Association for Information Systems
AIS Electronic Library (AISeL)

AMCIS 2008 Proceedings

Americas Conference on Information Systems (AMCIS)

2008

Workflow and Performance Under Computer Mediated Interruptions

K. Asli Basoglu
Washington State University, asli@udel.edu

Mark A. Fuller
Washington State University, mark@wsu.edu

Work Flow and Performance under Computer Mediated Interruptions

K. Asli Basoglu
Washington State University
kab@wsu.edu

Mark A. Fuller
Washington State University
mark@wsu.edu

ABSTRACT

Technologically enhanced computer mediated communication (CMC) environments create a trade-off between eliminating delays and increasing performance. In such environments, incoming interruptions can break the "flow" of work and deteriorate performance. In this regard, we describe a mechanism that explains why particular types of information are attended to, and how such interruptions interrupt work flow creating deterioration in performance. Specifically, this study investigates to specific facets of interruptions, the influence of task presentation format and interruption relevance on performance. Results showed significant performance differences related to different presentation format and interruption relevancy. Furthermore, flow had a significant effect on work performance. Future research should future propose more comprehensive taxonomies of both interruption in task characteristics, and examine the effects of such interruptions in systematic ways and in different contexts.

Keywords

Flow, interruptions, performance

INTRODUCTION

Technologically enhanced computer mediated communication (CMC) environments create a trade-off between eliminating delays and increasing performance. CMC tools such as electronic mail systems, instant messaging, chat tools, Internet-enabled phone systems, and PC-based video teleconferencing systems all provide an opportunity for creating connectivity and enhancing productivity in the workplace. Paradoxically, these tools also create the opportunity for interruptions, in the form of email notifications, task reminders, or incoming instant messages, all of which can break concentration and the flow of work resulting in impaired performance. Depending on the task and interruption characteristics, the impairment of the performance may vary.

Interruptions can vary on dimensions such as frequency, duration, complexity, timing, and content (Speier, Vessey, & Valacich, 1999). Interruptions have been shown to deteriorate performance (e.g., Kahneman, Laird, & Fruehling, 1983; Woodhead, 1965; Speier et al., 1999) by interfering with a person's cognitive processing, reducing a person's ability to sustain mental attention and effort (Baecker, Grudin, Buxton, & Greenberg, 1995), creating difficulties in rationing cognitive resources (Baron, 1986), breaking the flow of tasks (Bederson, 2004) and impairing task processing (March, 1994). These effects reduce task accuracy (Cellier & Eyrolle, 1992; Schuh, 1978) and increase the time required for task completion (Schiffman & Griest-Bousquet, 1992). As a result, interruptions can increase user frustration, and diminish feelings of control, and in general leave the user with a reduced sense of "flow" (Bederson, 2004).

MOTIVATION

Past research has addressed issues related to information technologies that have made use of the flow construct as defined by Csikszentmihalyi (1975, 1990). Flow has been defined as the psychological state in which an individual feels cognitively efficient, motivated, and happy (Moneta & Csikszentmihalyi, 1996, p. 277). When in the flow state, people become absorbed in their activities, while irrelevant thoughts and perceptions are screened out. If flow were absent in humans' experience "there would be little purpose in living" (Csikszentmihalyi, 1990). A number of early studies examined the concept of flow in technological environments. Ghani and Deshpande (1994) studied the structure of flow experiences in information technology use. Chen, Wigand, and Nihal (1999, 2000) analyzed the factors and conditions associated with flow activities in using the Web. Koufaris (2002) compared several models including the flow model to help us understand online consumer behavior. Finally, Novak and Hoffman (2002) developed a theoretical model of flow within the hypermedia environment of the Web. Finally, recent work by Finneran and Zhang (2005) examined the promises and important challenges of studying flow, a psychological state, in the computer-mediated environments (CME).

The current research builds on this past research by examining flow in computer mediated environments, incorporating the concept of technology mediated interruptions. Our goal is to provide a conceptual model of interruptions integrating the concept of flow, which we believe will be useful in explaining task performance in such environments. Specifically, we investigate the influence of task presentation format and interruption relevance on flow related constructs, and then examine the downstream effects of these constructs on performance. This study contributes to the literature be providing a theoretical explanation for how interruptions can influence performance. Further, this study has practical implications related to helping knowledge workers manage their work environments more effectively.

THEORY DEVELOPMENT AND HYPOTHESES

In this section, we define interruptions. Based on existing literature, we then introduce our research model and, hypothesize how task presentation and interruption relevancy impact performance.

Interruptions

Interruptions are defined as uncontrollable, unpredictable stressors that produce information overload, requiring additional decision-maker effort (Cohen, 1980), and which typically results in the recipient discontinuing his or her current activity (O'Conaill & Frohlich, 1995). While interruptions may not be critical to completing the task at hand, they typically require "immediate attention" and are activities that "insist on action" (Covey, 1990). While somewhat similar conceptually, distractions (a term sometimes used interchangeably with the concept of interruptions in day-to-day life) refer to stimuli that do not require "immediate attention", such as various forms of background noise.

Theoretical Basis

We use two theories from the psychology literature to explain why certain information is attended to, and how that information can affect task performance.

Kerckhoff and Davis (1962) proposed filter theory to illustrate how individuals attend to incoming information based on "filtering factors". They concluded that there are early stage social status variables, consensus stage variables, and later stage complimentarily variables that influence what a person pays attention to while selecting a mate. Filter theory can be adapted to help explain how the source and types of interruption "cues" may influence task performance.

Building upon Filter theory, Murstein (1970) proposes a three stage model that explains the selection of potential social partners, in essence a model that describes why particular people are attended to more than others. We apply this model to help explain individual reactions to particular type of interruptions. In the *stimulus stage*, we evaluate the interruption in terms of its initial physical attributes (appearance) such as importance flags, interruption form, interruption source, etc. The second stage of Murstein's model is the *value stage*, where attention is drawn beyond the physical form of the interruptions "package", but is now focused on the content of the interruption. In this stage, factors like the complexity of the message, the amount of time needed to respond, the urgency of the required response, and the recipient's familiarity with the topic, are all brought into play. In the final *role stage*, we decide on our role if we are to attend the interruption. Only if an interruption successfully passes each of these filter stages does the person switch (attend) to the interruption task.

Another theory relevant to interruption research—specifically on the why interruptions may impair performance—was proposed by Csikszentmihalyi (1975) and termed *flow*. Csikszentmihalyi (1991) argues that all activities have a flow channel (defined as the balance between one's skills and challenge level to sustain control over an activity) which allows "optimal experience" in a task. By challenging the person at his/her skill level to process more information than one actually can, and making the person lose control over the work, interruptions may break the flow and impair performance. The features Csikszentmihalyi (1996) presents for the state of flow experience are as follows:

1. Clear goals.
2. Immediate feedback.
3. Balance between challenge and skill.
4. Action and awareness merge.
5. Distractions are excluded from consciousness.
6. There is no worry of failure.
7. Self-consciousness disappears.
8. The sense of time becomes distorted.
9. The activity becomes rewarding in itself.

Over the years, the flow construct has also been used in technology mediated environments, and a variety of additional features that contribute to flow have been identified. For example, Hoffman and Novak (1996) also included telepresence and interactivity, Chan (2000) and Ghani (1995) added perceived control, Ghani (1995) and Skadberg and Kimmel (2004) included enjoyment.

Conceptual Model

Different types of interruptions are coped with in different ways. Common to all interruptions is the idea that they force the individual to switch tasks for certain amount of time. The amount of time spent at the interruption, however, varies. While some interruptions are attended to for only short period of time (such as scanning your incoming email to identify the sender), other interruptions may force the individual to resolve a more complex task right away (diverting attention away from the initial task).

As discussed above, Filter Theory can provide an explanation for why particular interruptions are attended to more than others. The following provide an example of the sort of factors that would be in play related to incoming e-mail. The first *stimulus* filter is focused on the sender, the aesthetics, and the attraction of the incoming interruption. As an example, if an e-mail is from one's boss, that might be sufficient to help this particular interruption to pass through the stimulus filter. If the interruption successfully draws the individual attention, the next filter the interruption must pass through is the *value* filter. The value filter is essentially a content check, where the importance or urgency of the interruption is assessed. Continuing our example, an email from one's boss might be about preparing a presentation for an unanticipated meeting that is to occur one hour from now, or it might be about making some plans to play golf next week. The urgency associated with the former content may cause this interruption to pass through the value filter. The final filter is the *role* filter, which determines the role the recipient has in the interruption task. Continuing our example is the recipient expected to prepare the presentation, or simply attend the meeting. The answer to that question will drive the individual's response to interruption.

Based on this discussion, we propose the following conceptual model in Figure 1. Interruptions (and their relevant characteristics) can effect task characteristics (e.g. complexity, time pressure, importance, etc.) and task performance. Fragmented cognitive processing resulting from new task and cognifitive requirements can cause breaks in flow, impacting performance.

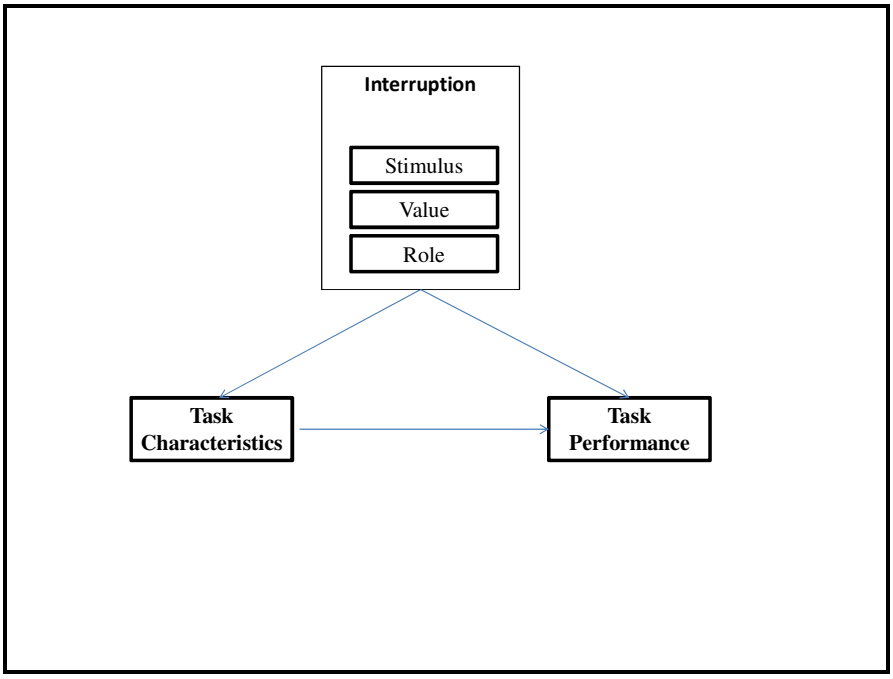

Figure 1: Conceptual Model

The research model (Figure 2) below illustrates the specific factors explored in this research. Specifically, this research examines how information presentation and interruption relevancy influence three unique aspects of flow, entitled *interruption effect, challenge,* and *control*.

We argue that information presentation and interruption relevancy play an important role in maintaining primary task flow (optimal experience), which is argued to be main determinant of the performance. Each of these concepts is discussed next.

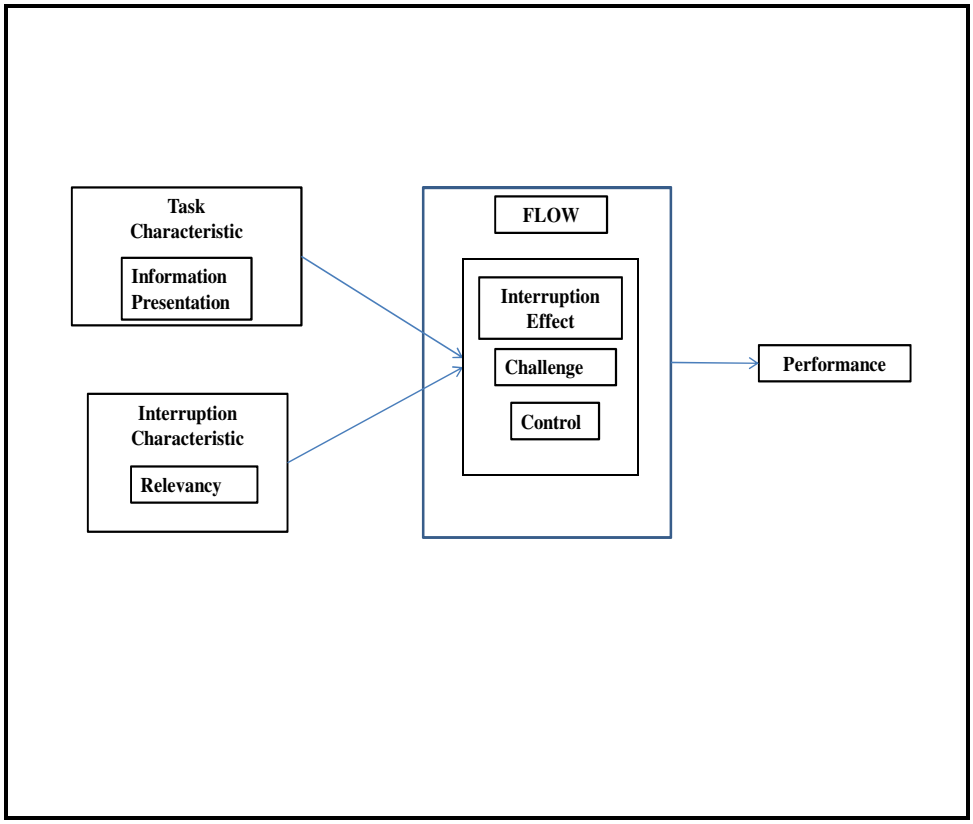

Figure 2: Research Model

Task Information Presentation Format

Information format is defined as the presentation and organization of information about the available alternatives and their attributes (Cooper-Martin, 1993). In this study we analyzed the two commonly observed types of information presentation used over the Internet; matrix and list. Matrix format is composed of several rows and columns where each cell contains one particular information set. On the other hand, with the list format which is composed of several lines, each line represents a particular information set. In the matrix format, the individual can not only visualize and see a representational graphic, but with this type of information presentation, the individual can see more different information sets (e.g. products, items etc.) on a layout. Even though the list presentation provides more detailed descriptive information, it does not include visualization or graphics. Painton and Gentry (1985) argued that visual presentation may result in elimination of some alternatives as well as cue for some several attributes. Furthermore, with a matrix representation, individual is likely to use less cognitive capacity and spend less effort compared to a list representation in order to locate an information set. By not overwhelming the cognitive capacity, cognitive load is reduced and attention is less narrowed (Kahneman, 1973) compared list representation.

Interruption Relevance

Relevant interruptions are defined as those that are related to individual's current task or that is in the work agenda. They assist in completion of the primary task, such as by contributing direct answers or providing necessary or helpful information which furthers the progress in the primary task completion. Whereas irrelevant interruptions are those that

are not in one's work agenda and they do not actually contribute to completing the primary task. Yet other interruptions are both irrelevant and unrelated in that they neither contribute towards the primary task completionnor are connected in content to the primary task (SuwatanaPongched, 2003).
We argue that relevant interruptions may impair performance more than irrelevant/unrelated. We argue that when the interruption is relevant, then the individual may lose some of the primary task information (cues) from the short term memory or even replace the lost information with information from interruption task. In other words, the individual may lose control over the task which will break the flow.

Flow

Csikszentmihalyi (1975) argued that when in the flow state, people become absorbed in their activity, and the focus of awareness is narrowed down to the activity itself. The concentration is so intense that there is no attention left over. Irrelevant perceptions and thoughts are screened out and worries about problems disappear (Csikszentmihalyi, 1990).

Later research has introduced the concept of control, which has been added as one of the main antecedents of flow (Ghani, 1995; Chan, 2000). Control is defined as one's capacity/ability to dominate the task. Control is critical to attaining a flow state because it provides a sense of confidence and eliminates loss of self, timelessness, etc. It is important because flow can only occur in a situation in which people do not feel anxiety or depression (Chen et al., 1999).

Another factor related to flow is challenge. A person is said to be challenged when their capabilities, skills, and experiences are not enough to cope with the current situation. If the challenges of an activity are higher or lower than the individual's skill level, than flow cannot be achieved. Situations in which challenges and skills are perceived to be equivalent are thought to facilitate the emergence of flow (Chan et. al., 1999).

For this study, we specifically consider the balance between challenge and skill as well as control as antecedents of flow. In the presence of an interruption, the person is likely to lose control and be challenged to a degree. The main reason for this is that, interruptions require "instant attention" without prior notice and requires cognitive capacity to process new incoming information. As we argued above, the lack of either of the two will take the person out of their optimal experience area and create anxiety, stress, demotivation etc. which will narrow their focus (Kahneman, 1973) and impair performance.

Given the nature of interruptions, and our belief that such interruptions may impair flow, we also introduce the concept of "interruption effect". We define interruption effect as the degree to which interruptions influence one's short term memory. Interruptions are more likely to cause the information from primary task to exit the short term memory after completion of interruption task. We argue that the loss in primary task cues breaks the flow and impairs performance.

Therefore, when a person is exposed to interruptions, in addition to control and challenge, interruption effect plays an important role in influencing flow.

Based on the above, we propose the following hypotheses:

H1: The flow constructs (interruption effect, challenge, and control) will negatively affect the performance.

H2: The performance under task presentation in matrix format will get less impaired compared list presentation format when the interruption is relevant.

H3: The performance under task presentation in matrix format will get less impaired compared list presentation format when the interruption is irrelevant/unrelated.

For the next hypotheses, we hypothesize that even though relevant interruptions may be more harmful than irrelevant/unrelated, the matrix presentation will be offsetting this effect.

H4: When the interruption is relevant and task presentation in matrix format, performance will get less impaired compared when the interruption irrelevant/unrelated with a list task presentation format.

METHODOLOGY

Design

A between subject, 2x2 factorial design was used to conduct a (pilot) lab experiment. In the experiment, the information presentation format (matrix-list) and interruption relevancy (relevant-irrelevant/unrelated) will be manipulated.

Subjects

Our pilot study sample consisted of 87 undergraduate students taking an introductory course in management information systems at a large northwestern university. Subjects were given extra credit for participating in the study. 45% of the participants were female, and 55% was male. Average age of the participants was 20. A reward of $5 was promised to the top 1% performers. The top performers are sorted with respect to score obtained from the experiment.

Treatment Conditions

During the experiment, the participants were randomly assigned to one of the four treatment conditions. In order to create interest and engagement, students were given a primary task where they were asked to find the prices of the party item prices given to them. Finding one item price required them to first type the search words (given), then select the category (given), and find the appropriate item that fitted the description given to them. In this regard, when they were searching for the item, they were assigned to either list or the matrix presentation condition.

While the participants were completing their tasks, they received relevant or irrelevant/unrelated interruptions. Relevant interruptions required the participants either to make changes on their primary task document and their search items or asked them add/subtract/change items and find the prices. On the other hand, irrelevant interruptions were more like instant messages where participants could respond back. Interruptions in this condition were questions about their plans for spring break, location of their class etc.
Participants first completed a presurvey, and a postsurvey after finishing their task.

Factors Investigated

The dependent variable was the score they obtained, which is the number of correctly identified item prices.
Presurvey questionnaire collected information about demographics, as well as participant personality, web challenge, and cognitive spontaneity.
The postsurvey questionnaire collected information regarding perceived control (Ghani, 1995), interruption effect, and challenge (Pearce et al., 2004).
Manipulation checks regarding interruption relevancy and presentation format were successful. We also included a random question to check attention; as a result one participant was eliminated.

Control Variables

We have controlled for gender as well as computer skills.

FINDINGS

We conducted some preliminary analysis given that data collection was conducted as of February 27, 2008.

We first validated the scales used. A Confirmatory Factor Analysis was conducted using MPlus 5. The results indicate that the three perceived control scale items loaded between 0.8 to 0.91 with a Cronbach's alpha of 0.94, and the challenge scale items loaded above 0.85 with a Cronbach's alpha of 0.881. The interruption effect items loaded with 0.87 to 0.94 with a Cronbach's alpha of 0.844. Overall, CFI=0.945, and SRMR=0.042, and RMSEA=0.063.
Furthermore, flow constructs explained 74.5 % of the variance, where each variable had significant effect on score; control ($F=4.68$, $p=0.01$), challenge ($F=5.1$, $p<0.001$), and interruption effect ($F=8.5$, $p<0.001$).

We conducted preliminary analysis with the data. We conducted multiple comparisons via Tukey HSD. The results indicate that under the same information presentation format, when the relevancy of interruption changed, the impact on score significant ($p<0.001$). However, keeping the interruption relevancy same across two conditions, the information presentation format had no significant effect on the score. As hypothesized, when the subjects were exposed to irrelevant interruptions with matrix presentation format, they significantly had higher scores compared to participants exposed to relevant interruptions with list presentation format ($MD=5.68$, $p<0.001$). Furthermore, participants working with list presentation exposed to irrelevant interruptions had significantly higher scores than those working with matrix presentation exposed to relevant interruptions ($MD=3.12$, $p=0.036$).

CONCLUSION

In this paper, we have attempted to analyze the effects of interruptions on performance using flow as a primary factor influencing performance. Our results showed that interruption relevancy had a significant effect on performance as well as on flow. However, information presentation format (specifically having a matrix representation of the data) diminished the negative effect of interruptions on performance. In addition to analyzing the impacts of interruptions, we also attempted to understand how individuals evaluate interruptions and decide which to attend to. In this regard, we have adapted the Stimulus-Value-Role (SVR) Model to our IS-interruptions context. We argued that computer mediated interruptions also go through a similar kind of filtering (selection) process which helps the decision maker to decide on a strategy to cope with it.

FUTURE RESEARCH

There is lack of systematic research regarding the the effects of interruptions on work productivity, research applicable to a wide variety of information technology contexts such as e-commerce, computer mediated and supported decision making etc. Future research should propose more comprehensive taxonomies of both interruptions as well as task characteristics, and examine the effects of such interruptions in systematic ways.

REFERENCES

Csikszentmihalyi, M., (1996) *Creativity, Flow and the Psychology of Discovery and Invention*. HarperCollins, New York.

Cooper-Martin. (1993) E. Effects of information format and similarity among alternatives on consumer choice processes, *Journal of the Academy of Marketing Science, 21,* 3, 239–246.

SuwatanaPongched, P., A more complex model of relevancy in interruptions, available at http:// www.spong.org/~pechluck/HCI/content-of-interruptions.pdf (verified 6/24/04).

Baecker, R.M., Grudin, J., Buxton, W.A., and Greenberg, S. (1995) *Readings in human-computer interaction: Toward the year 2000.* San Francisco: Morgan Kauffman.

Cellier, J., & Eyrolle, H. (1992). Interference between switched tasks, *Ergonomics*, 35, 1, 25-36.

Chen, H. (2000) Exploring Web Users' On-line Optimal Flow Experiences, *Unpublished PhD Dissertation*, School of Information Studies, Syracuse, NY: Syracuse University.

Chen, H., R. Wigand, and M.S. Nilan (1999) Optimal Experience of Web Activities, *Computers in Human Behavior,* 15 5, 585-608.

Czerwinski, M., Cutrell, E., & Horvitz, E. (2000) Instant messaging: Effects of relevance and time. In S. Turner & P. Turner (Eds.), People and computers XIV: Proceedings of HCI 2000, 2, British Computer Society, 71-76.

Csikszentmihalyi, M. (1988). The Flow Experience and Human Psychology, in Csikszentmihalyi, M. and Csikszentmihalyi, I.S. (Eds.), *Optimal Experience: Psychological Studies of Flow in Consciousness,* New York: Cambridge University Press, 15-35.

Csikszentmihalyi, M. (1990) *Flow: The Psychology of Optimal Experience*, New York: Harpers Perennial.

Csikszentmihalyi, M. and Csikszentmihalyi, I.S. (Eds.) (1988) *Optimal Experience: Psychological Studies of Flow in Consciousness*. New York: Cambridge University Press.

Finneran, C. and Zhang, P. (2005) Flow in computer mediated environments: Promises and challenges, CACM, 15, 82-101.

Ghani, J. (1995) Flow in Human Computer Interactions: Test of a Model, in Carey, J. (Ed.), *Human Factors in Information Systems: Emerging Theoretical Bases,* New Jersey: Ablex Publishing Corp, 291-311.

Hoffman, D.L. and Novak, T.P. (1996) Marketing in Hypermedia Computer-Mediated Environments: Conceptual Foundations, *Journal of Marketing,* 60, 50-68.

Huang, M.H. (2003) Designing Website Attributes To Induce Experiential Encounters, *Computers in Human Behavior, 19,* 4, pp 425-442.

Kahneman, D. (1973) *Attention and effort.* Englewood Cliffs, NJ: Prentice Hall.

Kerckhoff, A. C. and Davis, K. E. (1962) Value consensus and need complementarity in mate selection, *American Sociological Review*, 27, 295-303.

Koufaris, M. (2002) Applying the Technology Acceptance Model and Flow Theory to Online Consumer Behavior, *Information Systems Research, 13,* 2, 205-223.

Laird, D.A., Laird, E.C., & Fruehling, R.T. (1983) *Psychology and human relations and work adjustment*. New York: McGraw Hill.

Milford, J.T., and Perry, R.P. (1977). A methodological study of overload, *Journal of General Psychology*, 97, 131-137.

Moneta, G.B. and Csikszentmihalyi, M. (1996) The effect of perceived challenges and skills on the quality of subjective experience, *Journal of Personality* 64, 2, 275–310.

Murstein, B.I. (1970) Stimulus-value-role: A theory of marital choice, *Journal of Marriage and the Family* 32, 465-81.

Schiffman, N., & Griest-Bousquet, S. (1992) Optimal shopping performance under graphic and numeric CRT formatting, *Human Factors*, 27, 4, 433-444.

Skadberg, Y.X. and J.R. Kimmel (2004) Visitors' Flow Experience while Browsing a Web Site: Its Measurement, Contributing Factors and Consequences, *Computers in Human Behavior,* 20, 403-422.

Speier, S., Valacich, J.S, & Vessey, I. (1999) Information overload through interruptions: An empirical examination of decision making, *Decision Sciences* 30, 2, 337-360.

Speier, S., Vessey, I., & Valacich, J.S. (2003) The effects of interruptions, task complexity, and information presentation on computer-supported decision-making performance," *Decision Sciences*, 34, 4, 771-797.