to researchers and retailers. Nel et al. (1999) found a significant positive relationship between flow when using a Web site and the likelihood of that site being revisited. So did Wan and Nan (2001). Shopping enjoyment as well as perceived usefulness has a significant relationship with the intention to return, although no flow elements have an effect on unplanned purchases (Koufaris 2002). Skadberg and Kimmel (2004) have found that increased learning in current session leads to future return and learning intention. So, we propose:

Hypothesis 10. Flow experiences causes positive behavioral intentions toward the web site.

In this section, the research questions and hypotheses are presented. First, attempting to address the lack of validated flow measure in IS field, a validity study using multiple approaches is proposed. There are three sub-studies. Second study investigates a comprehensive mode of flow. In this model, all theoretical dimensions of flow are included. All preconditions of flow are incorporated as direct determinants of flow. Site complexity is posited as the external factor. Also consequences of flow in online shopping scenario are of interest. In the next chapter, the research methodologies used to investigate those questions are laid out.

CHAPTER IV

METHODOLOGY

Figure 4.1 on next page shows the steps in the overall research plan. The first step was to review the literature and develop a model based on prior research and our own ideas about the impact of flow on online shopping. A pilot study was conducted to provide insight on the channel models of flow in online shopping environments and to test the constructs involved. The purposes of this exploratory study were (1) to assess the flow experience in Internet shopping using the 4-channel model; and (2) to test measures of relevant variables. Our research plan evolved based on the results of the pilot study and an extended literature review. We modified our plan to include a more thorough validity study for flow measures in response to the unsatisfactory performance of the flow measures in the pilot study. This was also motivated by the discovery of a flow scale in sports psychology that had previously been validated, the Flow State Scale (FSS). Eventually our project consisted of two studies: a validity study for flow measures (Study 1) using multiple approaches and an investigation of flow in the Internet shopping (Study 2) by a controlled experiment.

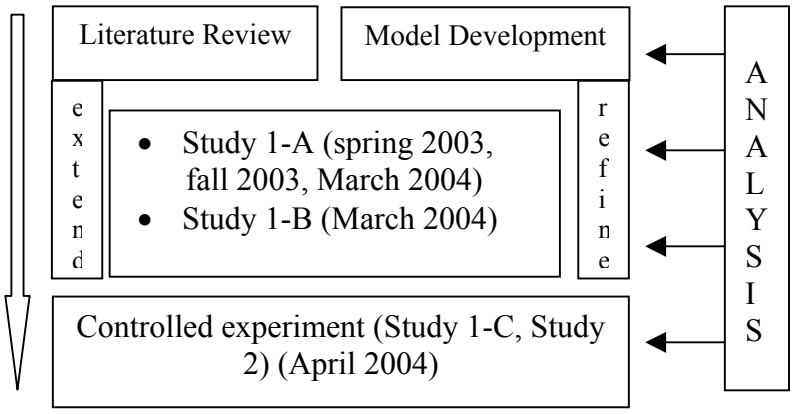

Figure 4.1 Research Design

In the validity study, there were three sub-studies. Study 1-A used mouse movements of subjects to identify behavioral correlates of flow. The mouse movement data were collected from three similar experiments. How to utilize and analyze the rich mouse movement data presented a big challenge. We developed a set of procedures to transcribe and code mouse movement data. Then we tested whether movements correlated with flow ratings. Study 1-B was a construct validity study of nomological networks of flow. We made sure to use techniques to reduce the memory loss and distortion typically associated with survey methodology. The data collected in Study 2 happened to allow us to carry out a factorial validity study for flow measures using a bigger sample size, which became Study 1-C. The main purpose of the controlled experiment (Study 2) was to investigate the effect of Web site complexity on flow experience and the relationships between flow experience and outcome variables. A comprehensive procedure was used to select existing Web sites so that they

operationalized site complexity both properly and realistically. A nested experimental design enabled us to examine the effects across product categories. This chapter will discuss methodological aspects of abovementioned studies including the pilot study.

4.1 Pilot Study

We chose to discuss the design of and briefly report results of the pilot study because we felt it was important. Not only did it provide us a chance to try out measurement and experimental procedures, but also it showed that flow occurred in Internet shopping, which is worth reporting. In the study, mouse movements were captured using screen-capture software, which led us to conduct a study to identify behavioral correlates of flow states in order to assess construct validity for self-reported flow measures. This study eventually became part of Study 1-A.

4.1.1 Design

The pilot study was conducted spring of 2003. Student subjects were recruited to carry out a shopping task in a computer lab. A total of 126 students from MIS courses in a major southwest university participated (69 males and 57 females). They were junior and senior business majors and experienced Internet users. Subjects were shopping for CDs, DVDs, or video games from a Web site assigned to them. The products were decided by a poll when subjects were signing up for participation. One of two Web sites was randomly assigned to the subjects. The two Web sites were www.amazon.com and www.cdworld.com. They were comparable sites in that they had a relatively similar product assortment, and had considerably large collections to meet the various needs of the subjects. At the same time, they were different in terms of content, design style, and

familiarity. Www.amazon.com is an award-winning, popular site while www.cdworld.com is a simpler looking, lesser known site. Using the two contrasting sites gave us a chance to look at the impacts of design and familiarity. Incentives for participants included extra credit for their class and entering a drawing for one of six $50 prizes towards their planned purchase. The task was designed to maximize the relevance and involvement of participants in order to overcome the shortcomings of using students as subjects.

In terms of procedures, subjects first answered a pre-shopping questionnaire to collect demographic data (gender, age, major, level), previous computer usage and attitude, previous online shopping experience and attitude (3 items), and novelty (3 items). One special methodological treatment in this study was using the Experience Sampling Method to capture "on the spot" data concerning shoppers' internal states Csikszentmihalyi and Csikszentmihalyi (1988). As subjects interacted with the Web sites, a two-page Experience Sampling Form was scheduled to pop up once. Since we thought the sampling method might interfere with the subjects' train of thought, we decided to only use the sampling form once. In the questionnaire, there were 7-point scales for flow [8 items], semantic differential scales for emotional states (18 items, 6 items for each of Pleasure, Arousal, and Dominance) taken from Mehrabian and Russell (1974), and 7-point scales of in-progress responses and feelings about the current activity (12 items). There was also a self-assessment question on whether subjects perceived they were in flow. Subjects were asked to answer these questions right away once the form appeared. Once they finished the questions, they could go back to

shopping. Since there is no research on how long it would take to establish flow, we used a random number from 5 to 7 minutes after the subjects starting shopping, which was used as the interval in Chen et al. (1998).

Upon finishing shopping, subjects would answer a post-shopping questionnaire to collect data on shopping outcomes. In this questionnaire, besides the 7-point scales for shopping outcomes (intention to return to website, goal fulfillment, and Web site attitude and perceptions, total 7 items), open ended questions were asked to gain insights on Web site features in terms of being helpful and easy to use. Also, a self-assessment of flow was included to deal with the cases in which subjects felt flow after the sampling questionnaire.

4.1.2 Data Analysis and Results

Factor analysis was used to identify distinct factors in our measures. The individual difference scales factored into Overall Online Shopping Attitude (3 items) and Novelty (2 items, dropping one). The emotional state scales (Pleasure, Arousal, and Dominance) factored as expected, but exhibited low reliability coefficients (Arousal and Dominance were under .70.) caused concern. In-progress responses also factored into Responses to Activity, Responses to Site, and Preference. Shopping outcomes factored into two factors (Fulfillment and Post Shopping Attitude) instead of the three factors we anticipated. We believe that was because the originally proposed three factors were quite closely interrelated.

The main question of this study was to investigate the presence of flow in Internet shopping. We developed measures for flow based primarily on the dimensions

described and used by Csikszentmihalyi and Csikszentmihalyi (1988). Flow theory implies that subjects will describe their experience differently, depending on the channel they are in, which is determined by the ratio of challenge and skill. In the sampling form, questions corresponding to a very broad spectrum of dimensions of experience were included. These dimensions referred to cognitive involvement (concentration, involvement, etc.), affective states (pleasure, arousal, and dominance), and motivational states (behavioral intentions). The positive end of each of these dimensions was expected to be more typical of flow (Massimini and Carli 1988). Based on the 4-channel model of flow, we classified cases into four groups based on the z-score of reported challenges and skills in the sampling form. We labeled cases using the rules in the following table (Table 4.1).

Table 4.1 The 4-Channel Flow Model and Coding Rules in the Pilot Study

Skills	**Challenges**	**Coding**	**Z-score of Skills**	**Z-score of Challenges**	**# of cases**
High	High	**Flow**	Positive	Positive	26
High	Low	**Boredom**	Positive	Negative	53
Low	Low	**Apathy**	Positive	Negative	22
Low	High	**Anxiety**	Negative	Positive	25

The average scores on each dimension are presented in Table 4.2. The results display a pattern similar to those reported by Massimini and Carli (1988). Channel 1, which is supposed to be the optimal experience, has the highest scores on most flow dimensions. Since related questions were worded in a way so that a lower score reflects more pleasure, channel 1 had the lowest score on the PScore, AScore, and DScore,

which are composite scores for Pleasure, Arousal, and Dominance respectively. This means that subjects felt the most pleased, most aroused, and most dominant in the situation in channel 1. Channel 1 also had the highest score on Exploratory Intention, but not on Satisfaction and Success, on which channel 2 had the highest scores. This can be explained by recognizing that skill plays a more prominent role in performance-based judgments. However, except for the PScore, none of the differences are statistically significant at 0.01 level. Lack of significance may be due to several reasons. First, Internet shopping is no doubt less exciting than rock climbing and playing games online. As a result, the occurrence of flow might be less frequent and less intense. Second, looking for an assigned product in a crowded computer lab may have distracted subjects and made it difficult for them to achieve flow. Third, the reliability of some of the measures was relatively low.

Table 4.2 The Quality of Experience by Channels

Channel		**1**	**2**	**3**	**4**
		Flow	Boredom	Apathy	Anxiety
Number of cases		*26*	*53*	*22*	*25*
1	Concentration	5.42	5.08	4.5	4.96
2	In Control	6.5	6.57	6.14	6
3	Involvement	5.62	4.96	4.36	5.04
4	Loss of track of time	3.35	3.42	3.23	4.24
5	Enjoyment	4.88	4.79	4.27	4.36
6	Telepresence	3.15	2.17	2.14	2.48
7	Satisfaction	5.92	6.15	5.09	4.24
8	Success	5.54	6.23	5.41	3.96
9	Exploration Intention	5.04	4.60	4.23	3.8
10	PScore	2.89	3.08	3.52	3.63
11	AScore	4.45	4.58	4.73	4.26
12	DScore	3.39	3.62	3.83	3.81

One of the purposes of this study was to probe relations among constructs of interest. Although no conclusions about causal relationships can be drawn, we can still gain some insights. Correlations are presented in Table 4.3. The directions of these correlations make sense. One interesting result is that Challenge, the assessment for challenges presented by the assigned shopping task, does not have a significant correlation with Overall Challenge, the assessment of overall challenge of using the Internet and shopping online. With the exception of a negative correlation with OverallSkill and Skill, OverallChallenge does not correlate significantly with any other variable. It may be that the Internet is so commonplace and our subjects are such experienced users that OverallChallenge is no longer a differentiating variable. But perceived Skills and Challenge of a particular activity are still factors affecting people's experiences. It can be seen that Satisfaction and Success have a positive correlation with both OverallSkill and Skill, and a negative correlation with Challenge.

FlowScore (the composite score of all questions for flow dimensions) is positively correlated to OnlineShopping attitude, OverallSkill, and NoveltyScore, but not to OverallChallenge, Challenge, or Skill. This may appear surprising at first, but FlowScore has a positive correlation with Satisfaction and Success, which are correlated with Challenge and Skill. Moreover, in our analysis in last section, it has shown that the ratio of challenges and skills is a good indicator of flow experience. Lack of correlation may be the result of a nonlinear relationship. The perceived Importance of and Preference toward the activity are correlated with the FlowScore.

Table 4.3 Correlations among Constructs

	Online-Shopping	Overall-Skill	Overall-Challenge	Novelty Score	Challenge	Skill	Satisfac-tion	Success	Impor-tance	Attitude1	Fulfill-ment	PScore	AScore	DScore	FlowScore	Post-Attitude	InSite-Attitude
OnlineShopping	1.000																
OverallSkill	**0.815**	1.000															
OverallChallenge	**-0.354**	**-0.538**	1.000														
NoveltyScore	0.058	0.018	0.186	1.000													
Challenge	0.159	0.045	0.126	-0.002	1.000												
Skill	**0.284**	**0.430**	**-0.273**	0.076	***-0.219***	1.000											
Satisfaction	0.133	**0.219**	-0.138	0.139	**-0.366**	**0.481**	1.000										
Success	0.117	**0.207**	-0.147	0.064	**-0.477**	**0.484**	**0.673**	1.000									
Importance	**0.250**	0.108	0.037	0.153	0.100	0.053	**0.243**	0.105	1.000								
Preference	**0.273**	0.276	-0.142	0.154	-0.040	**0.287**	**0.417**	**0.327**	0.162	1.000							
Fulfillment	-0.170	-0.144	0.078	0.163	**-0.238**	0.097	***0.206***	**0.307**	0.094	0.145	1.000						
Pscore	-0.117	-0.146	0.023	-0.070	0.085	-0.263	**-0.439**	**-0.463**	**-0.235**	**-0.643**	**-0.238**	1.000					
Ascore	0.024	0.017	-0.032	-0.152	**-0.235**	0.030	0.097	0.054	-0.038	-0.103	-0.153	0.095	1.000				
Dscore	***-0.192***	**-0.245**	0.124	-0.029	-0.038	-0.242	***-0.208***	***-0.199***	**-0.272**	**-0.248**	-0.142	**0.375**	-0.072	1.000			
FlowScore	**0.238**	**0.205**	-0.097	***0.194***	0.033	0.155	**0.331**	**0.330**	**0.269**	**0.560**	**0.241**	**-0.442**	-0.037	-0.130	1.000		
PostAttitude	0.045	-0.006	0.061	**0.244**	**-0.235**	***0.189***	**0.462**	**0.422**	0.022	**0.346**	**0.539**	**-0.369**	-0.038	0.005	**0.399**	1.000	
InSiteAttitude	0.060	-0.002	0.019	***0.189***	-0.159	0.166	**0.419**	**0.404**	0.048	**0.462**	**0.463**	**-0.485**	-0.055	-0.092	**0.479**	**0.848**	1.000

Emotional states are not totally orthogonal. In our results, Pleasure and Dominance have a positive correlation, but there is no correlation either between Arousal and Please, or between Arousal and Dominance. Not surprisingly, PScore correlates with Satisfaction (and Success), Importance, and Preference. Among emotional states, the PScore is the only one correlated with the FlowScore. PScore also correlates with InSiteAttitude, PostAttitude, and Fulfillment. Dominance correlates with OnlineShopping and OverallSkill and attitude variables toward the activity at the moment. Arousal only correlates with Challenge, which is expected from the theory of flow in that a certain level of challenge keeps subject from feeling bored and apathetic. In regard other outcome variables, although the FlowScore has no correlation with InSiteAttitude and PostAttitude, it has a positive correlation with Fulfillment. It may seem surprising first, however, PScore correlates with InSiteAttitude and PostAttitude and PScore correlates with FlowScore. Thus, there may have a mediating relationship.

We also tried to discover factors that lead to flow experience. Other than the variables aforementioned, we also examined the effects of gender, familiarity, and site by mean comparison. Male participants had slightly higher InSiteAttitude ($p<0.05$), and PostAttitude ($p<0.05$) than female participants. And they reported lower scores in FlowScore ($p<0.01$). The relationship between gender and flow needs further examination.

Familiarity was coded according to subjects' responses as to whether they had visited the site before. Eighty-seven subjects were not familiar with the assigned Web site. It was thought that an unfamiliar site might present a bigger challenge, and then

affect flow experience. Participants reported a lower Challenge, higher Skill, higher FlowScore, and higher levels of emotional response for a familiar site; however, mean comparisons did not show any significant difference in those variables. On the other hand, subjects reported significantly higher InSiteAttitude and PostAttitude in a familiar site (both $p < 0.01$).

The effects of the sites were also examined. Half the participants were assigned to www.amazon.com and the other half to www.cdworld.com. Amazon visitors reported slightly higher Skill and lower Challenge, and had a higher score in flow and emotional responses, though none of them were significant. Subjects did report a significantly higher score in InSiteAttitude, PostAttitude, and Fulfillment. The results are similar to those with Familiarity. It is reasonable in that www.amazon.com is a much more popular site than www.cdworld.com, and most participants assigned to amozon.com reported that they were familiar with the site.

4.2 Study 1-A

In this study coding of subjects' mouse movement was used to identify patterns and indicators (if any) of flow in using the Internet. The procedure for all three studies that comprise Study 1-A (Study 1-A-1, Study 1-A-2, and Study 1-A-3 in Table 4.4) was similar. College students taking Information Systems classes were asked to participate in these studies in return for extra credit in their courses. Before visiting an assigned Web site, subjects were asked to fill out a pre-shopping questionnaire regarding their Internet usage and demographic data. Then they were directed to a Web site. They were asked to surf the site for a while and behave like a "real shopper." A sampling

questionnaire was scheduled to pop up after 5 to 7 minutes. A major part of the sampling forms included items for flow, emotions (in terms of pleasure, arousal, and dominance), perceived usefulness, and intentions. Then subjects were asked to go back shopping until they felt their goal was met. A post-shopping questionnaire collected data based on subjects' experience after the sampling form; thus items on the forms were similar to those of sampling forms. When visiting an assigned Web site, subjects' mouse movements were captured in individual video files with screen-capture software.

Table 4.4 Study 1-A: Behavioral Correlates of Flow

Study	Flow Measure	Time	# of Subject	Analysis
1- A-1 (the pilot study)	ESF	Spring 2003	126	1. develop an initial set of behavioral categories using 10 subjects 2. refine those categories using another 10 subjects
1- A-2	IFS	Fall 2003	55	Compare 10 subjects
1- A-3	FSS	Spring 2004	79	Compare 10 subjects

The major difference among the three studies was in the questions regarding flow experience. Subjects' reports of flow experience were measured in all three studies by sampling forms, although different scales were used in each study. In Study 1-A-1, conducted in the spring of 2003, flow was measured using 7 questions based on the original Experience Sampling Form developed by Csikszentmihalyi and Csikszentmihalyi (1988). One question per dimension of flow was used. In Study 1-A-2 conducted in the fall of 2003, flow was measured using the Internet Flow Scale, a scale

comprised of the "best of breed" scales used in previous Information Systems research on flow. In Study 1-A-3, the Flow State Scale was used as the measure for flow experience. Thus each study was designed to provide validity evidence linked to behavioral correlates for a different flow scale. There were also other minor modifications, such as rewording of certain questions and changes in the Web sites involved, but they were not expected to detract from the comparability of the results since the focal point of our study was to identify behavioral characteristics of being in flow and not in flow. Details for these studies can be found in previous section and Appendix B.

4.2.1 Transcription

The first step in data analysis of Study 1-A was to transcribe the video files from the studies in which they were collected. First we transcribed a set of video files of 10 subjects. Those 10 were selected from the 126 subjects of Study 1-A-1 based on their flow scores, which were the summation of questions measuring flow. We chose the five subjects out of 126 with the highest flow scores on ESF and the five with the lowest ESF scores. The principal researcher first transcribed the videos and provided a set of instructions on how to transcribe the video. Another researcher looked at the videos and original transcripts, adding any missing information based on the transcribing instructions. If necessary, the transcribing instructions were refined as well. The principal researcher viewed the videos and transcripts again, discussing with another researcher about additions and reconciling the changes. The video files of mouse movements were generated by screen-capture software (Camtasia®) (Techsmith, Inc.).

Subjects were asked during the experiment to activate the software before they visited the Web site. Thus, the whole session was captured by it. For the purposes of our study, we transcribed the part of the session starting with when subjects accessed the web site until the time when the sampling forms popped up. Transcripts were thus naturally segmented into pages. One segment consisted of a group of mouse movements on one Web page (please see the excerpt of a segment in Figure 4.2). We use the term "mouse movements" in a broad sense to also include other actions of Web site visitors (such as typing) and events such as the appearance of messages. Each segment had two parts. The first part is the title line, in which we recorded the type and content information of the page. To make the transcripts as consistent as possible across different Web sites, we classified Web pages into several broad categories, such as Home page, department page, product page and so forth (See Table 4.5). In Figure 4.2 a department page is shown and the department is Movies.

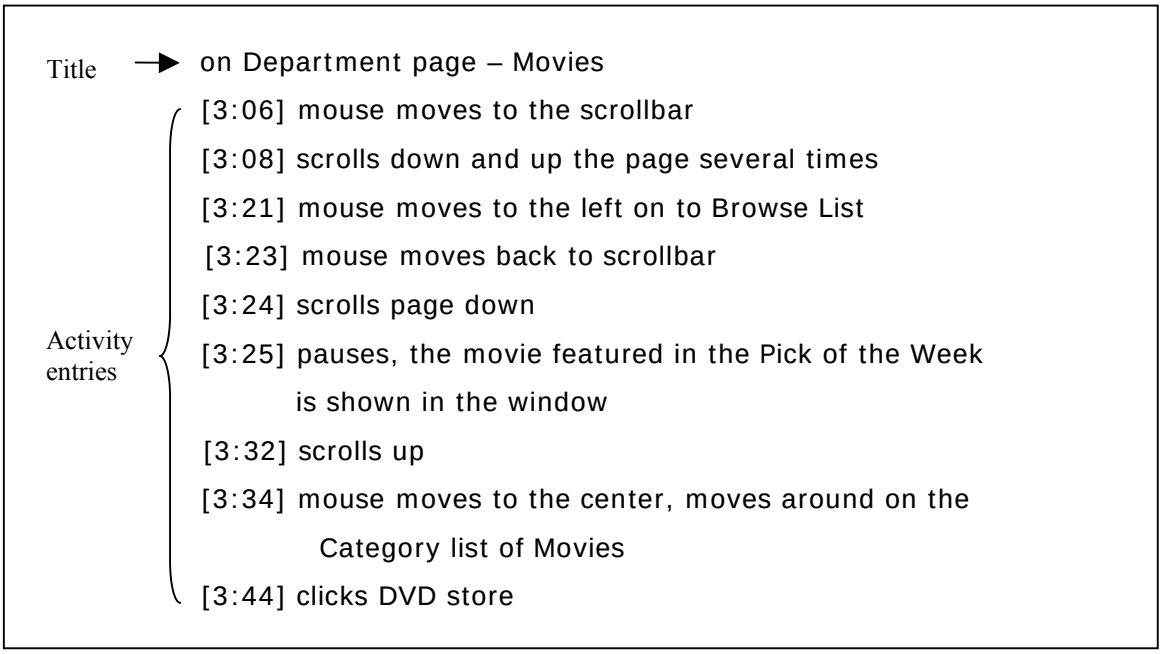

Figure 4.2 An Excerpt of Transcript

Table 4.5 Web Page Types

Types of web page	**Definition**
Home page/root page	The beginning of the web site.
Store pages and department pages	These pages present information on a broad group of products. For example, Women's or Men's sections in a department store.
Category pages and subcategory pages	These pages present information of a finer group of products. For example, Women's coats or dresses.
Product list pages	These pages list a group of products within a category or subcategory.
Product pages	These pages feature one product and present detailed information. There also may be pages presenting one aspect of product, such as Larger Image page.
Search result pages	These pages present search results; normally a page listing all or partial results list.
Transaction pages	Pages involved in completing a transaction, such as sign-in page, billing address page, and payment page.
Functional pages	These pages provide useful functions, such as advanced search engine page and informational pages.

The second and major part of a segment is the activity entries describing mouse movements and events. Normally, each entry is an action or an event that cannot be broken down further. For each entry, there is an associated time stamp. Thus, we can calculate how long it takes to accomplish the action. For example, it took the subject in Figure 4.5 two seconds (from 3:06 to 3:08) to move the mouse to scrollbar and she or he spent 13 seconds (from 3:08 to 3:21) scrolling the page up and down. Other information we thought relevant to visitors' actions were recorded as well for example, appearance of a popup advertisement or an Internet Security warning message, or a broken link (i.e., Error 404). There were more subtle things that could affect subjects as well. For an instance, one mistake a Web site makes is having extra items in shopping cart, which might be put in by previous user.

4.2.2 Coding

The next step was to code the transcripts. The development of initial categories of behaviors related to flow states was in part deductive, i.e., based on our expectations of the differences that would occur in Web behavior given flow theory, and in part inductive, in that some categories were suggested by analysis of the set of 10 transcripts. Categories were defined based on behaviors that were expected to indicate that subjects were in flow, those indicating that subjects were out of flow, and certain events that could prevent subjects from being in flow. Once an initial set of behavioral categories had been developed, another 10 subjects were used to confirm and refine the behavioral categories. Selection of subjects was similar in that the five with the next highest flow scores and the five with the next lowest scores were sampled. The development of

category systems was difficult because some behaviors that originally seemed related to flow were not able to be coded and others were too difficult to measure in an objective fashion. This difficulty was partly due to the fact that flow is basically a subjective and cognitive state. However, there were still certain aspects that we could infer with some confidence from observable behaviors. The categories resulting from this process are shown in Table 4.6. The detailed transcribing and coding procedure can be found in Appendix C.

Before getting into the discussion of each correlate, one point worth noting is that those correlates are merely possible symptoms of being in flow or not in flow, but that they do not provide certain inferences. For example, P1-2 states that using search engine to look for a product is a sign of having a clear goal. Since whether a subject has a clear goal or not can only be assessed by asking the subject the question directly, it is impossible to know for sure by just looking at their behavior. However, if she or he uses a search engine to search for a particular product, normally it is plausible to infer that the visitor has something in mind and thus has a clear goal.

Table 4.6 Behavioral Categories of Flow

Correlates	Symptoms	Level
Positive		
Clear goal		
P1-1	Browsing products in one category	Whole session
P1-2	Use of search engine	One activity entry
Concentration		
P2	Systematic mouse movements	One segment
Mergence of activity and awareness		
P3-1	Going through product hierarchy from top to bottom consecutively (3 or more pages)	A group of segments
P3-2	Going through pages at same level consecutively (3 or more pages)	A group of segments
Negative		
Navigation problems		
N1-1	Trying alternative ways of reaching the product	A group of segments
N1-2	Going back and forth	A group of segments
N1-3	Nonsystematic mouse movements	One segment
Interruptions		
N2-1	Advertisements	One activity entry
N2-2	Task-related messages	One activity entry
Errors		
N3-1	Technical errors on the web page	One segment
N3-2	Logical flaws on the web page	One segment
N3-3	Mistakes made by visitors	One segment

There were two kinds of behavioral categories: positive correlates and negative correlates. The positive correlates represent an appearance of flow preconditions and dimensions. Not all the preconditions and dimensions of flow are observable from mouse movements and actions. Some are more observable than others. For example, the balance of perceived challenge and skill is normally difficult to see directly, except that the visitor may run into trouble when trying to find a particular product, which on

the other hand is a negative sign of unbalance. It would also be difficult to find observable behaviors that can be measured in an objective fashion for certain dimensions, for example, loss of self-consciousness and the sense of time distortion. Based on an analysis of the preconditions and dimensions of flow, three aspects with possible corresponding observable behaviors are a clear goal, concentration, and mergence of activity and awareness. Normally, having a clear goal can be manifested into two behavioral actions: searching for a product via search engine or browsing products in one category. Concentration and involvement are high when the visitors are absorbed by the Web pages. For instance, when a person spends a considerably long time on a certain page, along with scrolling down the page slowly and/or systematically, it is natural to conclude that she or he may be reading the page carefully. Thus, this can be taken to be a sign of high concentration. Concentration and involvement are likely to be indicated also by the mouse moving along the text line by line (sometimes even highlighting part of it) and the mouse moving through a list item by item. We term those behaviors "systematic mouse movement." The dimension of "merging of activity and awareness" means that activity "becomes spontaneous, almost automatic" (Csikszentmihalyi 1990, p.53). In the Internet shopping context, we can see a navigation pattern in which a visitor goes through the product hierarchy logically from top to bottom and/or goes through product list pages one by one. From the subject's view, the interaction is a smooth chain of actions. Thus, we concluded that this pattern is a positive sign of being in flow.

We also realize that there are signs of not being in flow or cases that make it harder for a visitor to get into flow. They are: navigation problems, interruptions, and various kinds of "errors." Navigation problems normally occur when visitors do not find what they want, or go to a page that is not what they thought it was. When navigation problems occur, it is very annoying and visitors become impatient very quickly. Sometimes they feel panicked and helpless. In those cases, visitors would try to solve the problem by going back to previous pages to start again or trying an alternative path; they may also stay on the wrong page to figure out what to do. Thus, navigation problems present a threat to the "sense of control" and "perceived balance of challenge and skills." Navigation problems manifest in behaviors across a group of pages or on a single page. For example, if the visitor does not achieve what in is in mind the first time, she or he may try alternative ways (N1-1), such as going back and taking another route or trying another search word. Second, if a visitor goes back and forth to one page or within a couple of pages, probably she or he is trying to figure a way out (N1-2). Also, when a visitor becomes frustrated, mouse movements may become quick and seem impatient, sometimes in a jumpy and irregular manner on a page (N1-3).

The second kind of threat is the interruption. In order to be in flow, visitors have to be in a series of seamless transitions both physically and cognitively. An interruption will break this cycle. Common interruptions are pop-ups, dropdown, floating, or even jumping advertisements (N2-1). There is another kind of message boxes we all encounter when surfing online, such as "Secure Connection" and "Cookie Alert." These fall into the category of N2-2. Based on our observation, those message boxes do not

seem to bother visitors as much, but still they interfere with visitors' action. In most cases, when a message box occurs, subjects dismiss it right away in a reflexive matter and resume whatever they were doing. On the hand, advertisements are quite different in that they are designed to catch people's eye and they often do, and as a result they break the train of thoughts of visitors. Subjects seemed to make an effort to comprehend them and then dismiss them or even follow them in some cases. However, we included both kinds of interruptions into our coding system, only differentiating them for later analytical purposes.

The third kind of threats is "errors" by Web sites and by visitors. There are three broad types of errors a Web site can make. The first is due to some technological problem or difficulties (e.g., unavailable servers or network problem), such as broken links, page is not found, or page cannot be displayed. This definitely has considerable effects on visitors in that they have to rethink their next action. The second kind is subtler in that Web pages are displayed correctly, but the content has flaws in it. This kind of error is mostly the result of imperfections in design and programming. One example of this is extra items in shopping cart left from previous visitors. Another example is no special message for "no item in this category", rather a blank list, leaving the visitor to figure out what that means. Those errors confuse visitors. Also, although "no result" of a search is logically correct, it still affects the visitor in a way that will not allow them to further what they initially intend to do. The third kind of errors are those made by visitors themselves. For example, they input the wrong search word or click the wrong button. They may realize it right away and correct it, or the mistake may

cause more confusion later. In summary, all these errors have the potential to confuse visitors and change their course of actions.

From the discussion above, we can see these behavioral correlates occur at different level. Some occur on one page/segment and some can only be observed by examining a group of segments. In order to address this issue, we first code the transcripts segment by segment. For each segment, we filled out a coding card, see Figure 4.3. Then, we drew a diagram depicting the subject's trace tree (Figure 4.4). By examining the trace tree, we can code correlates that can only be observed by looking at multiple segments. When coding, the transcripts were the major basis; however, video files were used in cases in which the situation was not clear enough from the textual description. Detailed coding rules and explanations are supplied with the coding card and diagram, which can be found in Appendix C.

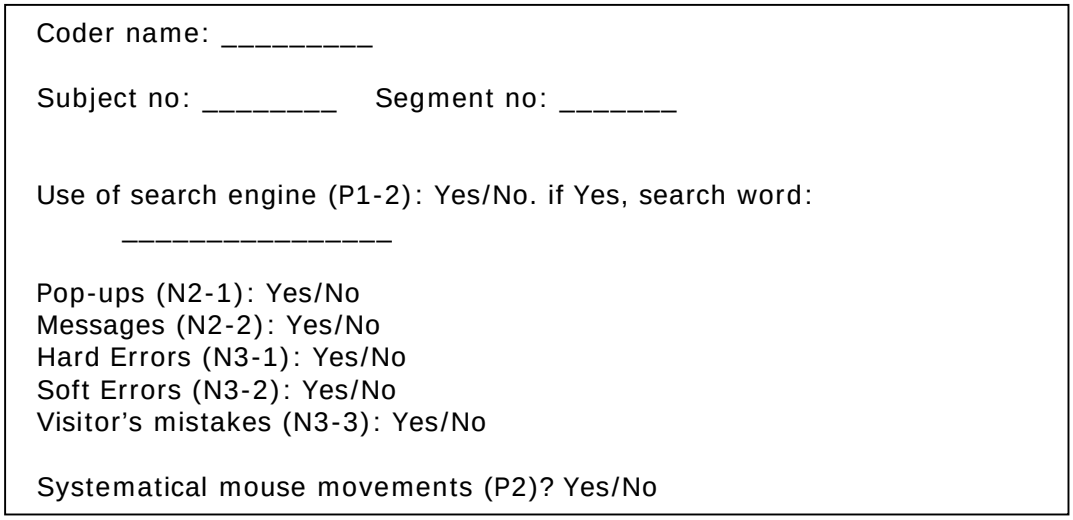

Figure 4.3 A Coding Card

The second coder was trained by coding three cases together with the first coder. Then after two coders coded another three cases independently, disagreements were discussed and resolved. Finally, four more cases were coded by two coders independently. The results were used to compute inter-coder reliability. From the coding rules, it is evident that there is only one category that requires subjective judgments by coders, which is systematic vs. non-systematic mouse movement (P2 vs. N1-3). Thus there is a need to calculate inter-coder reliability for this category. In these four cases, there were total 46 segments, inter-coder reliability (Cohen's Kappa) was .792 and significant (t = 5.789). Since Kappa has the tendency to be overly conservative (Neuendorf 2002, p. 151), we were satisfied with the level of coder reliability. For other correlates, we summarize the percentage of agreement in Table 4.7. The average agreement is 88.64%. Thus, the first coder coded the rest of the cases. During the whole time of training and coding, flow score information was removed and kept away from the coders.

Table 4.7 Percentage of Agreement for Behavioral Correlates

Correlates	Percentage of Agreement
P1-1	75%
P1-2	100%
P3-1	75%
P3-2	75%
N1-1	100%
N1-2	75%
N2-1	75%
N2-2	100%
N3-1	100%
N3-2	100%
N3-3	100%

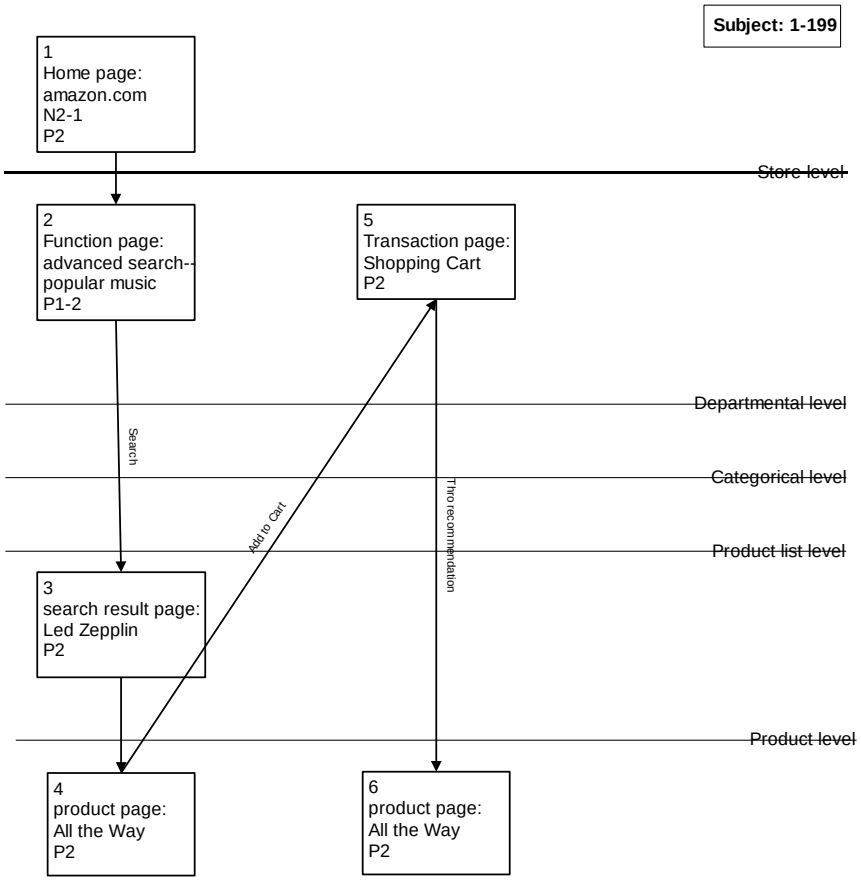

Figure 4.4 An Example of Trace Tree Diagram

If behavioral differences between subjects whose flow scores were high and whose flow scores were low resulted, it would be evidence of construct validity for the respective flow measures. Two major measures we examined for purposes of validity assessment were the Internet Flow Scale (IFS) and the Flow State Scale (FSS). Selected video files were transcribed for both Study 1-A-2 and Study 1-A-3. Because of the labor intensity of transcribing video files, we used 10 subjects for each study first, five with high flow scores and five with low flow scores. Transcripts were analyzed using the

previously developed behavioral categories. The number of correlates for individual cases were counted and summarized in a table. Naturally, we expected people in flow (subjects with high flow scores) would have more occurrences of positive correlates and fewer negative correlates than people not in flow (subjects with lower flow scores).

4.3 Study 1-B

Study 1-B was designed to test a nomological network including flow in two different contexts in order to gain insights in construct validity of flow measures. Two flow measures under investigation were the Internet Flow Scale (IFS) and the Flow State Scale (FSS) from the field of sports psychology. The two contexts were computer game playing and online shopping. Other related constructs as shown in Section 3.2 were skill for the activity, love for the activity, computer anxiety, and computer playfulness. The wording of the FSS items was modified slightly to fit into the gaming and shopping situations. The IFS was made up of various "best-of-breed" scales used in previous flow studies; for details of those scales please refer to Table 3.2 in Section 3.1. Concentration and enjoyment were assessed using two four-item scales by Koufaris (2002), which were designed for online shopping. Control was measured by a 5-item scale from Ghani (1995). Measurement for time distortion was adapted from a 5-item scale used by Agarwal and Karahanna (2000). Telepresence was measured using an 8-item scale developed by Kim and Biocca (1997), and used by Novak et al. (2000) and Klein (2003). No readily useable scales for mergence of activity and awareness and loss of self-consciousness in Information Systems research were available. We went back to the original work of Csikszentmihalyi, focusing on the essence of those dimensions, to

create our own questions. Questions for measuring perceived challenge (PC) and perceived skill (PS) were based on those by Koufaris (2002), but to deal with the fact that PC and PS are complex and multi-faceted concepts (Ellis et al. 1994), several additional questions were added to take the two situations into account. Computer anxiety was measured by a 4-item scale used in Thatcher and Perrewe (2002), which were selected from 19 items in the scale developed by (Heinssen et al. 1987). Playfulness was measured using the scale developed by Webster and Martocchio (1992). There were also questions regarding respondents' skills and attitude for the activities. All the responses were gathered using 7-point Likert scales that ranged from 1 to 7. See Appendix D for these questions.

Respondents were solicited from a group of college students taking communication and Information Systems classes. Subjects were asked to recollect their most recent experience playing a game or shopping online. Since two contexts were involved, there were two versions of the questionnaires. In order to reduce the effects of memory loss or distortion, only subjects were included who had played games or shopped online within a month before the time the survey was conducted. Respondent skill in game playing or shopping online was measured using self-report items. In a pretest, respondents were asked to indicate whether they had played game and/or shopped online in the past month. The version of the questionnaire corresponding to the activity they had engaged was given to them. In cases that they had engaged in both activities, the version given to them was chosen based on random selection using a random-number table. Data collection was conducted in the spring of 2004.

4.4 Study 1-C and Study 2

A controlled experiment was designed to collect data for both Study 1-C and Study 2. To recall the research model, please refer to Section 3.3. In this section, we will discuss issues of experimental design.

4.4.1 Experimental Design

The independent variable in this study was site complexity, an external IT related factor that we posited would influence one of the preconditions of flow: perceived skill and challenge. Two levels of Web site complexity were manipulated: High and low complexity. The experiment was complete nested design with two nesting factors: product category and Web site. At each level of complexity, there were four Web sites selected. These Web sites belong to two product categories: books & magazines and computers. And within each category, there were two Web sites. Thus, total eight Web sites involved. Nesting allowed us to test for and statistically control some of the differences due to aspects of Web site implementation which are unrelated to complexity.

Originally, three levels of two aspects of site complexity (structural and content) were proposed to study possible curvilinear relationship between complexity and other constructs. However, practical difficulties prevented the implementation of this design in this study. First, at least nine Web sites with different levels of complexity were needed to manipulate three levels of complexity. Since developing our own Web sites was not possible, it represented a huge challenge to select proper Web sites from our experiences in pilot studies. It would be almost impossible to find Web sites possessing

three levels of structural complexity while have same level of content complexity, vice versa. Also such a design with a large number of cells would request a large sample size, which sometimes can be difficult as well. Thus, we decided to combine the structural and content complexity as one site complexity factor and vary its levels as high and low. Thus, it gave us more room for selecting Web sites.

In order to insure that our manipulation was effective, we needed to find or develop Web sites that differed in degree of complexity. We had two choices: to develop our own Web sites or to use existing Web sites in the study. Both strategies have been used in previous research. For example, Koufaris (2002) and Skadberg and Kimmel (2004) used existing Web site, while Tarasewich (in press) used a site developed by researchers. Wan and Nan (2001) employed a hybrid approach by development a mirror site for a real commercial store and used these two Web sites as treatments. As will be explained below we decided to select existing Web sites of real online stores. In order to control for possible differences in content we decided to nest different instantiations of Web sites within the two levels of complexity. There were a total of eight Web sites involved in the design, two product categories with four Web sites for each. Within each level of complexity (high vs. low), there were two product categories, with two Web sites in each category. Each subject was assigned to one of the eight Web sites. Therefore, the design was a one way two level random effects nested experimental design with two nested factors: product category and Web site. We nested two specific Web sites within each product category and two product categories within

both levels of complexity. Nesting enabled us to test for and statistically control some of the differences due to those aspects of Web site that are not related to complexity.

The following sections explain how we selected Web sites, ranked them according to complexity, and selected those used in this study. Following this we describe the experimental procedures, measurement, and selection of samples.

4.4.2 Operationalization of Independent Variable and Web Site Selection

Our independent variable was site complexity, including both structural and content aspects. We employed existing commercial Web sites in our study, instead of building our own, although the advantages of building Web sites are obvious. Although using existing commercial sites can be limiting in terms of design styles and control over manipulation regarding independent variables, it provides the compensating advantage of "being real." The sites used in this study are working sites with vast selections of products and real information. They represent the way Web sites was designed and operated in real world, and thus increase the applicability of our study's findings to practice. To build a site to attain this level of reality would be prohibitive in terms of time, budget, and technical expertise for the current study.

In selecting existing sites, we adapted the procedure for Web site selection outlined in Nadkarni and Gupta (2003). A comprehensive list of 25 product categories was compiled based on the directories of the ten most popular search engines and Web directories, for example, yahoo.com, msn.com, and google.com. Appendix E presents the list of directories and the list of product categories selected. A group of over 40 Ph. D. students in a business school were asked to rate those product categories based on

their familiarity. They were asked to indicate five product categories that they were most familiar with and five that they were most unfamiliar with. Their responses were summarized to find out which sites were most familiar and which were most unfamiliar to people. These categories are listed in Table 4.8. There were reasons to be cautious about the results since the sample was rather specialized: most Ph. D. students were between 25 and 35, had low incomes, lived in rented apartments and houses, and were experienced computer and Internet users. Also a considerable number of Ph.D. students were international students. Although this list may not be generalizable to the total online population, it was useful for our study because college students, who were our targeted subjects, shared similar characteristics with the Ph.D. students.

For each of the most familiar Web site categories, five or six of representative Web sites were selected. They were drawn from the list of most popular Web sites in the yahoo.com directory, which posts a list of the ten most popular sites for all product categories. Thirty-two Web sites were included in the final Web site pool.

Table 4.8 Most Familiar and Unfamiliar Product Categories

	Most familiar category	**Most unfamiliar category**
1	Books & Magazines	Antiques & collectables
2	Computers	Tools & hardware
3	Clothing	Pets
4	Movies & Music	Garden & lawn
5	Consumer electronics	Flowers and Florists

The next step was to determine the structural complexity of the Web sites. A group of students from upper level and graduate supply chain classes was asked to be raters of Web sites. Each of the 32 Web sites was rated by two raters on over 60 objective attributes. There were two kinds of attributes: overall attributes and page attributes. Around 10 page attributes, based on those in Tarasweich (in press) and Nadkarni and Gupta (2003), were scored; they were page length, number of graphics, percentage of white space, percentage of text, number of links, page layout, and colors. Please refer to Table 4.9 and Appendix E for those attributes. For each Web site, the raters based their scores on information gathered from five example pages: the home page, an intermediate page, a product list page, a product page, and a search result page. In addition, raters also gathered information on overall attributes of the site, such as the total number of shopping aids and the average depth of pages. The scores from two raters were first averaged; page scores such as page length, number of links were then averaged across page types. A sample worksheet can be found in Appendix E.

To assess content complexity, we used the evaluations of Web sites on www.bizrate.com. Bizrate regularly ranks commercial Web sites based on product information, other related information, popularity of the site, and user satisfaction and reports. We included three scores from their report as indicators of content complexity: ease of navigation, product variety, and clarity of product information.

Table 4.9 Web Site Classifying Attributes

Attribute	Definition	Cluster 1	Cluster 2	F	Sig.
Depth	the depth of hierarchy from home page (root) to the deepest leaves (normally the product page)	4.45	4.50	.018	.894
Navigation	Ease of navigation score (1-10) (from Bizrate.com)	8.68	8.24	11.228	.002
Prod_var	Product variety score (1-10) (from Bizrate.com)	8.85	8.32	21.600	.000
Clarity	Clarity of product information (1-10) (from Bizrate.com)	8.50	8.22	6.205	.019
Shopping_aid	Number of shopping aids listed by two raters.	6.36	6.61	.100	.754
Personalization	Whether the site has the capability of personalization. 1: when two raters both said yes; 0.5: when only one rater said yes; 0: when both two raters said no.	.77	.33	9.667	.004
prodL_no	the number of products listed on a product list page,	43.64	12.86	18.019	.000
Prod_inform	on a product page, number of information items about a product, such as price, image, description, reviews, related items, shipping, sale, availability, and so on.	5.55	5.44	.075	.787
Len_A	The average length of web pages across five kinds of pages.	3.66	1.82	19.436	.000
White_A	The average percentage of white space of web pages across five kinds of pages.	.64	.56	5.395	.028
Text_A	The average percentage of text of web pages across five kinds of pages.	.39	.34	1.524	.228
Image_A	The average number of images of web pages across five kinds of pages.	26.23	11.75	24.880	.000
Link_A	The average number of links of web pages across five kinds of pages.	121.69	67.02	41.356	.000

K-means cluster analysis was used to classify these 32 web sites in terms of complexity based on their scores on the indicators. We tried several combinations of classification variables that had been used in previous literature (Nadkarni and Gupta 2003; Nadkarni 2004) and displayed fairly large variation in our data. The final classification variables and the resulting clusters are listed in Table 4.9. From the ANOVA test of these variables we can see product variety, number of products per page, average length of page, average number of links per page, and average number of image per page are more discriminative than others.

The 32 Web sites were classified into two clusters. Centroid values of the final classifying attributes are also listed in Table 4.9. These values indicate that overall Cluster 1 was more complex than Cluster 2. The Web sites' cluster membership and distance to centroid of the cluster are listed in Table 4.10. Three Web sites from the original set (cdworld.com, dillards.com, and nextag.com) were not rated by bizrate.com, and they were excluded from initial cluster analysis. There were 11 Web sites in Cluster 1 and 18 Web sites in Cluster 2. In certain categories, such as clothing and consumer electronics, almost all Web sites were classified into one same cluster. This suggests that little difference existed among those Web sites. Based on the cluster results, we selected a total of eight Web sites from two categories (books & magazines and computers). The Web sites with asterisks in the table are the ones selected; the ones with two asterisks are high in complexity and the ones with one asterisk are comparatively low in complexity.

Table 4.10 Web Site Cluster Membership

Category	Web site	Cluster results	Distance
Books and Magazines	Amazon.com **	1	36.93
	Barnes& Nobel *	2	6.01
	Powell's	1	63.86
	Buy.com *	2	11.009
	Booksamillion.com **	1	35.416
Computers	J&R music and computer **	1	70.907
	Cdw.com	2	33.115
	Nextag.com	.	.
	tiger direct	2	26.089
	new egg **	1	21.845
	Gateway.com *	2	17.663
	Compusa.com	2	23.765
	Pcconnection.com *	2	14.87
Clothing	Dillards.com	.	.
	Macys.com	2	15.629
	Nordstroms.com	2	9.698
	Jcpenney.com	2	17.679
	Llbean.com	2	9.551
	blue fly	2	13.139
Movies and Music	Cduniverse.com	1	30.021
	Borders.com	1	22.076
	Blockbuster.com	2	31.063
	Cdnow.com	1	46.478
	Cdworld.com	.	.
	Cdconnection.com	1	26.981
	tower records	1	34.981
Consumer electronics	best buy	2	6.525
	sharper image	2	27.492
	parts express	1	27.288
	outpost.com	2	6.819
	circuit city	2	22.188
	radio shack	2	8.633

Thus, we selected eight Web sites to use in the controlled experiment. They represent two levels (high vs. low) of complexity, structural and content complexity combined, for two product categories. Thus, for each level in each category, we have two sites. Therefore, it gave us a nested experimental design.

4.4.3 Subjects

College students from a variety of majors in a major university were solicited as subjects. Since most college students are also online shoppers, using college students as subjects was a reasonable choice. There is little reason to believe they will behave differently than other shoppers in the age range of 18 to 30, although older shoppers might act differently. The desired sample size was determined by examining the model and the statistical tests that will be used in the study. Basically, the necessary sample size depends on the expected effect size and the desired power level. First, a one-way ANOVA will be used to compare means among channels (Hypothesis 1). We expect a medium effect size based on the results of Study 1-A-1. If the 4-channel model is used, the sample size would be need to be around 220 (45 per channel) to detect differences with power of 0.80 (Cohen 1992). However, since the segmentation of subjects into channels was not done on the basis of random selection but by values of perceived skills and perceived challenge, unequal numbers of subjects may be obtained for the different channels. Second, in this experiment eight Web sites were involved as treatments. We would test differences by complexity with product type nested within complexity levels and site nested within product level (Hypothesis 3). We expected a medium effect size.

In order to be able to detect differences at site level and at power of 0.80 the desirable sample size should be around 360 (around 45 per site).

Thirdly, because we will use structural equation modeling in our data analysis and it is a large-sample technique, it is suggested that over 200 subjects are needed (Tabachnick and Fidell 2000, p.659). MacCallum et al. (1996) provided a method to calculate the minimum sample size based on the degrees of freedom in the structural model and desired level of power. For a model with degrees of freedom more than 100, 178 subjects are required for a test of lack of fit at a power of 0.8.

4.4.4 Procedure and Experimental Context

A laboratory experiment similar to the pilot studies was conducted in April 2004, however, but with the eight pre-selected Web sites. A package of documents and instructions was given to subjects when they arrived. A subject number and a site code labeled with selected Greek letters, representing one of the eight Web sites, were written on the instruction sheet. The assignment of site codes was sequential from the first (Site Alpha) to the last (Site Lambda), and then continued from the first one again. Since the arrival of subjects was a random process, the assignment of Web sites was also random. Furthermore, the way we assigned sites to subjects reduced the possibility of having uneven sample sizes within the cells to the minimum.

First, subjects were asked to sign the document for informed consent if they agreed to participate. Next, they filled out the pre-shopping questionnaire. Then the subject was directed to go to the Web site assigned to them through a simple Web page, which is developed by the research and is shown in Figure 4.5. By clicking the

corresponding link, subjects were led to the assigned site. Before this point, subjects had no idea which Web store they were going to visit. Thus, potential bias towards a site, such as a prior perception, was reduced to some extent. An experience sampling form similar to those utilized in the pilot study was scheduled to appear 6 to 8 minutes after subjects started shopping. Subjects were instructed to answer it at once when it appeared on the screen. Once they completed the experience sampling form, subjects were asked to go back shopping. After shopping, subjects were required to answer a post-shopping questionnaire. All of the experimental manipulations and measures were conducted online and all measures were captured by computers.

4.4.5 Measurement

The pre-shopping questionnaire collected demographic data and assessed individual differences: general computer and Internet usage, online shopping history, general information regarding online shopping, novelty, and playfulness. Novelty was measured with the two-item scale used by Novak et al. (2003) and in Study 1-A; playfulness was assessed using the seven-item scale developed by Webster and Martocchio (1992) that was also used in Agarwal and Karahanna (2000). The list of questions can be found in Appendix F. Related studies and reliability measure are also summarized in the Appendix.

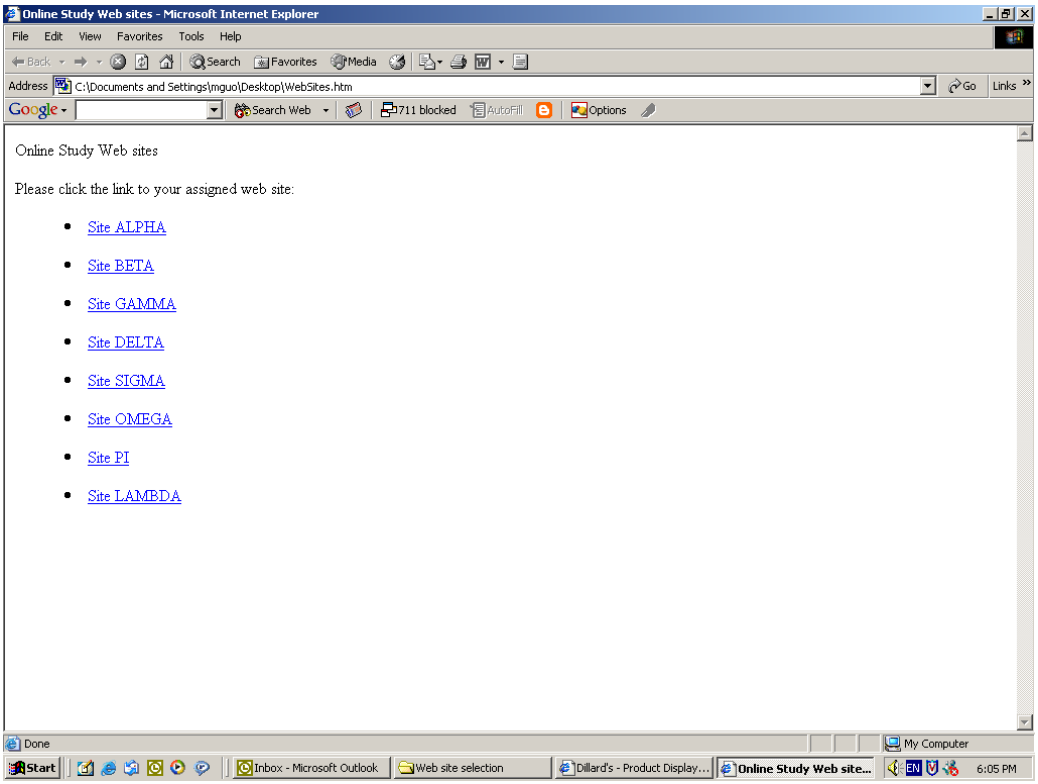

Figure 4.5 The Web Page Directing Subjects to Assigned Web Site

In our research model, flow and related core constructs serve as mediating variables between complexity and outcomes of the shopping experience. Two sets of flow measures (IFS and FSS) were included in this study. We included both scales for two reasons. First, we wanted to conduct another validity study (Study 1-C) and this required use of both scales. Second, we included both scales because we had to collect data before the final results of the validity study were in. Based on the results of the study, we would use one scale, but we were not sure which one at the time of final data collection. The original items of these two competing measures with reliability coefficients can be found in Appendix A. Those questions have been modified slightly

to fit into the current situation and based on the results of previous study results. The final version was listed in Appendix F.

To measure perceived Web complexity we tried out items from several measures. In Study 1-A-2 we used a scale developed and validated by Nadkarni and Gupta (2003). This instrument is a 19-item Likert scale with three subscales. Although it had been cross-validated using different samples, it did not perform well in our studies at all. Please refer Appendix B for related results. The complexity measure we used in this study was a mixture of items from Geissler et al. (2001), Nadkarni and Gupta (2003), and Nadkarni (2004). Those measures have exhibited good reliability in previous studies. However, since this was our first time to use them, we were very cautious in selecting items based on their face validity and completeness in that they could cover various aspects of site complexity. Please refer to Appendix A for the original scales. There were three groups of measures. The first group was composed of items from Geissler et al (2001) and took the format of a 7-point Likert scale. In all there were five questions. The second group was comprised of questions from the semantic differential scales developed by Nadkarni and Gupta (2003) and Nadkarni (2004). We selected nine questions that seemed to have the most potential in terms of face validity. These items took the format of 7-point semantic differential scales. Since it was the first time we used these complexity measures, we added two very straightforward statements regarding the overall complexity at the end of the questionnaire. These two questions were: “I found this web site was complicated” and a reverse version “I felt the web site was pretty simple.” Recall also that we had objective measures of Web site complexity

based on the attributes coded for each of the sites during the selection process. This will enable us to compare these two types of measures.

Flow is expected to affect shopping outcomes in terms of perceived usefulness of the site, emotional responses, and behavioral intentions. The perceived usefulness scale was a well-tested measure in the IS field. We used the version developed by Koufaris (2002) since it was designed for online shopping. Emotional response was measured by the Pleasure-Arousal-Dominance scales (Mehrabian and Russell 1974, p.218). Emotional response is also a second-order factor with three sub factors: pleasure, arousal, and dominance. Although the reliability of the scales was not particularly high in previous studies except for the pleasure construct, the scale has been used before with acceptable reliability (Bearden et al. 1993, p. 180-181). To measure behavioral intentions, we assessed subjects' intention to explore the site further (Donovan and Rossiter 1982), intention to revisit (Donovan and Rossiter 1982; Koufaris 2002; and Palmer 2002), intention to purchase on the site (Wan and Nan 2001), and recommendation (Wan and Nan 2001). The composite measure was made up of questions from various studies.

In this chapter, we presented our overall research plan and design details for each of our studies. These studies address two questions. Study 1 used multiple approaches to conduct a series of validity studies for flow measures and Study 2 investigated the impact of site complexity on flow in Internet shopping using a controlled experiment. In the next two chapters, we will discuss the results of our studies.

CHAPTER V

A VALIDITY STUDY OF FLOW MEASURES

In this chapter we report the results of validity study (Study 1), which consisted of three parts: examining behavioral correlates of flow using mouse movement data (Study 1-A), testing nomological networks of flow via survey data (Study 1-B), and a factorial validity study of two flow scales (Study 1-C). The results for each study will be discussed in that order.

5.1 Study 1-A

As discussed in Section 4.1 and 4.2, there were three sub-studies in Study 1-A, whose purpose was to identify behavioral correlates from mouse movement data to provide validity evidence for flow measures. A total of 40 cases were transcribed and coded, 20 cases for Study 1-A-1, 10 cases for Study 1-A-2, and 10 cases for Study 1-A-3. The results are summarized in Tables 5.1 to Table 5.3, respectively. In the tables, we report the flow scores of subjects. Flow scores were summation on questions (7-point Likert scale) of Experience Sampling Form for Study 1-A-1. In Study 1-A-2 and Study 1-A-3 the flow scores were summations of questions from the IFS and FSS. Number of segments (pages) each subject visited and total time spent are also reported in the tables. To save room, we only reported the total number of occurrences of positive and negative correlates in these tables. In calculating the total number of occurrences, we count the category of a clear goal (P1) as 0 in the cases that both P1-1 and P1-2 are zero, and

otherwise it is counted as 1. This is because the presence of either of the correlates will indicate a clear goal. For a detailed breakdown report, please refer to Appendix G.

Table 5.1 Behavioral Correlates Summary for Study 1-A-1

Sub-No	ESF Flow Score	Flow Level	# of Segments	Time Spent	Site Assigned	# of Positives	# of Negatives
1-202	17	Low	8	4:10	cdworld.com	2	1
1-123	19	Low	20	4:20	amazon.com	3	7
1-136	19	Low	11	4:47	cdworld.com	7	2
1-127	19	Low	26	9:04	amazon.com	7	8
1-102	20	Low	12	4:42	cdworld.com	5	1
1-115	20	Low	11	4:51	amazon.com	3	5
1-120	21	Low	24	5:07	cdworld.com	9	0
1-105	23	Low	14	4:58	amazon.com	4	5
1-135	23	Low	18	4:57	amazon.com	7	3
1-116	23	Low	30	5:01	cdworld.com	11	0
average						*5.2*	*3.2*
1-199	40	High	6	4:04	amazon.com	6	1
1-121	41	High	9	4:15	amazon.com	6	0
1-165	41	High	17	5:08	amazon.com	9	4
1-189	41	High	17	4:59	amazon.com	6	0
1-191	41	High	6	4:59	amazon.com	6	1
1-147	41	High	14	5:00	amazon.com	10	1
1-185	42	High	9	4:54	amazon.com	7	4
1-108	43	High	9	4:51	cdworld.com	4	0
1-213	43	High	9	4:07	amazon.com	8	0
1-151	44	High	20	4:37	cdworld.com	9	2
average						*7.1*	*1.3*

Table 5.2 Behavioral Correlates Summary for Study 1-A-2

Sub-No	IFS Flow Score	Flow Level	# of Segments	Time Spent	Site Assigned	# of Positives	# of Negatives
2-149	64	Low	9	3:24	dillards.com	5	0
2-143	77	Low	32	5:00	dillards.com	9	0
2-150	78	Low	16	5:01	buy.com	10	1
2-103	87	Low	18	5:02	cdworld.com	4	7
2-146	98	Low	19	5:00	dillards.com	7	4
average						*7*	*2.4*
2-139	173	High	9	2:01	dillards.com	6	2
2-152	173	High	5	4:50	buy.com	6	2
2-128	173	High	26	5:06	macys.com	6	0
2-137	188	High	32	4:47	macys.com	16	0
2-111	202	High	18	5:09	buy.com	9	0
average						*8.6*	*0.8*

Table 5.3 Behavior Correlates Summary for Study 1-A-3

Sub-no	FSS Flow Score	Flow Level	# of Segments	Time Spent	Site Assigned	# of Positives	# of Negatives
3-104	65	Low	12	4:46	cdworld.com	3	8
3-175	65	Low	18	4:59	cdworld.com	4	0
3-109	75	Low	3	2:04	outpost.com	3	1
3-124	88	Low	20	5:21	macys.com	5	0
3-139	98	Low	17	4:47	buy.com	5	2
average						*4*	*2.2*
3-177	177	High	29	4:46	dillards.com	15	0
3-162	178	High	7	4:45	cdworld.com	3	3
3-144	183	High	26	4:12	macys.com	7	0
3-131	183	High	20	4:58	dillards.com	10	2
3-122	189	High	7	2:46	cduniverse.com	4	2
average						*7.8*	*1.4*

As discussed before, we expected that people in flow (with high flow scores) should display more positive correlates than people not in flow (with low flow scores), while people in flow display fewer negative correlates. This pattern occurs in all three studies in that the averages of positive correlates of high flow score groups are higher that those of low flow score groups. On the other hand, high flow score groups on average have fewer negative correlates than low flow score groups. Although the differences were not significant within each study, pooling across studies yields differences (n=40) at p=0.05 level (Table 5.4). This result gave us certain confidence in flow measures, especially IFS and FSS, because they corresponded with subjects' behaviors in our analysis.

Table 5.4 Mean Differences for Number of Positive and Negative Correlates

	Flow score	**Mean**	**F**	**Sig.**
# of Positive	Low	5.65	4.509	.040
	High	7.65		
# of Negatives	Low	2.75	4.635	.038
	High	1.2		

Our purpose in this study was to use behavioral data to assess the construct validity of flow measures; however, it would be beneficial to look into the positive and negative correlates more closely. Just by eyeballing the data, we observed a couple of interest things. First, positive correlates occur in not-in-flow cases; negative correlates occur in in-flow cases as well. It seems the relative number of positive and negative

correlates is the key determinant. Second, among negative correlates (please refer to detailed reports in Appendix G), navigation problem (N1) and the errors (N3) have a stronger impact than interruptions (N2), task-related message (N2-2) in particular. This observation is consistent with our original expectation that this kind of messages would not affect visitors too much because we are so used to it. Also, among positive correlates, the signs of visitors going through product list (P3-2) and spending time on reading (P2) seem to be a good indicator of flow.

5.2 Study 1-B

A total of 149 respondents participated in Study 1-B. There were 88 cases in the online shopping task and 61 for the gaming task. Seven cases had incomplete data and were still included in the analysis. Respondents included 98 female and 50 male students. No differences in terms of measured variables due to gender were found. Subjects' majors included communication, accounting, marketing, finance, management, information systems, economics and others. The average age of the subjects was 20.5 years.

In analyzing the data, we first used exploratory factor analysis to see whether a reasonable factor structure could be extracted. Then the MTMM matrix was constructed. Lastly, we tested the relationships in the proposed nomological network.

Table 5.5 Rotated Factor Matrix for FSS

Factor	Factor loadings								
Item	Conc.	Enjoy	Goal	Loss	Cont.	Merge.	Time	Fdbk.	9
Concentration									
FSS-C1	.850								
FSS-C2	.496								
FSS-C3	.747								
FSS-C4	.812								
Enjoyment									
FSS-E1		.638							
FSS-E2		.614							
FSS-E3		.805							
FSS-E4		.680							
Clear goal									
FSS-CG1			.558						.416
FSS-CG2			.549						
FSS-CG3			.684						
FSS-CG4			.690						
Loss of self-consciousness									
FSS-L1				.723					
FSS-L2				.425					
FSS-L3				.710					
FSS-L4				.829					
Sense of Control									
FSS-CON1					.611				.410
FSS-CON2					.626				
FSS-CON3					.430				
FSS-CON4					.627				
Mergence of activity and awareness									
FSS-M1						.651			.481
FSS-M2						.587			
FSS-M3						.566			
FSS-M4						.675			
Time distortion									
FSS-TD1							.795		
FSS-TD2							.833		
FSS-TD3							.628		
FSS-TD4							.542		
Feedback									
FSS-FB1								.167	.909
FSS-FB2								.437	
FSS-FB3								.843	
FSS-FB4								.576	
Balance of challenge and skill									
FSS-CS1									
FSS-CS2									
FSS-CS3									
FSS-CS4									

5.2.1 Factor Analysis and Reliability

As a first step, exploratory factor analysis was run on both sets of measures separately on pooled data. Jackson and Marsh (1996) reported that the FSS had a nine first-order factor structure. We used the maximum likelihood factor method with equamax rotation with Kaiser Normalization to determine if the same structure held for this data. As Table 5.5 shows, with the exceptions of one item in feedback and the balance of challenge and skill measures, an identical structure resulted (three other items had minor cross loadings). The solution explained 64.23% of the variance. In the results, none of the items in the perceived balance of challenge and skill (FSS-CS) loaded on any factor.

The same procedure was repeated for the IFS scales. Results are shown in Table 5.6. The extracted factors accounted for 63.72% of the variance. It is clear that the IFS did not factor as cleanly as the FSS, with more cross-loading items. In particular, the concentration, enjoyment, and telepresence dimensions seem to have factored cleanly, and the sense of control, perceived skill, and time distortion dimensions have been recovered at least partially. However, the mergence, loss of self-consciousness, and perceived challenge dimensions were scattered across factors.

Table 5.6 Rotated Factor Matrix for IFS

Factor	Factor loadings								
Item	Conc.	Enjoy	Cont.	Loss	Merge.	Time	Tele.	Skill	9
Concentration									
IFS-C1	.627								
IFS-C2	.750								
IFS-C3	.871								
IFS-C4	.599								
Enjoyment									
IFS-E1		.553							
IFS-E2		.826							
IFS-E3		.768							
IFS-E4		.795							
Sense of Control									
IFS-CON1			.486						
IFS-CON2					.404				
IFS-CON3					.602				
IFS-CON4			.722						
Loss of self-consciousness									
IFS-L1									
IFS-L2									
IFS-L3				.483			.550		
Mergence of activity and awareness									
IFS-M1					.483				
IFS-M2									
IFS-M3					.633				
Time distortion									
IFS-TD1						.569			
IFS-TD2						.653			
IFS-TD3									.792
IFS-TD4						.702			
IFS-TD5									.959
Telepresence									
IFS-T1									
IFS-T2							.534		
IFS-T3							.742		
IFS-T4							.722		
IFS-T5							.625		
IFS-T6							.774		
IFS-T7							.735		
IFS-T8				.598					
Perceived Challenge									
IFS-PC1			-.498						
IFS-PC2		.465							
IFS-PC3									
IFS-PC4			-.428					-.643	
Perceived skill									
IFS-PS1					.504				
IFS-PS2			.433						
IFS-PS3								.709	
IFS-PS4								.756	

Reliability measures (Cronbach's alpha coefficient) for most dimensions in FSS were similar to or even better than those from the previous study in both shopping and gaming contexts; the exceptions were FSS-CS and FSS-FB (refer to Table 5.7). An explanation could be that this scale was developed in sports psychology and has been validated in the context of sports events, and so it may be more suitable in situations that place greater emphasis on action and competition. In these situations, the judgment of performance and the assessment of one's challenge and skill are of special importance. While computer/video games share these characteristics with sports, they would be less relevant or meaningful in online shopping activities. Reliabilities for the IFS are similar to those from previous studies that used one or more of its dimensions. However, the reliabilities of the newly developed dimensions are low, e.g., perceived challenge and mergence.

Table 5.7 Reliability Coefficients (Crobach's Alpha) of FSS and IFS in Study 1-B

Factors (number of items)	**In current study**			**In previous studies**
	POOLED	GAME	SHOPPING	
	N= 149 or 148	N=61 or 60	N=88 or 87	
FSS-C (4)	.8932	.9227	.8516	.82 *
FSS-E (4)	.8679	.8949	.8567	.81 *
FSS-CON (4)	.9138	.9156	.8950	.86 *
FSS-M (4)	.8403	.8986	.7473	.84 *
FSS-L (4)	.8059	.8315	.7290	.81 *
FSS-TD (4)	.7958	.7777	.8026	.82 *
FSS-CS (4)	.6726	.8597	.5413	.80 *
FSS-CG (4)	.8758	.9065	.8153	.84 *
FSS-FB (4)	.7867	.8753	.7470	.85 *
				N differs
IFS-C (4)	.8919	.9223	.8659	.910 **
IFS-E (4)	.9146	.9322	.9054	.944 **
IFS-CON (4)	.7005	.5280	.7419	.813 **
IFS-M (3)	.5803	.6103	.5310	N/A
IFS-L (3)	.4002	.4482	.4006	N/A

Table 5.7 Continued

Factors (number of items)	**In current study**			**In previous studies**
	POOLED	GAME	SHOPPING	
	N= 149 or 148	N=61 or 60	N=88 or 87	
IFS-T (8)	.8994	.9228	.8783	N/A
IFS-TD (5)	.8639	.8939	.8397	.93 ***
IFS-PC (4)	.5850	.5775	.3647	N/A
IFS-PS (4)	.7607	.7994	.6902	N/A

*: Jackson and Marsh (1996), N =394
**: Koufaris (2002), N= 280
***: Agarwal and Karahanna (2000), N= 270

5.2.2 Multitrait-Multimethod Matrix Analysis

In our study, we apply the MTMM approach to the two sets of flow dimension scales. Each respondent answered all questions in both the FSS and IFS. Thus, in our matrix (Table 5.8), the traits are the flow dimensions and the method is the two scales (FSS vs. IFS). Correlations between pairs of factors (here, flow dimensions) are arranged by methods in the table. The diagonals show the reliability of each factor, measured with Cronbach's alpha coefficients. The parts within the same method are called monomethod blocks. There are two such blocks in our matrix, the upper left and lower right blocks, for the FSS and IFS respectively. Within monomethod blocks are heterotrait-monomethod triangles, which are correlations of different factors sharing a common method. The parts with different methods are called heteromethod blocks, for example the one block on the lower left corner. The diagonals of such blocks are validity diagonals, which are the correlations of common factors across different methods. Since in our case, FSS and IFS only share six common flow dimensions—concentration (C), enjoyment (E), mergence of activity and awareness (M), loss of self-consciousness (L), sense of control (CON), and time distortion (TD)—the validity

diagonal (boldfaced cells in the table) only consists of those cells that contain correlations between common flow dimensions, i.e., FSS-C vs. IFS-C, FSS-E vs. IFS-E, FSS-M vs. IFS-M, FSS-L vs. IFS-L, FSS-CON vs. IFS-CON, FSS-TD vs. IFS-TD. The rest of heteromethod blocks are two heterotrait-heteromethod triangles. This table contains more information than a typical MTMM matrix because factors not shared by FSS and IFS are also included.

Table 5.8 MTMM Matrix for FSS and IFS in Study 1-B

	FSS-C	FSS-E	FSS-M	FSS-L	FSS-CON	FSS-TD	FSS-CS	FSS-CG	FSS-FB	IFS-C	IFS-E	IFS-M	IFS-L	IFS-CON	IFS-TD	IFS-T	IFS-PC	IFS-PS
FSS-C	*0.8932*																	
FSS-E	.531**	*0.8679*																
FSS-M	.466**	.388**	*0.8403*															
FSS-L	.290**	.219**	.372**	*0.806*														
FSS-CON	.585*	.411**	.668**	.553**	*0.9138*													
FSS-TD	0.155	.350**	0.105	-0.013	-0.007	*0.7958*												
FSS-CS	.402**	.497**	.443**	0.278**	.537**	0.127	*0.673*											
FSS-CG	.503**	.466**	.566**	.314**	.707**	0.115	.522**	*0.8758*										
FSS-FB	.454*	.416**	.598**	.278**	.647**	0.003	.507**	.712**	*0.7867*									
IFS-C	**.777****	.664**	.325**	0.147	.344**	.364**	.340**	.316**	.306**	*0.892*								
IFS-E	.459**	**.823****	.342**	0.113	.357**	.350**	.439**	.369**	.342**	.649*	*0.9146*							
IFS-M	.427**	.447**	**.764****	.304**	.554**	0.115	.406**	.526**	.527**	.423**	.383**	*0.5803*						
IFS-L	.229**	.296**	.308**	**0.139**	0.157	.399**	0.032	0.073	0.061	.406**	.267**	.415**	*0.4*					
IFS-CON	.342**	.318**	.567**	.424**	**.694****	-0.105	.470**	.500**	.576**	0.146	.312**	.526**	0.057	*0.7705*				
IFS-TD	.214**	.332**	0.14	-0.46	0.048	**.631****	0.161	0.06	-0.024	.470**	.476**	.269**	.456**	-0.067	*0.864*			
IFS-T	.312**	.412**	.288**	-0.5	0.124	.446**	0.095	0.141	0.103	.542**	.389**	.426**	.699**	-0.019	.588**	*0.8994*		
IFS-PC	-0.7	0.4	-.349**	-.239**	-441**	.191*	-0.11	-.271**	-.259**	0.148	0.09	-.262**	0.012	-.652**	.217*	0.128	*0.585*	
IFS-PS	.366**	.309**	.620**	.352**	.669**	-0.009	.565**	.581**	.619**	.210*	.324**	.576**	.178*	.746**	0.087	0.12	-.558**	*0.761*

Correlations based on pooled data. *: significant at .05 level, **: significant at .01 level

There are several things we look for when interpreting MTMM matrix (Campbell and Fiske 1959). First, since a concept should correlate more highly with itself than with any other concepts, the reliability diagonal should consistently be the highest in the matrix. In our matrix, all factors both from FSS and IFS except IFS-L meet this requirement. Secondly, coefficients in the validity diagonals should be significantly different from zero and large enough to give confidence for further examination. This is essential evidence of convergent validity. All of the correlations except L in our matrix meet this criterion. Third, a validity diagonal coefficient should have a higher value than those in its column and row in the heterotrait-heteromethod block. All dimensions except L meet this requirement. Fourth, a validity coefficient should be higher than all coefficients in the heterotrait-monomethod triangles. This principle emphasizes that trait factors should be stronger than methods factors. Although the majority of dimensions in our matrix meet this requirement, this is not true in all cases. For example, the FSS-TD vs. IFS-TD correlation of .631 is less than .649 (IFS-C vs. IFS-E) and .668 (FSS-M vs. FSS-CON). Lastly, similar patterns of factor interrelationships should be seen in all of the heterotrait triangles of both the monomethod and heteromethod blocks. In our case, two out of three triangles share a similar pattern. That is, the FSS and FSS-IFS heterotrait triangles have similar patterns of correlations, but the IFS heterotrait triangle does not. The last three criteria provide some degree of evidence for discriminant validity.

There are also characteristics of a MTMM matrix that suggest that a measure is not valid. When values in the heterotrait-hetromethod triangles are as high as those in

the validity diagonal, or when the heterotrait values are as high as reliabilities in a monomethod block, construct validity is called into question. In our matrix, this occurs for IFS-M and IFS-L, indicating issues with these two scales.

Other than flow dimensions, we also included preconditions into the table so that we could examine the patterns of interrelationships between flow dimensions and preconditions. Based on theory we made certain predictions to determine whether our data provided evidence supporting them. One set of prediction pertained to the dimensions of flow and another concerned preconditions of flow. Dimensions of flow should correlate significantly with each other both within methods and cross methods. Specifically, in FSS, concentration (C), mergence of action and awareness (M), loss of self-consciousness (L), feeling of control (CON), time distortion (TD) should correlate with each other and also with corresponding dimensions in IFS. In the case of the IFS, besides the above listed dimensions, telepresence (T) is included. In Table 5.8, except for a couple of cases, the flow dimensions correlate with each other, even across methods in most cases.

Preconditions of flow should correlate significantly to dimensions of flow. In FSS, the perceived balance of challenge and skill (CS), having a clear goal (CG), and a quick and unambiguous feedback (FB) are preconditions and they should correlate to dimensions of flow (namely, C, E, M, L, CON, and TD in both FSS and IFS, and T in IFS). In our results, FSS-CS, FSS-CG, and FSS-FB correlate with most flow dimensions, with the exception of FSS-TD, IFS-TD, IFS-L, and IFS-T. In the IFS, PC and PS are preconditions of flow. Since flow theory states that the balance of these two

is the precondition of flow, it is not suitable to make predictions regarding PC and PS individually. However, we should be able to predict the directions of relationship between PC/PS and flow dimensions. That is, both PS and PC should correlate positively with flow dimensions according to flow theory. Our results show that PS has positive correlations with all dimensions of flow in both FSS and IFS, except TD and T. PC has fewer significant correlations with flow dimensions, although, contrary to the prediction, the overall direction of the correlations is negative. In regard to relationships among preconditions across scales, we predicted that the FSS-CS would correlate with IFS-PS positively and with IFS-PC negatively. This prediction was partly supported by the correlation between the FSS-CS and the IFS-PS. In the case of FSS-CS versus IFS-PC, the correlation is not significant.

In summary, examining the MTMM matrix has provided some evidence of construct validity because most of the patterns in the MMTM matrix are as predicted. On the other hand, some problematic areas are apparent, mainly, IFS-L and IFS-M.

In addition to examining correlations, we conducted exploratory factor analysis (Maximum Likelihood, Equamax rotation with Kaiser Normalization) on all items combined from the common factors in FSS and IFS. We expected the corresponding variables across methods should load onto the same factors. Most dimensions load together, with the exception of M and L (Table 5.9). Overall, these results are a positive sign for validity of the FSS and IFS.

Table 5.9 Rotated Factor Matrix for Common Dimensions from FSS and IFS

	Factor Loadings					
	Enjoy.	Conc.	Time	Cont.	merge	Loss
Enjoyment						
FSS-E1	.683					
FSS-E2	.688					
FSS-E3	.762					
FSS-E4	.582					
IFS-E1	.595					
IFS-E2	.846					
IFS-E3	.801					
IFS-E4	.766					
Concentration						
FSS-C1		.821				
FSS-C2		.503		.407		
FSS-C3		.783				
FSS-C4		.841				
IFS-C1	.452	.600				
IFS-C2		.759				
IFS-C3		.786				
IFS-C4		.523				
Time distortion						
FSS-TD1			.665			
FSS-TD2			.682			
FSS-TD3			.465			
FSS-TD4			.469			
IFS-TD1			.633			
IFS-TD2			.812			
IFS-TD3			.570			
IFS-TD4			.801			
IFS-TD5			.637			
Sense of control						
FSS-CON1				.740		
FSS-CON2				.745		
FSS-CON3				.540	.433	
FSS-CON4				.700		
IFS-CON1				.549		
IFS-CON2				.350	.400	
IFS-CON3				.632		
IFS-CON4				.491		
Mergence of activity and awareness						
FSS-M1				.472		.547
FSS-M2						.615
FSS-M3						.485
FSS-M4						.692
IFS-M1						
IFS-M2						.770
IFS-M3				.606		
Loss of self-consciousness						
FSS-L1					.758	
FSS-L2					.450	
FSS-L3					.751	
FSS-L4					.851	
IFS-L1					.506	
IFS-L2			.489			.417
IFS-L3			.395			.425

5.2.3 Correlation with Other Constructs

The other constructs included in the nomological network (Section 3.1 Figure 3.2) were computer anxiety, computer playfulness, general skill in the activity (computer game or online shopping), and love for the activity (games or shopping). Love for games was measured by one question; love for shopping was measured by two questions. Skill in games was the average of two questions and skill in shopping was measured by one question. At the very end of the questionnaires, we presented the respondents a paragraph describing flow (Novak et al. 2000) and then asked them to report whether they felt like they were in flow the last time they played game or shopping online. Correlations among these variables are presented in Table 5.10.

Due to the different nature of flow dimensions, we believe that it would be more meaningful and useful for future study to treat the dimensions individually in examining relationships between flow and related constructs. Overall, the nomological network was supported. As predicted, playfulness, love, and skill all have significant positive correlations with most dimensions, while computer anxiety has negative correlations with all flow dimensions except FSS-TD. One observation is that between playfulness and computer anxiety, both have relationship with most of flow dimensions. Another observation is that PS seems correlated with (or affected by) external constructs (playfulness and love) more than PC does. This may suggest the need for further study on the effects of antecedents, including personal traits and individual differences on PC, PS, and in turn on CS. The results have also reinforced our conviction of the

individuality of flow dimensions, since the significant correlations are not uniform across the board. We can see that an external factor, that is, a factor that impacts flow dimensions but not the preconditions (in current study, computer anxiety and playfulness can be thought as external factors, so can love and skill), may affect some dimensions but not others. Different external factors impact different dimensions.

Table 5.10 Correlations of Flow and Related Constructs

	Playfulness	**Computer anxiety**	**Love**	**Skill**	**Flow (self reported)**
FSS-C	.179*	-.209*	.359**		.340**
FSS-E	.308**		.603**	.303**	.365**
FSS-M	.257**	-.298**	.297**	.360**	.267**
FSS-L	.240**	-.236**		.178*	
FSS-CON	.318**	-.348**	.310**	.448**	.166*
FSS-TD		.178*	.263**		.429**
FSS-CS	.287*		.237**	.350**	.172*
FSS-CG			.264**	.369**	
FSS-FB	.219**	-.347**	.244**	.487**	.169*
IFS-C	.217**		.488**	.320**	.566**
IFS-E	.192*		.579**	.349**	.379**
IFS-M	.194*	-.217**	.365**	.429**	.404**
IFS-L			.278**		.428**
IFS-CON	.221**	-.361**	.278**	.459**	
IFS-TD			.247**		.535**
IFS-T			.278**		.626**
IFS-PC		.294**		-.333**	
IFS-PS	.214**	-.333**	.333*	.618**	.256**

*: significant at .05 level, **: significant at .01 level

In the table above, we present results based on pooled data for both gaming and shopping. Analysis on split data show similar, but somewhat different patterns in Table 5.11 and Table 5.12. These results imply that in different situations, certain dimensions

are more prominent; and intensities of dimensions vary across different situations. The results also suggest that the effects of external factors on flow dimensions differ from one dimension to another and that the strength of relations may also vary in different situations. Another difference discernible in the split data is that playfulness and computer anxiety have no significant correlations with the IFS measures in gaming. One possible explanation is that gaming is closer to sports than regular computer use and Internet shopping. The FSS was originally designed to measure flow in sports events, thus it is a better measure for computer/video game than the IFS, which originated in IS and marketing research.

Table 5.11 Correlations of Flow and Related Constructs in Game Context

	Playfulness	**Computer anxiety**	**Love**	**Skill**	**Flow (self reported)**
FSS-C			.402**	.354**	.428**
FSS-E	.355**		.532**	.469**	.424**
FSS-M	.269*		.332**	.506**	.323*
FSS-L	.262*				
FSS-CON	.373**		.390**	.433**	.268*
FSS-TD			.274*		.383**
FSS-CS	.287*			.530**	
FSS-CG			.329*	.502**	
FSS-FB		-.321*		.570**	.275*
IFS-C			.496**	.357**	.569**
IFS-E			.447**	.529**	.423**
IFS-M			.538**		.570**
IFS-L					.420**
IFS-CON				.415**	
IFS-TD					.544**
IFS-T			.277*		.540**
IFS-PC					
IFS-PS			.361**	.722**	.336**

*: significant at .05 level, **: significant at .01 level, n = 61

5.2.4 Discussion

This study was designed to assess the construct validity of two flow scales, the FSS, and the IFS. The approach we took was to compare and contrast these two using multitrait-multimethod matrix analysis and to examine a nomological network including flow and related constructs. Data were collected using paper-pencil questionnaires on people's recall of the most recent time they played computer/video games or shopped on the Internet.

Table 5.12 Correlations of Flow and Related Constructs in Online Shopping Conext

	Playfulness	**Computer anxiety**	**Love**	**Skill**	**Flow (self reported)**
FSS-C		.259*	.271*		.255*
FSS-E	.273**		.674**	.320**	.331**
FSS-M	.272*	-.416**		.320**	
FSS-L	.245*	-.490**		.272*	
FSS-CON	.312**	-.559**		.363**	
FSS-TD			.318**		.504**
FSS-CS			.239*	.213*	
FSS-CG		-.221*			
FSS-FB	.272*	-.351**		.424**	
IFS-C			.479**	.298**	.567**
IFS-E			.717**	.313**	.371**
IFS-M		-.236**		.274**	.274**
IFS-L			.347**		.445**
IFS-CON	.250*	-.562**	.236*		
IFS-TD			.319**		.577**
IFS-T			.262*		.693**
IFS-PC		.556**		-.341**	.225*
IFS-PS	.273*	-.582**	.226*	.469**	

*: significant at .05 level, **: significant at .01 level, n = 88

Overall, results provided evidence for the construct validity of these two scales. Since there were two contexts involved in our study, there is evidence that the flow measures apply across different situations for the most part. The results also suggest that certain dimensions, such as concentration and enjoyment, can be considered to be "core" dimensions of flow since they showed consistent relationships with other constructs. This implies that there may be a standard measure for flow, at least for those core dimensions.

The independence the flow dimensions exhibited in their correlations with other constructs suggests that we consider treating flow dimensions separately and investigating relationships between individual flow dimensions and other constructs (antecedents and consequences), rather than assuming flow is an umbrella concept. It also seems possible that in some situations, one or two dimensions may be the primary source of effects on outcomes.

One of our major objectives in this study was to compare and contrast the two flow measures so that we could determine which was more suitable for future use. Generally the FFS outperformed the IFS, even though the IFS was specifically designed for the computer mediated environment. In the IFS, mergence and loss of self-consciousness, the concepts not previously measured, had the weakest results; several of the dimensions in the IFS that parallel those in the FFS had expected patterns of results. That there were problems with mergence and loss of self-consciousness measures does not mean they should be ignored; further efforts in item development are necessary.

Because the FSS outperformed IFS, we are inclined to recommend the use of FSS with certain modifications. First, a major issue for the FSS is the measure for balance of challenge and skill. Although it is theorized that this balance is the key precondition of flow, this measure is problematic. This may be because the items measuring this balance in the FSS are compound questions. For example, one question reads "I was challenged, but I believed my skills would allow me to meet the challenge." The failure to emerge as a factor in our study might be an indicator of a wording problem, although in the original study the factor turned out as it should have (Jackson and Marsh 1996). This problem could be corrected by development of separate measures for perceived challenge (PC) and perceived skill (PS). As Ellis et al. (1994) pointed out: both PC and PS are complex and situation-laden concepts. Therefore, there is a need to develop different measures for PC and PS in different contexts. We started this effort in our study. In our measures of challenge and skill, items of PC and PS were designed to capture different aspects of the situation. However, the issue of determining the balance of these two is introduced and in need to be solved.

Second, in order to use the FSS in contexts such as online shopping, scale items must be adapted to fit into the specific situation. Our questionnaires used items already modified from their original version in the attempt to apply the FSS to computer/video gaming and online shopping context. There is definitely room for further improvement. In the case of measuring flow in other contexts, PC and PS should have different sets of questions adapted to the situation at hand. Another advantage of using the FSS is that it includes measures for having a clear goal and feedback. Although it is not

recommended to treat preconditions and dimensions of flow as the same type of construct, the FSS provides readily usable measures. Hence, in our opinion, a set of complete measures for flow should include measures for preconditions (perceived challenge, perceived skill, a clear goal, and feedback) and dimensions (concentration, control, mergence of action and awareness, loss of self-consciousness, time distortion, enjoyment, and any other dimensions deemed to be relevant for the situation, for example, telepresence.)

Two limitations of this study should be discussed. First we measured flow experience through subject recall rather than in the immediate situation, an approach strongly warned against by Finneran and Zhang (2002). Due to resource constraints involved in obtaining a fairly large sample, this data collection method was the only practicable one. We attempted to overcome memory loss and distortion issues associated with surveys on past events by requiring that respondents had to have played game or shopped online no more than one month before the study. Most respondents had engaged in the activities within two weeks before the study. In the questionnaires, we included questions to help respondents recall their experiences, such as questions asking the particular game they played and the sites they visited the last time they were online. Based on the positive results from this study, a research project is currently being conducted that collects "on-the-spot" data using the experience sampling approach (Csikszentmihalyi and Csikszentmihalyi 1988) during an experiment.

Second, methods should be as independent as possible (Campbell and Fiske 1959). However, in our study, we treated two scales that are both self-report and pen-

and-pencil based as two distinct methods in MTMM. But, it is reasonable for our purpose to compare and contrast two different scales and the comparison did provide evidence of construct validity for these two measures. The nature of flow as a subjective experience makes it difficult to use other methods to measure this phenomenon, though it is not totally impossible. In Study 1-A, we undertook a research effort to discover observable behavioral correlates of flow in web navigation. Once that is established, a true MTMM study can be carried out.

5.3 Study 1-C

Since Study 1-B provided a basis for further validation these measures, in this study we used a larger sample size and confirmatory factor analytic approach to study the internal structure of flow. A total of 357 respondents participated in the study. Several cases had incomplete data and final sample size was 354. Respondents included 214 female and 143 male students. No differences in responses due to gender were found. Subjects' majors included communication, accounting, marketing, finance, management, information systems, and others. The average age was 21.2 years.

The analysis had two stages. First, we assessed the reliability of items and used confirmatory factor analysis to compare several alternative factor structure models through a series of model modifications. In constructing and estimating confirmatory factor models, we used AMOS 5, which is a covariance-based SEM package developed by Arbuckle (Byrne 2001).

5.3.1 Reliability and MTMM matrix

Before conducting any model testing, we examined reliability of each factor (Table 5.13). For the convenience of comparison, we also include coefficients from previous studies in the table. However, for certain factors, items are not exactly the same across studies.

Table 5.13 Reliability Coefficients (Crobach's Alpha) of FSS and IFS in Study 1-C

Factor (# of items)	**Meaning**	**Study 1-C**	**Study 1-B**			**Study 1-A-3**	**PREV-IOUS**
			POOLED	GAME	SHOPPING		
		N=354 or 357	N= 149 or 148	N=61 or 60	N=88 or 87	N=79	
FSS-C (4)	Concentration	.8958	.8932	.9227	.8516	.9078	.82 *
FSS-E (4)	enjoyment	.9110	.8679	.8949	.8567	.9315	.81 *
FSS-CON (4)	Control	.9008	.9138	.9156	.8950	.8892	.86 *
FSS-M (4)	Mergence	.7187	.8403	.8986	.7473	.7758	.84 *
FSS-L (4)	Lose of self-consciousness	.8282	.8059	.8315	.7290	.8552	.81 *
FSS-TD (4)	Time distortion	.8013	.7958	.7777	.8026	.8005	.82 *
FSS-CS (3)	Challenge/skill	.6670	.6726	.8597	.5413	.5205	.80 *
FSS-CG (4)	Clear goal	.9279	.8758	.9065	.8153	.9603	.84 *
FSS-FB (4)	Feedback	.8791	.7867	.8753	.7470	.8970	.85 *
						Study 1-A-2	
						N=54	N differs
IFS-C (4)	Concentration	.8864	.8919	.9223	.8659	.7879	.910 **
IFS-E (4)	Enjoyment	.9225	.9146	.9322	.9054	.9421	.944 **
IFS-CON (5)	Control	.8160	.7005	.5280	.7419	.7990	.813 **
IFS-M (3)	Mergence	.7179	.5803	.6103	.5310	.9483	N/A
IFS-L (3)	Lose of self-consciousness	.7300	.4002	.4482	.4006	.3331	N/A
IFS-T (8)	Telepresence	.8992	.8994	.9228	.8783	.8459	N/A
IFS-TD (5)	Time distortion	.8502	.8639	.8939	.8397	.8574	.93 ***
IFS-PC (5)	Perceived challenges	.6888	.5850	.5775	.3647	.7476	N/A
IFS-PC (4)	Perceived challenges	.7621	N/A	N/A	N/A	N/A	N/A
IFS-PS (5)	Perceived skills	.8277	.7607	.7994	.6902	.6186	N/A

*: Jackson and Marsh (1996), N =394
**: Koufaris (2002), N= 280
***: Agarwal and Karahanna (2000), N= 270

From the table we can see that most factors, except FSS-CS and IFS-PC, had acceptable and high reliability. For the FSS, except for mergence and challenge/skill, all other factors had better reliability coefficient than in Jackson and Marsh (1996). For the IFS, all factors, with the exception of time distortion, improved from our previous studies. Dropping one item from IFS-PC improved the reliability to .7621, which will be used in later analysis.

As in Study 1-B, we also constructed a MTMM matrix, Table 5.14. In this table, the validity diagonal is in bold, which consists of 6 correlations between common dimensions of FSS and IFS. The reliability of factors is italic. We included other related factors at the bottom of the table, for example, perceived challenge and perceived skill. The results are similar to those in Study 1-B (Table 5.8). The reliability coefficients have the highest value in the row and column they are in. Except L (loss of self-consciousness), coefficients on validity diagonal are all large and significantly different from zero. They are also the second high values in the row and column they are in. This provides essential evidence of convergent validity. Except TD, these coefficients are higher than others in the heterotrait-monomethod triangles.

We expected the flow dimension factors should have significant correlation among them, which are consist with the data in the table except time distortion (TD). In this table, we also include precondition factors of flow. These preconditions all have significant correlations with flow dimensions, except TD. And the directions are correct in that challenge has negative correlations and others have positive correlations.

Table 5.14 MTMM Matrix for FSS and IFS in Study 1-C

	FSS-C	FSS-CON	FSS-E	FSS-M	FSS-L	FSS-TD	IFS-C	IFS-CON	IFS-E	IFS-M	IFS-L	IFS-TD	IFS-T	FSS-CS	PC	PS	FSS-CG	FSS-FB
FSS-C	*0.90*																	
FSS-CON	0.69**	*0.90*																
FSS-E	0.48**	0.43*	*0.91*															
FSS-M	0.58**	0.63**	0.48**	*0.72*														
FSS-L	0.46**	0.64**	0.24**	0.47**	*0.83*													
FSS-TD	-0.07	-0.04	0.23**	0.07	0.03	*0.80*												
IFS-C	**0.77****	0.52**	0.62**	0.51**	0.38**	0.14*	*0.89*											
IFS-CON	0.56**	**0.76****	0.43**	0.60**	0.51**	-0.06	0.47**	*0.82*										
IFS-E	0.51**	0.45*	**0.83****	0.50**	0.22**	0.11*	0.70**	0.48**	*0.93*									
IFS-M	0.56**	0.61**	0.59**	**0.68****	0.37**	0.06	0.61**	0.64**	0.68**	*0.72*								
IFS-L	0.22**	0.13*	0.52*	0.27**	**0.04**	0.34**	0.43**	0.06**	0.53**	0.41**	*0.73*							
IFS-TD	0.28**	0.20	0.55*	0.31**	0.10	**0.44****	0.50**	0.15**	0.57**	0.47**	0.63**	*0.85*						
IFS-T	0.25**	0.11	0.58**	0.26**	0.04	0.42**	0.51**	0.09	0.60**	0.41**	0.82**	0.71**	*0.90*					
FSS-CS	0.34**	0.44*	0.19**	0.38**	0.33**	-0.11*	0.23**	0.47**	0.22**	0.30**	0.03	0.00	0.07	*0.67*				
PC	-0.43**	-0.52*	-0.45*	-0.48**	-0.23**	0.08	-0.42**	-0.59**	-0.50**	-0.54**	-0.14**	-0.12**	-0.17**	-0.33**	*0.76*			
PS	0.47**	0.64*	0.37**	0.56**	0.42**	-0.12*	0.39**	0.70**	0.42**	0.57**	0.07	0.15**	0.11*	0.58**	-0.70**	*0.83*		
FSS-CG	0.48**	0.42*	0.44**	0.49**	0.22**	-0.02	0.40**	0.47**	0.45**	0.39**	0.17**	0.20**	0.20**	0.36**	-0.47**	0.59**	*0.93*	
FSS-FB	0.60**	0.63**	0.54**	0.64**	0.44*	0.08	0.47*	0.62*	0.51*	0.55**	0.21**	0.25**	0.24*	0.40	-0.51*	0.55**	0.58**	*0.88*

**: .01 level (2-tailed), *: .05 level (2-tailed)

5.3.2 Model Comparison

We used confirmatory factor analysis to compare a set of alternative models in order to determine most suitable model in terms of model fit, parsimony, and theoretical interpretation. Jackson and Marsh (1996) found that both of the two alternative models of flow measurement had acceptable model fit. The first model is a first-order model with nine factors, each corresponding to flow preconditions and dimensions, and the second model is a hierarchical model with a global, second-order flow factor explaining the correlations among the nine first-order factors. Although we disagreed with their equal treatment for all nine dimensions in the higher order model, since we believe preconditions and actual dimensions of flow ought to be separated, we adopted their approach for measurement validation. We started by comparing two basic alternative models for both the FSS and IFS. Then based on model fit results, we made modifications. In Table 5.15, we report those models with goodness-of-fit indices.

Before getting into a discussion of the specifics of those models, first let us introduce some of the goodness-of-fit indices. There are over a dozen fit indices reported by statistical packages. We selected those that have been reported regularly in literature and have been suggested by experts. The first measure we used is χ^2. Although it has been viewed by methodologists as being of little value and should not be given weight in model evaluation (MacCallum 1998), the χ^2 test of overall fit continues to be reported in research articles. χ^2 is the minimum discrepancy between the unrestricted sample covariance matrix and the covariance matrix of the restricted model (the model we are investigating). It tests the likelihood ratio that the residuals produced by our

model are not significantly different from zero. Thus, we would like to have a small χ^2 value and an insignificant p-value. Well-known issues with this statistic are due to its sensitivity to sample size and its basis on the χ^2 central distribution (Byrne 2001). One of the first fit statistics to address the problem is the ratio of χ^2/df, which should be less than 3 (Gefen et al. 2000).

Table 5.15 Goodness of Fit: Alternative Models

	Model description	**Goodness of fit indices**							
		χ^2	DF	χ^2/df	NFI	NNFI	CFI	RMSEA	ECVI
	FSS ***First-order model***								
	Jackson and Marsh (1996)	1124.95	585?		n/a	.904	.915	.051	n/a
1	Full model	1317.683	524	2.515	.85	.890	.903	.066	4.333
2	Full, modified model	1088.82	518	2.102	.876	.920	.930	.056	3.719
3	Reduced model	531.33	234	2.271	.921	.946	.954	.060	1.879
	Second-order model								
	Jackson and Marsh (1996)	1254.21	585		n/a	.892	.900	.055	n/a
4	Full model	1540.064	551	2.795	.825	.870	.880	.071	4.810
5	Full, modified model	1341.969	546	2.458	.848	.894	.903	.064	4.278
6	Reduced model	644.698	243	2.496	.904	.929	.938	.068	2.149
	IFS ***First-order model***								
7	Full model	2430.887	783	3.105	.772	.815	.832	.077	7.566
8	Full, modified model	1982.072	777	2.551	.814	.864	.877	.066	6.329
	Second-order model								
9	Full model	3334.294	810	4.116	.687	.726	.742	.094	9.973
10	**Full FSS model with T**	1654.022	808	2.046	.851	.907	.917	.054	5.456

For a long time, the Normed Fit Index (NFI) developed by Bentler and Bonett (1980) has been the practical criterion of choice. It is a measure of how close the restricted model to a perfect fit (saturated model). Later, Bentler (1990) revised NFI to take sample sizes into account; that is the Comparative Fit Index (CFI). The

recommended cutoff value is larger than .90 for NFI and .95 for CFI. Although all those indices are reported by most statistical packages, Bentler (1990) suggested that CFI should be the choice.

RMSEA has been strongly recommended by MacCallum (1998) since it is not based on a null model and its distributional properties are known. RMSEA is the Mean Square Error of Approximation. This index considers the error of approximation in the population and tries to assess how well the model fits the population covariance matrix as if it were available (Byrne 2001). The discrepancy is measured by RMSEA, which is expressed per degree of freedom. Thus the index is sensitive to the number of estimated parameters in the model. Normally, values less than .05 indicate good fit and over .08 indicate considerable errors. MacCallum et al. (1996) elaborate that RMSEA values from .08 to .10 indicate mediocre fit and values higher than .10 indicate poor fit. Researchers have also called for the use of confidence intervals to assess the precision of RMSEA estimates. A narrow interval is desirable (MacCallum et al. 1996).

ECVI (the Expected Cross-Validation Index) measures the discrepancy between the fitted covariance matrix in the analyzed sample and the expected covariance matrix that would be obtained in another sample of equivalent size. Except for a constant scale factor, ECVI is equivalent to AIC, Akaike's Information Criterion. Thus both address the parsimony issue of models, taking the number of estimated parameters and statistical goodness of fit into account. ECVI is used to compare a group of models, for each of which an ECVI is calculated. Then all ECVI values are ranked; the model having the smallest value exhibits the greatest potential for future replication. There is no

determined appropriate range of values for ECVI (Byrne 2001, p. 86). It is also suggested by MacCallum (1998) to use this index for comparing alternative models.

In Table 5.15, the full, first-order factor model (Model 1) of FSS is similar to the first-order model of Jackson and Marsh (1996)'s. Except for CS, which was measured by three items, all other factors had four items. Please refer to Appendix F for questions. It had similar values of fit indices as the original model, except RMSEA with a confidence interval of .061 to .070. Based on modification indices (larger than 30), we freed six covariances among error terms to be estimated. Those covariances were among items belonging to feedback (FB), mergence (M), concentration (C), and control (CON). So our full, modified model (Model 2) had better fit statistics than the base full model (Model 1). The RMSEA has a confidence interval of .051 to .061. In these two models, factor TD has insignificant covariances with a majority of other factors. Also, exploratory factor analysis showed that items of factors CS and M did not have consistent loadings. We decided to try a reduced model (Model 3) excluding factors TD, CS, and M. All indices improved, except the RMSEA, which has a confidence interval of .053 to .067.

The next group of models was second-order models. In these models, a higher-order, global flow factor was used to explain correlations among underlying factors. We followed the same steps as for the first-order factor models. We ran a model without freeing any constraints first. Then based on modification indices, we revised the model specification. The changes we made were to free five covarainces among error terms.

Fit statistics improved. However, compared to the first-order models, second-order models had no better goodness of fit.

We then turned our attention to the IFS measures. We took the same approach as with the FSS. We examined both first-order models and a second-order model. It was apparent that IFS models as a whole did not perform as well as FSS models, especially the second-order model of the IFS, which had a very poor fit. It was unlikely to be able to improve IFS models significantly by minor model modifications. Thus, we stopped here without further model respecifications.

5.3.3 Discussion

Our purposes in this study were to investigate the internal structure of flow experience, to validate flow measures by comparing a set of models derived from two flow scales, and to select a scale for later analysis. Overall, the FSS outperformed the IFS scales, which was consistent with the results of Study 1-B. In examining the models of FSS, the reduced model had the best fit statistics. However, at this point in time, without further empirical evidence, it was hard to interpret the model and to theoretically justify the exclusion of three factors, namely, CS, TD, and M. The full models, especially the model with modifications (Model 2), had acceptable goodness of fit too, while it was consistent with the theory. Thus, we decided to use the FSS as the main body of our flow measure in later analysis. The advantage of using the FSS scale is that it is a more holistic scale than the IFS. The IFS was not as comprehensive in coverage as the FSS was in two respects. First, items for two dimensions (loss of self-consciousness and mergence of action and awareness) in IFS had to be developed by the

investigator, since they were not included in previous IS or marketing studies of flow. Secondly, the IFS does not include two important preconditions of flow, quick feedback and a clear goal. In the end, it is always highly desirable to use previously developed and validated instruments in research.

However, the FSS scale was not without issues. First of all, the goodness-of-fit statistics for the full FSS were merely acceptable and not as good as those for the reduced model (Model 3). The decisions involved in selecting a particular model based on theory and interpretability introduced certain amount of subjectivity. Hence, there is room for further validation and modification, which we will keep our effort on.

Secondly, in previous IS and Marketing literature, telepresence has been conceptually and empirically included as one of the dimensions of flow in computer mediated environments. Therefore, we constructed a model (Model 10) with ten first-order factors. Basically, it is the full FSS scale (Model 2) with the Telepresence scale included. The goodness-of-fit indices were acceptable and are also reported in Table 5.15. In Table 5.16, we report the regression weights of items on factors; all were significant. Since standardized regression weights are the factor loading of items to factors, significant and high (>.707) regression weights are a sign of convergent validity (Straub et al. 2004). In our measure, most items met this requirement, with exception in CS, M, L, TD, and T.

Table 5.16 Standardized Regression Weights

			Estimate
FSS_CS2	<---	FSS-CS	.727
FSS_CS3	<---	FSS-CS	.818
FSS_CS4	<---	FSS-CS	.363
FSS_FB1	<---	FSS-FB	.722
FSS_FB2	<---	FSS-FB	.803
FSS_FB3	<---	FSS-FB	.863
FSS_FB4	<---	FSS-FB	.807
FSS_C1	<---	FSS-C	.701
FSS_C2	<---	FSS-C	.769
FSS_C3	<---	FSS-C	.930
FSS_C4	<---	FSS-C	.896
FSS_M1	<---	FSS-M	.543
FSS_M2	<---	FSS-M	.483
FSS_M3	<---	FSS-M	.765
FSS_M4	<---	FSS-M	.693
FSS_CON1	<---	FSS-CON	.795
FSS_CON2	<---	FSS-CON	.854
FSS_CON3	<---	FSS-CON	.834
FSS_CON4	<---	FSS-CON	.773
FSS_E1	<---	FSS-E	.776
FSS_E2	<---	FSS-E	.831
FSS_E3	<---	FSS-E	.890
FSS_E4	<---	FSS-E	.904
FSS_L1	<---	FSS-L	.707
FSS_L2	<---	FSS-L	.665
FSS_L3	<---	FSS-L	.801
FSS_L4	<---	FSS-L	.799
FSS_TD1	<---	FSS-TD	.663
FSS_TD2	<---	FSS-TD	.719
FSS_TD3	<---	FSS-TD	.730
FSS_TD4	<---	FSS-TD	.728
FSS_CG1	<---	FSS-CG	.850
FSS_CG2	<---	FSS-CG	.910
FSS_CG3	<---	FSS-CG	.906
FSS_CG4	<---	FSS-CG	.840
IFS_T1	<---	IFS-T	.469
IFS_T2	<---	IFS-T	.581
IFS_T3	<---	IFS-T	.844
IFS_T4	<---	IFS-T	.793
IFS_T5	<---	IFS-T	.815
IFS_T6	<---	IFS-T	.813
IFS_T7	<---	IFS-T	.741
IFS_T8	<---	IFS-T	.774

On conclusion of the third study we had achieved our purposes of finding valid measures of flow and of selecting a better measure for later use. Before moving to the next chapter, we would like to make an observation on the first-order and second-order models. In this study all the second-order models used a global flow factor to explain correlations among other factors. In modeling, no differentiation was made between flow precondition factors (e.g., challenge/skill, clear goal, and feedback in the FSS, and perceived challenge and perceived skill in the IFS) and dimension factors. Overall, first-order models had better goodness-of-fit statistics than their second-order counterparts. One possible reason is that the first-order models only tested correlations among those factors, which according to the theory should correlate closely. However, in second-order models, treating all factors the same might not be appropriate because there is a theoretical distinction between preconditions and characteristics of flow. Ignoring the distinction actually may have incorrectly modeled the relationships among those factors. This could be the reason that the model fit indices were not as good as first-order models. This observation gives us some confidence in the model we proposed, in which direct factors (preconditions) of flow were modeled explicitly. Studying such a model will be the focus of next chapter, since it involves testing a structural model.

5.4 Conclusion

In this chapter we have presented results from our validity study for flow measures. We examined validity of flow measures from three aspects: behavioral correlates, nomological network, and factorial validity. Collectively, these studies provided certain evidence of construct validity for flow measures and suggest the FSS is

a better scale to use as the main body of the flow measure. We decided to supplement the FSS with the telepresence dimension as well. In the next chapter, the results of Study 2, an investigation of a comprehensive flow model in Internet shopping using the technique of structural equation modeling, will be presented.

CHAPTER VI

TEST OF FLOW MODELS

The results of the second part of this research project are reported in this chapter. After evaluating the flow measures to determine which measure was best for further research, we continued the investigation to examine the antecedents and consequences of flow in online shopping. We conducted an experiment in which subjects were asked to visit Web sites with two different levels of complexity across two product categories. Details of the procedures were described in Section 4.4. The results of this analysis are presented in three sections. First we present several manipulation checks that examine whether our treatments were effective. Second we conduct a test of the channel model of flow, which is the standard theoretical model in flow research. Subjects are segmented into channels based on perceived challenge and skills. Their experiences in terms of flow dimensions are compared across channels. Third, we evaluate the structural model hypothesized in Section 3.3 using structural equation modeling. We start from that model and run a series of models to find a model with both better fit-indices and theoretical basis and interpretability. Conclusions and implications are discussed at the end of the chapter.

6.1 Manipulation Checks

In our study, eight Web sites in two product categories were used as treatments. Selection of the Web sites was conducted according to a systematic procedure described in Section 4.4. We used two methods to check whether the manipulation was effective.

First, we watched the mouse movements of subjects to see whether they followed the experimental instructions and visited the Web site assigned to them. Using a random number table, we selected 34 subjects out of total 354 and watched the video files of their sessions. All of them visited and stayed on the Web sites assigned to them. From this we concluded that the basic manipulation had been effective

Secondly, we examined the relationships between perceived complexity and objective complexity in order to determine whether the complexity manipulation, which was based on objective measures, led to differing levels of complexity as perceived by subjects. This was equivalent to testing Hypotheses 4 in our research model. Based on objective ratings of over 60 attributes of Web sites, eight Web sites were selected as the treatment in our study, as described in Section 4.4. Among these, four were high in complexity and four were low in complexity. In our study, we differentiated objective complexity and perceived complexity. Objective complexity was represented by objective ratings by two raters using established dimensions of complexity, while perceived complexity was the subjective perception of complexity as rated by subjects. These two were not the same type of constructs, but we expected them to be related. We posited that subjects would find a Web site with high objective complexity more complicated than those with low objective complexity (Hypothesis 4).

The 3-factor scale for site complexity (Nadkarni and Gupta 2003) was not used in this study because of its poor factor analysis results in our pilot studies. Instead, a total of 16 questions regarding site complexity were compiled from various studies and used as the measure for perceived complexity in the current study. Factor analysis using

the Maximum Likelihood extraction method and equamax rotation yielded the three-factor structure shown in Table 6.1. Examination of the items (refer to Appendix F) yielded clearly interpretable factors, suggesting that these three groups of items formed meaningful sub-dimensions of site complexity. For example, question OC1 ("I found this web site was complicated.") and question OC2 ("I felt the web site was pretty simple.") were designed originally to assess overall perceived complexity. Question COM1 ("The web site is complex.") and question COM4 ("The web site is overwhelming.") also expressed an overall feeling toward a Web site. Thus, we combined these four into one factor and label it as "Overall Complexity." When we looked at the next group of questions, e.g., COM2 ("The web site is interactive."), COMN2 ("open/cluttered"), and COMN4 ("sparse/dense"), they were more or less related to the design of the Web page. Therefore, we label them as "Presentation." On the other hand, the last group of questions concerned the navigational aspect of a site. For example, question COMN6 ("logical/illogical") and question COMN7 ("predictable/unpredictable") seemed to relate to ease of movement through the site. Those items were thus combined into three factors, summarized in Table 6.2. Reliabilities of the items making up each factor were acceptable according to standards discussed in Straub et al. (2004).

Table 6.1 Rotated Factor Matrix of Perceived Complexity Measure

	Factor		
	1	2	3
OC1	.704		
OC2	.611		
COM1	.552		
COM2	.565	.515	
COM3			
COM4	.578		
COM5			
COMN1			
COMN2		.741	
COMN3		.405	
COMN4		.496	
COMN5			.541
COMN6			.715
COMN7			.469
COMN8		.541	.508
COMN9		.500	

Extraction Method: Maximum Likelihood.
Rotation Method: Equamax with Kaiser Normalization. Rotation converged in 26 iterations.

Table 6.2 Perceived Complexity Factors

Factor	**Meaning**	**Items**	**reliability**
COMP-1	Overall complexity	OC1, OC2, COM1, COM4	.8024
COMP-2	Presentation	COM2, COMN2, COMN3, COMN4, COMN9	.7673
COMP-3	Navigation	COMN5, COMN6, COMN7, COMN8	.8135

To verify whether subjects' perceived complexity was high for Web sites with a high level of objective complexity, the complexity scores were calculated as averages of perceived complexity factors. Mean values for each Web site are reported in Table 6.3. In each cell, there are three values. The first value is the mean value, the second value is the number of subjects for which the score was calculated, and the third value is the standard deviation. Also included in this table are mean values for subject self-reported familiarity with the Web site and with the product.

Table 6.3 Mean Values of Perceived Complexity of Web Sites

Objective Complexity	Category	Site No.	Site	COMP-1-A	COMP-2-A	COMP-3-A	Fam-site	Fam-Prod
High	Computer	1, Alpha	J&R computer	2.7611	3.8311	2.2056	1.5227	5.0227
				45	45	45	44	44
				1.35989	1.20677	1.09789	1.26654	1.57729
High	Computer	2, Beta	Newegg.com	3.5389	4.6756	2.8889	1.8864	4.4318
				45	45	45	44	44
				1.41216	1.11868	1.17085	1.58798	1.80951
	Total			3.15	4.2533	2.5472	1.7045	4.4273
				90	90	90	88	88
				1.43286	1.23245	1.17971	1.4397	1.7136
High	Books	5, Sigma	Amazon.com	2.8920	3.9022	2.3667	4.6667	5.4889
				44	45	45	45	45
				1.38974	1.14306	.96913	2.19504	1.53182
High	Books	6, Omega	Booksamillion.com	2.8239	4.1500	2.3693	2.0976	4.6341
				44	44	44	41	41
				1.30916	1.21627	1.10297	1.71471	1.72853
	Total			2.8580	4.0247	2.3680	3.4419	5.0814
				88	89	89	86	86
				1.34271	1.17968	1.03153	2.3545	1.6748
Total				***3.0056***	***4.1397***	***2.4581***	***2.5632***	***4.9023***
				178	179	179	174	174
				1.36241	1.20856	1.10904	2.127	1.699
Low	Computer	3, Gamma	Gateway.com	3.0284	3.5511	2.2611	3.7955	4.3182
				44	45	45	44	44
				1.16041	.98917	.75933	2.07510	1.73571
Low	Computer	4, Delta	PCConnection.com	3.3693	4.0533	2.5222	1.6818	4.4091
				44	45	45	44	44
				1.36131	1.14368	1.01386	1.53672	1.87168
	Total			3.1989	3.8022	2.3917	2.7386	4.3636
				88	90	90	88	88
				1.26920	1.09277	.90026	2.1036	1.795
Low	Books	7, PI	Barns&Noble.com	3.0625	3.9818	2.2216	4.6744	5.2791
				44	44	44	43	43
				1.34912	.94285	.85626	2.19003	1.73652
Low	Books	8, Lambda	Buy.com	3.0341	3.7318	2.5398	2.2326	5.2791
				44	44	44	43	43
				1.45633	1.16694	.97191	1.58621	1.43636
	Total			3.0483	3.8526	2.3807	3.4535	5.2791
				88	88	88	86	86
				1.39573	1.06218	.92458	2.2630	1.5841
Total				***3.1236***	***3.8292***	***2.3862***	***3.0920***	***4.8161***
				176	178	178	174	174
				1.33229	1.07506	.90980	2.207	1.750
Total (all sites)				**3.0643**	**3.9849**	**2.4223**	**2.8276**	**4.8592**
				354	357	357	348	348
				1.36241	1.15286	1.01382	2.18038	1.72296

The table shows that perceived complexity is not very strongly related to objective complexity. Web sites with higher objective complexity have lower perceived overall complexity (COMP-1); however, this difference was not significant. Web sites with higher objective complexity were perceived to be significantly more complex in terms of presentation (COMP-2) and navigation (COMP-3) than those with lower objective complexity in terms of mean ratings, but only COMP-2 was significant. Please refer to Table 6.4 for the test results. Thus, Hypothesis 4 was just partially supported. Category main effects on all three factors were not significant. In those tests, we included two covariates: site familiarity and product familiarity. Product familiarity was significant for all perceived complexity factors, while site familiarity was only significant for navigation aspect (COMP-3) of perceived complexity. These results are not surprising in that the knowledge of product is one of important aspects of task complexity when making buying decisions. It is only natural for visitors to perceive a Web site to be more complex when they have little product knowledge because they have to both comprehend the content and figure out the structure of the site.

One explanation for inconsistency between objective site complexity and perceived site complexity is that when visiting a Web site, visitors may not browse all parts of the site and they judge perceived complexity based on the particular parts they have experienced. On the other hand, the procedure for rating objective complexity includes a thorough browsing of the site by viewing five types of Web pages, which emphases the "totality" of the site in the measure.

Table 6.4 Test for Differences in Complexity

	COMP-1 (Overall)		**COMP-2 (Presentation)**		**COMP-3 (Navigation)**	
	F	p-value	F	p-value	F	p-value
Main effect						
Category	.046	.831	.049	.825	.313	.576
Objective Complexity	1.116	.292	4.796	**.029**	.256	.613
Category * Objective Complexity	.637	.425	1.815	.179	.837	.361
Covariant						
Site familiarity	2.637	.105	3.524	.061	4.818	.029
Product familiarity	16.273	.000	5.013	.026	16.046	.000

It is also possible that since only two raters were assigned for each site in the objective ratings their ratings might not be representative, considering the sheer number of pages on each site. Second, other factors, such as the task at hand, can also affect perceived complexity. For example, as an experienced shopper myself, normally I would not find amazon.com to be complicated although it is a vast Web site and has much going on in its pages. But if I were looking for items in a domain I was unfamiliar with, I might feel it was overwhelming. Although we measured familiarity with the site and with the product category and they did not have obvious relationship with perceived site complexity, we still could not exclude this possibility. Third, combining the above two explanations, the lack of relationship might well be that the aspects we rated to calculate the objective measure might not be the features that affect people's perception on complexity the most. Nevertheless, these results suggest that the relationship between objective and subjective complexity is worthy of future study. In subsequent

analysis, we will use perceived complexity as one of the antecedents of flow as we proposed in our model (Figure 3.3), since we deem that this factor more directly affects the online flow experience.

6.2 The Channel Model of Flow

According to flow theory, we can segment subjects' experiences into different channels based on the relationship between perceived challenge and perceived skill. The channel with high perceived challenge and perceived skill is called Flow, which represents the optimal experience. Therefore, experiences in this channel should have the highest scores in terms of flow dimensions (Hypothesis 1a). The flow score should be moderate if there is a high value on one but not both of the two dimensions (these represent the Boredom and Anxiety channels) (Hypothesis 1b). Lastly, the flow score should be lowest when challenge and skill are simultaneously at low levels (the Apathy channel) (Hypothesis 1c). Please refer to Figure 2.1 and related discussion in previous chapters.

Thus, the central focus was the relationship between perceived challenge and skills and flow. In our study, there were three constructs related to this balance: perceived challenge (PC), perceived skills (PS), and perceived balance of challenge and skill (CS). Descriptive data for the three variables is summarized in Table 6.5. The values for mean, standard deviation, and median are based on item averages. Although perceived challenge had better reliability than in the validity studies, e.g., Study 1-B (please refer to Table 5.7 and related discussion for detail of reliabilities of constructs), the reliability was further improved by dropping Item 2 from the original 5-item scale.

This improved reliability from .69 to .76. Because the 4-item scale had higher reliability, it was used in subsequent analysis.

Table 6.5 Descriptive Summary for PC, PS, and CS

Constructs	# of items	Reliability (Cohen's α)	Mean	Std. Dev.	Median
Perceived challenge (PC)	5 items	.6888	2.89	1.04	2.8
	4 items	.7621	2.63	1.20	2.5
Perceived skills (PS)	5 items	.8277	5.5	1.13	5.8
Perceived balance (CS)	3 items	.6670	5.138	1.18	5.33

We conducted tests of the traditional flow models in two ways. First we assigned subjects to the four channels based on the relationship between PC and PS, as suggested in the traditional four-channel model. The distribution of PC and PS was graphically displayed in a scatter chart (Figure 6.1). From the table and the figure, it is clear that online shopping activities were not considered as a challenging task and normally people believed they had considerable skills for it. We think this is a common perception, but using a sample of college students made it more so. In segmenting subjects into channels we used a median split. If PC or PS exceeded or was equal to its median, it was coded as 1; otherwise it was coded as 0. Results are presented in Table 6.6.

Table 6.6 Results of Segmentation

PC	PS	Channel	# of cases
1	1	Flow	35
1	0	Anxiety	149
0	0	Apathy	56
0	1	Boredom	114

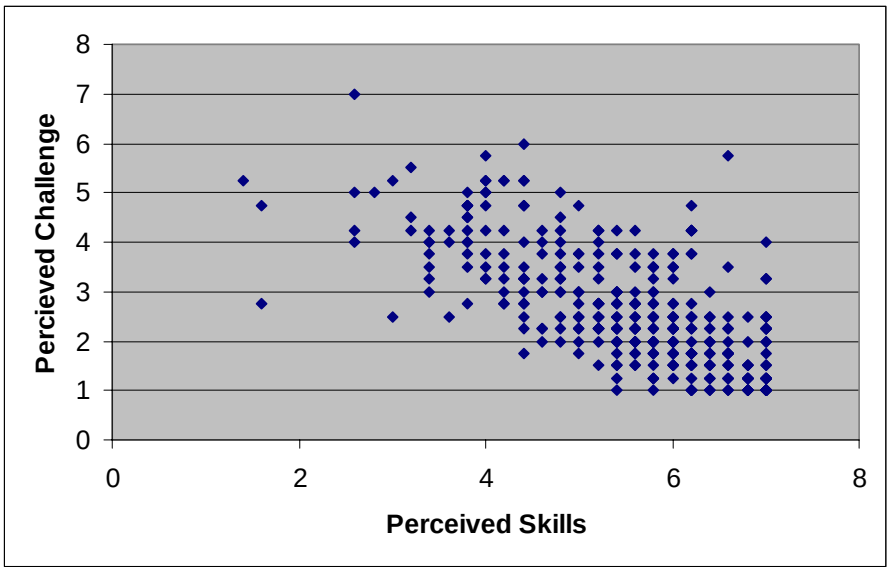

Figure 6.1 Scatter Chart of Perceived Skill and Perceived Challenge

The mean values of flow dimensions and consequences in four channels are reported in Table 6.7 and Figure 6.2. The results were not consistent with flow theory in that the Flow channel did not have highest score on all flow dimensions and consequences; rather the Apathy or Boredom channels had higher scores in some cases. Overall, the worst channel was Anxiety and the best was Boredom. The Flow channel and the Apathy channel were in between. Thus, Hypothesis 1 was not supported. Neither were its sub hypotheses. Except for the Time Distortion and Telepresence dimensions, all other dimensions had significant mean differences among channels (df = 350) using a random effects ANOVA model of channels on dimension scores (averages of items). In Table 6.7, both F values and significance levels are reported for each flow dimension and other related constructs.

Table 6.7 Flow Scores for 4-Channel Model

Channel		C	CON	E	M	L	TD	T	P	A	D	PU	BI
Flow	Mean	5.171	6.007	3.664	5.564	6.179	3.579	3.275	4.548	3.643	4.491	4.157	4.193
	Std. Dev	1.429	.7753	1.481	.9632	.9712	1.716	1.416	1.016	.8206	.7453	1.308	1.707
Anxiety	Mean	4.515	4.960	3.175	4.403	5.379	3.617	3.056	4.152	3.340	4.333	3.737	3.327
	Std. Dev.	1.389	1.227	1.226	1.050	1.253	1.270	1.173	1.087	.8910	.6308	1.245	1.605
Apathy	Mean	5.201	5.688	3.960	5.134	5.719	3.594	3.451	5.024	3.637	4.411	4.603	4.621
	Std. Dev.	1.070	1.117	.9986	.9653	1.292	1.181	1.121	.9274	.8979	.5929	1.026	1.478
Boredom	Mean	5.700	6.314	4.412	5.715	6.270	3.276	3.411	5.214	3.734	4.519	4.702	4.989
	Std. Dev.	1.121	.7995	1.348	.9102	.9658	1.296	1.406	.9848	.8451	.7479	1.377	1.625
Total	Mean	5.070	5.614	3.746	5.056	5.799	3.500	3.255	4.671	3.544	4.421	4.226	4.153
	Std. Dev.	1.359	1.201	1.367	1.144	1.212	1.319	1.276	1.127	.8852	.6790	1.335	1.759
F		19.25	38.07	21.37	42.09	14.39	1.63	2.24	25.82	4.89	1.76	14.51	25.12
p-value		.000	.000	.000	.000	.000	.182	.083	.000	.002	.155	.000	.000

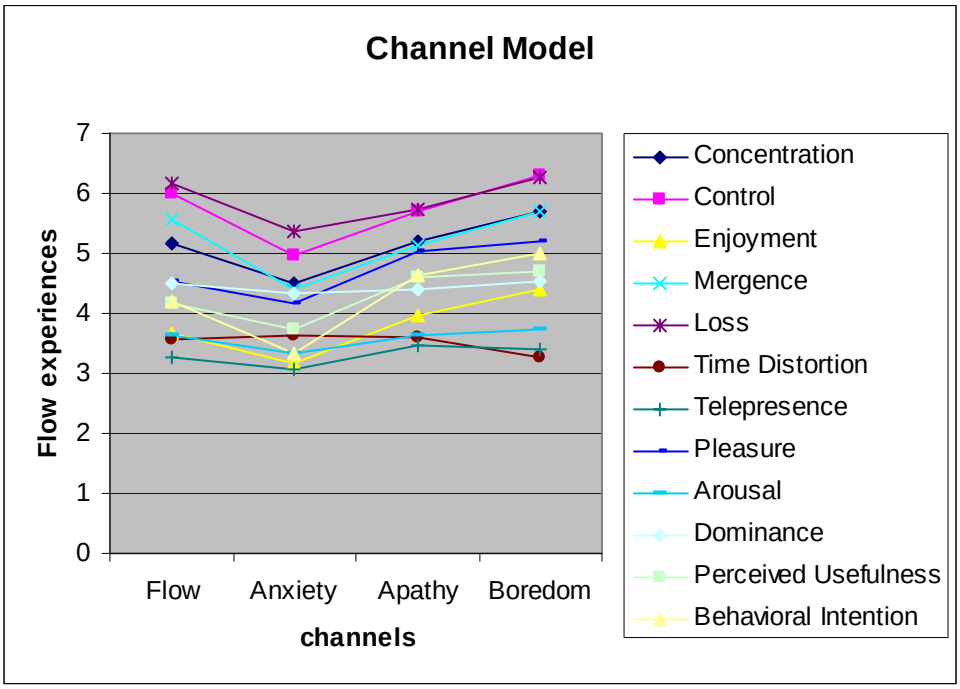

Figure 6.2 Experiences of the Subjects in the 4 Channels

In a second analysis we segmented subjects into two channels (in flow vs. not in flow) based on the score for balance of challenge and skill. The coding rule was that if CS exceeded and equal to median value (5.33), the case was coded as in flow; otherwise it was not in flow. There were 169 non-flow cases and 185 in-flow cases. The mean values of flow dimensions and consequences are in Table 6.8. In-flow and non-flow experiences were significantly (df = 352, please find F values and significance levels in Table 6.8 too.) different and the in-flow scores were higher on most dimensions, with the exception of Time Distortion, Telepresence, Arousal, and Dominance. This result was consistent with flow theory as traditionally presented. However, it is not consistent with the results of Chen et al. (1998), who only found mixed support for flow theory. In their study, they had a different operationalization of balance between perceived skill and perceived challenge, and they only compared flow experience on two dimensions: enjoyment and attention. Those differences make it difficult to compare the results from the two studies. Thus, this remains an interesting issue for further investigation.

Table 6.8 Flow Scores for Not-in-Flow and In-Flow Cases

Channel		C	CON	E	M	L	TD	T	P	A	D	PU	BI
Non-flow	Mean	4.630	5.124	3.410	4.580	5.465	3.611	3.092	4.368	3.435	4.338	4.019	3.740
	Std. Dev.	1.377	1.256	1.353	1.094	1.280	1.255	1.168	1.088	.9201	.6311	1.338	1.739
In-flow	Mean	5.472	6.062	4.053	5.491	6.104	3.399	3.403	4.948	3.643	4.496	4.415	4.530
	Std. Dev.	1.214	.9510	1.309	1.010	1.061	1.370	1.354	1.092	.8422	.7133	1.307	1.696
Total	Mean	5.070	5.614	3.746	5.056	5.799	3.500	3.255	4.671	3.544	4.421	4.226	4.153
	Std. Dev.	1.359	1.201	1.367	1.144	1.212	1.319	1.276	1.127	.8852	.6790	1.335	1.760
F		37.32	63.37	20.64	66.33	26.36	2.30	5.33	25.00	4.95	4.84	7.91	18.71
p-value		.000	.000	.000	.000	.000	.13	.022	.000	.027	.028	.005	.000

Our analyses do not support the 4-channel model of flow. On reflection, however, this does not necessarily imply that the 4-channel model is invalid in general. It may rather be evidence of the special nature of shopping online and Web surfing in general. In these activities, challenge and sensation may not be sought after; rather subjects may be more interested in having an enjoyable experience and finding what they want to purchase online. In this case, having the appropriate skills to find and to purchase what one wants may become a more prominent drive for visitors' flow experiences, which echoes the comparison of game playing and shopping online that we found in Study 1-B. This suggestion is consistent with the finding that in the case in which challenge was perceived to be high and skill low, flow scores were lowest. That may suggest that Web site visitors have a low tolerance of difficulty and easily get frustrated. A correlation test shows that both PC and PS correlate with flow dimensions (Table 6.9), but not consistent with flow thoery. The correlations between PC and flow dimensions were mostly negative, like in Study 1-B. PS has positive correlations with flow dimensions. In terms of magnitude, PS haS higher correlations with flow dimensions than PC, as shown in Table 6.9.

Table 6.9 Correlations between Flow Dimensions with PC and PS

	C	CON	E	M	L	TD	T
CS	.336**	.439**	.192**	.382**	.330**	-.107*	.074
PS	.469**	.639**	.370**	.561**	.416**	-.120*	.111**
PC	-.428**	-.575**	-.437**	-.484**	-.233**	.076	-.175

The results supported the simpler 2-channel model of flow based on perceived balance of challenge and skill. People feeling a balance of challenge and skill had a better experience than those who were not in balance. A simple linear regression analysis on averages of PC and PS on CS showed that PS contributed more to the feeling of balance. Both the coefficients of PC (β=.148, p=.015) and PS (β=.679, p=.000) were significant (df = 351), but the skills coefficient was more substantial, which can be shown using a stepwise regression (Table 6.10). The adjusted R square is the amount of variance explained by the model. Model 1 with only PS explains 32.9 percent of variance in CS. Adding PC (Model 2) increased adjusted R square, but not by much. This is also consistent with the interpretation that skill is more important than challenge in online shopping.

Table 6.10 Stepwise Regression Result of PS and PC on CS

Model [a]		Adjusted R square	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
			Beta	Std. Error	Beta		
1	(Constant)	.329	1.837	.256		7.186	.000
	PS		.600	.046	.575	13.185	.000
2	(Constant)	.338	.856	.474		1.807	.072
	PS		.709	.063	.679	11.206	.000
	PC		.146	.060	.148	2.450	.015

a Dependent Variable: CS

Overall, perceived balance seems to be a more effective factor in predicting flow than perceived challenge and skills individually. Thus, in the following analysis, we focused on CS and investigated PC and PS in post hoc analysis.

6.3 Effects of Complexity and Consequences of Flow: Structural Models

In investigating the relationships among site complexity, preconditions of flow, flow and its dimensions, and outcome variables, we tested the proposed structural model that incorporates the hypothesized relationships. The model is shown in Figure 6.3, which is a redrawing of research model in Figure 3.3. Structural equation modeling (SEM) was used to investigate relationships among constructs in the model. SEM is suitable here because the relationships between the constructs are complex and involve mediating effects. "The intricate causal networks enabled by SEM characterize real-world processes better than simple correlation-based models" (Gefen et al. 2000). SEM has also been used in testing treatment means in experimental studies also (e.g., Aiken et al. 1994).

A two-step approach was employed in model construction and testing (Anderson and Gerbing 1988; Novak et al. 2000). First, the measurement model was assessed to see if any structural model existed that had an acceptable goodness-of-fit using a confirmatory factor analysis (CFA) model with covariances between all pairs of factors. In the statistical software (AMOS) we used, modification indices (based on The Lagrange Multiplier test) were used as basis to identify measured variables that loaded on multiple latent factors and latent factors with many loadings of measured variables that should not load on them. Those variables should be deleted to form a base model for subsequent analysis. After the "purifying" process, we fit the research model. We refined the model by dropping low t-statistics paths (based on the Wald test) and adding parameters to the model when appropriate (based on the Lagrange Multiplier test).

Using theory as primary guide, every change made to the model was based on the consideration of interpretability and improvement in fit indices. The resulting model should have a better overall fit and R-square statistics, as well as a theoretically reasonable structure.

6.3.1 Purifying the Measurement Model

Based on our analysis of previous studies, our base model (CFA1) included the latent factors and measured variables for three complexity factors (COMP1, COMP2, and COMP3), perceived balance of challenge (CS) and skill, clear goal (CG), feedback (FB), playfulness (PLAY), concentration (C), control (CON), enjoyment (E), mergence (M), loss of self-consciousness (L), time distortion (TD), telepresence (T), perceived usefulness (PU), behavioral intentions (BI), and pleasure (P).

Maximum likelihood estimation was used to fit the model with the data from a sample of 354 subjects. Although many tests of statistical significance and indices of fit help in the evaluation of model fit, "there is ultimately a degree of subjectivity and professional judgment in the selection of a 'best' model" (March and Jackson 1999). In our assessment of the models, we gave priority to the RMSEA with considerations of other fit indices, following the suggestions of MacCallum (1998). As Table 6.11 shows, overall goodness-of-fit for this initial model was reasonable in that RMSEA was equal to .050 (with confidence interval of .048 to .052 and p-value of .428) and CFI was .863. Two items measuring Telepresence were dropped due to cross-loadings with other latent factors. Several items also caught our eyes based on examination of the modification indices for covariances among error terms. First, we freed the covariances between Item

4 and Item 7 of Play in the fourth analysis (CFA4), and then for some items among CON, C, and M in the fifth (CFA5). CFA5 has acceptable goodness-of-fit and forms the measurement model for our next analysis.

Table 6.11 Model Modification Process for Purifying the Measurement Model

Model	χ^2	DF	χ^2/df	NNFI	NFI	CFI	RMSEA	ECVI	Modification & Reason
CFA1	5130.12	2713	1.897	.857	.757	.867	.50	16.176	The base model
CFA2	4894.48	2638	1.855	.876	.765	.874	.049	15.479	Drop T1 due to cross loading
CFA3	4701.00	2564	1.833	.869	.770	.879	.049	14.938	Drop T2 due to cross loading
CFA4	4448.70	2562	1.736	.885	.783	.893	.046	14.234	Free some error covariances
CFA5	4283.04	2557	1.675	.894	.791	.902	.044	13.793	Free more error covariances

6.3.2 Structural Models

Our empirical modeling was based on the measurement model (CFA5) resulting from the previous purification procedure. In testing the structural model, we entered the factors in three phases. In the first phase, we only included the factors of flow dimensions and tested a second-order model of flow. Then, we included the three preconditions of flow. Lastly, we entered external factors – the three complexity factors – and consequences of flow: perceived usefulness, pleasure, and behavioral intentions. This approach provided the opportunity to examine the hypothesized model step-by-step using a series of hierarchical models.

Jackson and Marsh (1996) developed and validated a flow measure (FSS) that included all the preconditions and dimensions. We used their measure in our study and

compared our measurement model with theirs in Chapter V. However, we took a different approach to modeling the higher-order flow factor than Jackson and Marsh. They included both flow preconditions and dimensions as constituents of their second order factor, flow. However, this does not seem appropriate since the preconditions are not part of the flow construct per se, but are factors that create flow. Including both flow dimensions and preconditions in the same higher order factor may be the reason that higher-order models had relatively poor fit in their study.

To develop a measure of flow based on its core dimensions we first examined a model with a global factor flow as indicated by its underlying dimensions: concentration (C), sense of control (CON), mergence of activity and awareness (M), loss of self-consciousness (L), telepresense (T), time distortion (TD), and enjoyment (E). This is illustrated in Figure 6.3. Except for time distortion, all other dimensions had significant paths with Flow. Fit of this measurement model was not ideal (df=396, χ^2=1092.995, χ^2/df=2.760, CFI=.896, NNFI=.886, NFI=.847, RMSEA=.071). After dropping the non-significant path between flow and time distortion, model fit improved (df=291, χ^2=793.434, χ^2/df=2.727, CFI=.918, NNFI=.908, NFI=.877, RMSEA=.070) to some extent (see Figure 6.4). Based on the results, we used Model 2, which has six significant underlying dimension factors, in later analysis. The decision of not dropping more dimensions, for example, T, was based on both theoretical and statistical concerns. Inclusion of T is supported by previous literature (e.g., Novak et al. 2003) and the path coefficient, though modest, was significant in our model.

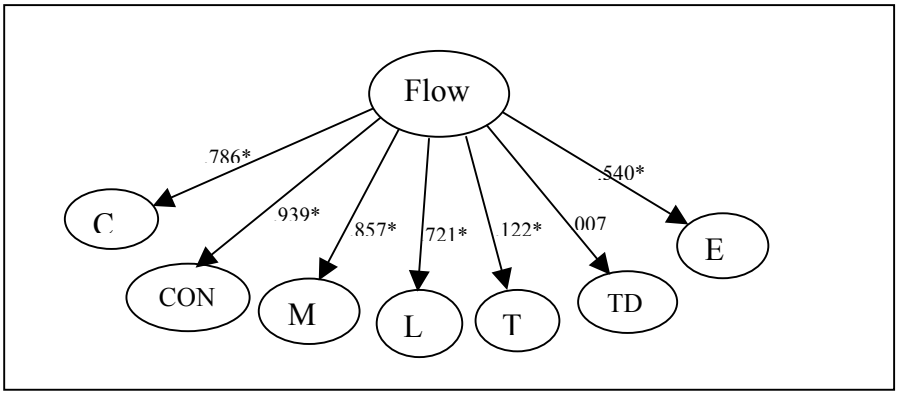

Figure 6.3 Second Order Flow Measurement Model 1

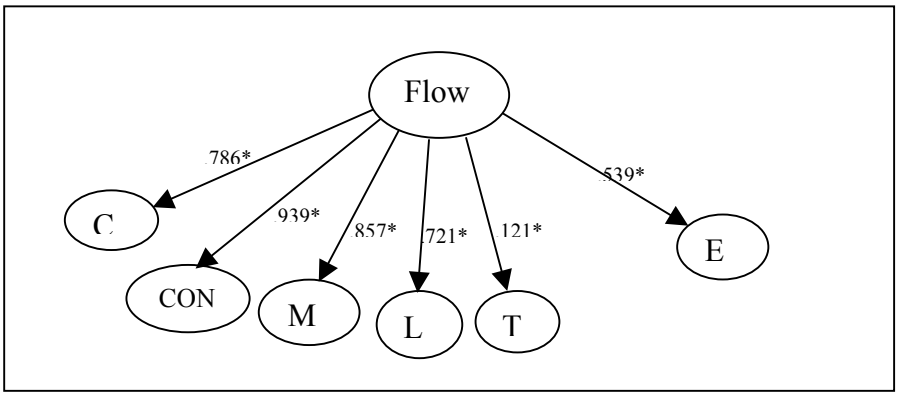

Figure 6.4 Second Order Flow Measurement Model 2

In the second phase of analysis, we included preconditions of flow in the model (Figure 6.5). In this model, the effects of individual preconditions were modeled as direct effects on flow. Goodness of fit was acceptable (df=615, χ^2=1532.879, χ^2/df=2.492, CFI=.900, NNFI=.891, NFI=.844, RMSEA=.065). Among the preconditions, balance of challenge and skill (CS) and feedback (FB) had positive and significant paths to flow; clear goal (CG), however, had a non-significant path. Covariances among these exogenous factors were all significant. This suggested that

there might exist more complex relationships among the preconditions and between preconditions and flow.

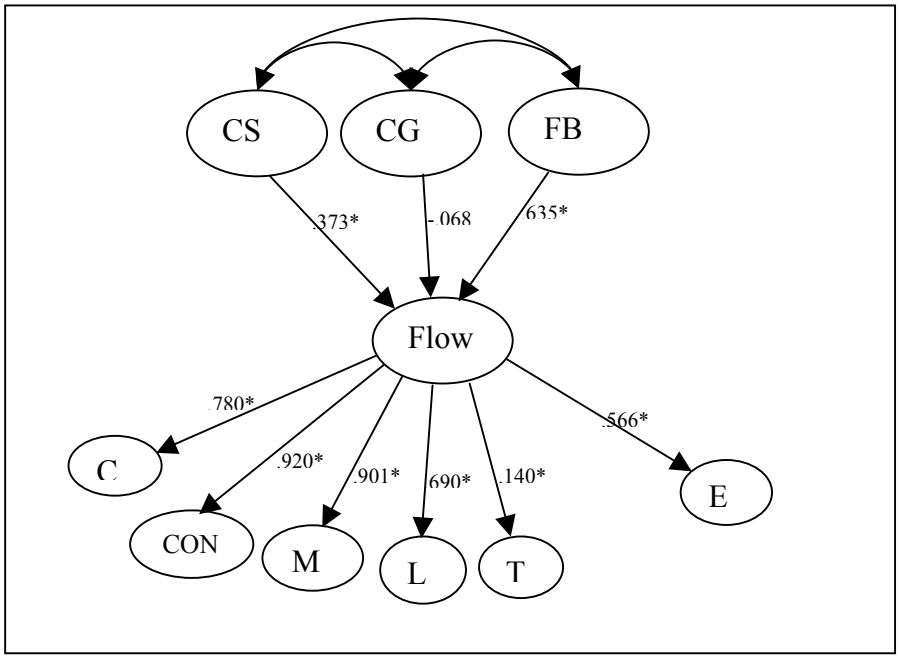

Figure 6.5 Flow with Preconditions

In the last phase, we entered the external factors (complexity), an individual characteristic (playfulness), and consequences (perceived usefulness, pleasure, and behavioral intention) (See Figure 6.6). The model had reasonable initial fit (CFI =.846 and RMSEA = .056). The path coefficients were all significant at the $p<.01$ level except the paths from playfulness (Play) to Flow. All the significant coefficients were in the hypothesized direction. Estimated correlations among the four independent variables in

the base model were all significant ($p<.01$), but they are not shown in the figure for simplicity's sake.

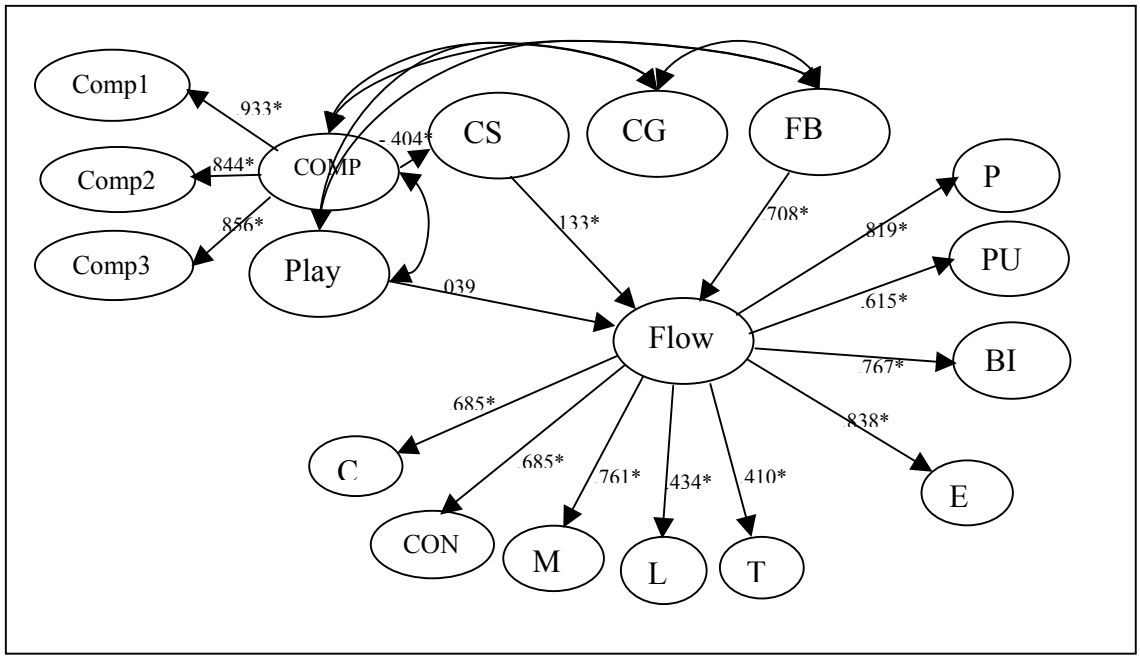

Figure 6.6 The Full Model -- Base

In order to improve the model fit, but still maintain theoretical interpretability, we performed a series of model modifications based on the modification indices and regression weights of existing paths. The process is summarized in Table 6.12. Figure 6.7 shows the paths and standard path coefficients of the final revised model. All path coefficients were significant at $p<.01$ level. Estimated correlations among the independent variables were all significant. First, we dropped non-significant path from playfulness to Flow. Considering the previously observed effect of playfulness (Agarwal and Karahanna 2000), we hypothesized the mediating effect of balance of

challenge and skill according to flow theory and added path from Play to CS, which turned out to be significant. The effect of perceived usefulness on behavioral intention was included because it has been widely supported by literature (e.g., Davis 1989; Gefen and Straub 2000; Moon and Kim 2001; Gefen et al. 2003).

Table 6.12 Model Modification in Refining the Theoretical Model

Model	χ^2	DF	χ^2/df	NNFI	NFI	CFI	RMSEA	ECVI	Modification & Reason
Base	4905.61	2320	2.114	.840	.745	.846	.056	14.832	This is the base model
Step 1	4887.86	2320	2.107	.841	.746	.847	.056	14.781	Drop Play->Flow, add Play->CS
Step 2	4704.14	2319	2.029	.852	.755	.858	.054	14.267	Add PU->BI.

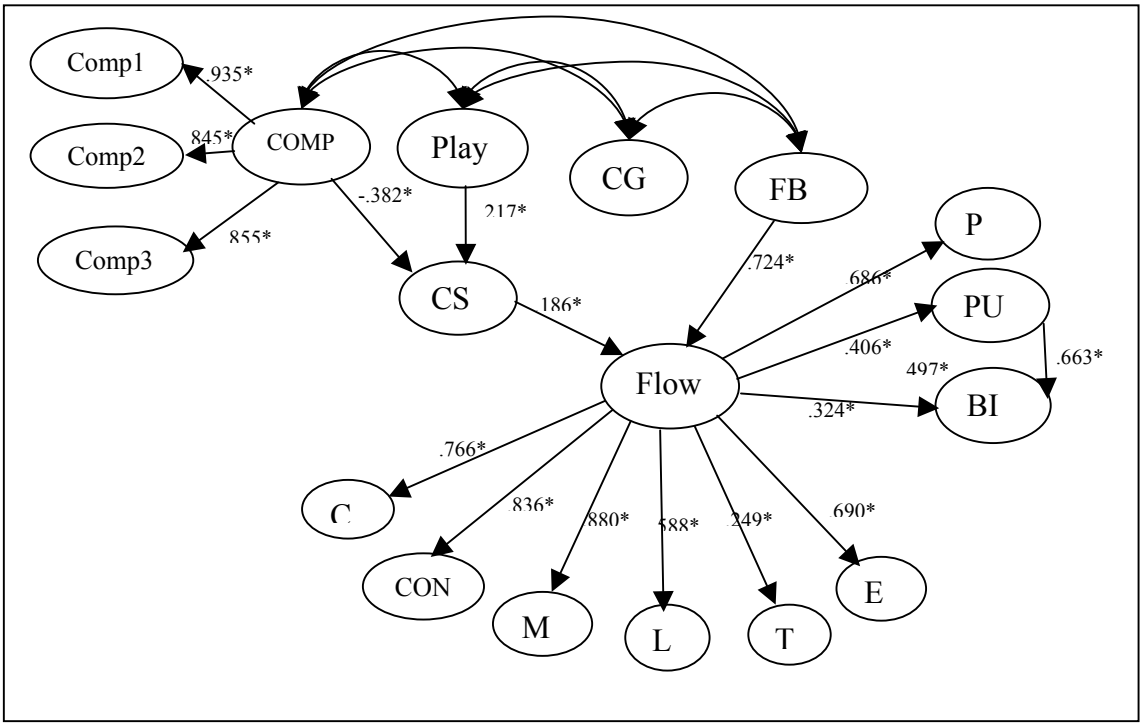

Figure 6.7 The Full Model – Revised

6.3.3 Hypotheses and Follow-Up Analysis

An examination of the results for the base model and revised models suggests that, for the most part, our hypotheses were supported. First of all, according to the original flow theory, the three preconditions of flow are the balance of challenge and skill, a clear goal, and a quick and unambiguous feedback mechanism. In our revised model, the balance of challenge and skill and feedback had significant relationships with flow. Both Hypothesis 2a regarding the effect of balance of challenge and skill, and Hypothesis 6 regarding the effect of feedback were then supported. But, the effect of clear goal was not certain at this point although it was highly correlated with other precondition factors, because the path from CG to Flow was not significant (Hypothesis 5 was not supported). We still think a clear goal contributes to flow in some way. In follow-up analysis, we posited that clear goal had an indirect effect on flow via balance of challenge and skill (Figure 6.8). The path between clear goal and balance of challenge and skill was significant. The model had good fit (CFI=.861, RMSEA=.053).

One contribution of this study is that it adds to the evidence provided by Ghani (1995) on perceived balance of challenge and skill on flow in the field of Information Systems and Marketing. This is the first study we are aware of that has measured the impact of clear goal on flow in information systems, and feedback has been examined only in the sense of download speed and interactivity in previous research.

The external factor in our research model was complexity of the Web site. We posited that perceived Web site complexity would affect flow through the balance of challenge and skill negatively (Hypothesis 3a), which was supported by our model. It is

not the first time to include complexity as an external factor of flow. Huang (2003a) found that site complexity distracted users' attention, one of the dimensions of flow. Our result further explained the issue by modeling the mediating effect of perceived balance of challenge and skill on the complexity-flow relationship.

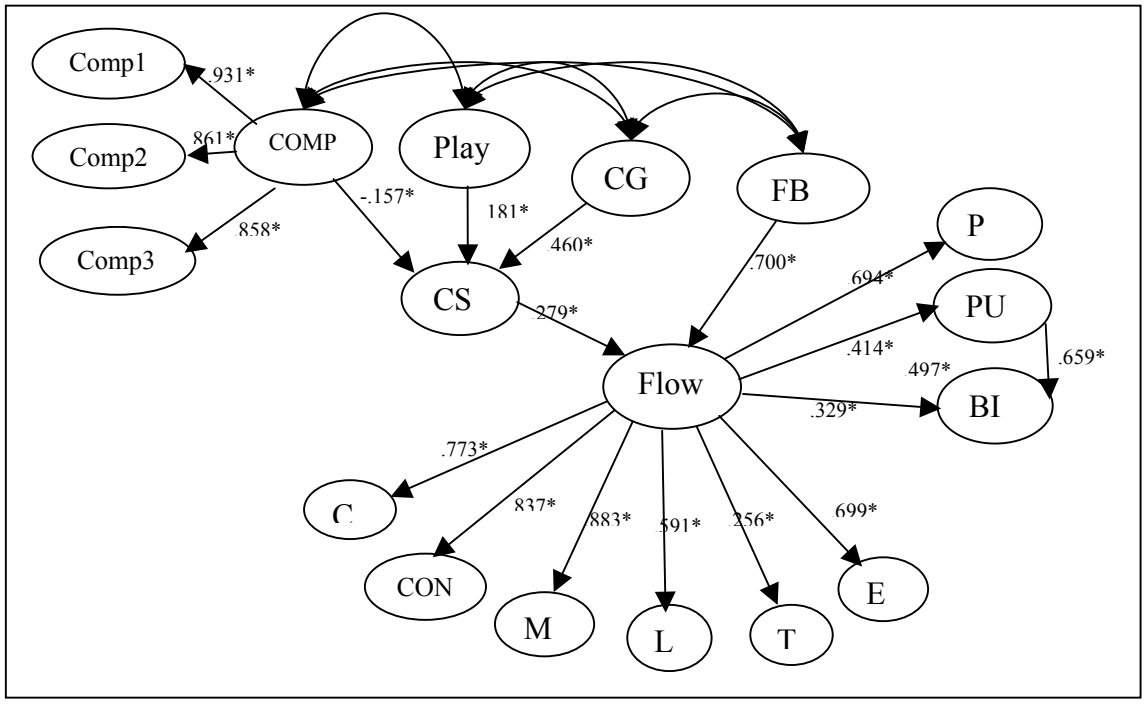

Figure 6.8 The Model with Indirect Effect of Clear Goal

Besides the abovementioned antecedents of flow, we also included individual characteristics in terms of playfulness in our research model (Hypothesis 7). It was found that playfulness had a positive influence on balance of challenge and skill, but no direct linkage to flow. Agarwal and Karahanna (2000) found that playfulness was

directly related to flow, which at first sight seems different from our results. However, since their model did not include the balance of challenge and skill as a precondition of flow and our revised model shows a positive and significant relationship between balance and flow, together the results suggest that balance and skill mediate the impact of playfulness on flow

The consequences of flow we assessed were perceived usefulness (PU), behavioral intentions (BI), and pleasure (P). All the paths were positive and significant. Thus, Hypothesis 8, Hypothesis 9, and Hypothesis 10 were supported by our model. These results are consistent with previous studies. Furthermore, there was one path not hypothesized, i.e., PU to BI. However, this was not surprising in that numerous studies have supported the effect of perceived usefulness on behavioral intentions (in terms of intended usage and so on) in online shopping context (e.g., Davis 1989; Moon and Kim 2001; Koufaris 2002; Gefen et al. 2003).

To test hypotheses related to perceived skill and perceived challenge and to explore their relative impact on flow, we substituted perceived skill (PS) and perceived challenge (PC) for balance of challenge and skill (CS) in the model (Figure 6.9). The goodness of fit indices showed a similar level of fit (RMSEA = .053 and CFI = .857), and most path coefficients in the model were similar too. Both paths between complexity and perceived skill and perceived challenge were significant at $p<0.01$, with one positive (complexity and PC) and one negative (complexity and PS). Hypotheses 3b and 3c were thus supported.

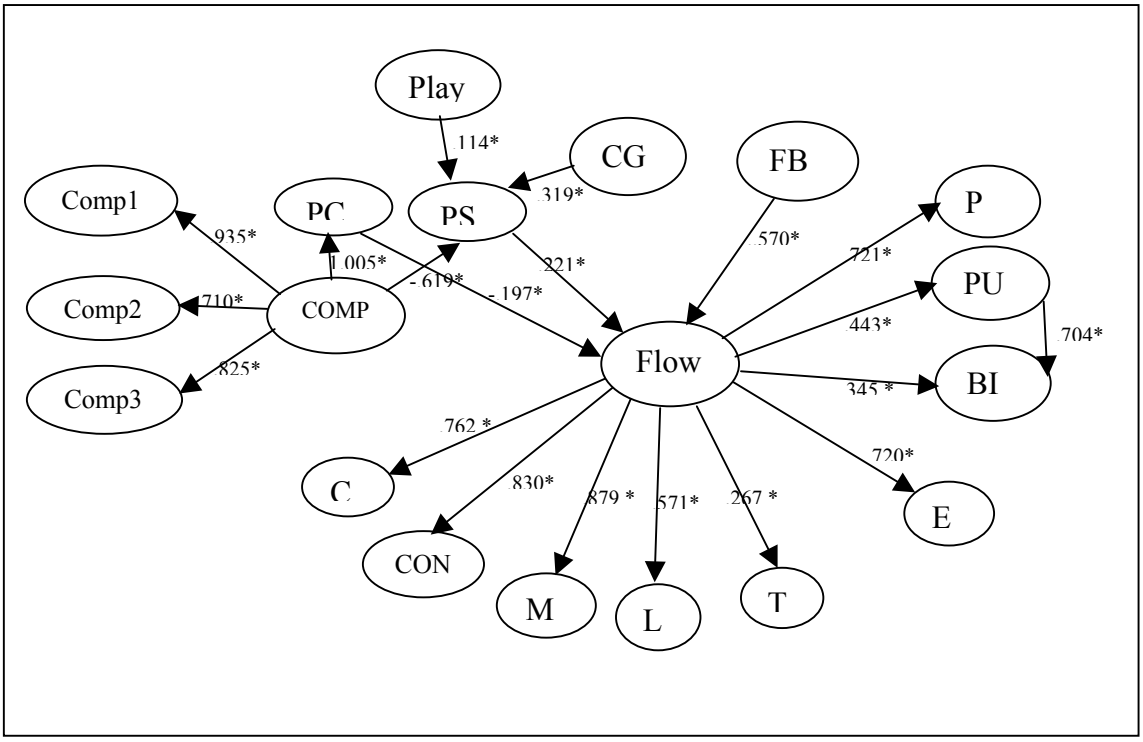

Figure 6.9 The Model with Perceived Skill and Perceived Challenge

In the model, PC had negative, significant path to Flow ($p<.05$) and PS had positive, significant path to Flow ($p<.01$). Therefore, Hypothesis 2b was not support while Hypothesis 2c was. In interpreting the results, we have to consider inconclusive results of previous studies, thus the analysis was exploratory in nature. In Novak et al. (2000) and Koufaris (2002), both challenge and skill have positive relationships with flow. However, in Skadberg and Kimmel (2004), none of the relationships is significant. Mixed results of current study and previous research suggest that the relationships between challenge and flow and between skill and flow are more complex than we thought. Balance of the two has been demonstrated to have positive effect on flow. But

the relative relationship of perceived skill and challenge is not clear yet. Undoubtedly this is an area worth further examining in future. Ghani (1995) tries to explain the phenomenon by including curvilinear relationships. This approach can be used in future research.

Also, there were positive paths between clear goal and perceived skill, and between playfulness and perceived skill, but not with perceived challenge. No other studies have investigated those relationships before. The results showed again skill was a more important and determinant factor in online shopping situation.

Another major part of our research model dealt with the dimensionality of flow. We modeled the relationships using a second-order factorial structure. In the original model, flow was conceptualized as a global variable with seven first-order factors: concentration (C), feeling of control (CON), mergence of action and awareness (M), loss of self-consciousness (L), time distortion (TD), telepresence (T), and enjoyment (E). Tests of the structural equation models basically supported this structure, except in the case of time distortion, whose path was not significant and was excluded from our analysis. We observed that the relationships among those dimensions were complex. We saw distinctive dimensions as supported by our model. But, from the path coefficients we can see that the individual dimensions did not have equally strong relationships with the underlying flow construct. For example, in our model the coefficients of control and mergence were larger than the others. Also certain dimensions were not "orthogonal" or independent of one another. For example, modification indices suggested the inclusion of paths between loss of self-consciousness

and feeling of control and between telepresence and enjoyment. On the other hand, some flow dimensions showed independence regarding their relationships with other constructs. Recall in Study 1-B, when we examined a nomological network related to flow, we found that individual dimensions were independent in terms of their relationships to other related constructs, such as computer anxiety. In our model, the most obvious evidence was the potential path from telepresence to perceived usefulness. Although in the current study we did not test these possible relationships in order to avoid over-fitting the model and exploiting particularities in the data, nevertheless, those areas are worthy of further investigation in the future.

There were some concerns regarding our data analysis using the technique of SEM. One was the large number of measured variables (approximately 75 items). Because our sample size was 354, which was large in relation to minimum sample size recommendations (MacCallum et al. 1996) and typical CFA standards, and because most of the indicators of constructs (e.g., playfulness, FSS, and perceived usefulness) had previously been shown to be good measures, the large number of measured variables should not be a serious problem.

Second, the way we approached data analysis using structural equation modeling was not purely confirmatory, since we utilized model respecification and modification (Byrne 2001, p.91). Although we restricted ourselves from engaging in extensive model revision in the modeling procedure, it is still important to bear this in our mind when interpreting the final model. In a cynical comment on structural modeling, MacCallum (1999) says “All structural equation models are wrong. Some are more wrong than

others." He strongly urges a theory-driven research orientation in using SEM and a cautious attitude in concluding that any model is "true." In fact a model that fits only represents one plausible and approximate explanation of the real-world phenomena.

6.4 Discussion

In this chapter we investigated the channel models of flow and our proposed research model. In the research model, we specified antecedents and consequences of flow in addition to flow dimensions. The major theoretical differences between our model and previous models (Jackson and Marsh 1996; Novak et al. 2000, etc.) are: 1) It included all dimensions of flow and 2) It separated the preconditions and dimensions of flow. The analysis basically supported our model, suggesting that previous work is incomplete to some extent, although it is informative and useful as a starting point. For example, the omission of mergence of awareness and activity and loss of self-consciousness in previous IS and Marketing studies does not seem to be justifiable based on our results. On the other hand, the inclusion of telepresence seems a valuable extension to flow theory in computer-mediated environments. Telepresence seems likely to play an important role in time distortion, enjoyment, and perceived usefulness. This also suggests that although flow is a general feeling that people can experience in variety of activities, there may be different "flavors" of flow in different situations. For example, in our model, time distortion was not significant. This suggests that it may not be that important to flow in online shopping contexts. Thus, in the future, a better approach to study flow in other activities might be to include all proposed dimensions and also new possible dimensions in an initial analysis, and at the same time realize that

we may need to eliminate those that do not have a strong presence in a particular context. However, any elimination should be based on sound reasoning rooted in theory and empirical results in addition to statistical tests. One possible drawback of this approach is that it would be difficult to recognize different levels of flow across contexts if we use different flow dimensions.

If we take this point even further, flow theory can be thought of as a general explanation, which can have special elements added to it when applied to various scenarios. For example, it seems perceived skill is a more dominant factor in Internet shopping in that the channel with high skills (boredom channel) had the highest scores on flow dimensions, while channels with high challenge (flow channel and anxiety channel) had lower scores. Also, other factors (playfulness and clear goal) affect flow via perceived skill rather than perceived challenge. This observation suggests that the mechanism of flow, the antecedents of flow and the preconditions that affect flow differ in Internet shopping from other activities, such as playing online games, whitewater rafting, or playing chess.

The four-channel model was not supported in our study, which suggests that the channel segmentation using challenge and skill may not be suitable in understanding Internet shopping, especially the notion of challenge. Challenge might not even be the best terminology for this case, because challenge bears a negative tone in shopping activities, while in gaming world challenge is not necessarily a bad thing at all. This may suggest a need to develop a new construct, which is the counterpart of challenge, in online searching and shopping activities.

The next chapter will summarize our main findings and implications. We will also discuss the contributions and limitations of these studies. Furthermore, we will present suggestions for future studies that might continue this research stream in productive directions.

CHAPTER VII

CONCLUSION

Flow is the enjoyable and engrossing experience that people feel when acting with total involvement. This dissertation has studied the flow experience and the antecedents and consequences of flow in online retail environments. We attempted to describe this experience as well as the contextual structures that influence the experience of flow. In our study, flow was operationalized as a higher-order construct with its theoretical dimensions as underlying constructs. These dimensions are concentration, feeling of control, mergence of activity and awareness, loss of self-consciousness, time distortion, telepresence, and enjoyment. According to flow theory, there are three preconditions for flow to occur: perceived balance of challenge and skill, having a clear goal, and quick and unambiguous feedback. This study measured and investigated the relationship of these preconditions to flow. We also studied Web site complexity, an external factor that was hypothesized to influence flow experience.

In this section we summarize the results of these studies and discuss the main findings and contributions of this research. We then discuss some practical implications of our research. Then, we consider some limitations of our study. Finally, we discuss future research to deepen our understanding of flow in online environments.

7.1 Main Findings and Contributions

There were two major parts of this dissertation: The first concentrated on the validity of flow constructs and measures and the second part investigated flow in

Internet shopping. Finneran and Zhang (2002) identified two major problems in studies of flow in the field of Information Systems and Marketing: (1) inconsistent conceptualizations of measurement of the flow construct and (2) use of inconsistent and incomplete flow models in studies. These problems represent barriers to progress in this research stream. In our investigation of flow in Internet shopping, we conducted a series of studies designed to overcome these two barriers and to address key conceptual and methodological issues. We will discuss the main findings and contributions of each of our studies below.

7.1.1 Validity Study

In the first part of this dissertation, we tried to address the problem of inconsistent conceptualization and measurement of the flow construct. We conducted three validity studies using different and complementary approaches. Study 1-A sought to relate flow to behavioral criteria in online shopping. As part of three experiments, we captured user mouse movements in video files. We transcribed a total of 40 cases from these experiments. Of these, in 20 cases flow was measured using the Experience Sampling Form (ESF) questions (Csikszentmihalyi and Csikszentmihalyi 1988), in 10 cases flow was measured using the Internet Flow Scale (IFS), and in 10 cases flow was measured using the Flow State Scale (FSS, Jackson and Marsh 1996). The IFS is a measure composed of the "best of breed" scales from previous studies in Information Systems and Marketing. It consists of 9 factors: perceived challenge, perceived skill, concentration, sense of control, mergence of activity and awareness, loss of self-consciousness, time distortion, enjoyment, and telepresence. The IFS lacked measures

of two other preconditions of flow: a clear goal and feedback. The FSS is a more complete measure in that it incorporates all three preconditions and six dimensions identified in flow theory.

We developed a set of categories to code mouse movements that included both positive and negative correlates of flow based on theory and induction from the first ten cases studied. These correlates were behavioral indicators of being in flow and events that may inhibit or prevent flow experiences. For example, a smooth, continuous pattern of mouse movements was taken to be an indicator of being in flow, whereas signs of a navigation problem were indicators of a non-flow experience. We then use this scheme to code transcripts of the sessions of online shopping. Our data supported our expectation that more positive correlates occurred in cases with high flow scores while more negative correlates occurred in cases with low flow scores. The same pattern was found in all three groups of cases. This result provided initial support for the construct validity of flow. In addition, it is possible that, with further development, the behavioral correlates established in our study can be used as objective measures of flow in future work. Combined with self-reported flow measures, which have been the only data collection method used in flow research, objective measures provide another choice and the possibility of triangulation in measuring flow. This study also made methodological contributions. To our knowledge, it is the first to use mouse movement data in the study of flow in online consumer behavior. The methods we developed to transcribe and code the data may also provide useful tools for future research using mouse movement data.

In Study 1-B we conducted a traditional construct validity investigation in which we developed a nomological network of predictions about how flow (measured by both the IFS and the FSS) should relate to other constructs and assessed the relationship of flow measures to other logically-related constructs. We included two contexts in the study (computer/video games and online shopping) and asked subjects to recall their last experience in one of the two contexts and fill out measures of the constructs in the network. The results supported the predicted relationships between flow and other constructs. Flow was positively correlated with love for the activity, computer playfulness, and skill; however, flow was negatively correlated with computer anxiety. This result held for both the IFS and FSS. Similar results were found in both gaming and shopping contexts. We then constructed a multitrait-multimethod (MTMM) matrix including the common dimensions form the IFS and FSS. For the most part, the matrix showed convergent and discriminant validity for these two flow measures. There were, however, issues with certain dimensions, such as loss of self-consciousness, mergence of activity and awareness, and time distortion.

Study 1-C was a factorial validity study that assessed the validity of the flow construct in the IFS and FSS via factor analysis using a larger sample size than was the case in the previous two studies. Both the IFS and FSS measures had acceptable reliability coefficients on most dimensions. In this study we took a confirmatory factorial analytic approach to compare a set of models of the factorial structure of the IFS and FSS. Based on model fit, we concluded that the FSS was a better measurement model for flow.

Overall, the FSS outperformed the IFS in these construct validity studies. Based on the results of this analysis we concluded that the best measurement of flow could be obtained through use of the FSS plus one new dimension -- telepresence. This measurement system was employed in the second study of this dissertation. The dimension of telepresence was included because it captures the uniqueness of Internet shopping as a form of computer-mediated communication.

Overall, these three studies have provided evidence of construct validity for flow and, in particular, for the FSS flow measure. Although it was developed in the field of sports psychology, it transferred robustly into Information Systems. Our study was the first one that we are aware of that systematically examined the construct validity of flow involving two complete measures. Valid measurement is one of the cornerstones of quality research and this is certainly true in the study of flow in Information Systems.

7.1.2 Testing a Comprehensive Model of Flow

The second part of this dissertation was devoted to a test of a comprehensive flow model (Figure 3.3) in Internet shopping. The model was comprehensive in that it examined (1) all theoretically proposed underlying dimensions of flow; (2) the mediating effects of the preconditions of flow: balance of perceived challenge and skill, a clear goal, and feedback; and (3) the antecedents and consequences of flow. We also incorporated one individual characteristic factor that we expected to influence flow, computer playfulness. Consequences of flow were cognitive evaluation (in terms of perceived usefulness), emotional responses (in terms of pleasure), and behavioral

intentions to revisit and purchase. We conducted a controlled experiment in which complexity of Web sites was manipulated across two types of Web sites.

Overall, the results of the study supported our model. Preliminary analysis of the measurement model indicated that flow was a second-order construct comprised of seven underlying dimensions: concentration, sense of control, mergence of activity and awareness, loss of self-consciousness, time distortion, enjoyment, and telepresence. All the first order factors except time distortion had significant paths from flow. In the structural model, flow was found to be positively related to outcome variables. Balance of challenge and skill and feedback had positive effects on flow. Although having a clear goal and playfulness had no direct effects on flow, they affected flow via the balance of challenge and skill. Perceived Web site complexity was found to have a significant negative relationship with perceived balance of challenge and skill. When we considered the separate effects of perceived challenge and perceived skill, most results were as expected. Perceived site complexity had a positive relationship with perceived challenge while it had negative relationship with perceived skill. In turn, challenge had negative effect on flow and skill had positive effect. This inconsistency suggested a future research area.

By testing this comprehensive model of flow we were able to overcome some of the conceptualization issues noted in previous work. To begin with, we used the full operationalization of the flow construct that included all theoretic dimensions. This approach has several advantages. First, it would enable us to relate our results with results from other work on flow in both EC and other contexts, and therefore be able to

compare results with results from that research, yielding a better understanding of flow. Second, it would give us a chance to study the relative strength of individual flow dimensions and relationships among them. For example, our results suggested that time distortion might function as an indirect dimension in Internet shopping via telepresence. Although we cannot assert such a relationship based on the results of one study, the model provided a means for examining the relationship between these two dimensions in the future. The third advantage of including all the dimensions is that it makes it possible to compare flow experiences in different contexts, because different dimensions are likely to contribute to flow more in some contexts than in others. Do flow experiences have different "flavors?" For example, in our study, we showed that telepresence was an interesting aspect in Internet shopping. By conducting studies in both similar and dissimilar contexts, we will be able to examine and compare flow dimensions across contexts and to discover the common and distinctive aspects of flow experience in different contexts.

Inconsistency among flow models was another issue in previous work. In particular, previous flow models included different preconditions of flow. In most previous work, a clear goal and feedback were not included (e.g., Nel et al. 1999; Agarwal and Karahanna 2000; Huang 2003a). Furthermore, if feedback was considered in a model, it was operationalized as download speed or interactivity (e.g., Novak et al. 2000). Also, the balance of challenge and skill was often modeled as two separate factors: perceived challenge and perceived skill (e.g., Koufaris 2002; Novak et al. 2003; Skadberg and Kimmel 2004). This study included all preconditions of flow in one

model as they were framed in the original formulation of flow theory: perceived balance of challenge and skill, a clear goal, and feedback. In measuring feedback, it was related to visitors' perception of their own performance in accomplishing shopping tasks. Such a comprehensive approach allowed us to study the relationship among preconditions and their relationships with flow. Our model supported the positive paths from feedback to flow and from the balance of challenge and skill to flow, which was consistent with flow theory. The effect of having a clear goal on flow was indirect through balance of challenge and skill, as was that for computer playfulness.

We also studied an alternative structural model using perceived challenge and perceived skill instead of the balance between these two. It was found that perceived skill had a stronger effect on flow than did perceived challenge, although both of dimensions had significant effects. However, the nature of effect of perceived challenge on flow is inconclusive considering the direction of the effect was not in accordance to the theory and previous studies. Furthermore, playfulness and a clear goal had significant effects on perceived skill, thus affecting flow indirectly. This suggests that in Internet shopping, skill was a more important factor than challenge.

Furthermore, we investigated the channel models of flow in online shopping. Based on perceived skill and perceived challenge, we segmented visitors into four channels. According to flow theory, the channel with high challenge and high skill is the flow channel, and subjects in this channel should have the highest scores of flow dimensions. Our data, however, did not support such a prediction. The channel with higher skill had better flow scores than that with both high skill and high challenge.

However, there is no study using 4-channel model in Information Systems and Marketing to study online flow experience. Only one study examined 2-channel model in a Web surfing situation and not totally consistent with flow theory (Chen et al. 1998). Our analysis of the 2-channel model supported flow theory.

The exogenous, independent variable was an IT- and design-related factor, Web site complexity. In the manner we operationalized site complexity, both structural and content complexity were considered and included in a single variable. We followed a systematic procedure to select existing Web sites as treatments based on objective site complexity. During the experiment, data regarding subjects' perceptions of flow, site complexity, and consequences of flow were collected using the experience sampling method. In regard to the relationship between objective site complexity and perceived site complexity, we found a more complex link between them than we originally expected. We elected to use perceived complexity as the exogenous variable in our testing of structural models due to the fact that it reflected subject experience with the sites rather than abstract properties of the sites that subjects may not experience in a single visit to the site. The lack of a consistent relationship between objective and subjective complexity measures suggests a need for further investigation.

We used structural equation modeling (SEM) to test our proposed structural model (Figure 3.3). Perceived site complexity was found to affect balance of challenge and skill negatively, and then in turn affect flow as we expected. The alternative model with both perceived challenge and perceived skill supported the hypothesized effects of

complexity on them. These findings have practical implications, which will be discussed later in this chapter.

The experimental setting allowed us to closely control treatment conditions and to monitor subjects. In addition to manipulating complexity, the experiement also included a nested design on two factors: product category and Web site. This design provided us a chance to test for potential effects of important aspects of Web sites that are not related to site complexity, e.g., product familiarity and site familiarity. Effect of category on perceived complexity factors was not significant but both product familiarity and site familiarity had significant effects on complexity factors. We then statistically controlled for these variables in our analysis. Using existing Web sites contributed to the realism of the study.

Another contribution of this study was the use of the experience sampling method. The experience sampling method, originally developed by Csikszentmihalyi and Csikszentmihalyi (1988) and adapted to the computer environment by Chen et al (1998), was implemented using pop-up forms to capture "on the spot" data. This approach was able to overcome the problem with paper-and-pencil survey data, which tends to ignore the situated, dynamic nature of flow and introduces errors because of memory loss and distortion. Results suggested that this was a viable means of collecting data that did not disturb the subjects very much.

7.2 Implications

We can draw several implications from our analysis for practice. The findings of this study can be applied to other kinds of Web sites as well. Although we focused

mainly on online shopping, as an activity it shares commonalities with other online activities, such as surfing for fun and looking for information. Thus, a non-commercial Web site with the purpose of information dissemination can also benefit from our findings, although our discussion will still focus on commercial sites.

First of all, of special interest to online retailers, the study indicates that flow experience leads to better outcomes in terms of positive emotions, perceived usefulness, and behavioral intentions to purchase, return to the site, and recommend the site to others. The study suggests that flow is a desirable state that does occur during online shopping. This suggests that online retailers should strive to create a strategy to foster such an experience for their customers.

Several antecedents were shown to have effects on flow, some of which can be improved by design and using appropriate technology. First, feedback was found to be an important factor leading to flow. Thus, in order to provide quick and unambiguous feedback to the customer, we should employ proper technology and site design to ensure a short download time and quick response. In addition, a logical design is needed to clearly indicate whether visitors are on the right track to achieve their goals. This implies that after an important action by a visitor, a Web page should show whether the action has been accomplished successfully. For example, after a consumer puts items into a shopping cart, the subsequent page should have information about the shopping cart and the newly added items. Many Web sites have this functionality, but some exhibit poor design of this type of pages and resulted in unexpected outcomes. One well-known Web site used the shopping cart page as an opportunity to recommend other

products based on the items put into cart, which was a good idea by itself. However, the design of the page made it difficult for visitors to differentiate information concerning what was in the shopping cart from additional product recommendations. The recommendations occupied the majority of the page, while the shopping cart was pushed into a corner. Mouse movement data showed that this page was a problematic one, especially for those not familiar with the site. Other useful features to give visitors feedback are the product hierarchy and some indicators that show where visitors are in the site map.

Our results also suggest that lower levels of challenge are preferable in online shopping. Thus, reducing the challenge of the site for consumers should be the focus of effort. One way to accomplish this is to reduce perceived site complexity, thus reducing perceived challenge. Although we did not posit a directional relationship between perceived site complexity and feedback, the covariance between them were negative and significant in our model. This may suggest that perceived site complexity may affect flow via more than one path, directly and via an indirect path through feedback. In our model, perceived complexity consisted of three sub-factors: overall complexity, presentation, and navigation. It seems reasonable to suggest that we could improve the Web site by reducing the elements associated with these factors. Web sites that were objectively rated as more complex were more complex in terms of presentation and navigation. Thus, using a more open and sparse, less distracting page design may reduce perceptions of complexity. Making the links more predictable and navigation more logical will also help reduce navigation problems and thus foster flow. Mouse

movement data showed that navigation problems were one of the major categories in behavioral correlates that prevented visitors from experiencing flow.

7.3 Limitations

One of the major limitations in our study is related to the sample. We relied on college students as major source of participants due to our limited access to other populations. Although they are representative of younger online consumers (age range from 18 to 30), the typical subjects in this study have characteristics that differentiate them from other segments of the general population. They are heavier computer and Internet users than other segments. The majority of subjects also had experience with online shopping and some are frequent online consumers, which also may not be the case for other groups. Using a more representative sample will certainly make the results more generalizable, and this is what we plan to do in future research.

Experimentation as a method has its own drawbacks, although it provides the obvious advantage of tight control and strong ability to infer causal effects. In the case of studying flow, besides the lack of generalizability, the experimental setting presented a possible problem in terms of internal validity (Cook and Campbell 1979, p 80). Flow is a state that can be attained only under certain circumstances. In addition to the preconditions for flow, the surrounding environment also plays an important role. The environment for the experiments was a computer lab in which subjects were run in batches to save time and allow more students to participate. This setup was not an ideal replication of many real shopping situations, since the common practice of online shopping is at home alone by oneself. In the lab there were distractions from other

students and from noise in the hall outside the computer lab. We tried our best to control these. We examined the computers during each run to make sure the setup of browsers and other related software was the same on all computers in the lab. We scattered subjects as far as possible and whenever possible. We asked subjects to behave as much like a real shopper as possible. Nevertheless, despite all these efforts, the experimental setting was still different from real life shopping.

Another limitation of our study is connected with the use of survey data in which we asked subjects to recall past experiences in one of the validity studies (Study 1-B). This method might introduce errors into data due to memory loss and distortion. However, the results of this study were consistent with those from studies in which subjects reported their immediate experiences, which suggest that these errors were not significant in our study.

7.4 Future Research

To address the limitations and further our understanding of flow in the Internet environment, several research avenues can be taken. First, it would be useful to continue and expand the study of behavioral correlates of flow. The promising results from this study suggest that this approach to studying flow is useful. It takes a concept normally defined as a personal, subjective state and studies it from an objective perspective. We can enhance our study using the existing data by transcribing more cases, further refining rules, and comparing these correlates by dimension of flow rather than with overall flow score. Furthermore, we can conduct similar studies with methodological improvements so that we can reduce subjectivity during transcribing and coding to a

minimum. One such approach would be to incorporate stimulated recall into data collection. After their mouse movements have been captured, subjects will be asked to recall their thoughts and produce a protocol when watching their own movements in the video files. This will give us a chance to reconstruct what happened more accurately and allow us to verify our rules, which so far were developed purely based on our interpretation of their behavior.

Second, the relationship among dimensions of flow should be investigated. In the original flow theory, dimensions of flow are presented as parallel factors. In all previous empirical studies and our current study as well, all the dimensions including enjoyment were modeled as parallel factors without considering the relationships among them. Results of the current study suggested the possibility that there were more complex interdependencies among flow dimensions. An investigation of those relationships is worthwhile to further clarify the nature of the flow construct. For example, in current study we dropped time distortion from the measurement model due to the non-significant path coefficient. Time distortion could be the result of telepresence instead of a separated dimension of time. Furthermore, our analysis suggested a possible relationship between telepresence and enjoyment.

Additionally, the relationship between perceived challenge and flow as well as the relationship between perceived skill and flow is of interest. Our results were not in total consistency with previous studies. The balance of challenge and skill has positive effect on flow, but how the balance is reached has several possibilities, shown in Figure 7.1. One of the possibilities (A) is that perceived skill (PS) and perceived challenge

(PC) have opposite relationships with flow, like the case we found in current study. The second possibility (B) is that both PS and PC have positive relationships with flow, but with different slopes. This is the case in Novak et al. (2000) and Koufaris (2002). The third is not to assume linear relationship among flow, PS, and PC. C depicts an example of this case. Thus it would be worthwhile to study the relative relationships of perceived skill and perceived challenge in future.

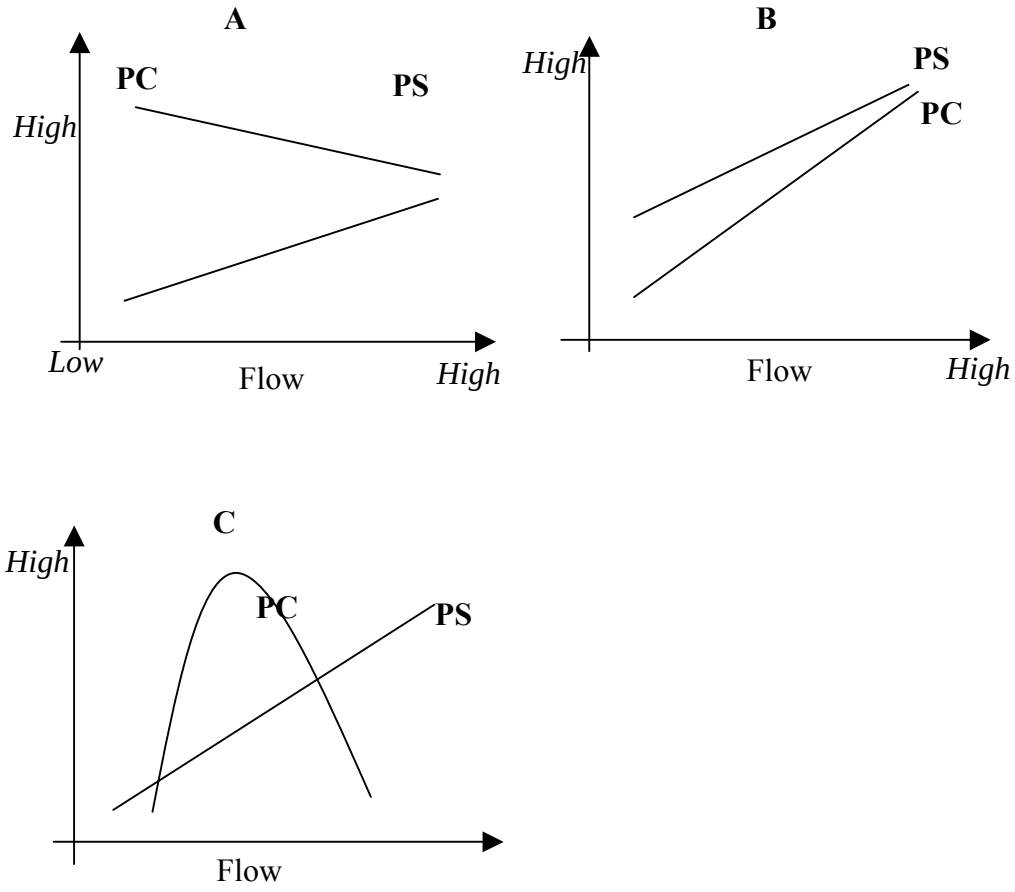

Figure 7.1 Examples of Possible Relationships between PS and PC

Third, we can further the study of the effects of site complexity on flow. In current study we did not reach a firm conclusion on the relationship between objective site complexity and perceived site complexity. The lack a consistent relationship between objective complexity and perceived complexity raises questions about measurement of complexity. However, it also highlights a future research area because our analysis showed there were certain relationships between the complexity measures. In rating objective complexity, we emphasized the "totality" of the site in that each Web site was rated on five sample pages representing five types of Web pages and for each page, information on more than 10 attributes were gathered. Two people rated each Web site. Their ratings were averaged. Final ratings used to determine the complexity level of a site were based on averages of these attributes across page types. Using only two raters for each site might not be sufficient to achieve complexity ratings for the site, since in total they would just use ten pages to rate the whole site. Thus, one way to enhance our study will be to assign more raters for each site and maybe that will give us a more accurate objective rating on overall complexity.

Moreover, there may be a disconnection between objective and subjective ratings of complexity. The perception of content complexity depends on the viewing task at hand. During their visit to the site, the pages visited by the subjects may well not be the same pages sampled during rating the objective complexity. It is possible that the parts of the Web site visited by subjects were not compatible with those sampled by the raters, and thus there was a discrepancy between the value assigned to the complexity manipulation and the actual complexity experienced by the subjects. Since an

individual's perceived complexity is not necessarily related to the overall objective complexity of a Web site, another way to study the impacts of site design may to be study typical kinds of "trips" or routes of visitors to see how parts of a Web site (a group of Web pages) affect visitors. Furthermore, we can study the individual aspects (presentation and navigation) of complexity on flow.

For both practical and theoretical purposes, it would be useful to include other external factors besides site complexity when studying flow in the Internet. Because we found a positive path from feedback to flow, it would be natural to look for those factors that have the potential to affect or improve feedback. There was a significant negative correlation between perceived site complexity and feedback. Thus, the relationship between site complexity and feedback bears further scrutiny. Another group of factors that would be interesting to consider include ambient features of a Web site (Eroglu et al. 2001; Dailey 2004). Those factors have been studied through the lens of atmospherics. The field of atmospherics has investigated how to design a space to create certain effects in buyers. More specifically, atmospherics is the effort to design buying environments to produce specific emotional effects in the buyers in order to increase purchase probability (Kolter 1974). For example, in studies of physical environments, it has been found that ambient factors have an effect on consumers' perception of brand image and quality inference (Baker et al. 1994) and on patronage intentions (Baker et al. 2002). Several researchers have proposed approaches to study online atmospherics (Eroglu et al. 2001; Dailey 2004). In online stores, these ambient factors include cues for navigation (for example, links, logo), cues with high task relevance (for example,

price and sale information in bold font), and cues with low task relevance (for example, the artistic quality of a design). These factors represent another aspect of online shopping environments. Thus, ambient factors can be studied along with site complexity or independently for their effects on flow. All these aspects of a Web site can be improved by design. Investigating the effects of these factors on inducing flow in online shopping will eventually contribute to the design improved shopping experience by creating more capable Web sites.

Fourth, we can replicate our study to include other kinds of product categories and other kinds of Web sites, such as non-commercial Web sites. That will give us a broader understanding of flow in more contexts, studying the commonality and distinct aspects of flow experience. And also, by replication we can assess the generalizability of our model.

A possible approach to improve experimental design would be to construct a mirror Web site of a real site (Wan and Nan 2001), which will give us both the advantages of realism and control. Another aspect to improve the study to is to use other samples than college students.

7.5 Final Words

We strived to be theoretically rigorous, methodologically innovative, and practically relevant in our research. In this dissertation, we conducted two major studies to understand flow in Internet shopping. One was a three-part validity study of the measurement of the flow construct and the second was an examination of flow experience in Internet shopping using a comprehensive structural model. Our results

provided evidence of the construct validity of flow and supported our model of flow. This dissertation project has attempted to make contribution to both theory and methodology and to practice. And hopefully we achieved our goals.

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APPENDIX A

SOURCES OF MEASURES

General assessment of online shopping

(coefficient alpha=0.8 in study 1)

- G1. I like shopping online.
- G2. I think I am a skillful online shopper.
- G3. Using commercial web sites to shop presents a challenge for me.

Novelty

(Novak et al. (2003), coefficient alpha=0.78 in study 1-A-1)

- I often click on a link just out of curiosity
- I enjoy visiting unfamiliar web sites just for the sake of variety.

Playfulness

(Agarwal and Karahanna (2000), reported coefficient alpha=0.94)

- When using the Web I am Spontaneous.
- When using the Web I am Flexible.
- When using the Web I am Creative.
- When using the Web I am Unoriginal. (reversed)
- When using the Web I am Imaginative.
- When using the Web I am Playful.
- When using the Web I am Uninventive. (reversed)

Internet Flow Scale

This scale is made up by using measures for flow dimensions in previous Information System literature and creating new items for those dimensions that have not been studies in Internet context.

Concentration

(Koufaris 2002, reported coefficient alpha=0.910)

During my last visit to Booksamillion.com …

- I was absorbed intensely in the activity.
- My attention was focused on the activity.
- I concentrated fully on the activity.

- I was deeply engrossed in the activity.

Enjoyment
(Koufaris 2002, reported coefficient alpha=0.944)

During my last visit to Booksamillion.com …

- I found my visit interesting.
- I found my visit enjoyable.
- I found my visit exciting.
- I found my visit fun.

Perceived Control
(Ghani 1995, Koufaris 2002, reported coefficient alpha=0.92 and 0.813 respectively)

During my last visit to Booksamillion.com …

- I felt confused. (reversed)
- I felt calm.
- I felt in control.
- I felt frustrated. (reversed)

Time Distortion
(Agarwal and Karahanna 2000, reported coefficient alpha=0.93)

- Time appears to go by very quickly when I am using the Web.
- Sometimes I lose track of time when I am using the Web.
- Time flew when I am using the Web.
- Most times when I get on to the Web, I end up spending more time that I had planned.
- I often spend more time on the Web than I had intended.

Telepresence
(Novak et al. 2000 and Klein 2003, no reported coefficient alpha)

- I forget about my immediate surroundings when I use the web.
- After using the Web, I feel like I come back to the "real world" after a journey.
- Using the web creates a new world for me, and this world suddenly disappears when I stop browsing.
- When using the Web, I feel like I am in a world created by the Web site.
- When using the Web, my body is in the room, but my mind is inside the world created by the web site I visit.
- I felt I was more in the world generated by the Web site than the "real world".
- The world generated by Web site seemed to me "somewhere I visited" rather than "something I saw".
- I forgot that I was in the middle of an experiment.

Mergence
(items are newly created)

During my visit to the web site …

- It seemed my interaction with the web sites was seamless.
- I felt I was just reacting to the web site without thinking.
- My interaction with the web sites was very smooth.

Loss of self-Consciousness
(items are newly created)

During my visit to the web site …

- I was very self-conscious. (reversed)
- I kind of forgot about myself when shopping.
- I lost the consciousness of my identity and felt like "melted" into the site.

Perceived Challenges
(Koufaris 2002, reported coefficient alpha = 0.803)

- Using Booksamillion.com challenged me to perform to the best of my ability.
- Using Booksamillion.com provided a good test of my skills.
- Using Booksamillion.com stretched my capabilities to the limits.

Perceived Skills
(Koufaris 2002, reported coefficient alpha = 0.918)

- I am very skilled at using the Web.
- I know how o find what I want on the Web.
- I know more about using the Web than most users.

Flow State Scale
This is a collection of 36 5-point Likert items developed in the field of sports psychology (Jackson and Marsh 1995).

Challenge/skill balance
(Reported coefficient alpha = 0.80)

Q1. I was challenged, but I believed my skills would allow me to meet the challenge.
Q10. My abilities matched the high challenge of the situation.
Q19. I felt I was competent enough to meet the high demands of the situation.
Q28. The challenge and my skills were at an equally high level

Clear goals
(Reported coefficient alpha = 0.84)

Q2. I knew clearly what I wanted to do.
Q11. I had a strong sense of what I wanted to do.
Q20. I knew what I wanted to achieve.

Q29. My goals were clearly defined.

Unambiguous feedback
(Reported coefficient alpha = 0.85)

Q3. It was really clear to me that I was doing well.
Q12. I was aware of how well I was performing.
Q21. I had a good idea while was performing about how well I was doing.
Q30. I could tell by the way I was performing how well I was doing.

Concentration on task at hand
(Reported coefficient alpha = 0.82)

Q4. My attention was focused entirely on what I was doing.
Q13. It was no effort to keep my mind on what was happening.
Q22. I had total concentration.
Q31. I was completely focused on the task at hand.

Action-awareness merging
(Reported coefficient alpha = 0.84)

Q5. I made the correct movements without thinking about trying to do so.
Q14. Things just seemed to be happening automatically.
Q23. I performed automatically.
Q32. I did things spontaneously and automatically without having to think.

Sense of Control
(Reported coefficient alpha = 0.86)

Q6. I felt in total control of what I was doing.
Q15. I felt like I could control what I was doing.
Q24. I had a feeling of total control.
Q33. I felt in total control of my body.

Loss of self-consciousness
(Reported coefficient alpha = 0.81)

Q7. I was not concerned with what others may have been thinking of me.
Q16. I was not worried about my performance during the event.
Q25. I was not concerned with how I was presenting myself.
Q34. I was not worried about what others may have been thinking of me.

Transformation of time
(Reported coefficient alpha = 0.82)

Q8. Time seemed to alter (either slowed down or speeded up).
Q17. The way time passed seemed to be different from normal.

Q26. It felt like time stopped while I was performing.
Q35. At times, it almost seemed like things were happening in slow motion.

Autotelic experience
(Reported coefficient alpha = 0.81)

Q9. I really enjoyed the experience
Q18. I loved the feeling of that performance and want to capture it again.
Q27. The experience left me feeling great.
Q36. I found the experience extremely rewarding.

Perceived Site Complexity

1. Nadkarni and Gupta (2003)

Likert Scale
Component complexity
(reported coefficient alpha = 0.87)

- The clarity between text and image was high.
- The images on the web pages were similar.
- The information items on the pages were similar.
- The text on the web page was short.
- The web page backgrounds were not visually dense at all.
- The graphics on the web page were not visually dense at all.
- The layout of the web pages was not visually dense at all.

Coordinative complexity
(reported coefficient alpha = 0.84)

- The range of the alternative links to find information was broad.
- The choice of both image and text clicks was high.
- The variety of information clusters (groups of related information) was low.
- The links at the website were logical.
- The layout across the web page was uniform.
- The backgrounds across the web pages were uniform.
- The information clusters (groups of related information) were interrelated.

Dynamic complexity
(reported coefficient alpha = 0.72)

- The information on the succeeding links from the initial page was predictable.
- Individual links took me to desired pages always.
- Procedures to browse the website were clear.

- Information presented was unambiguous.
- Information presented on the website was uncertain.

Semantic Differential Scale

Using the following scales, please rate the extent to which the following adjectives describe the web site at an overall level:

Component complexity

• Uniform	1	2	3	4	5	Varied
• Open	1	2	3	4	5	Cluttered
• Regular	1	2	3	4	5	Irregular
• Dense	1	2	3	4	5	Sparse

Coordinated complexity

• Free flowing	1	2	3	4	5	Constraining
• Patterned	1	2	3	4	5	non-patterned
• Organized	1	2	3	4	4	disorganized
• Logical	1	2	3	4	5	illogical

Dynamic complexity

• Flexible	1	2	3	4	5	Rigid
• Certain	1	2	3	4	5	Uncertain
• Predictable	1	2	3	4	5	Unpredictable
• Distracting	1	2	3	4	5	Non-distracting
• Interfering	1	2	3	4	5	Non-interfering

2. Nadkarni 2004

reported alpha for the first 5 items = 0.87

Using the following scales, please rate the extent to which the following adjectives describe the web site at an overall level.

• Uniform	1	2	3	4	5	Varied
• Open	1	2	3	4	5	Cluttered
• Congruent	1	2	3	4	5	Incongruent
• Sparse	1	2	3	4	5	Dense
• Coherent	1	2	3	4	5	Incoherent

3. Geissler et al. 2001

reported coefficient alpha = 0.74 and 0.81)

Based on your review of the web site home page, please circle the number that best describes how well each of the following attributes describes the home page. (1 – Dose not describe at all, 7 – Describes very well)

- complex
- dense
- interactive
- crowded

- overwhelming
- has much variety

Perceived Usefulness
(Koufaris 2002, reported coefficient alpha=0.924)

- Using the site can improve my shopping performance.
- Using the site can increase my shopping productivity.
- Using the site can increase my shopping effectiveness.
- I find the site is not very useful. (reversed)

Emotional Responses
(Mehrabian and Russell 1974, Holbrook et al. 1984)
Pleasure
(Holbrook et al. 1984, reported coefficient alpha=0.89)

- happy/unhappy,
- pleased/annoyed,
- satisfied/unsatisfied,
- contented/melancholic,
- hopeful/despairing,
- relaxed/bored

Arousal
(Holbrook et al. 1984, reported coefficient alpha=0.89)

- stimulated/relaxed,
- excited/calm,
- frenzied/sluggish,
- jittery/dull,
- wide-awake/sleepy,
- aroused/unaroused

Dominance
(Holbrook et al. 1984, reported coefficient alpha=0.88)

- controlling/controlled,
- influential/influenced,
- in control/cared-for,
- important/awed,
- dominant/submissive,
- autonomous/guided

Behavioral Intentions

- Given the chance, I would like to return to the site in the future.
- Given the chance, I would like to make purchase on this site in the future.

- I would like to explore more of the site.
- I will recommend this site to my friends.

Computer Anxiety
(Thatcher and Perrewe 2002, reported coefficient alpha = 0.94)

- I feel apprehensive about using computers
- It scares me to think that I could cause the computer to destroy a large amount of information by hitting the wrong key.
- I hesitate to use a computer for fear of making mistakes that I cannot correct.
- Computers are somewhat intimidating to me.

APPENDIX B

REPORTS FOR STUDY 1 – A

The purpose of these studies was fourfold. Firstly, it was to assess the flow experience in Internet shopping using the 4-channel model. The second objective was to validate measures of involved variables. Thirdly, the mouse movement data collected is the base for discovery of behavioral correlates. Fourthly, it was a good chance to further explore the possible factors leading to flow experience. This would give us more confidence in selecting the influential factors for later studies. These studies have been carried out in spring and fall of 2003 and spring of 2004, respectively. Since in Chapter 4, the results of Study 1-A-1 have been reported in detail, we mainly report results of Study 1-A-2 and Study 1-A-3 in this section.

B.1 Screen Shots of Study 1-A-1

We planed to examine the applicability of the experience sampling method (ESM) in an online context. ESM is a data collection method using scheduled stimuli to prompt participants to answer experience related questions. These questions make up Experience Sampling Form (ESF). Chen et al. (1998) used prescheduled computer software to prompt Internet surfers to answer flow related questions. The time interval was set to be random from 5 to 7 minutes apart, and a typical session produced two or three data points. However, their measures were inadequate and yielded mixed results. ESM has been a major methodological advance in flow research, however it has not been a regular data collection method in studying flow in computer-human interaction,

which was thought be to a main weakness (Finneran and Zhang 2002). To continue Chen et al.'s exploratory work and to respond to the call of measuring situated, personal, and individual experiences (Finneran and Zhang), we planed to experiment with this method. In Study 1-A-1 conducted spring of 2003, we scheduled the sampling form to appear after five to seven minutes into the session and a considerably large number of people reported they felt flow. It seems that seven-minute interval would be a reasonable judgment because a considerable number of subjects reported being in flow. Only one sampling form was scheduled because an online shopping session normally lasts 15 to 20 minutes, and more than one popup questionnaire is likely to annoy participants.

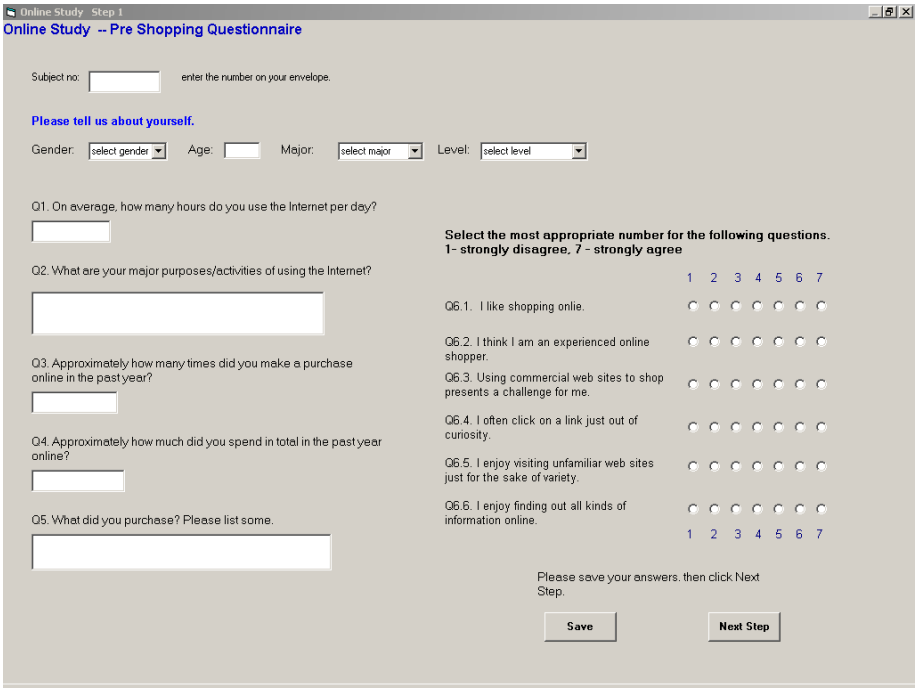


Figure B.1 Pre Shopping Questionnaire (Study 1-A-1)

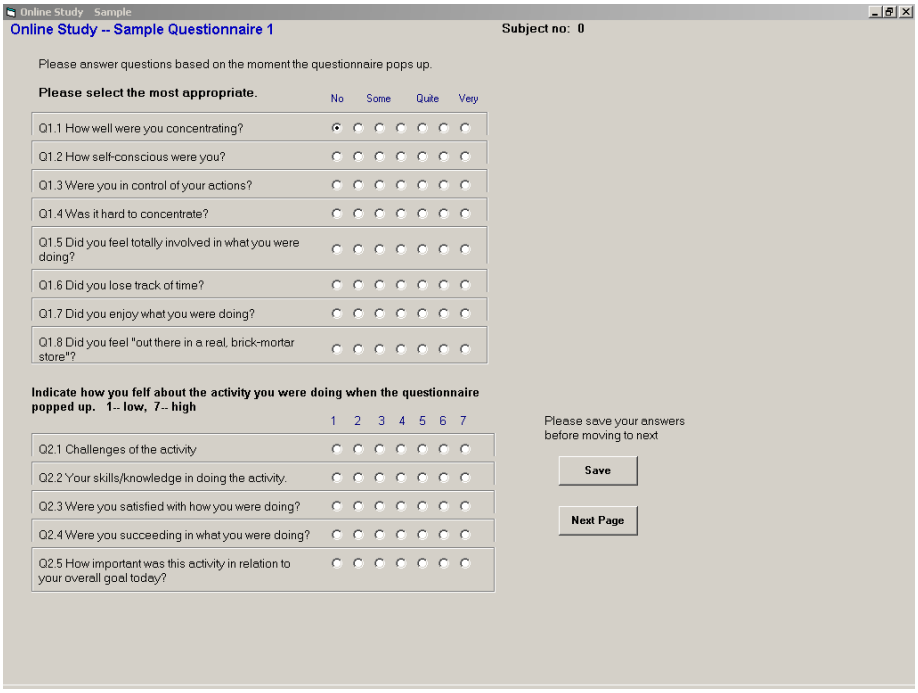


Figure B.2 Sample Form 1 (Study 1-A-1)

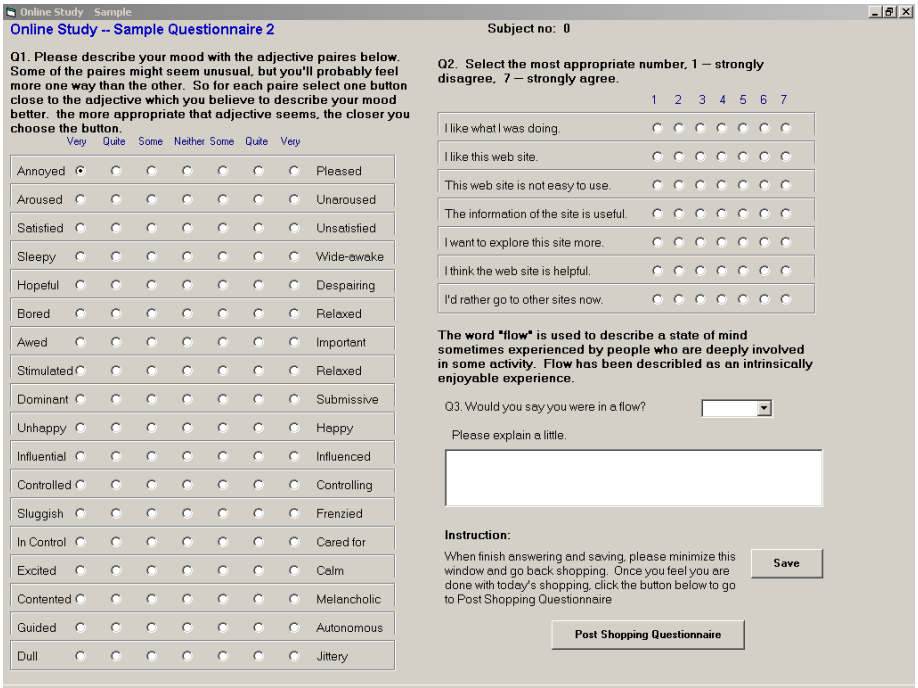


Figure B.3 Sample Form 2 (Study 1-A-1)

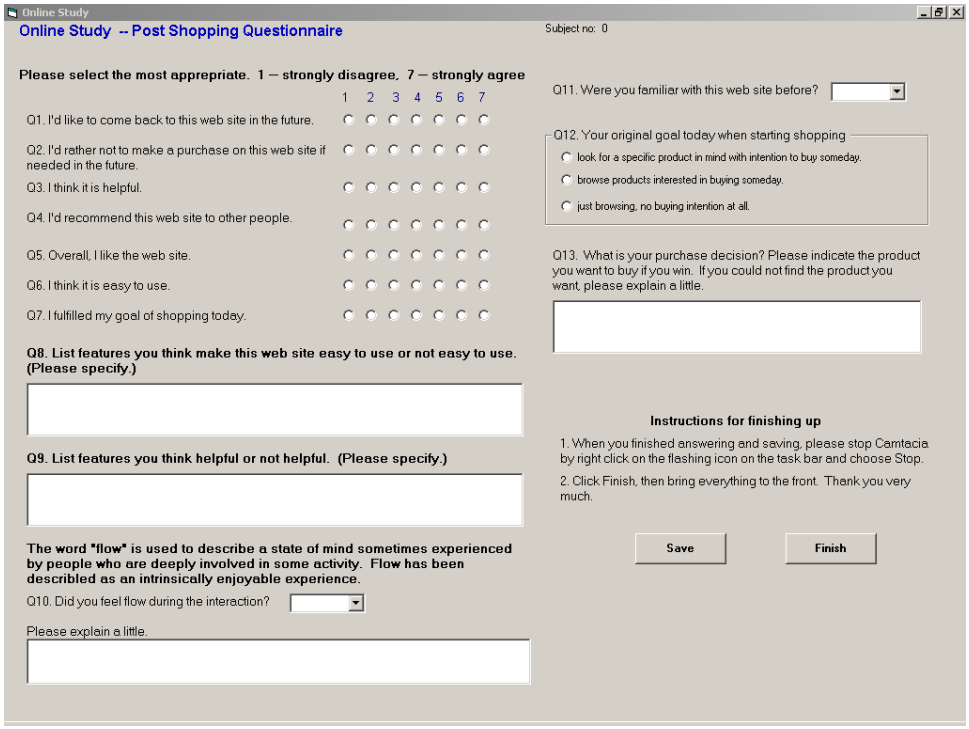


Figure B.4 Post Shopping Questionnaire (Study 1-A-1)

B.2 Study 1-A-2

In this study, we tried to use a different number of sampling forms during the session and vary the length of those forms. Our purpose was to find a better way to employ this method, less intrusively and with enough efficiency. Ten to fifteen participants were exposed to each of the three conditions (listed below):

a. a pre-shopping questionnaire; 1 long sampling form appears when 5-7 minutes into the session, and a post-shopping questionnaire appears after shopping;

b. a pre-shopping questionnaire, 1 long sampling form appears when 5-7 minutes into the session; 1 short sampling form appears after 5-7 minutes, and a post-shopping questionnaire appears after shopping;

c. a pre-shopping questionnaire, 1 long sampling form 5-7 minutes into the session, 2 short sampling forms appears each after 5-7 minutes; and a post-shopping questionnaire appears after shopping.

Pre-shopping questions are basically demographic data, habit and history of using the Internet and online shopping. Also personal novelty and playfulness were measured. In long sampling form, questions on flow, perceived complexity, emotional responses, behavioral intentions, and cognitive evaluates were included. Shorter version sampling form just included selected questions of those constructs. In post-shopping question, besides questions regarding the experience during shopping, manipulation checks were included.

In Study 1-A-2, flow measure we used were Internet Flow Scales, which is developed based on previous researches in IS and Marketing. Concentration and enjoyment are assessed using two four-item scales used in Koufaris (2002), which were designed for online shopping and had the highest reliability measure. Control is measured by a 5-item scale from Ghani (1995). Measurement for time distortion is adopted and slightly changed from a 5-item scale used by Agarwal and Karahanna (2000). Telepresence is measured using a 7-item scale developed by Kim and Biocca (1997), and used before by Novak et al. (2000) and Klein (2003). No readily useable measurement scales for mergence and loss of self-consciousness in online shopping are available. We will go through the regular procedure of scale development. For mergence, two questions are taken from the focused immersion scale (Agarwal and Karahanna 2000) to form the initial question set. For loss of self-consciousness, one

question is taken from the ESF (Csikszentmihalyi and Csikszentmihalyi 1988). Two more questions are created by reading descriptions of informants regarding this state and taking the words that seems defining this property: melting and reacting. The next step is to test them in a selected sample and to solicit suggestions. The result will be tested one more time using a different sample before the planned study.

Perceived challenges and skills are each measured with a five-item scale. Since no study has measured these two constructs in terms of site complexity, we intentionally add repeated questions directly related to structure complexity and content complexity, and treat them as multi-dimensional constructs.

In Study 1-A-2, six web sites were involved, two for each of the product categories: clothing, electronics, and music/movie. Those web sites are: www.macys.com (more complex) vs. www.dillards.com, www.buy.com (more complex) vs. www.outpost.com, and www.cdworld.com vs. www.cduniverse.com. Based on the objective comparison of structure and content complexity, I expected one in each category to be more complex than the other. Those criteria are length of pages, amount of information available, page layout, and so on. Subjects' perception on site complexity was measured using a newly developed scale (Nadkarni and Gupta, 2003). Nadkarni and Gupta's scale has three subscales: component complexity (7 items), coordinative complexity (7 items), and dynamic complexity (5 items). Mouse movements were also captured.

B.2.1 Data Analysis and Results

Total 55 subjects participated in the study. First we did factor analysis on IFS. The Result is shown in Table B.1. 71.54% variance has been explained. However, we can see that the factor structure on some of the dimensions is not as expected.

Table B.1 Rotated Factor Matrix For IFS (Study 1-A-2)

	Factor								
	Conc.	Enjoy	Con.	Time	Tele.	PS	Merge.	8	9
Concentration									
C1							.742		
C2	.619								
C3	.553								
C4	.430						.643		
Enjoyment									
E1							.651		
E2		.491					.636		
E3		.601							
E4		.576							
Control									
CON1			.758			.434			
CON2	.501		.520						-.547
CON3			.404			.580			
CON4			.670						
CON5		.594							
Time distortion									
TD1								.740	
TD2				.639					
TD3				.623					
TD4								.880	
Telepresence									
TE1				.596					
TE2				.734					
TE3					.595				
TE4					.702				
TE5					.831				
TE6					.873				
TE7					.655				
Mergence									
M1	.503			.406			.607		
M2	.515	.456		.434			.402		
M3	.595	.563							
Loss of self-consciousness									
L1				.510					
L2									.400

L3		.632			
Perceived Challenge					
PC1		-.584			
PC2					-.469
PC3		-.547			
PC4		-.429	-.419		
PC5		-.403	-.652		
Perceived Skill					
PS1			.613		
PS2			.413		.408
PS3			.763		
PS4	.400		.534		
PS5					

Extraction Method: Maximum Likelihood. Rotation Method: Equamax with Kaiser Normalization.
a Rotation converged in 40 iterations.

Then, we conducted analysis on complexity scales. However mean comparison results were mixed. First, in the electronics category, the simpler Web site had higher perceived site complexity in all three subscales; second, in music/movie category, the relationship is not consistent across the three subscales. The clothing web site results were as expected. There are several possible reasons for this. Perceived complexity is indeed a multi-dimensional constructs and certain aspects of web sites may contribute more than others in terms of perceived site complexity. Also, relationship between objective complexity and perceived complexity may not be linear. For example, a page with less text seems simpler than a page with more text; however if the text does not provide enough information, from the customers' point of view, it is harder to figure out what to do then, therefore, it is more complex. Thus, direct comparison of objective measures may not reflect the impact of a site on people's perception of its complexity.

Also, factor analysis did not yield a structure as expected; show in Table B.2. Although with the small sample size (55), the results can hardly be conclusive, we will continue analyzing pilot study data (1) to discover a meaningful solution for factor

structure; (2) to find out features of Web sites that relate closely to perceived complexity when shopping online. These features will be used as major criteria in selecting web sites for the study.

Table B.2 Rotated Factor Matrix for Web Site Complexity Scale (Study 1-A-2)

	Factor		
	1	2	3
Component			
COM1			
COM2			
COM3			
COM4	.411		
COM5	.865		
COM6	-.539		
COM7	.741		
Coordinative			
COO1			
COO2			
COO3		.416	
COO4		.819	.459
COO5			.972
COO6			
COO7		.433	
Dynamic			
DY1		.675	.411
DY2			
DY3		.794	
DY4			
DY5			.485

Extraction Method: Maximum Likelihood. Rotation Method: Equamax with Kaiser Normalization.
a Rotation converged in 5 iterations.

Reliability coefficients dimensions of IFS, sub-scales of Web site complexity and other constructs are presented in Table B.3. Loss of self-consciousness, perceived skill, complexity subscales, Arousal, and Dominance do not have acceptable reliability coefficients.

Table B.3 Reliability Coefficients of Constructs (Study 1-A-2)

Construct	# of items	Reliability coefficient
Internet Flow Scale		
Concentration	4	.7879
Enjoyment	4	.9421
Control	5	.7990
Mergence	3	.9483
Loss of self-consciousness	3	.3331
Time distortion	4	.8574
Telepresence	7	.8459
Perceived challenge	5	.7476
Perceived skill	5	.6186
Complexity	19	
Component	7	.0624
Coordinative	7	.5355
Dynamic	5	.4864
PAD	18	
Pleasure	6	.8364
Arousal	6	.6238
Dominance	6	.5069
Playfulness	7	.7633
Perceived usefulness	4	.8117
Behavioral intention	4	.9257

There were only 35 subjects answered the first short sample forms and 11 subjects answered the second short sample form. Since we only collected very limited data on short sample forms, we were not able to do more data analysis on those and test the change of experience over time.

B.2.3 Screen Shots

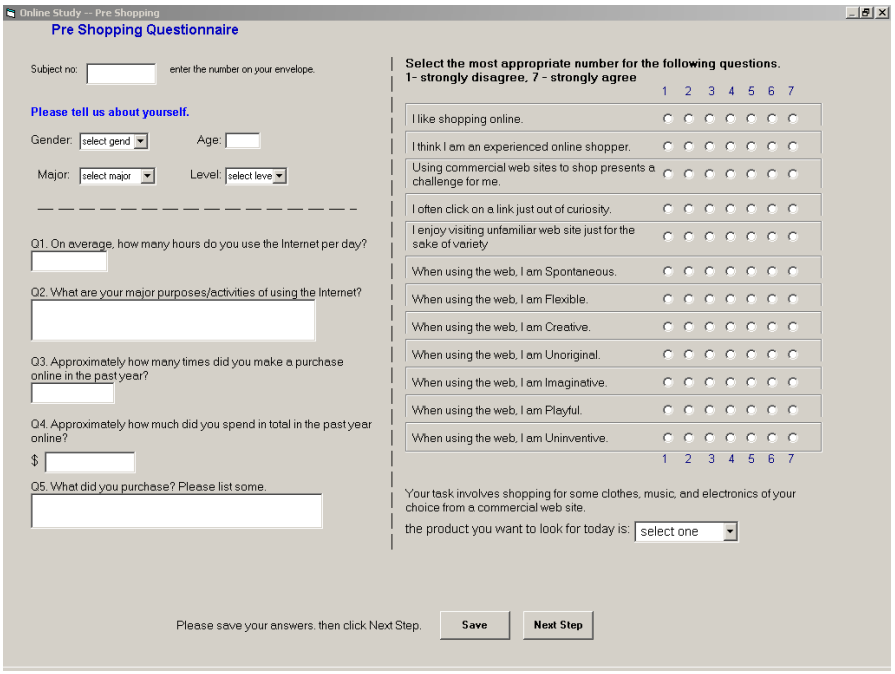


Figure B.5 Pre Shopping Questionnaire (Study 1-A-2)

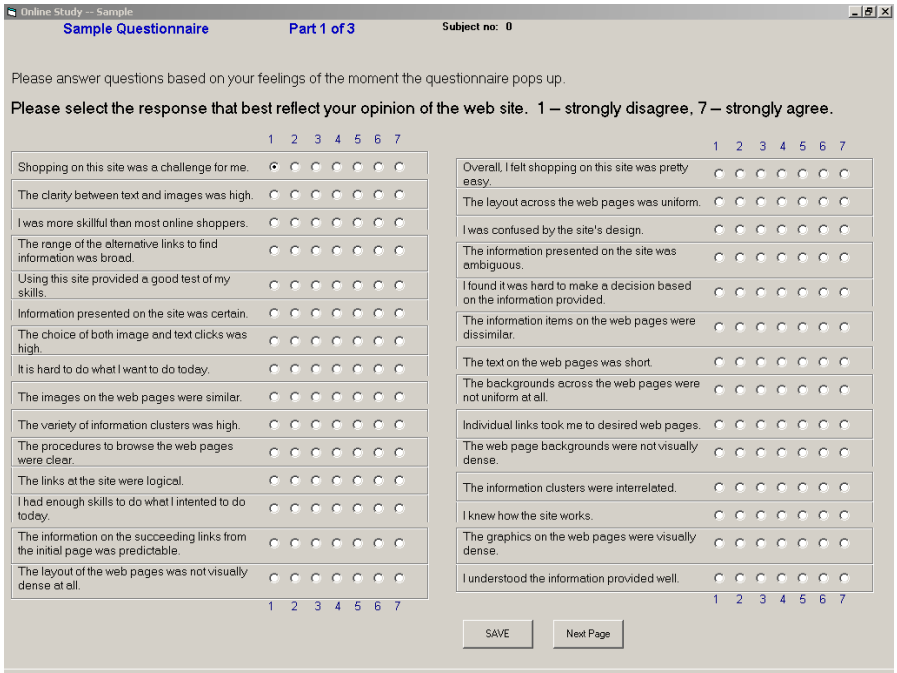


Figure B.6 Sample Form, Part 1 (Study 1-A-2)

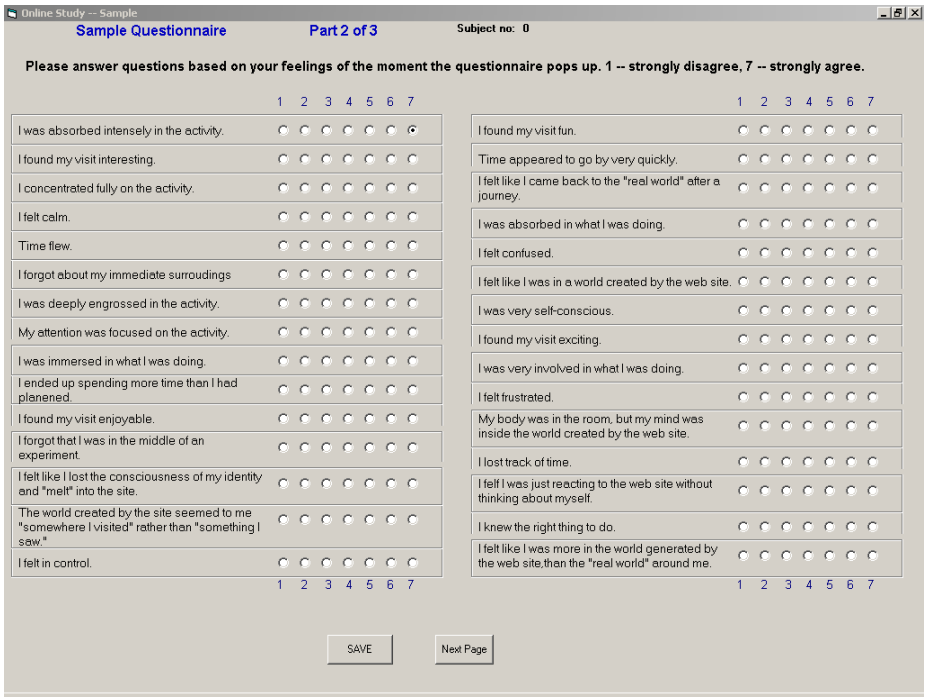


Figure B.7 Sample Form, Part 2 (Study 1-A-2)

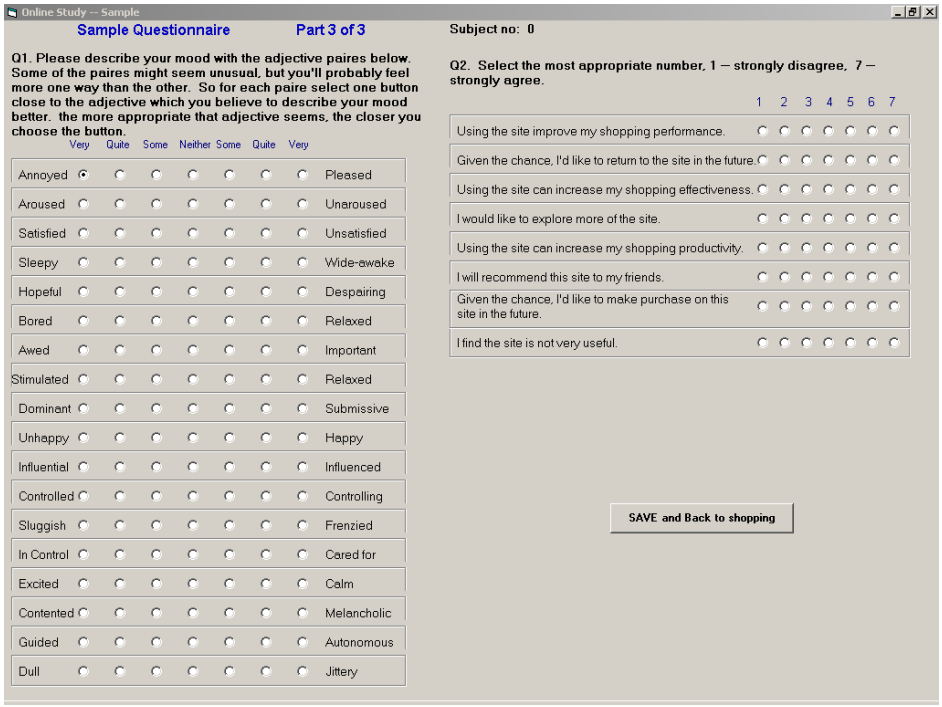


Figure B.8 Sample Form, Part 3 (Study 1-A-2)

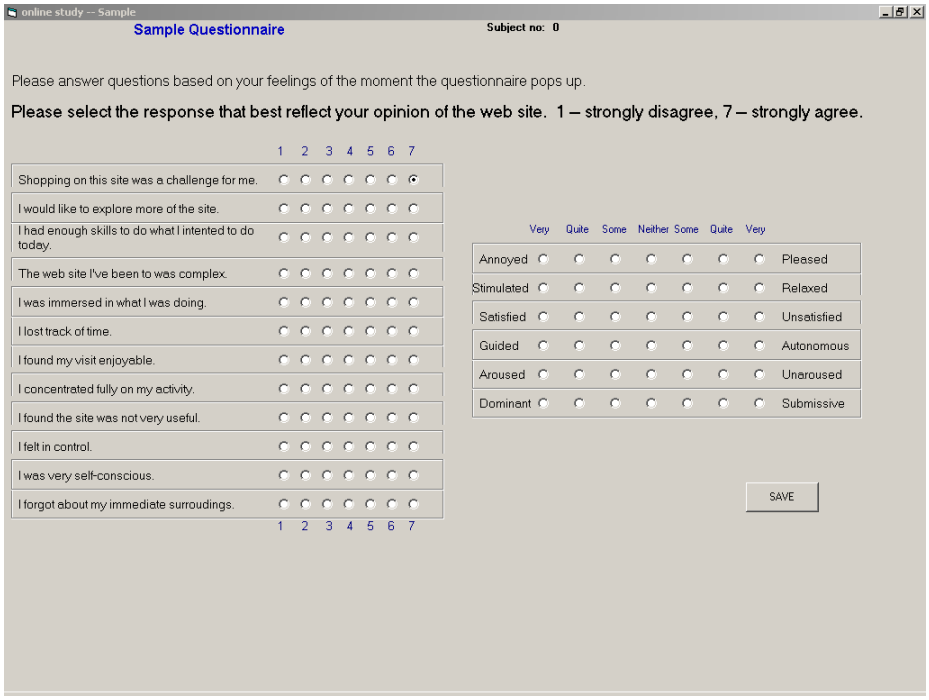


Figure B.8 Short Sample Form (Study 1-A-2)

B.3 Study 1-A-3

We conducted a study similar to Study 1-A-2 in spring of 2004. The major differences were: (1) We used FSS (Flow State Scale, Jackson and Marsh 1996) as the measure of flow and (2) Only one sampling form (full version) was scheduled to pop up during the session. Please see the section of screen shots.

B.3.1 Data Analysis and Results

There were 79 subjects who participated in this study. We focused on Web site complexity scale and Flow State Scale (FSS, Jackson and Marsh 1996). Factor analysis results for these two scales are presented in Table B.4 and Table B.5, respectively. The result for complexity scale (Nadkarni and Gupta, 2003) was still not satisfactory. The total variance explained is 38.340. Majority of the items in FSS loaded as on expected

factors and total variance explained is 71.918. However, the precondition of the perceived balance of challenge and skill did not emergence as a distinctive factor. Another problem is there are cross-loading items. But, compared to IFS in study 1-A-2, it seems this scale had better performance.

Table B.4 Rotated Factor Matrix for Web Site Complexity Scale (Study 1-A-3)

	Factor		
	1	2	3
Component			
COM1	.461		
COM2			
COM3	.495		
COM4			
COM5			.954
COM6			.478
COM7			.326
Coordinative			
CO1		.532	
CO2	.711		
CO3		.506	
CO4	.810		
CO5	.607		
CO6		.405	
CO7			
Dynamic			
DY1	.720		
DY2	.487		
DY3	.718		
DY4		.416	
DY5	.731		

Extraction Method: Maximum Likelihood. Rotation Method: Equamax with Kaiser Normalization.
a Rotation converged in 4 iterations.

Table B.5 Rotated Factor Matrix for Flow State Scale (Study 1-A-3)

	Factor								
	Clear goal	Enjoy	Loss	Merge.	Conc.	control	Time	Fd.bk	9
Clear goal									
FSS-CG1	.867								
FSS-CG2	.864								
FSS-CG3	.866								
FSS-CG4	.793								

Enjoyment							
FSS-E1	.667						
FSS-E2	.741						
FSS-E3	.806						
FSS-E4	.763						
Loss of self-consciousness							
FSS-L1		.770					
FSS-L2		.625	.451		.433		
FSS-L3		.772					
FSS-L4		.676					
Mergence							
FSS-M1			.559				
FSS-M2						.424	
FSS-M3			.490				
FSS-M4			.418				
Concentration							
FSS-C1				.536			.480
FSS-C2				.667			
FSS-C3				.672			
FSS-C4				.763			
Control							
FSS-CON1							.640
FSS-CON2					.600		
FSS-CON3					.860		
FSS-CON4		.416			.542		
Time distortion							
FSS-TD1						.656	
FSS-TD2						.789	
FSS-TD3						.596	
FSS-TD4						.781	
Feedback							
FSS-FB1			.462			.356	.608
FSS-FB2						.717	
FSS-FB3			.463				
FSS-FB4	.462					.442	
Balance of challenge and skill							
FSS-CS1							
FSS-CS2			.604				
FSS-CS3			.654				
FSS-CS4							

Extraction Method: Maximum Likelihood. Rotation Method: Equamax with Kaiser Normalization.
a Rotation converged in 31 iterations.

Table B.6 shows the reliability coefficients of constructs. All flow factors have acceptable reliability, except perceived balance of challenge and skill. As in Study 1-A-

2, sub-scales of complexity, Arousal, and Dominance do not have acceptable reliability value.

Table B.6 Reliability Coefficients of Constructs (Study 1-A-3)

Construct	# of items	Reliability coefficient
Internet Flow Scale	36	
Concentration	4	.9078
Enjoyment	4	.9315
Control	4	.8892
Mergence	4	.7758
Loss of self-consciousness	4	.8552
Time distortion	4	.8005
Clear goal	4	.9603
Feedback	4	.8970
Perceived balance	4	.5205
Complexity	19	
Component	7	.3521
Coordinative	7	.0654
Dynamic	5	.6532
PAD	18	
Pleasure	6	.8118
Arousal	6	.5440
Dominance	6	.5556
Playfulness	7	.8144
Perceived usefulness	4	.8443
Behavioral intention	4	.9167

B.3.2 Screen shots

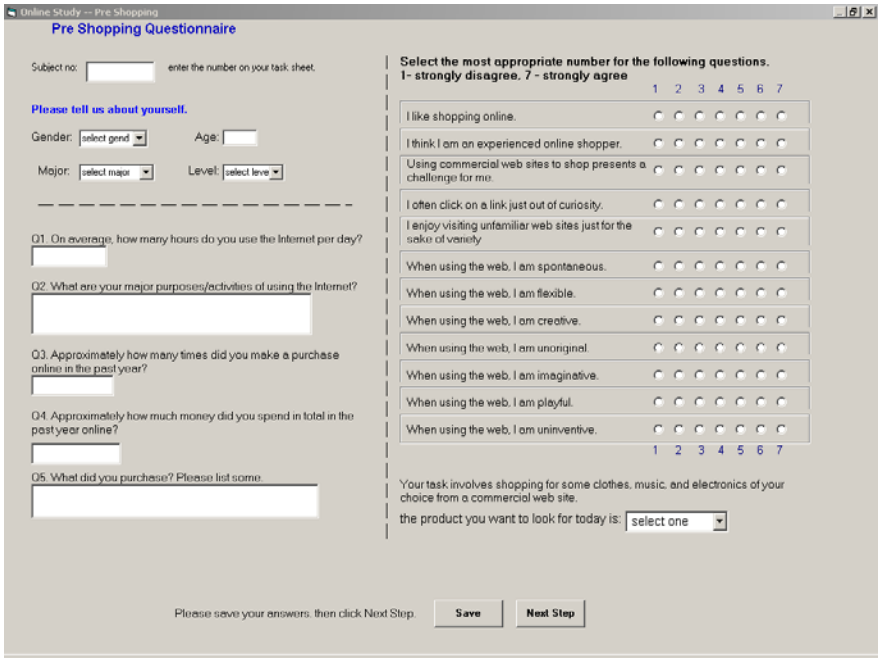


Figure B.9 Pre Shopping Questionnaire (Study 1-A-3)

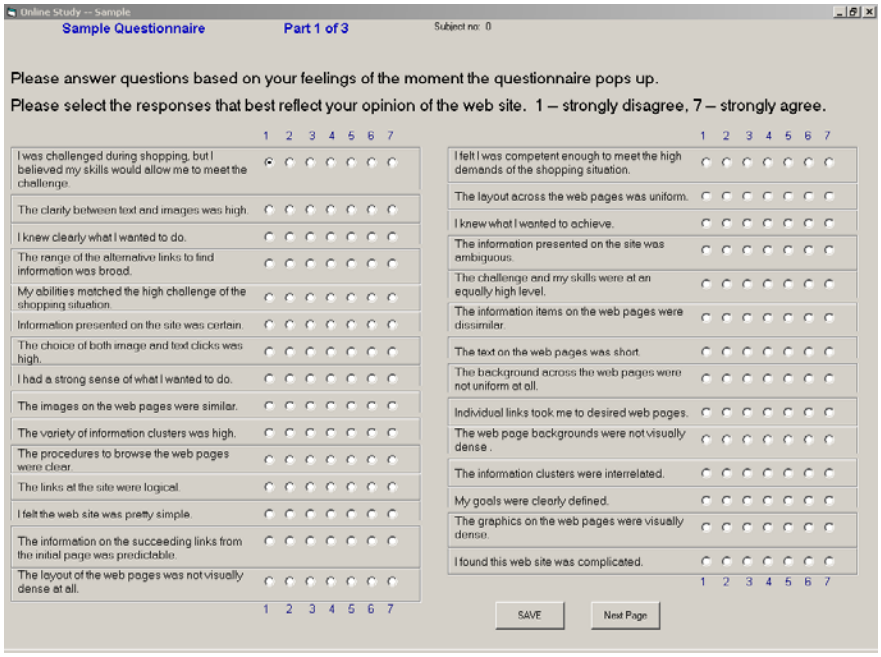


Figure B.10 Sample Form, Part 1 (Study 1-A-3)

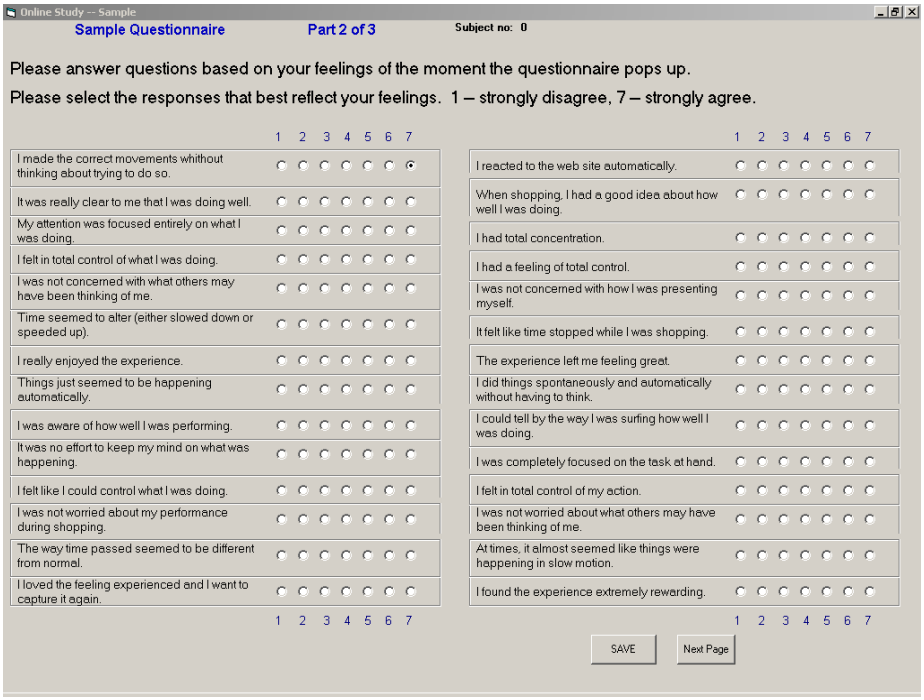


Figure B.11 Sample Form, Part 2 (Study 1-A-3)

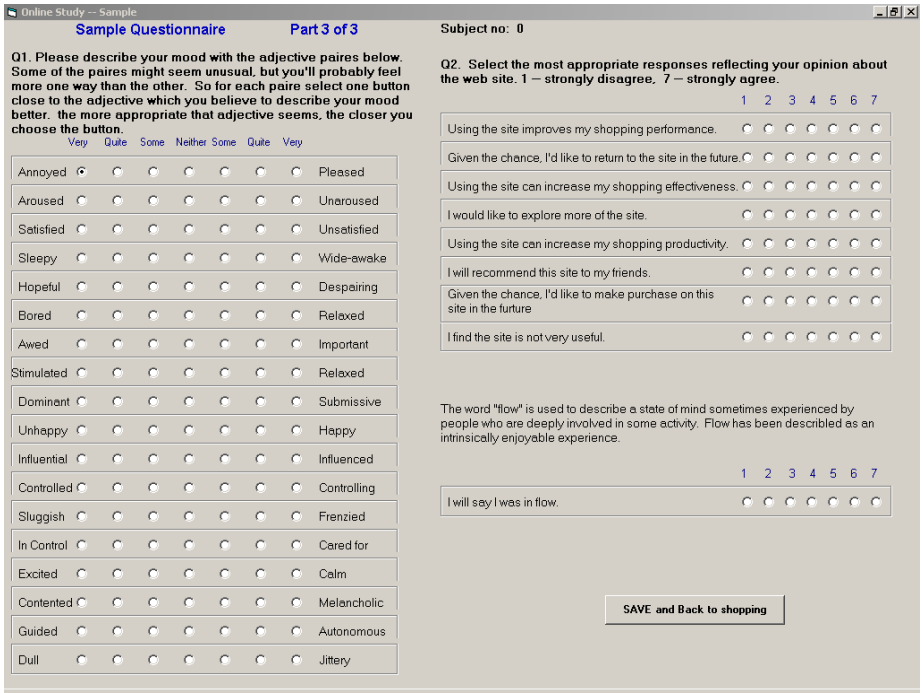


Figure B.12 Sample Form, Part 3 (Study 1-A-3)

APPENDIX C

BEHAVIORAL CORRELATES ANALYSIS METHOD

Phases:

1. **transcribing** video files:
    a. The principal researcher first transcribes the videos and provides a set of instructions of how to transcribe the video.
    b. Another researcher looks at the videos and original transcripts, adding any missing information based on the transcribing instructions. If necessary, refine transcribing instructions too.
    c. The principal researcher looks at the videos and transcripts again, discussing with another researcher about the additions and reconciling on the changes.

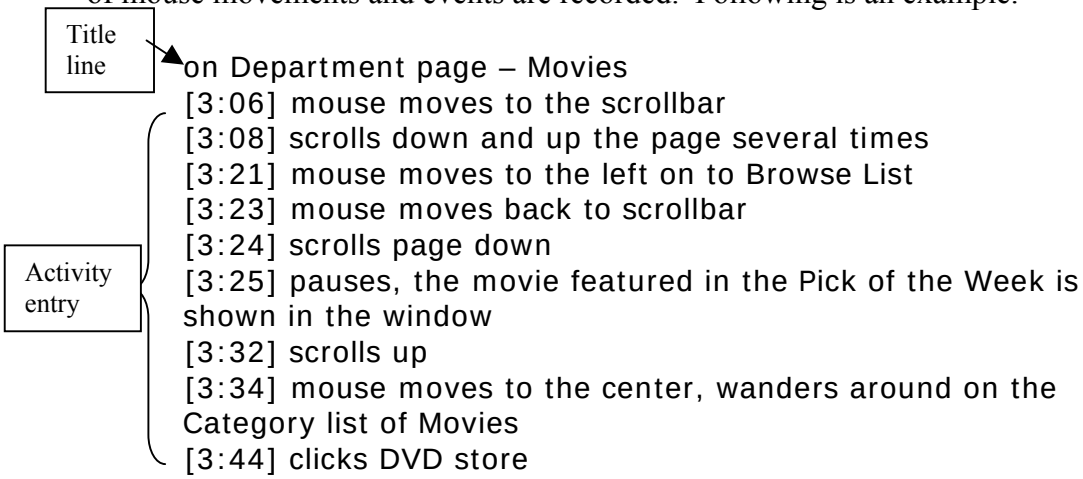
2. **coding** the transcripts

3. **analyzing** the pattern

How to Transcribe

- About the experiment and video files

The video is generated by a screen capturing software, Camtasia. In the experiment, after answering a computerized (developed by principal researcher using Visual Basic) pre-shopping questionnaire, subjects go to next page with more instructions. They are told to start recording and click a button "Start shopping." This button will close the VB program and starts a timer. Subjects then go shopping on assigned web site. The timer is set to 5-7 minutes. However the shopping time may be less than that since subjects has to open IE and type in URL etc. Sometimes, they read instructions on their task sheet after clicking the button. In some rare cases, subjects start recording late. When the timer goes off, a sampling form with questions pops up. Subjects are asked to answer them right away. They can go back shopping till they feel they make a decision about the purchase. Subjects are told to stop recording once they finishing shopping. Upon stopping, the Camtasia generates an avi file. Watching this file is like watching the subject surfing the site over his shoulder with all the mouse movements, actions, and page changes.



- Transcribing instructions

Length

Transcribe the portion from the beginning till the sampling form pops up

Format of the transcripts

Transcripts are naturally segmented into pages. For each page the subject is on, a group of mouse movements and events are recorded. Following is an example.

Title line

on Department page – Movies

Activity entry

[3:06] mouse moves to the scrollbar
[3:08] scrolls down and up the page several times
[3:21] mouse moves to the left on to Browse List
[3:23] mouse moves back to scrollbar
[3:24] scrolls page down
[3:25] pauses, the movie featured in the Pick of the Week is shown in the window
[3:32] scrolls up
[3:34] mouse moves to the center, wanders around on the Category list of Movies
[3:44] clicks DVD store

Each segment has two parts: title line and activity entries. First line is the title line, including page type and content of the page. In this example, it is a Department page, and the department is Movies. Rest of the segment is the activities of the subject. For example, the mouse moves to scrollbar at 3:06, which is the first movement the subject makes on the page. Each entry is a unit of activity whose granularity seems to have sufficient detail for further coding and interpretation. When transcribing, we look for change of action, which signals a new entry. For each entry, a time stamp is associated with it, which is the beginning of the action. So that, by subtraction, we can figure out how long each action takes.

Types of web page	**Definition**
Home page/root page	The beginning of the web site.
Store pages and department pages	Those are pages present information of a broader group of products. For example, Women or Men in a department store.
Category pages and subcategory pages	Those are pages present information of a finer group of products. For example, Women's coats or dresses.
Product list pages	Those are pages listing a group of products within a category or subcategory.
Product pages	Those are pages featuring one product and presenting detail information. There can be pages present one aspect of product, such as Larger Image page.
Search result pages	Those are pages presenting search results; normally a page listing all or partial result list.

Transaction pages	Pages involved in completing a transaction, such as sign-in page, billing address page, and payment page.
Functional pages	Such as advanced search engine page and informational pages.

If necessary, a brief description of the content of page or the part shown on screen/browser should be recorded. For an instance, at 3:25, the subject pauses, page stands still for 7 seconds till next action. It would be helpful to briefly describe what is shown in browser. Normally a segment ends when a click occur.

For each page, first identify the type and the content. The types are:

- home page: content is the store name (web site);
- department page: the content is the department name;
- category page: the content is the category name;
- product list page: the content is the product name (more general);
- product page: the content is the a more specific product name;
- search result page: the content is the searching phrase.

Most times, the content is the link clicked on the page before. In the example above, the page is a department page and the department is Movie, which is the link clicked by subject last time.

Sometimes, subjects go through multiple product list pages or search result pages. In this case, use a number after content to indicate different pages. For example, if a subject goes through a couple of product list page of comedy movies, the title line will be:

Product list page – comedy 1, Product list page – comedy 2, and so on.

If the page has "abnormal" things, which may have impact on subject experience, those things have to be recorded too. Examples of such things include broken link notice (404 error, page not found, and such) and page flaws, such as extra items in shopping cart.

The major part of the transcript is subjects' actions, including mouse movements, any typing, and sometimes using of keyboard. Scrolling a page down or up can be done in multiple ways. One is dragging scrollbar of browser on the right; clicking the PageDown or PageUp Arrow of the scrollbar box is the second way; the third way to using PgUp and PgDn key on keyboard; the forth way is using the scroll wheel on the mouse.

Other things needed to recorded are events occurred, which are listed below. New events can be added into the list once encountered during transcribing.

- Interruptive advertisement from the web site: such as popup windows, floating ads, dropping down ads, and so on.
- Task-related messages: normally they are issued by browsers, such as security message, cookie alert, and so on.

Terminology of the page and browser

Some terminology used in transcribing is listed here to assist in making the transcripts consistent. We use amazon.com and cdworld.com as examples.

Browser:

The parts of browser that are relevant to transcribing mouse movement data are:

- Back key on the menu
- URL field
- Scrollbar, scrollbar box, pageDown and pageUp arrow at the right

Amazon.com:

Due to copyright concerns, no screenshots will be included in the dissertation.

Some sample pages are provided; important features are marked on the pages. The hierarchy of the page in amazon.com is Home page, Store page, Department page, Category page, (Subcategory page, sometimes), Product list page, and Product page (sometimes with product image pages)

- Home page: It is the first page of Amazon.com. The top part of the page is store navigation bar (a list of stores) and the feature bar under it. At the left column of the page, there is the search engine and underneath that is store list. Normally the center of the page is a letter to customers.

- Store page: Normally on a store page, the center part is featured product and on the left column is the department list underneath search engine.

- Department page: The left part of department page is the category link list and links to related categories. Right part of the page is featured product list with little information for each product. There is a department title under the feature bar.

- Category page: Category page looks very similar to department page in that it also has two major parts. On the left is subcategory list and on the right is featured product list. The difference is that it normally has a path list under the feature bar.

- Product list page: It is a page listing a number of products under same category. Each product is presented with minimum information.

- Product page: It is a page featuring one product with/without other related product. Normally the detailed product information is shown as the major part of the page.

- Transaction page – Shopping cart: Shopping cart page is the one after a shopper clicks add item. Normally the shopping cart information is located at the right column of the page. Major part of the page is devoted to recommendations.

There are other kinds of pages too, for example:

- Transaction pages: include log-in page, shopping cart page
- Informational page: for example, shipping rules and rates

CDWorld.com:

Since this experiment was conducted, cdworld.com changed their Web site, and no screen shots of the old site are available. Here is brief description of the pages

- Homepage: a simple page with white background. Top is a *Navigation Bar* (with buttons to various stores and departments), left is *Feature list* (including links to Top Sellers, Concert Calendar, etc.) and Best Seller list. Main part of the page is items featured in the center.

- Information page: Pure information, such as Top sellers, New releases, no links to the titles.

- Store page: this is the CDWorld store page, presenting featured products at center. At the top is the logo and *Search Engine*, on the left is *Browse List*, including links to various departments.

- Front Store page: this page features both CDworld's Movie Store and the other movie store that sells restricted materials.

- Department page: Similar to Store page. At the top is the store logo and Search Engine, and on the left is Browse List. There is also a *Path List* (made up of links of a hierarchy) next to the Browse List. Main parts at center are 1) *Category list* (links to categories under this department) and 2) featured items (such as pick of the week)

- Category page: similar to Department page, but with no Path List. Main part is *Subcategory List*, basically no featured items on this kind page.

- Product list page: similar to Department page, with all the store logo, Search Engine, Browse List, and Path List. Center is the *Product List*; normally it lists about 20 products per page. Each product is on one row, with minimal data, no image. At top of the list, there is a *Sort By* field; at the end of the list, there is a *Page Navigation Ba*r, made up of Page Numbers and Before/Next buttons.

- Product page: product description is the main component of the page. At the top is the store logo and Search Engine, and on the left is Browse List.

- Transaction page: sign in, shopping cart, etc
    - Shopping cart page: shows the content of the shopping cart

Coding Instructions

There are two steps in coding a verified transcript: first for individual pages or segmentations and second for the whole case. Coders do not necessarily to be the same person as transcribers.

Step 1.
For each page, fill the following coding card:

Coder no: _____

Subject no: _____ Segment no: _____

Use of search engine (P1-2): Yes/No. if Yes, search word:
_____
Pop-ups (N2-1): Yes/No
Messages (N2-2): Yes/No
Hard Errors (N3-1): Yes/No
Soft Errors (N3-2): Yes/No
Visitor's mistake (N3-3): Yes/No

Systematical mouse movements (P2)? Yes/No

Non-systematical mouse movements (N1-3) ? Yes/No

Notes:
For each question, circle yes or no. For any Yes, please write down the code according to following rules.

- Search engine use (P1-2)

If subject uses search engine, write down P1-2.

- Definition of Advertisement and messages (N2-1)

Advertisement from the web site can take forms such as popup windows, floating ads, dropping down ads, and so on, write down N2-1

- Definition of Task-related messages (N2-2)

Normally they are issued by browsers, such as security message, cookie alert, and so on.

Write down N2-2.

- Definition of Hard Errors (N3-1)

Such as broken links ("page not found"), or unavailable server, or network difficulties, label, write down N3-1

- Definition of Soft Errors (N3-2)

"Soft" error in that the page is correctly displayed but has logical flaws in them. For example, extra items in a shopping cart, or no special message displayed when there is no item in a category, write down N3-2.

- Definition of Errors due to individual (N3-3)

Errors can be caused by subjects, such as, typing in a wrong key word or not familiar with the use of the site, write down N3-3.

- Definition of systematical mouse movements (P2)

One of the signs of concentration and involvement is systematical mouse movements. When judging whether a subject's mouse movements on one page is systematical or not, we look for following signs:

1. scrolls page up and down slow enough to be able to comprehend the content, sometimes, with pauses in between.
2. mouse moves through a list of items/links in a steady manner.
3. mouse moves along the lines or along the edge of a paragraph, sometimes, with highlighting part of the text.
4. mouse moves at parts of a page, but show an inherent logic, e.g., moves among pieces of product information, such as price, image, short description, availability and such.

There may be other movements less typical than abovementioned. And on one page, a subject's movements can be combination of those mentioned. Most times, if there is a long (about 10 seconds) gap between adjacent entries, we will pay close attention and make a judgment. However just use 10-second gap just as pure heuristic not a requirement. Look at video to decide whether we can infer a concentration on the activity from subjects.

Write down P2 for systematical mouse movement on coding page. Also, write down the length of time. For example, if a subject was reading a paragraph for 13 second, write down P2 (13). The length of time is approximation. If possible, also write down a short note, such as "reading a paragraph", "comprehending the page", "typing and thinking"

- Definition of non-systematical mouse movements (N1-3)

Due to various reasons, people can get confused on a web site. One of the symptoms of confusion and frustration is non-systematical mouse movements on a page. When

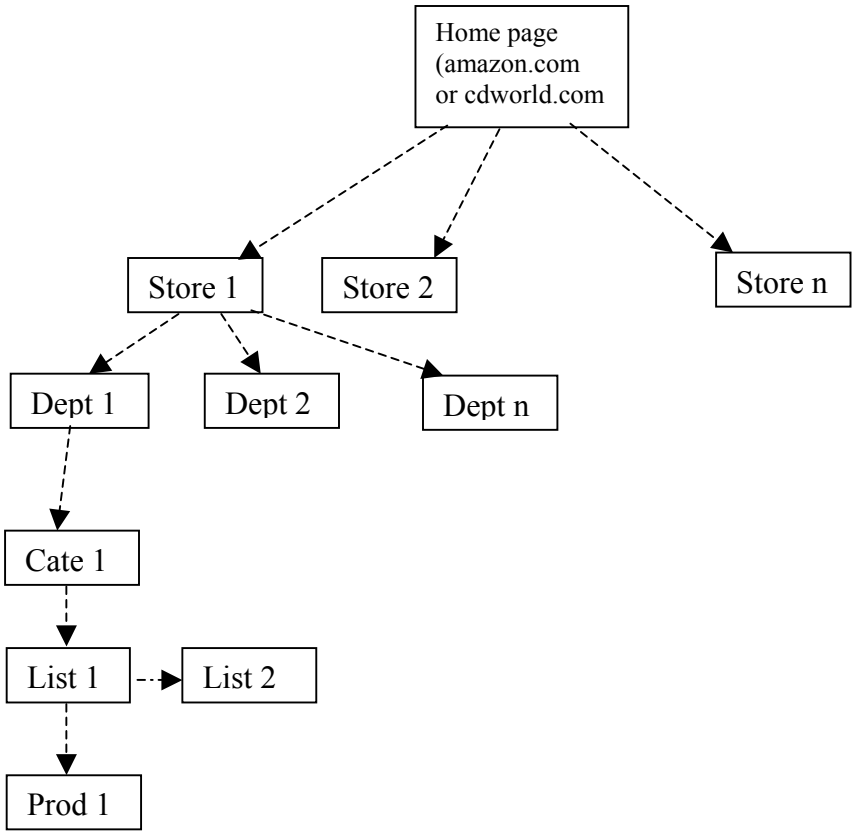
judging whether a subject's action is non-systematical or not, we look for following signs and write down N1-3:

1. Mouse moves on the screen in a zigzag, jumpy, circle manner
2. Mouse moves fast but without a clear aim
3. Mouse switches among a group of links or items

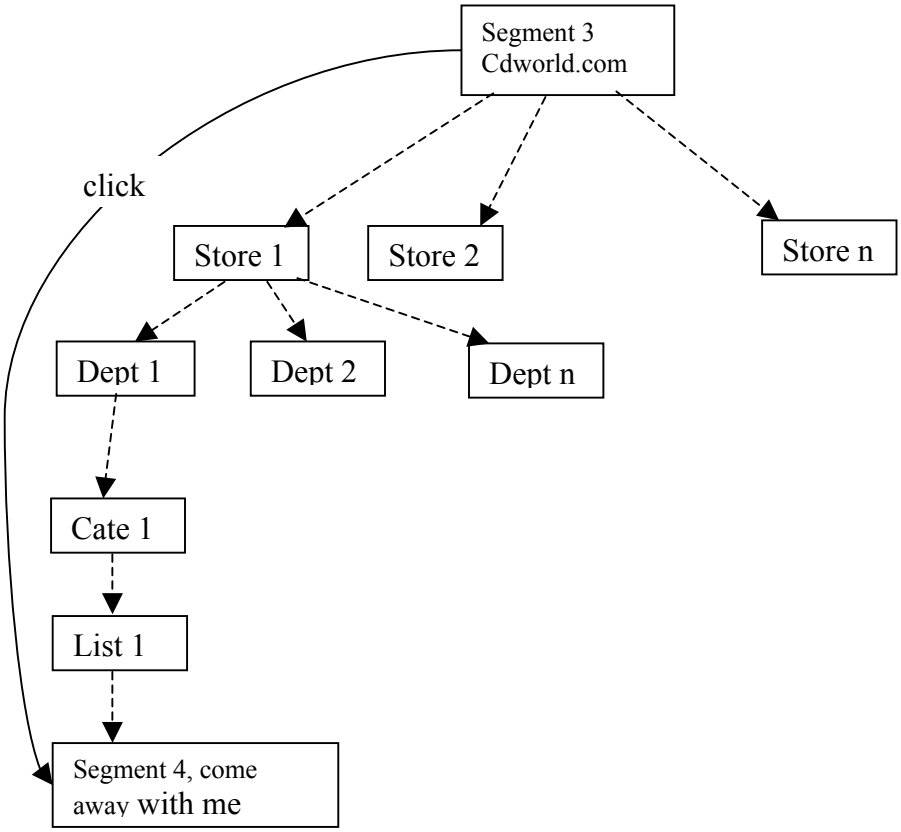
Also, if possible, write down a short note about the behavior of subjects. Systematical actions and non-systematical actions are not mutually exclusive; they just two extreme ends of a spectrum. There are cases that are neither systematical nor non-systematical. In some cases, subjects may display both behaviors; in those cases, make a judgment on a more obvious aspect and make a note.

Step 2.

This time what we look for is the patterns across multiple pages. The method is to draw a trace tree of the transcript on a template, which is illustrated below.



When reading through the transcript, we fill in segmentation no and content (the store names, department name, category names, product names, etc) on each node. Then connect the nodes by drawing a branch between the nodes, mark the methods of navigation (click or search) on the branch. For example:



Based on the drawing, we code following:

1. One kind of product: if the activities are with in one store (P1-1).
2. Logically going through product hierarchy: a series of consecutive (3 or more branches) moves down the trace tree (P3-1).
3. Logically going through product list and/or product page: a series of consecutive (3 or more branches) moves horizontal through product list pages, sometimes, with visits to individual product pages in between (P3-2)
4. Try alternative ways: subject tries to go to a node by using alternative route (N1-1).
5. Go back and forth: subject visits one page (except P3-2) or takes one route several times (N1-2), especially without accomplishing his/her original intention.

Step 3.

Classify above collected information into categories, based on our rules and put those marks in a timeline fashion. For example:

Segment no	Detail category	Board category
1	P1-1	P
2	Nothing	Nothing
3	P2	P
4	P2	P
5	P3-2	P
6	N2-2	N
…	…	…

Then, summarize the number of occurrences for each case and put them in a table like following:

Subject no	P1-1	P1-2	P2	P3-1	P3-2	N1-1	N1-2	N1-3	N2-1	N2-2	N3-1	N3-2	N3-3

Analyzing the pattern

We can look at the pattern by number of occurrences of each category and by sequence of those occurrences to see the difference of flow and non-flow cases

APPENDIX D

TASK SHEET AND QUESTIONNAIRES FOR STUDY 1-B

D.1 Task Sheet

Subject No: _____

Purpose of the Study:

This survey is designed to collect data on subjective experiences when shopping online or playing games. Your input is extremely valuable and critical; your participation is greatly appreciated.

Steps:

1. Please read the Informed Consent Form in your package. If you agree, please sign both of the copies in ink.
2. You will find one (1) index card in your package; please write down (print) your name, course number, and instructor name on the card. This card will be used solely for class credit purpose.
3. There are two versions of this survey; however you will only need to answer one of them.

   Circle the answers that apply for next two questions:

   a. Have you played a computer or video game in the past month?
   Yes No

   b. Have you shopped online (including both purchasing or looking for a product without an actual purchase) in the past month? Yes No

   You will be asked to fill out the survey for the activity you answered *yes* for. If you answered *yes* to both questions, the researcher will randomly assign a survey to you.
   Please ask the researcher for the survey now by raising your hand. Show her or him your answer to above questions and you will get a copy of the questionnaire.
4. Please take time to answer all the questions on the survey faithfully.
5. When you finish, bring the package (with everything inside) to the researcher, who will sign both copies of Informed Consent Form. One will be given back to you as future reference.

D.2 Survey: Computer/Video Games

Subject No: _____ (the one on your task sheet)

The following questions ask you about how you use computers. Please circle the most appropriate number that corresponds to your experiences on the scale.

		not at all			*average*			*very*
1.	Do you like to play computer/video games?	1	2	3	4	5	6	7
2.	Overall, how good are you at playing computer/video games?	1	2	3	4	5	6	7
		strongly disagree						*strongly agree*
3.	When using the computer I am spontaneous.	1	2	3	4	5	6	7
4.	I feel apprehensive about using computers.	1	2	3	4	5	6	7
5.	When using the computer I am unoriginal.	1	2	3	4	5	6	7
6.	Computers are somewhat intimidating to me.	1	2	3	4	5	6	7
7.	When using the computer I am creative.	1	2	3	4	5	6	7
8.	When using the computer I am playful.	1	2	3	4	5	6	7
9.	When using the computer I am imaginative.	1	2	3	4	5	6	7
10.	I hesitate to use a computer for fear of making mistakes that I cannot correct.	1	2	3	4	5	6	7
11.	When using the computer I am flexible.	1	2	3	4	5	6	7
12.	It scares me to think that I could cause the computer to destroy a large amount of information by hitting the wrong key.	1	2	3	4	5	6	7
13.	When using the computer I am uninventive.	1	2	3	4	5	6	7

When you answer the following questions, please think of the last time you played a game on computer or a video game.

14. When was the last time you played a computer/video game?

_____

15. What was the name and version of the last game you played?

_____

16. What is the highest level you can reach or points you can earn for that game?

_____

17. What level do you normally achieve when playing that game? Or typically, how many points you earn?

_____

18. How long did you play the last time you played the game?

_____

19. How many points did you earn or which level did you reach the last time you played the game?

_____

Please circle the most appropriate numbers on the scale based on the experience of the last time you played the computer or video game you just described.

		Not at all		*Average*			*Very*	
20.	Normally, how good are you at playing that game?	1	2	3	4	5	6	7
21.	How good was your performance the last time you played the game?	1	2	3	4	5	6	7
	As you played the game,	*Strongly disagree*						*Strongly agree*
22.	I was challenged, but I believed my skills would allow me to meet the challenge.	1	2	3	4	5	6	7
23.	I made the correct movements without thinking about trying to do so.	1	2	3	4	5	6	7
	As you played the game,	*Strongly disagree*						*Strongly agree*
24.	I knew clearly what I wanted to do.	1	2	3	4	5	6	7
25.	It was really clear to me that I was playing well.	1	2	3	4	5	6	7
26.	My attention was focused entirely on what I was doing.	1	2	3	4	5	6	7
27.	I felt in total control of my action.	1	2	3	4	5	6	7

28.	I was not concerned with what others may have been thinking of me.	1	2	3	4	5	6	7
29.	Time seemed to alter (either slowed down or speeded up).	1	2	3	4	5	6	7
30.	I really enjoyed the experience.	1	2	3	4	5	6	7
31.	My abilities matched the high challenge of the situation.	1	2	3	4	5	6	7
32.	Things just seemed to be happening automatically.	1	2	3	4	5	6	7
33.	I had a strong sense of what I wanted to do.	1	2	3	4	5	6	7
34.	I was aware of how well I was playing.	1	2	3	4	5	6	7
35.	It was no effort to keep my mind on what was happening.	1	2	3	4	5	6	7
36.	I felt like I could control what I was doing.	1	2	3	4	5	6	7
37.	I was not worried about my performance during the event.	1	2	3	4	5	6	7
38.	The way time passed seemed to be different from normal.	1	2	3	4	5	6	7
39.	I loved the feelings experienced when playing the game and I want to capture those feelings again.	1	2	3	4	5	6	7
40.	I felt I was competent enough to meet the high demands of the game.	1	2	3	4	5	6	7
	As you played the game,	*Strongly disagree*						*Strongly agree*
41.	I performed automatically.	1	2	3	4	5	6	7
42.	I knew what I wanted to achieve.	1	2	3	4	5	6	7
43.	While I was playing, I had a good idea about how well I was doing.	1	2	3	4	5	6	7
44.	I had total concentration.	1	2	3	4	5	6	7
45.	I had a feeling of total control.	1	2	3	4	5	6	7
46.	I was not concerned with how I was presenting myself.	1	2	3	4	5	6	7
47.	It felt like time stopped while I was playing.	1	2	3	4	5	6	7
48.	The experience left me feeling great.	1	2	3	4	5	6	7
49.	The challenge and my skills were at an equally high level.	1	2	3	4	5	6	7

50.	I did things spontaneously and automatically without having to think.	1	2	3	4	5	6	7
51.	My goals were clearly defined.	1	2	3	4	5	6	7
52.	I could tell by the way I was playing how well I was doing.	1	2	3	4	5	6	7
53.	I was completely focused on the task at hand.	1	2	3	4	5	6	7
54.	I felt in total control of my action.	1	2	3	4	5	6	7
55.	I was not worried about what others may have been thinking of me.	1	2	3	4	5	6	7
56.	At times, it almost seemed like things were happening in slow motion.	1	2	3	4	5	6	7
57.	I found the experience extremely rewarding.	1	2	3	4	5	6	7
58.	I was absorbed intensely in the activity.	1	2	3	4	5	6	7
59.	I found the activity interesting.	1	2	3	4	5	6	7
	As you played the game,	*Strongly disagree*					*Strongly agree*	
60.	I felt confused.	1	2	3	4	5	6	7
61.	Time appeared to go by very quickly.	1	2	3	4	5	6	7
62.	I forgot about my immediate surroundings.	1	2	3	4	5	6	7
63.	It seemed my interaction with the game was seamless.	1	2	3	4	5	6	7
64.	I was very self-conscious.	1	2	3	4	5	6	7
65.	The world generated by the game seemed to me "somewhere I physically visited" rather than "something I saw on the screen".	1	2	3	4	5	6	7
66.	Playing this game was a challenge for me.	1	2	3	4	5	6	7
67.	My attention was focused on playing the game.	1	2	3	4	5	6	7
68.	I found playing the game enjoyable.	1	2	3	4	5	6	7
69.	I knew how this game worked.	1	2	3	4	5	6	7
70.	I felt calm.	1	2	3	4	5	6	7
71.	Sometimes I lost track of time.	1	2	3	4	5	6	7
72.	After playing the game, I felt like I came back to the	1	2	3	4	5	6	7

	"real world" after a journey.							
73.	I felt I was just reacting to the game without thinking.	1	2	3	4	5	6	7
74.	I kind of forgot about myself when playing the game.	1	2	3	4	5	6	7
75.	Playing this game provided a good test of my game playing skills.	1	2	3	4	5	6	7
76.	I was confused by the game's design.	1	2	3	4	5	6	7
77.	I concentrated fully on playing the game.	1	2	3	4	5	6	7
78.	I found playing this game exciting.	1	2	3	4	5	6	7
	As you played the game,	*Strongly disagree*						*Strongly agree*
79.	I felt in control.	1	2	3	4	5	6	7
80.	I ended up spending more time than I had planned.	1	2	3	4	5	6	7
81.	I felt I was in a world created by the game.	1	2	3	4	5	6	7
82.	My interaction with the game was very smooth.	1	2	3	4	5	6	7
83.	I lost the consciousness of my identity and felt like "melted" into the game.	1	2	3	4	5	6	7
84.	It was hard to play the game.	1	2	3	4	5	6	7
85.	Playing the game created a new world for me, and this world suddenly disappeared when I stopped playing.	1	2	3	4	5	6	7
86.	I was deeply engrossed in playing the game.	1	2	3	4	5	6	7
87.	I found playing the game fun.	1	2	3	4	5	6	7
88.	I felt frustrated.	1	2	3	4	5	6	7
89.	Time flew by fast when I was playing.	1	2	3	4	5	6	7
90.	My body was in the room, but my mind was inside the world created by the game.	1	2	3	4	5	6	7
91.	I had enough skills to do what I intended to do.	1	2	3	4	5	6	7
92.	I spent more time playing the game than I had intended.	1	2	3	4	5	6	7
93.	I am highly skilled at playing that game.	1	2	3	4	5	6	7
94.	I felt I was more in the world generated by the game than the "real world" around me.	1	2	3	4	5	6	7
95.	Overall, I felt playing the game was pretty easy.	1	2	3	4	5	6	7

96. I forgot that I was in the middle of playing a game. 1 2 3 4 5 6 7

The word "flow" is used to describe a state of mind sometimes experienced by people who are deeply involved in some activity. One example of flow is the case where a professional athlete is playing exceptionally well and achieves a state of mind where nothing else matters but the game; he or she is completely and totally immersed in it. The experience is not exclusive to athletics: Many people report this state of mind when engaging in hobbies, dancing, or working.

Activities that lead to flow completely captivate a person for some period of time. When one is in flow, time may seem to stand still, and nothing else seems to matter. Flow may not last for a long time on any particular occasion, but it may come and go over time. Flow has been described as an intrinsically enjoyable experience.

	As you played the game,	*Strongly disagree*						*Strongly agree*
97.	I would say I was in flow the last time I played game.	1	2	3	4	5	6	7

Finally, something about yourself:

98. Your age and gender:

99. Your major and level:

Thank you very much!

D.3 Survey: Internet Shopping

Subject No: _____ (the one on your task sheet)

The following questions ask you about how you use computers. Please circle the most appropriate number that corresponds to your experiences on the scale.

		Not at all			*Average*			*Very*
1.	Do you like shopping?	1	2	3	4	5	6	7
2.	Do you like shopping online?	1	2	3	4	5	6	7
3.	Overall, how good are you at shopping online?	1	2	3	4	5	6	7
		Strongly disagree						*Strongly agree*
4.	When using the computer I am spontaneous.	1	2	3	4	5	6	7
5.	I feel apprehensive about using computers.	1	2	3	4	5	6	7
6.	When using the computer I am unoriginal.	1	2	3	4	5	6	7
7.	Computers are somewhat intimidating to me.	1	2	3	4	5	6	7
8.	When using the computer I am creative.	1	2	3	4	5	6	7
9.	When using the computer I am playful.	1	2	3	4	5	6	7
10.	When using the computer I am imaginative.	1	2	3	4	5	6	7
11.	I hesitate to use a computer for fear of making mistakes that I cannot correct.	1	2	3	4	5	6	7
12.	When using the computer I am flexible.	1	2	3	4	5	6	7
13.	It scares me to think that I could cause the computer to destroy a large amount of information by hitting the wrong key.	1	2	3	4	5	6	7
14.	When using the computer I am uninventive.	1	2	3	4	5	6	7

When you answer the following questions, please think of the last time you shopped online (including both cases that you made actual purchase or you collected product information but without buying.)

15. When was the last time you shopped online?

_____

16. What was the product you were looking for?

_____

17. Which web site(s) did you visit the last time you shopped online?

_____

18. The last time you shopped online, how much time did you spend shopping?

_____

19. Did you accomplish what you planned to do the last time you shopped online?

_____

Please circle the most appropriate numbers on the scale based on the experience of the last time you shopped online as you just described.

		Not at all			*Average*		*Very*	
20.	How familiar were you with the web site(s)?	1	2	3	4	5	6	7
21.	How familiar were you with the product?	1	2	3	4	5	6	7
	As you shopped online,	*Strongly disagree*						*Strongly agree*
22.	I was challenged, but I believed my skills would allow me to meet the challenge.	1	2	3	4	5	6	7
23.	I made the correct movements without thinking about trying to do so.	1	2	3	4	5	6	7
24.	I knew clearly what I wanted to do.	1	2	3	4	5	6	7
25.	It was really clear to me that I was doing well.	1	2	3	4	5	6	7
26.	My attention was focused entirely on what I was doing.	1	2	3	4	5	6	7
	As you shopped online,	*Strongly disagree*						*Strongly agree*
27.	I felt in total control of what I was doing.	1	2	3	4	5	6	7
28.	I was not concerned with what others may have been thinking of me.	1	2	3	4	5	6	7

29.	Time seemed to alter (either slowed down or speeded up).	1	2	3	4	5	6	7
30.	I really enjoyed the experience.	1	2	3	4	5	6	7
31.	My abilities matched the high challenge of the situation.	1	2	3	4	5	6	7
32.	Things just seemed to be happening automatically.	1	2	3	4	5	6	7
33.	I had a strong sense of what I wanted to do.	1	2	3	4	5	6	7
34.	I was aware of how well I was performing.	1	2	3	4	5	6	7
35.	It was no effort to keep my mind on what was happening.	1	2	3	4	5	6	7
36.	I felt like I could control what I was doing.	1	2	3	4	5	6	7
37.	I was not worried about my performance during shopping.	1	2	3	4	5	6	7
38.	The way time passed seemed to be different from normal.	1	2	3	4	5	6	7
39.	I loved the feeling experienced when shopping and I want to capture those feelings again.	1	2	3	4	5	6	7
40.	I felt I was competent enough to meet the high demands of the situation.	1	2	3	4	5	6	7
41.	I reacted to the web sites automatically.	1	2	3	4	5	6	7
42.	I knew what I wanted to achieve.	1	2	3	4	5	6	7
43.	While I was shopping, I had a good idea about how well I was doing.	1	2	3	4	5	6	7
	As you shopped online,	*Strongly Disagree*						*Strongly agree*
44.	I had total concentration.	1	2	3	4	5	6	7
45.	I had a feeling of total control.	1	2	3	4	5	6	7
46.	I was not concerned with how I was presenting myself.	1	2	3	4	5	6	7
47.	It felt like time stopped while I was shopping.	1	2	3	4	5	6	7
48.	The experience left me feeling great.	1	2	3	4	5	6	7
49.	The challenge and my skills were at an equally high level.	1	2	3	4	5	6	7
50.	I did things spontaneously and automatically without having to think.	1	2	3	4	5	6	7
51.	My goals were clearly defined.	1	2	3	4	5	6	7

52.	I could tell by the way I was surfing how well I was doing.	1	2	3	4	5	6	7
53.	I was completely focused on the task at hand.	1	2	3	4	5	6	7
54.	I felt in total control of my action.	1	2	3	4	5	6	7
55.	I was not worried about what others may have been thinking of me.	1	2	3	4	5	6	7
56.	At times, it almost seemed like things were happening in slow motion.	1	2	3	4	5	6	7
57.	I found the experience extremely rewarding.	1	2	3	4	5	6	7
58.	I was absorbed intensely in the activity.	1	2	3	4	5	6	7
59.	I found the activity interesting.	1	2	3	4	5	6	7
60.	I felt confused.	1	2	3	4	5	6	7
61.	Time appeared to go by very quickly.	1	2	3	4	5	6	7
62.	I forgot about my immediate surroundings.	1	2	3	4	5	6	7
	As you shopped online,	*Strongly disagree*						*Strongly agree*
63.	It seemed my interaction with the web sites was seamless.	1	2	3	4	5	6	7
64.	I was very self-conscious.	1	2	3	4	5	6	7
65.	The world generated by the web site(s) seemed to me "somewhere I physically visited" rather than "something I saw on the screen".	1	2	3	4	5	6	7
66.	Shopping online last time was a challenge for me.	1	2	3	4	5	6	7
67.	My attention was focused on shopping.	1	2	3	4	5	6	7
68.	I found shopping online enjoyable.	1	2	3	4	5	6	7
69.	I knew how the web sites worked.	1	2	3	4	5	6	7
70.	I felt calm.	1	2	3	4	5	6	7
71.	Sometimes I lost track of time.	1	2	3	4	5	6	7
72.	After shopping, I felt like I came back to the "real world" after a journey.	1	2	3	4	5	6	7
73.	I felt I was just reacting to the web sites without thinking.	1	2	3	4	5	6	7
74.	I kind of forgot about myself when shopping.	1	2	3	4	5	6	7

75.	Shopping online provided a good test of my shopping and computer skills.	1	2	3	4	5	6	7
76.	I was confused by the design of those sites.	1	2	3	4	5	6	7
77.	I concentrated fully on the activity.	1	2	3	4	5	6	7
78.	I found shopping online exciting.	1	2	3	4	5	6	7
79.	I felt in control.	1	2	3	4	5	6	7
80.	I ended up spending more time that I had planned.	1	2	3	4	5	6	7
	As you shopped online,	*Strongly Disagree*						*Strongly agree*
81.	I felt I was in a world created by the web sites.	1	2	3	4	5	6	7
82.	My interaction with the web sites was very smooth.	1	2	3	4	5	6	7
83.	I lost the consciousness of my identity and felt like "melted" into the site.	1	2	3	4	5	6	7
84.	It was hard to shopping on those web sites.	1	2	3	4	5	6	7
85.	Using the web sites created a new world for me, and this world suddenly disappeared when I stop browsing.	1	2	3	4	5	6	7
86.	I was deeply engrossed in the activity.	1	2	3	4	5	6	7
87.	I found shopping online fun.	1	2	3	4	5	6	7
88.	I felt frustrated.	1	2	3	4	5	6	7
89.	Time flew by fast when I was shopping.	1	2	3	4	5	6	7
90.	My body was in the room, but my mind was inside the world created by the web sites.	1	2	3	4	5	6	7
91.	I had enough skills to do what I intended to do.	1	2	3	4	5	6	7
92.	I spent more time on shopping than I had intended.	1	2	3	4	5	6	7
93.	I think I was a skillful online shopper.	1	2	3	4	5	6	7
94.	I felt I was more in the world generated by the sites than the "real world" around me.	1	2	3	4	5	6	7
95.	Overall, I felt shopping was pretty easy.	1	2	3	4	5	6	7
96.	I forgot that I was in the middle of shopping online.	1	2	3	4	5	6	7

The word "flow" is used to describe a state of mind sometimes experienced by people who are deeply involved in some activity. One example of flow is the case where a professional athlete is playing exceptionally well and achieves a state of mind where nothing else matters but the game; he or she is completely and totally immersed in it. The experience is not exclusive to athletics: Many people report this state of mind when engaging in hobbies, dancing, or working.

Activities that lead to flow completely captivate a person for some period of time. When one is in flow, time may seem to stand still, and nothing else seems to matter. Flow may not last for a long time on any particular occasion, but it may come and go over time. Flow has been described as an intrinsically enjoyable experience.

	As you shopped online,	*Strongly disagree*						*Strongly agree*
97.	I would say I was in flow the last time I shopped online.	1	2	3	4	5	6	7

Finally, something about yourself:

98. Your age and gender:

99. Your major and level:

Thank you very much!

APPENDIX E

WEB SITE SELECTION

E.1 Web Directories

1	Yahoo!shopping
2	MSN shopping
3	Google shopping
4	Lycos shopping
5	ebay
6	Altavista shopping
7	Iwon Shopping
8	Shopping.com
9	bizrate

E.2 Product Categories

Please select five categories you are most familiar with and put "F" in front it, and five categories you are most unfamiliar with and put "UF" in front it.

		Category	**Examples**
	1	Antiques & Collectibles	Furniture, coins, china & crystal, trading cards, etc.
	2	Autos & Vehicles	Auto accessories, boats and marine, etc.
	3	Beauty Products	Makeup, skin care, fragrance, etc.
	4	Health & Personal care	Vision and hearing, dental care, medicine, nutrition and wellness, etc.
	5	Books & Magazines	
	6	Baby & Nursery	Apparel, bedding, travel gear, furniture, etc.
	7	Clothing, Apparel	Women's, Men's, shoes, etc.
	8	Accessories	Jewelry, watches, hand bags, etc.
	9	Computers	Notebooks, desktops, printers, scanners, monitors, networking, etc.
	10	Consumer Electronics	Audio, digital cameras, TVs, DVD players, etc.
	11	Music	CDs, cassettes, etc.
	12	Movies	VHS, DVDs, etc.
	13	Home	Furniture, kitchen, appliances, décor, etc.
	14	Garden & Lawn	Garden equipment & supplies, plants & seeds, outdoor

			furniture, etc.
	15	Pets	Cats, dogs, fish, supplies, pet foods, etc.
	16	Flowers	Roses, flowering plants, arrangements, flowers for various occasions, etc.
	17	Gifts	Gifts for wedding, birthday, etc.
	18	Food & Wine	Candy & Chocolate, beverage, gift baskets, meals, gourmet food, etc.
	19	Office Product	Office furniture, supplies, storage & organizers, etc.
	21	Sports & Fitness, Outdoors & Recreation	Golf, basketball, fan merchandise, camping, hiking, etc
	22	Travel & Luggage	Airline tickets, hotel, luggage, accessories, etc.
	23	Toys & Games	Toys for babies, dolls and figures, building toys, etc.
	24	Tools & Hardware	Power tools, hand tools, flooring, etc.
	25	Art & Entertainment	Art, crafts and hubbies, musical instruments, etc.
	26	Business & Industry	Agriculture, food services, construction, etc.

E.3 A Sample of Web Complexity Rating Sheet

In the table attributes are explained. Duplicated attributes are not repeated.

web site	the name of the site
web address	and address of the web site
Home Page	it is the starting/root page of a web site
length of the web page	how long the web page is.
percentage of white space	approximately how much of the page is white space
percentage of text	approximately how much of the page is white space
background color	the color of background
theme color	what is the dominate color besides background color. Most times it is the color of the logo, the color used as headings and/or on banners, etc.
page layout:	whether the page is horizontally and vertically balanced.
number of graphics	approximately how many graphics on the page
are there animated graphics?	whether there are animated graphics or flashes?
number of links	approximately how many links on the page, both text links and graphic links
Intermediate Page	it is a page presents information about a department or product category. Normally it has featured items and further category list.
URL	the address of a intermediate page

content	theme of the content, can be the department name, product category name, subcategory name, etc.
Product List Page	it is a page presents a group of products in a category.
product category name	the name of category which those products belong to
number of products per page	the number of products listed on this kind of page, only the products within the category, not including other advertisements.
Product Page	this is a page for one product.
product name	what is the name of the product
product information	what kinds of product information are provided, image, price, description, availability, sale information, customer review and/or rating, related products, etc.
Search Result Page	
item searched	what the search is about.
number of product per page	how many products typically listed on a search result page
Overall structure:	
average depth of pages	the number of level of menu hierarchy, the number of levels between the top and bottom categories; most times it is also the level of product hierarchy.
# of shopping support tools and what are they	number and kinds of shopping support tool available, such as search function, site map, help function, wish list, gift finder, account management, shop/browse history list, etc.
pop-up advertisement	how many pop-up advertisements you encountered
interface type	where the web page is regular interface, multipane interface, tabbed interface, or expend/contract interface
personalization capacity	whether the site provide personalization functionality.
Other:	
date of your visit	
time of your visit	
how long did you spend on the site	
response/download time	
network conditions	what kind connection is the access, phone line, cable, high speed broad band (e.g., DSL), local network e.g., on campus)

APPENDIX F

ITEMS USED IN STUDY 1-C AND STUDY 2

General assessment of online shopping

G1. I like shopping online.
G2. I think I am an experienced online shopper.
G3. Using commercial web sites to shop presents a challenge for me.

Novelty

N1. I often click on a link just out of curiosity
N2. I enjoy visiting unfamiliar web sites just for the sake of variety.

Playfulness

Play1. When using the web I am spontaneous.
Play2. When using the web I am flexible.
Play3. When using the web I am creative.
Play4. When using the web I am unoriginal. (reversed)
Play5. When using the web I am imaginative.
Play6. When using the web I am playful.
Play7. When using the web I am uninventive. (reversed)

Perceived Challenge

PC1. Shopping on this site was a challenge for me.
PC2. Using this web site provided a good test of my skills.
PC3. It was hard to do what I wanted to do.
PC4. I found it was hard for me to make a decision based on the information on the site.
PC5. Overall, I felt shopping on this site was pretty easy. (reversed)

Perceived Skills

PS1. I knew how the site works.
PS2. I was confused by the site's design. (reversed)
PS3. I understood the information on the site well.
PS4. I had enough skills to do what I intended to do.
PS5. I was competent to carry out the shopping activity.

Flow State Scale

Challenge/skill balance

FSS-CS2. My abilities matched the high challenge of the situation.

FSS-CS3. I felt I was competent enough to meet the high demands of the situation.
FSS-CS4. The challenge and my skills were at an equally high level

Clear goals
FSS-CG1. I knew clearly what I wanted to do.
FSS-CG2. I had a strong sense of what I wanted to do.
FSS-CG3. I knew what I wanted to achieve.
FSS-CG4. My goals were clearly defined.

Unambiguous feedback
FSS-FB1. It was really clear to me that I was doing well.
FSS-FB2. I was aware of how well I was performing.
FSS-FB3. When shopping, I had a good idea about how well I was doing.
FSS-FB4. I could tell by the way I was surfing how well I was doing.

Concentration on task at hand
FSS-C1. My attention was focused entirely on what I was doing.
FSS-C2. It was no effort to keep my mind on what was happening.
FSS-C3. I had total concentration.
FSS-C4. I was completely focused on the task at hand.

Action-awareness merging
FSS-M1. I made the correct movements without thinking about trying to do so.
FSS-M2. Things just seemed to be happening automatically.
FSS-M3. I reacted to the web site automatically.
FSS-M4. I did things spontaneously and automatically without having to think.

Sense of Control
FSS-CON1. I felt in total control of what I was doing.
FSS-CON2. I felt like I could control what I was doing.
FSS-CON3. I had a feeling of total control.
FSS-CON4. I felt in total control of my action.

Loss of self-consciousness
FSS-L1. I was not concerned with what others may have been thinking of me.
FSS-L2. I was not worried about my performance during shopping.
FSS-L3. I was not concerned with how I was presenting myself.
FSS-L4. I was not worried about what others may have been thinking of me.

Transformation of time
FSS-TD1. Time seemed to alter (either slowed down or speeded up).
FSS-TD2. The way time passed seemed to be different from normal.
FSS-TD3. It felt like time stopped while I was shopping.
FSS-TD4. At times, it almost seemed like things were happening in slow motion.

Autotelic experience
FSS-E1. I really enjoyed the experience
FSS-E2. I loved the feeling experienced and I want to capture it again.
FSS-E3. The experience left me feeling great.
FSS-E4. I found the experience extremely rewarding.

Internet Flow Scale

Concentration
IFS-C1. I was absorbed intensely in the activity.
IFS-C2. My attention was focused on the activity.
IFS-C3. I concentrated fully on the activity.
IFS-C4. I was deeply engrossed in the activity.

Enjoyment
IFS-E1. I found my visit interesting.
IFS-E2. I found my visit enjoyable.
IFS-E3. I found my visit exciting.
IFS-E4. I found my visit fun.

Control
IFS-CON1. I felt confused. (reversed)
IFS-CON2. I felt calm.
IFS-CON3. I felt in control.
IFS-CON4. I felt frustrated. (reversed)
IFS-CON5. I knew the right thing to do.

Time Distortion
IFS-TD1. Time appears to go by very quickly.
IFS-TD2. I lost track of time.
IFS-TD3. I ended up spending more time that I had planned.
IFS-TD4. Time flew.
IFS-TD5. I spent more time on the Web than I had intended.

Telepresence
IFS-T1. I forgot about my immediate surroundings.
IFS-T2. I forgot that I was in the middle of an experiment.
IFS-T3. I felt like I came back to the "real world" after a journey.
IFS-T4. I felt like I was in a world created by the web site.
IFS-T5. My body was in the room, but my mind was inside the world created by the web site I visit.
IFS-T6. I felt I was more in the world generated by the web site than the "real world" around me.

IFS-T7. The world generated by web site seemed to me "somewhere I visited" rather than "something I saw".
IFS-T8. Using the site creates a new world for me, and this world suddenly disappeared when I stop browsing.

Mergence
IFS-M1. It seemed my interaction with the web sites was seamless.
IFS-M2. I felt I was just reacting to the web site without thinking.
IFS-M3. My interaction with the web sites was very smooth.

Loss of self-Consciousness
IFS-L1. I felt like I lost the consciousness of my identity and "melted" into the site.
IFS-L2. I kind of forgot about myself when shopping.
IFS-L3. I felt I was just reacting to the web site without thinking about myself.

Perceived Complexity by Nadkarni and Gupta (2003) and Nadkarni (2004)
COMN1. Uniform/varied
COMN2. Open/cluttered
COMN3. Congruent/incongruent
COMN4. Sparse/dense
COMN5. Coherent/incoherent
COMN6. Logical/illogical
COMN7. Predictable/unpredictable
COMN8. Organized/non-organized
COMN9. Distracting/non-distracting (reversed)

Perceived Complexity
COM1. The web site is complex.
COM2. The web site is interactive.
COM3. The web site is crowded.
COM4. The web site is overwhelming.
COM5. The web site has much variety

Pleasure
P1. Unhappy/Happy
P2. Annoyed/Pleased
P3. Satisfied/Unsatisfied (reversed)
P4. Contented/Melancholic (reversed)
P5. Hopeful/Despairing (reversed)
P6. Bored/Relaxed

Arousal
A1. Stimulated/Relaxed (reversed)
A2. Excited/Calm (reversed)

A3. Sluggish/Frenzied
A4. Dull/Jittery
A5. Sleepy/Wide-awake
A6. Aroused/Unaroused (reversed)

Dominance
D1. Controlled/controlling
D2. Influential/Influenced (reversed)
D3. In control/Cared for (reversed)
D4. Awed/Important
D5. Dominant/Submissive (reversed)
D6. Guided/Autonomous

Perceived Usefulness
PU1. Using the site improve my shopping performance.
PU2. Using the site can increase my shopping productivity.
PU3. Using the site can increase my shopping effectiveness.
PU4. I find the site is not very useful. (reversed)

Behavioral Intention
BI1. Given the chance, I'd like to return to the site in the future.
BI2. Given the chance, I'd like to make purchase on this site in the future.
BI3. I would like to explore more of the site.
BI4. I will recommend this site to my friends.

Overall Complexity
OC1. I found this web site was complicated.
OC2. I felt the web site was pretty simple. (reversed)

Flow
Flow. I will say I was in flow.

The word "flow" is used to describe a state of mind sometimes experienced by people who are deeply involved in some activity. Flow has been described as an intrinsically enjoyable experience.

APPENDIX G

DETAILED REPORT ON BEHAVIORAL CORRELATES

FOR STUDY 1-A

G.1 Definition of Behavioral Correlates

Table G.1 Definition of Behavioral Correlates

Correlates	**Symptoms**
Positive	
Clear goal	
P1-1	Browsing products in one category
P1-2	Use of search engine
Concentration	
P2	Systematic mouse movements
Mergence of activity and awareness	
P3-1	Going through product hierarchy from top to bottom consecutively (3 or more pages)
P3-2	Going through pages at same level consecutively (3 or more pages)
Negative	
Navigation problems	
N1-1	Trying alternative ways of reaching the product
N1-2	Going back and forth
N1-3	Nonsystematic mouse movements
Interruptions	
N2-1	Advertisements
N2-2	Task-related messages
Errors	
N3-1	Technical errors on the web page
N3-2	Logical flaws on the web page
N3-3	Mistakes made by visitors

G.2 Detailed Report on Behavioral Correlates

Table G.2 Positive Behavioral Correlates

sub-no	flow score	Flow level	# of seg.	Time	Site Assigned	P	P1	P1-1	P1-2	P2	P3-1	P3-2
1-202	17	Low	8	4:10	cdworld.com	2	0			2		
1-123	19	Low	20	4:20	amazon.com	3	1		1	2		
1-136	19	Low	11	4:47	cdworld.com	7	0			7		
1-127	19	Low	26	9:04	amazon.com	7	0			4	3	
1-102	20	Low	12	4:42	cdworld.com	5	1		1	3	1	
1-115	20	Low	11	4:51	amazon.com	3	0			3		
1-120	21	Low	24	5:07	cdworld.com	9	0			6	2	1
1-105	23	Low	14	4:58	amazon.com	4	1		2	3		
1-135	23	Low	18	4:57	amazon.com	7	1		3	6		
1-116	23	Low	30	5:01	cdworld.com	11	1	1		7	3	
1-199	40	High	6	4:04	amazon.com	6	1		1	5		
1-121	41	High	9	4:15	amazon.com	6	1		1	5		
1-165	41	High	17	5:08	amazon.com	9	1		1	6		1
1-189	41	High	17	4:59	amazon.com	6	1	1		4	1	
1-191	41	High	6	4:59	amazon.com	6	1	1		5		
1-147	41	High	14	5:00	amazon.com	10	0			8	1	1
1-185	42	High	9	4:54	amazon.com	7	1	1		6		
1-108	43	High	9	4:51	cdworld.com	4	1		1	3		
1-213	43	High	9	4:07	amazon.com	8	1		1	6		1
1-151	44	High	20	4:37	cdworld.com	9	1			7		1
2-149	64	Low	9	3:24	dillards.com	5	1	1		3	1	
2-143	77	Low	32	5:00	dillards.com	9	0			7	1	1
2-150	78	Low	16	5:01	buy.com	10	0			9		1
2-103	87	Low	18	5:02	cdworld.com	4	1		5	2		1
2-146	98	Low	19	5:00	dillards.com	7	1	1		4	1	1
2-139	173	High	9	2:01	dillards.com	6	1	1		3	1	1
2-152	173	High	5	4:50	buy.com	6	1	1		4	1	
2-128	173	High	26	5:06	macys.com	6	0			5	1	
2-137	188	High	32	4:47	macys.com	16	1	1		13	1	1
2-111	202	High	18	5:09	buy.com	9	0			7	1	1
3-104	65	Low	12	4:46	cdworld.com	3	1		3	2		
3-175	65	Low	18	4:59	cdworld.com	4	1		1	3		
3-109	75	Low	3	2:04	outpost.com	3	0			3		
3-124	88	Low	20	5:21	macys.com	5	0			3	1	1
3-139	98	Low	17	4:47	buy.com	5	0			4		1

3-177	177	High	29	4:46	dillards.com	15	1	1		11	1	2
3-162	178	High	7	4:45	cdworld.com	3	1		2	2		
3-144	183	High	26	4:12	macys.com	7	0			6		1
3-131	183	High	20	4:58	dillards.com	10	1	1		6	2	1
3-122	189	High	7	2:46	cduniverse.com	4	1		1	3		

Table G.2 Negative Behavioral Correlates

sub-no	flow score	Flow level	# of seg.	Time	Site Assigned	N	N1-1	N1-2	N1-3	N2-1	N2-2	N3-1	N3-2	N3-3
1-202	17	Low	8	4:10	cdworld.com	1				1				
1-123	19	Low	20	4:20	amazon.com	7	1	2		1			1	2
1-136	19	Low	11	4:47	cdworld.com	2			1				1	
1-127	19	Low	26	9:04	amazon.com	8		1	2		4			1
1-102	20	Low	12	4:42	cdworld.com	1								1
1-115	20	Low	11	4:51	amazon.com	5	1		2	2				
1-120	21	Low	24	5:07	cdworld.com	0								
1-105	23	Low	14	4:58	amazon.com	5		1			2		2	
1-135	23	Low	18	4:57	amazon.com	3				1	2			
1-116	23	Low	30	5:01	cdworld.com	0								
1-199	40	High	6	4:04	amazon.com	1				1				
1-121	41	High	9	4:15	amazon.com	0								
1-165	41	High	17	5:08	amazon.com	4			1	3				
1-189	41	High	17	4:59	amazon.com	0								
1-191	41	High	6	4:59	amazon.com	1				1				
1-147	41	High	14	5:00	amazon.com	1				1				
1-185	42	High	9	4:54	amazon.com	4					3		1	
1-108	43	High	9	4:51	cdworld.com	0								
1-213	43	High	9	4:07	amazon.com	0								
1-151	44	High	20	4:37	cdworld.com	2					1	1		
2-149	64	Low	9	3:24	dillards.com	0								
2-143	77	Low	32	5:00	dillards.com	0								
2-150	78	Low	16	5:01	buy.com	1				1				
2-103	87	Low	18	5:02	cdworld.com	7	1				2	1	3	
2-146	98	Low	19	5:00	dillards.com	4			1		3			
2-139	173	High	9	2:01	dillards.com	2				1	1			
2-152	173	High	5	4:50	buy.com	2					1		1	
2-128	173	High	26	5:06	macys.com	0								
2-137	188	High	32	4:47	macys.com	0								
2-111	202	High	18	5:09	buy.com	0								
3-104	65	Low	12	4:46	cdworld.com	8		1	1	2	2		1	1

3-175	65	Low	18	4:59	cdworld.com	0								
3-109	75	Low	3	2:04	outpost.com	1				1				
3-124	88	Low	20	5:21	macys.com	0								
3-139	98	Low	17	4:47	buy.com	2					2			
3-177	177	High	29	4:46	dillards.com	0								
3-162	178	High	7	4:45	cdworld.com	3			1				2	
3-144	183	High	26	4:12	macys.com	0								
3-131	183	High	20	4:58	dillards.com	2					2			
3-122	189	High	7	2:46	cduniverse.com	2					2			

APPENDIX H

A SAMPLE OF DOCUMENT OF INFORMED CONSENT

PLEASE SIGN IN INK

DOCUMENT OF INFORMED CONSENT

An Investigation of Role of Consumer Behavior in E-retailing

I, by signing this document, declare that I am voluntarily participating in a research study that will validate a proposed model of web site structure based on consumer behavior and which will be part of the study for investigator's dissertation. I understand that the result of this study will be confidential. Although the researcher will have my name on this consent form, there will be no way to associate my name with my performance on the online portion of the study or with my answers to the questionnaire. I understand that the entire study session will be videotaped and use of tapes will be restricted to the investigator and designate research personnel. I understand the confidentiality is maintained to the best of the investigator in secured storage. After three (3) years, the videotapes will be destroyed. I understand that I may withdraw from this study at any time. I understand that this study will not require me to incur any cost to participate. However, while the possibility of injury is extremely low, should an injury occur, the cost of medical attention will not be paid by the investigator or by Texas A&M University.

My participation in this study will enable me to earn extra extra credit points in one of the following classes (INFO 250, and INFO 422), at a level to be determined by the instructor of my class. However, should I not complete the research study in its entirety, these points may be reduced by not more than half. Should I not faithfully attend to the tasks as directed in the study, the investigator may elect to withdraw me from the study. If this occurs, I will receive no extra credit points. Beyond the attainment of extra credit, there are no benefits to me from the study.

I understand that I will be asked to work on a computer to make a purchase from a selected web site. Meanwhile, I will verbalize what I see, what I do, and what I think. After the completion of the purchasing task, I will be asked to answer a questionnaire regarding my expereince of the purchasing. I further understand that if any of the questions on the questionnaire make me uncomfortable in any way I may refuse to answer. This failure to answer may reduce me extra credit points by not more than half. This one session will be the extent of my participation in this study. If I choose not to participate in this study, I am eligible to participate in other projects to earn an equal amount of extra credit points at the discretion of the instructor of the courses.

I understand that this research study has been reviewed and approved by the Institutional Review Board – Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subject's rights, I can contact the Institutional Review Board through Dr. Michael W. Buckley, Director of Support Services, Office of Vice President for Research at (979) 458-4067, mwbuckley@tamu.edu.

I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study. I have been given a copy of this consent form.

_____ _____

Signature of Subject Date Signature of Investigator Or authorized representative Date

For further questions: Yi Guo, WCBA 325P (845-9218), mguo@cgsb.tamu.edu, Dr. Scott Poole, WCBA 325F, (845-9541), mspoole@tamu.edu.

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SELECTED PUBLICATIONS

Hall, D., Guo, Y., Davis, R. A., and Cegielski, C. "Extending Unbounded Systems Thinking with Agent-Oriented Modeling: Conceptualizing a Multiple Perspective Decision-Making Support System," *Decision Support Systems,* in press

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