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# End-user adoption of animated interface agents in everyday work applications

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Recognizing the potential contribution that interactive software agents bring to everyday work applications, this paper reports on end-user adoption of animated interface agents in one particular work application environment: Microsoft® Office. The paper develops and empirically tests a theoretical model of the factors affecting an end-user's choice to adopt and utilize such interface agents. From this theoretical model, a survey instrument was adapted and administered to 261 participants, familiar with animated interface agents. Results from a partial least squares (PLS) analysis indicates that a variety of factors are at play, which inhibit or foster a person's choice to utilize and adopt animated interface agents. Of significance is that: (a) both perceived usefulness and perceived enjoyment are important influencing factors; (b) users with high scores in innovativeness toward information technology are less likely to find animated interface agents enjoyable; (c) individuals with high animation predisposition scores perceive animated interface agents to be more enjoyable; and (d) users who perceive animated interface agents to be more enjoyable also perceive them to be more useful. Such insights can be used to leverage the introduction and rollout of animated interface agents in everyday work applications in ways that promote their avid adoption and use.

*Keywords*: Interface agents; End user adoption; Computer interfaces; PLS

## 1. Introduction

The purpose of this paper is to conduct an empirical study of end-user adoption of animated interface agents incorporated into everyday work applications. The goal is to understand how individuals perceive, utilize, and adapt this technology and to utilize this knowledge to promote end-user acceptance of interface agents embedded in modern computer applications.

Interface agents are a specific type of intelligent agents. These are long-lived software programs that act autonomously, monitor and react to the environment and communicate and collaborate with other agents and users (Detlor 2004). Hess, Rees and Rakes (2000) describe autonomous software agents as persisting long enough to carry out homeostatic goals and reacting sufficiently within their domains to allow such goals to be met. To be considered an 'interface agent', an agent needs to directly communicate with a person through the input and output of the user interface (Lieberman 2001, Lieberman and Selker 2003). An interface agent is in charge of interacting with the user. It accepts user requests, directs them to computer devices or other agents, monitors task execution, and reports back to the person initiating the request. The agent may add graphics or animation to the interface, use speech input and output, or communicate via other sensory devices.

Past research heralds the potential contributions of interface agents to various computer systems that bring significant benefits to end-users. For example, interface agents may be employed in the form of personal application assistants, secretaries, butlers (Maes and Kozierok 1993, Lashkari *et al*. 1994, Maes 1994), Web guides (Keeble and Macredie 2000), shopping companions (McBreen and Jack 2001), virtual tutors in interactive learning environments (Lester *et al*. 1997, Johnson *et al*. 2000, Person *et al*.

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2000), storytellers (Cavazza *et al.* 2002), presenters, virtual actors (Hornby and Pollack 2001, Miranda *et al.* 2001), entertainers, and even home appliances aids (Müller *et al.* 2001).

Furthermore, interface agents may be effectively and efficiently utilized in end-user email applications and decision support systems (DSS). With email clients, interface agents may help users accomplish tasks carried out within an email application such as sorting messages, filtering information, finding addresses, scheduling meetings, and announcing reminders (Maes and Kozierok 1993, Maes 1994). In DSS, interface agents may provide an additional level of support between the user and the DSS, where tasks become more automated, requiring less action on the part of the user. As such, users are alleviated from concentrating on computing minutiae and are allowed to concentrate more on the managerial aspects of decisions (Hess *et al.* 2000). This complexity reduction can occur behind the scenes in terms of integrating heterogeneous applications and networks or upfront in terms of user interfaces (Bradshaw 1997).

Currently, interface agents are embedded in all Microsoft® (MS) Office applications starting with Office 97 (Windows) and Office 98 (Macintosh). In essence, MS Office interface agents act as personal digital assistants (PDAs), which interact with users directly, receive and process their requests, and collaborate with other parts of the system. They take the form of animated, graphic characters such as a paper clip or a wizard with anthropomorphic characteristics. MS Office agents offer tips and real-time advice (for example, shortcut keys) when they believe users may find this information useful and applicable. By functioning in this way, MS Office agents offer the potential to reduce workload and complexity, increase end-user efficiency, and make the process of utilizing an application more pleasant and enjoyable.

Despite these proposed benefits, there is no clear empirical evidence of the factors that influence a user's decision to adopt animated interface agents (Dehn and van Mulken 2000). First, most previous projects that study agent adoption lack a thorough methodological background. For example, they utilize non-validated measurement instruments or they perform empirical testing on sample sizes too small to yield statistically significant results. Second, most prior investigations are conducted in laboratory settings, which do not properly emulate real-life conditions that may potentially impact a user's decision to adopt interface agent technology. Third, few theories, frameworks, constructs, or research instruments exist that specifically tackle end-user interface agent adoption. The contemporary literature does not discuss the reasons why some individuals enjoy utilizing agents embedded in computer applications whereas others prefer to use more traditional input–output interfaces.

This paper aims to address this void by analyzing user adoption of animated interface agents in MS Office applications. This software environment was chosen for two reasons. First, there is an abundance of real-life users of this technology who may potentially offer valuable insights on their actual experience with animated interface agents. This may complement the findings of prior interface agent usage investigations conducted in laboratory settings. Second, considering the mandatory use of this technology in MS Office, it is important to understand this issue from an end-user perspective. Given this, it would be preferable to learn how best to leverage this type of technology in ways that users prefer and expect as a means of increasing the utility of this particular software application.

In terms of structure, the remainder of this paper is organized as follows. The second section (which follows) provides background on the conceptual constructs used in the paper's theoretical model. These are derived from several research areas such as technology acceptance, innovation research, and interface agent studies, which aim to explain user technology adoption behaviour. The third section presents the model in its entirety along with a series of hypotheses to be tested. The fourth section discusses the paper's methodology. The fifth section outlines the study's data analysis procedures and results. The final section offers a discussion of the findings and implications on the development and rollout of animated interface agents in everyday work applications.

## 2. Conceptual background

Though many models have been proposed over the years, the Technology Acceptance Model (TAM) is one of the most frequently utilized end-user technology adoption frameworks in the MIS literature. Its viability has been successfully tested in various technology acceptance studies across different areas (Adams *et al.* 1992, Hendrickson *et al.* 1993, Subramanian 1994, Szajna 1994, Taylor and Todd 1995a, Taylor and Todd 1995b, Szajna 1996, Gefen and Straub 2000, Bhattacherjee 2001, Moon and Kim 2001, Koufaris 2002, Serenko and Detlor 2003). As such, TAM is used as a basis for the structure of this study's theoretical model. The major advantage and distinction of utilizing TAM is twofold. First, as demonstrated by a substantial body of prior research, TAM may be successfully applied to investigations concerning user adoption behaviour in virtually any computer-related field. Secondly, it provides the basis for building technology acceptance frameworks in very narrow areas. TAM can be extended by incorporating novel domain-specific constructs and antecedents to accommodate a variety of factors that affect people's acceptance decisions with respect to newer technologies such as animated interface agents.

TAM identifies and measures key factors that influence an individual's decision to accept or reject particular information or computer technologies. According to TAM, someone's *behavioural usage intentions* are influenced by two key beliefs: perceived usefulness and perceived ease-of-use. *Perceived usefulness* is defined as 'the degree to which a person believes that using a particular system would enhance his or her job performance' (Davis 1989, p. 320). Across the many empirical tests of TAM conducted over the years, perceived usefulness has consistently been shown to be a strong determinant of usage intentions (standardized regression coefficients are typically around 0.6) and hence is selected for inclusion in this study's model.

Perceived ease-of-use, 'the degree to which a person believes that using a particular system would be free of physical and mental effort' (Davis 1989, p. 320) has exhibited a less consistent effect on user intention over past studies. In lieu of perceived ease-of-use, for reasons described below, this study proposes to utilize the construct of *perceived enjoyment*, which refers to 'the extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated' (Davis *et al.* 1992, p. 1113). Due to the nature of animated interface agents, which are often designed to increase user enjoyment with the human-computer interaction (HCI) process, this construct may be more appropriate. In addition, the usage of animated interface agents in MS Office is relatively simple; there is only one personalization interface where individuals may select an agent as well as categories of assistance. It is sufficient to double-click the agent to ask a question that makes MS Office interface agents very easy to use. Therefore, perceived ease-of-use was replaced by another, potentially, more relevant construct in this study's model.

The perceived enjoyment construct originates from the computer game field where perceived user (or player) enjoyment is a key factor by which to judge the quality and appeal of a particular software game (Malone 1982). Several studies empirically prove that perceived enjoyment explains significant variance in usage intentions in different computer-related fields (Igbaria *et al.* 1994, Igbaria 1996, Bourdeau *et al.* 2002, Choi *et al.* 2003). Many subsequent investigations include the construct of perceived enjoyment in TAM and recognize that people adopt computer technologies because of their entertaining potential. For example, Igbaria (1996) integrates the theoretical perspectives and empirical findings of previous research on the adoption, acceptance, and use of computers. His experiment presents and tests a framework of computer usage that includes perceived complexity of a system as an antecedent and comprises three motivational factors: perceived usefulness, perceived enjoyment, and social pressure. Venkatesh (2000) goes beyond the traditional construct of perceived ease-of-use in TAM by identifying a number of antecedents that may potentially affect this construct. Perceived enjoyment has been justified and empirically validated as being one of the variables that shape users perceptions of a system over time.

In addition, previous agent investigations find user enjoyment with interface agents as one of the key arguments in favor of agent technology adoption. It is based on an intuitive and appealing assumption that interface agents, especially animated ones, invoke positive mental emotions in their users (Maes 1995, Dehn and van Mulken 2000). When interface agents interact with users, an interface agent sometimes plays the role of a performer carrying out actions that people may find enjoyable under appropriate circumstances (Rist *et al.* 1997). The positive influence of such actions on the HCI process has been verified by preceding studies (Takeuchi and Naito 1995, Koda and Maes 1996, Suzuki *et al.* 1998). Thus, it is believed that perceived enjoyment may potentially influence user adoption behaviour towards interface agents and is incorporated in this study's theoretical model.

Regarding the two cognitive constructs of perceived usefulness and perceived enjoyment mentioned above, which are expected to influence behavioural intentions towards the use of interface agents, certain individual characteristics of users are suspected to impact the extent to which a person shapes such perceptions. These are computer playfulness, personal innovativeness towards information technology, and animation predisposition. These constructs are incorporated into this study's model. Though these constructs do not appear in the original version of TAM, many MIS researchers have modified and adjusted TAM over the years for their own specific studies. For example, the latest meta-analysis of the key projects that tests the viability of TAM suggests that significant factors are not included in TAM (Legris *et al.* 2003). Therefore, other frameworks, theories, and models should be investigated.

*Computer playfulness* is a situation-specific individual characteristic that represents a type of intellectual or cognitive playfulness. It describes an individual's tendency to interact spontaneously, intensively, and imaginatively with computers. As such, 'a high level of cognitive spontaneity indicates a high degree of computer playfulness and a low level of cognitive spontaneity indicates a low degree of computer playfulness' (Webster and Martocchio 1992, p. 202). Playfulness is an appropriate construct in the study of HCI because of the symbolic and abstract nature of computer systems. Computers strongly influence and encourage user playfulness, since they are relatively easy to use, provide quick instant responses, offer personalization features (Starbuck and Webster 1991), and incorporate playful items such as multimedia, graphics and animation (Yager *et al.* 1997).

The computer playfulness construct has been subjected to extensive empirical testing in various settings (Bozionelos and Bozionelos 1999, Agarwal and Karahanna 2000, Potosky 2002). Several investigations prove the effectiveness and fruitfulness of extending the computer playfulness construct and incorporating it into end-user acceptance models (Atkinson and Kydd 1997, Anandarajan *et al.* 2000, Moon and Kim 2001). Venkatesh (2000) pioneers the incorporation of computer playfulness into TAM. It has been confirmed that computer playfulness is an application-independent and intrinsic-motivation antecedent for system adoption and use. For instance, Lee *et al.* (2002) employ computer playfulness as an antecedent of TAM to investigate usage and acceptance behaviours with respect to mobile Internet services.

A user's orientation towards *personal innovativeness in information technology* (PIIT) may also impact a user's decision to adopt interface agents or not. PIIT is the domain-specific individual trait that reflects the willingness of a person to try out a new information technology innovation. It has been shown that individual characteristics play an important role in people's decisions to accept or reject innovations (Rogers 1962, Tornatzky *et al.* 1990, Rogers 1995, Roehrich 2002). Some users may be highly predisposed towards adopting innovations whereas others may prefer to continue exploring familiar avenues. The substantial body of prior research in the area of personal innovativeness highlights the importance of this concept (Hurt *et al.* 1977, Midgley and Dowling 1978, Hirschman 1980, Midgley and Dowling 1993). It has been shown that interface agents represent a particular type of innovation and that most existing innovation models, frameworks, concepts, and techniques may be successfully applied to agent adoption (Serenko and Detlor 2004).

Agarwal and Prasad (1998, p. 206) conceptualize PIIT as 'a trait, i.e. a relatively stable descriptor of individuals that is invariant across situational considerations'. Their research study provides evidence that PIIT serves as a key moderator for both antecedents and consequences of usage perceptions. Despite its newness, the concept of personal innovativeness in information technology has received considerable attention, recognition, and support in academia. For example, Karahanna *et al.* (2002) conclude that personal innovativeness is one of the factors that influences a person's perceived relative advantage of using group support systems. Limayem *et al.* (2000) provide strong support for the positive effect of personal innovativeness on someone's attitudes and intentions to shop online. This prior research manifests the appropriateness of incorporating PIIT in TAM to investigate the user adoption of animated interface agents.

*Animation predisposition* is an individual-specific trait that reflects a person's tendency towards watching animated films (Serenko 2004). Similar to computer playfulness and PIIT, the degree of animation predisposition is conceptualized as a trait. The measurements of this construct provided by the same individual are stable over time, and they are not influenced by situational factors; for example, by a software application the person is currently utilizing. As suggested by Nunnally (1978), a trait is a measurable dimension of behaviour and it may be assessed by the employment of self-report psychometric scales.

The incorporation of the animation predisposition construct in this study is relevant for two reasons. First, agents included in MS Office are realized in the form of virtual characters that closely resemble characters of animated films. For example, the *Genie* agent, developed by Microsoft, resembles the well-known animated character from the animated movie *Aladdin*. Secondly, anthropomorphism, which refers to the ascription of human-like features to non-human objects, is evident in both animation films and interface agents (Marakas *et al.* 2000). For instance, all interface agents embedded in MS Office exhibit many anthropomorphized features and functions. They express human emotions, such as smiling and eye blinking, or act as if they are virtual living beings. The motivation for this is that software anthropomorphization may add extra entertainment value, evoke positive emotions, and enhance the overall end-user experience (Nass *et al.* 1993, Burgoon *et al.* 2000). Therefore, computer users working with an animated agent may perceive themselves watching a short animated clip on the computer screen. They may also form a mental model where they relate the animated MS Agent to their favorite animated characters and transfer their attitudes and feelings towards those characters to the software agent.

## 3. The research model and hypotheses

The constructs discussed in the preceding section were combined into a single conceptual model depicting end-user adoption of animated interface agents in everyday work applications (see figure 1).

The purpose of the model is to measure individual behavioural intentions towards utilizing animated interface agents in everyday work applications. Consistent with many recent technology adoption studies (Venkatesh 1999, Venkatesh 2000, Agarwal and Karahanna 2000, Bhattacherjee 2001, Koufaris 2002), the proposed model omits two dependent variables: attitudes towards using the system and actual system use. All previous investigations have identified strong positive relationships between behavioural intentions towards use and actual system usage. Therefore, measuring only one variable of an individual's behavioural intentions towards using interface agents should satisfy the purpose of the model. The measurement of attitude towards using the agent is omitted because this construct contributes little to the purpose of

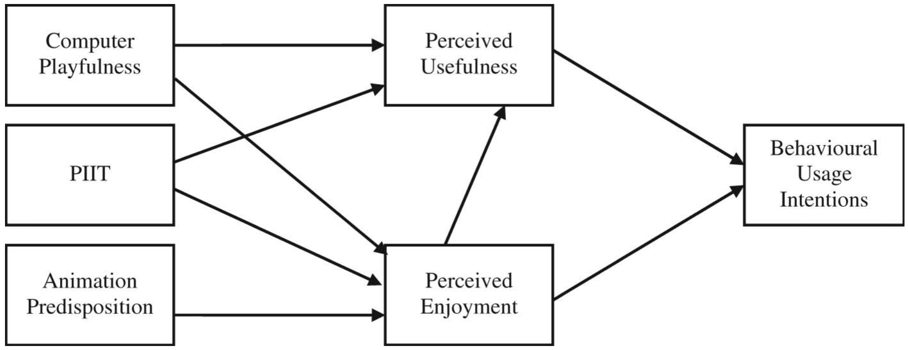



Figure 1. A model of user adoption of animated agents in everyday work applications.

the model. In addition, this allows keeping the questionnaire short. The following two hypotheses are offered:

> **H1:** Perceived usefulness of animated interface agents is positively associated with behavioural usage intentions towards animated interface agents in everyday work applications.
> **H2:** Perceived enjoyment with animated interface agents is positively associated with behavioural usage intentions towards animated interface agents in everyday work applications.

The empirical investigations by Davis *et al.* (1992) identify the positive interaction between perceived enjoyment and perceived usefulness. De Souza Dias (1998) offers empirical evidence of the strong direct effects of perceived enjoyment on both perceived usefulness and perceived ease-of-use of the system. Based on these observations, it is suggested that:

> **H3:** Perceived enjoyment with animated interface agents is positively associated with perceived usefulness of animated interface agents in everyday work applications.

Consistent with Davis' initial realization of TAM, the proposed model includes three independent external variables reflecting user individual differences: computer playfulness, PIIT, and animation predisposition. Webster and Martocchio (1992) demonstrate that computer playfulness is positively associated with a person's involvement in the HCI process. If a user is more involved in the process, he or she may explore more features of the agent and, therefore, perceive this agent to be more useful:

> **H4:** Computer playfulness is positively associated with perceived usefulness of animated interface agents in everyday work applications.

Previous studies demonstrate that the individual-specific trait of computer playfulness is positively associated with computer involvement, positive mood, satisfaction, learning, creativity, and exploratory computer behaviour (Glynn and Webster 1992, Webster and Martocchio 1992). Play research suggests that during more playful interactions with different tasks, playful individuals not only engage in exploratory behaviour but also spend more time and efforts on those activities and enjoy what they are doing to a higher extent (Csikszentmihalyi 1975, Csikszentmihalyi 1990). Lewis (1999) reports that computer playfulness has a strong positive effect on enjoyment ($\beta = 0.4$, $p < 0.001$). Therefore, it is hypothesized that:

> **H5:** Computer playfulness is positively associated with perceived enjoyment of animated interface agents in everyday work applications.

PIIT reflects the willingness of a person to try out a new information technology. Agarwal and Karahanna (2000) hypothesize, test, and empirically confirm that the degree of personal innovativeness in information technology, mediated by the level of cognitive absorption of an individual, has a substantial positive effect on perceived usefulness of a system. In addition, it is hypothesized that individuals with a high degree of PIIT will find animated interface agents in MS Office more enjoyable.

> **H6:** PIIT is positively associated with perceived usefulness of animated interface agents in everyday work applications.
> **H7:** PIIT is positively associated with perceived enjoyment with animated interface agents in everyday work applications.

Recall animation predisposition reflects an individual's propensity towards watching animated films. With respect to the purpose of this study, it is proposed that individuals who are highly predisposed towards watching animated movies will undertake attempts to manipulate settings of animated interface agents in everyday work applications. These users will also perceive animated interface agents more enjoyable in their own right, apart from all anticipated consequences (for instance, an agent's usefulness). The following hypothesis is suggested:

> **H8:** Animation predisposition is positively associated with perceived enjoyment with animated interface agents in everyday work applications.

## 4. Methodology

### 4.1 *Subjects*

In order to empirically validate the model, a survey was administered to 261 end-users, familiar with animated interface agents found in MS Office applications. Respondents to the survey comprised both undergraduate (fourth-year BCom.) and graduate (MBA and PhD) students of a North American university.

Although there is a view that the use of students in surveys and experiments corresponds to a convenience rather than a probabilistic sampling method (Kitchenham and Pfleeger 2002), it is suggested that surveying this sample population would yield statistical results generalizable to the entire user population for the following reasons. First, students are representative of the general user population of this technology. All students were familiar with animated agents in MS Office applications because the computer laboratories of the school had this technology installed for the past three years. The curriculum of these students necessitates that each of them is an intensive user of MS Office and becomes proficient at using these applications. Microsoft has embedded animated interface agents within the functionality of these applications. Although students varied in degrees of expertise, all of them were knowledgeable enough to offer insights on their experiences.

### 4.2 *Measures*

The survey used in this study (see appendix A) employed scales from past empirical investigations. The Likert scales for measuring *perceived usefulness* and *behavioural usage intentions* were adapted from Venkatesh and Davis (2000). Since their inception, these scales have been utilized across numerous technology adoption studies and subjected to successful reliability and validity testing (Mathieson 1991, Segars and Grover 1993, Taylor and Todd 1995b). The adaptation of these scales was based on previous investigations, which replaced the name of the system (WriteOne) and usage circumstances (MBA program) with an application to be tested and usage conditions (Subramanian 1994, Venkatesh and Davis 1996, Venkatesh *et al.* 2002).

The first *perceived enjoyment* scale was introduced and validated by Davis *et al.* (1992) in their motivational study of computer usage. The instrument consisted of three different pairs of words that rate an individual's feelings about using computer technologies. Later, Igbaria *et al.* (1994) expanded perceived enjoyment scale by indicating up to six different pairs of words. Subsequent research finds both scales valid, reliable, and consistent, and manifests the appropriateness and fruitfulness of applying and adjusting these tools to measure the degree of perceived enjoyment with different computer technologies (Teo *et al.* 1999, Venkatesh 2000, Koufaris 2002, van der Heijden 2003), including animated interface agents.

This study adapts the original scale developed by Davis and his colleagues (1992) to determine the level of perceived user enjoyment with animated interface agents, because it allows reducing the number of items in the questionnaire. Since the study's respondents are current users of animated interface agents in an MS Help menu, Davis' questions are adjusted by replacing 'would be enjoyable/fun/pleasant' with 'is enjoyable/fun/pleasant'.

The initial 22-item *Computer Playfulness Scale* (CPS) was introduced by Webster and Martocchio (1992), based on adaptation of Lieberman's (1977) Adult Cognitive Spontaneity Construct. This 22-item scale was subjected to a thorough statistical examination including factor analysis, internal consistency, concurrent, discriminant and predictive validity, predictive efficacy, and test-retest reliability. This methodologically sound evaluation of the scale provided a reliable initial assessment of this instrument and generated a short seven-item version of the CPS. Many subsequent studies have successfully subjected both full and short forms of CPS to rigorous validity and reliability testing (Atkinson and Kydd 1997, Yager *et al.* 1997, Potosky 2002, Hackbarth *et al.* 2003). To keep the questionnaire short, the short CPS was utilized in this investigation.

The self-report instrument for measuring the degree of PIIT has been operationalized by Agarwal and Prasad (1998) in the form of a four-item questionnaire. Both the instrument developers and succeeding researchers find this tool highly reliable and valid (Agarwal and Karahanna 2000, Agarwal *et al.* 2000, Thatcher and Perrewe 2002). Thus, the original PIIT scale is applied in this study with no modifications.

A detailed methodology on the operationalization of the measurement of an individual's *predisposition towards watching animated movies* was discussed by Serenko (2004). Given the absence of prior research in the area of user inclination towards watching animated films, a new instrument was created. During the instrument development, face validity of the scale was addressed, respondent's feedback was collected, and two pilot studies were conducted. At the end of the study, the animation predisposition construct was presented in the form of four reflective items measured on a seven-point Likert-type scale. Overall, the instrument was found reliable and valid.

In addition, the survey presented respondents with a definition of an interface agent in MS Office and several screenshots of agents. User demographics, such as age and sex, were also collected.

## 5. Data analysis and results

### 5.1 *Descriptive statistics*

Recall, the full study involved 261 individuals who were presumed current users of animated interface agents by virtue of their extensive usage of MS Office applications in which these agents are embedded. Sixty-seven percent of all respondents were 20 to 25 years old; 25% were 26 to 30; and 8% were over 30 years old. 58% and 42%, respectively, were male and female.

### 5.2 *Common method bias*

Before conducting formal tests of the hypotheses, a test on common method bias was completed. The common method bias is one of the major concerns of using survey methodology (Woszczynski and Whitman 2004). This bias occurs when independent and dependent variables are provided by the same source (i.e. by the same individual). This is particularly dangerous when respondents are asked to fill out items that tap into independent and dependent variables within the same survey instrument.

Two methods may be utilized to conduct a test of common method bias: a partial correlation procedure and Harman's one-factor test (Podsakoff and Organ 1986). These techniques utilize statistical procedures to isolate the covariance that emerges due to artificial reasons. With respect to this study, Harman's one-factor test was done. The employment of the partial correlation procedure is applicable when groups of respondents provide answers to dependent and independent variables that pertain to a uniform phenomenon rather than to the individuals themselves. As such, this type of common method bias test may be successfully administered in organizations, but it is not applicable to individual-level technology adoption studies (for an example of the PLS partial correlation procedure, see Bontis *et al.* 2002).

To perform the Harman's (1967) single-factor test, all variables – both dependent and independent – are entered into the model. The purpose of this test is to analyze whether a substantial amount of variance is present. The results of an un-rotated solution should be analyzed to determine the number of actual factors that emerge. Common method bias is present if a single or general factor appears that accounts for the majority of variables. Twenty-four items pertaining to the model's six constructs were entered into the analysis. A one-factor model of the un-rotated solution explained only 29% of variance, whereas a six-factor model explained 75%. This confirms that there was no common bias in the collected data.

### 5.3 *Measurement model*

The loadings of the total set of all items were estimated by using PLS, which is a common structural equation modeling technique used in management research (Bontis 1998, Bart *et al.* 2001, Bontis and Fitz-enz 2002, Bontis 2004). The use of PLS in this study is appropriate for the following reasons (Chin 1998, Gefen *et al.* 2000). First, sample size requirements are lower than those of covariance-based techniques (e.g. LISREL). Secondly, since PLS has been traditionally utilized in TAM-based investigations, the usage of this statistical tool will allow for the comparison of the predictive power of the proposed theoretical model with those of preceding projects. PLS estimates both measurement and structural models in a single run and estimates latent variables by employing a least squares estimation procedure.

The estimated loadings of the total set of measurement items are offered in table 1. Four CPS items with loadings below the selected threshold of 0.7 were dropped to ensure construct validity. Once these items were removed, each item was re-evaluated. The elimination of four CPS items

Table 1. Estimated loadings for the total set of measurement items.

| Item | Mean | Std. dev | Loading | Error | Item-total correlations |
|---|---|---|---|---|---|
| **CPS1** | 4.91 | 1.24 | 0.643* | 0.587 | 0.450 |
| **CPS2** | 4.80 | 1.37 | 0.740 | 0.453 | 0.622 |
| **CPS3** | 5.49 | 1.22 | 0.635* | 0.597 | 0.502 |
| **CPS4** | 5.29 | 1.29 | 0.659* | 0.566 | 0.682 |
| **CPS5** | 5.32 | 1.32 | 0.308* | 0.905 | 0.404 |
| **CPS6** | 4.81 | 1.22 | 0.733 | 0.463 | 0.589 |
| **CPS7** | 4.75 | 1.36 | 0.785 | 0.384 | 0.603 |
| **PIIT1** | 4.82 | 1.51 | 0.854 | 0.270 | 0.771 |
| **PIIT2** | 3.85 | 1.74 | 0.833 | 0.306 | 0.742 |
| **PIIT3** | 5.20 | 1.44 | 0.881 | 0.224 | 0.691 |
| **PIIT4** | 5.04 | 1.38 | 0.856 | 0.267 | 0.781 |
| **ANM1** | 5.71 | 1.37 | 0.844 | 0.287 | 0.753 |
| **ANM2** | 4.69 | 1.59 | 0.927 | 0.141 | 0.826 |
| **ANM3** | 4.55 | 1.64 | 0.881 | 0.193 | 0.834 |
| **ANM4** | 4.23 | 1.58 | 0.856 | 0.229 | 0.784 |
| **PU1** | 3.31 | 1.66 | 0.922 | 0.150 | 0.860 |
| **PU2** | 3.11 | 1.56 | 0.932 | 0.132 | 0.875 |
| **PU3** | 3.43 | 1.70 | 0.930 | 0.135 | 0.876 |
| **PU4** | 3.49 | 1.70 | 0.938 | 0.121 | 0.887 |
| **PE1** | 3.34 | 1.76 | 0.926 | 0.142 | 0.758 |
| **PE2** | 3.43 | 1.59 | 0.706 | 0.501 | 0.523 |
| **PE3** | 3.18 | 1.61 | 0.950 | 0.097 | 0.827 |
| **BI1** | 3.08 | 1.71 | 0.974 | 0.051 | 0.898 |
| **BI2** | 3.17 | 1.71 | 0.974 | 0.051 | 0.898 |

*Notes*: *-dropped items.

did not have any impact on the relationships among all constructs, including computer playfulness (for more detail on the unidimensionality of CPS, refer to Serenko and Turel (2005)). The item-to-total correlation coefficients of all items exceeded the cut-off value of 0.35. Further analysis is based on the re-evaluated model (i.e. which excludes items CPS1, CPS3, CPS4, and CPS5).

As suggested by Bontis *et al.* (2002), a matrix of loadings and cross-loadings was used to test discriminant validity (table 2). In order to evaluate the discriminant validity of measures, the loadings of an item with its associated factor (i.e. construct) to its cross-loadings were compared. All items, except PE2, had higher loadings with their corresponding factors in comparison to their cross-loadings. The PE2 question asked individuals how pleasant it was to use animated agents. The mean of this item was higher then those of the other two PE questions. Indeed, many respondents indicated that it was more pleasant than entertaining or enjoyable to use an agent. Recall that the purpose of animated agents is to make a computer interface more pleasant and appealing. It is assumed that many respondents found an animated agent pleasant to use even though they enjoyed it to a lesser extent. Thus, it was suggested that even though the PE2 item loading was slightly below two other cross-loadings, respondents were able to differentiate that question from the other items. In general, it was concluded that there is some confidence in the discriminant validity of the measures and their corresponding constructs.

Construct statistics is presented in table 3. First, tests for reliability of the measurement items relating to six constructs were conducted by estimating the Cronbach's alpha. Since this coefficient exceeded 0.8 for all items, it was concluded that all scales behaved consistently. The Fornell and Larcker (1981) measures of internal consistency and convergent validity of a construct were greater than 0.7 and 0.5 threshold, respectively. Table 4 offers the correlation matrix and discriminant validity assessment. The Fornell and Larcker (1981) measure of discriminant validity was calculated as the square root of the average variance extracted compared to the construct correlations. All values were greater than those in corresponding rows and columns. Overall, all other items exhibited high reliability, internal consistency, and convergent and discriminant validity.

### 5.4 *Structural model*

Bootstrapping was done to derive t-statistics to assess the significance level of the model's coefficients and to test the hypotheses. Two-hundred and fifty samples were generated, which is higher than the default resampling option of PLS-Graph 03.00. As suggested by Chin (2001, p. 14), 'resamples of 200 tend to provide reasonable standard error estimates'. Figure 2 presents the structural model. As such, four out of eight hypotheses were supported (H1, H2, H3, and H8), three hypotheses were rejected (H4, H5, and H6), and one linkage demonstrated reverse yet significant association between the constructs (H7).

In order to demonstrate the insignificance of the CPS–PU, CPS-PE and PIIT–PU relationships, the corresponding links were removed, and the PLS model was re-estimated. Since no changes to R-square, beta

Table 2. Matrix of loadings and cross-loadings.

| | CPS | PIIT | ANM | PU | PE | BI |
|---|---|---|---|---|---|---|
| **CPS2** | **0.776** | 0.316 | 0.023 | −0.114 | −0.059 | −0.058 |
| **CPS6** | **0.838** | 0.275 | 0.112 | −0.120 | −0.034 | −0.088 |
| **CPS7** | **0.897** | 0.354 | 0.088 | −0.151 | −0.100 | −0.125 |
| **PIIT1** | 0.295 | **0.854** | 0.093 | −0.183 | −0.175 | −0.230 |
| **PIIT2** | 0.380 | **0.833** | 0.071 | −0.169 | −0.131 | −0.167 |
| **PIIT3** | 0.315 | **0.881** | −0.033 | −0.272 | −0.290 | −0.267 |
| **PIIT4** | 0.335 | **0.856** | 0.095 | −0.149 | −0.139 | −0.125 |
| **ANM1** | 0.015 | 0.038 | **0.844** | 0.028 | 0.107 | 0.057 |
| **ANM2** | 0.077 | 0.030 | **0.927** | 0.117 | 0.179 | 0.151 |
| **ANM3** | 0.106 | 0.059 | **0.898** | 0.047 | 0.110 | 0.072 |
| **ANM4** | 0.113 | 0.053 | **0.878** | 0.057 | 0.132 | 0.124 |
| **PU1** | −0.084 | −0.244 | 0.055 | **0.922** | 0.662 | 0.751 |
| **PU2** | −0.113 | −0.233 | 0.081 | **0.932** | 0.695 | 0.769 |
| **PU3** | −0.182 | −0.200 | 0.084 | **0.930** | 0.649 | 0.744 |
| **PU4** | −0.198 | −0.218 | 0.070 | **0.938** | 0.687 | 0.778 |
| **PE1** | −0.072 | −0.191 | 0.179 | 0.688 | **0.926** | 0.737 |
| **PE2** | −0.057 | −0.174 | 0.070 | 0.426 | **0.706** | 0.486 |
| **PE3** | −0.082 | −0.244 | 0.139 | 0.723 | **0.950** | 0.802 |
| **BI1** | −0.102 | −0.215 | 0.101 | 0.797 | 0.774 | **0.974** |
| **BI2** | −0.115 | −0.264 | 0.137 | 0.797 | 0.777 | **0.974** |

Table 3. Construct statistics.

| | CPS | PIIT | ANM | PU | PE | BI |
|---|---|---|---|---|---|---|
| **Arithmetic mean (used items)** | 4.79 | 4.73 | 4.80 | 3.34 | 3.32 | 3.13 |
| **Cronbach's alpha** | 0.79 | 0.88 | 0.91 | 0.95 | 0.83 | 0.95 |
| **Internal consistency** | 0.797 | 0.917 | 0.935 | 0.963 | 0.900 | 0.974 |
| **Convergent validity** | 0.567 | 0.733 | 0.784 | 0.866 | 0.753 | 0.949 |

Table 4. Correlation matrix and discriminant validity assessment.

| | CPS | PIIT | ANM | PU | PE | BI |
|---|---|---|---|---|---|---|
| **CPS** | **0.753** | | | | | |
| **PIIT** | 0.380 | **0.856** | | | | |
| **ANM** | 0.089 | 0.049 | **0.885** | | | |
| **PU** | −0.155 | −0.241 | 0.078 | **0.930** | | |
| **PE** | −0.082 | −0.235 | 0.155 | 0.724 | **0.868** | |
| **BI** | −0.112 | −0.246 | 0.122 | 0.818 | 0.796 | **0.974** |

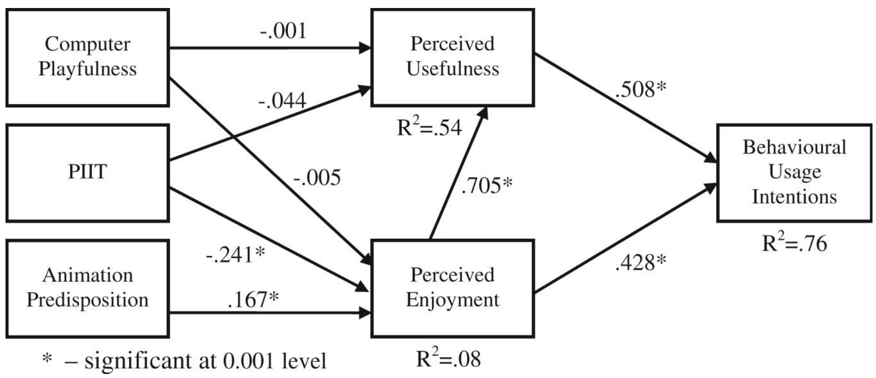



Figure 2. A model of user adoption of animated agents in everyday work applications – hypotheses testing.

coefficients, and t-values were observed, it was concluded that those linkages did not have any statistically significant effect on the model.

Being a new model that does not yet have an extensively researched theoretical base, the saturated model was tested. In the potentially fully saturated model, there are a total of 15 possible path relationships. Of those, one path was entirely rejected in the literature (i.e. computer playfulness has shown to be correlated with PIIT, but generally there is no path dependency) (Agarwal and Prasad 1998). The remaining 14 paths were simultaneously tested. As such, none of the originally hypothesized relationships were adversely affected (i.e. beta path values changed minutely), and no new link had statistically significant beta paths.

Often, the quality and predictive power of TAM-based models are measured by the analysis of R-square values of the BI construct. The interpretation of R-squares in PLS is identical to that in linear regression. According to Chin (1998), in order to estimate the predictive power of independent constructs, the effect size of each independent construct should be estimated. For this, one PU – BI, PE – BI, PIIT – PE, and ANM – PE link was removed at a time, and R-square values of BI were recorded. As recommended by Cohen (1988), the effect size values of 0.02, 0.15, and 0.35 may be viewed as a gauge as to whether a predictor has a small, medium, or large effect at the structural level.

Table 5 presents the R-square values and the effect sizes. It demonstrates that the degrees of perceived enjoyment and usefulness had a large effect size on the R-square value of BI, and that ANM and PIIT had a small effect size on PE.

In order to ensure predictive relevance of the model, a $Q^2$-value was calculated as suggested by Chin (1998, p. 317). A blindfolding procedure of PLS was applied that represents an adaptation of the predictive sample reuse technique. As such, the total model's $Q^2$ was 0.704 (i.e. $Q^2 > 0$), which implies that the model has predictive relevance.

Table 5. The effect size.

| | PE | | BI | |
|---|---|---|---|---|
| | $R^2_{included} = 0.083$ | | $R^2_{included} = 0.756$ | |
| | ANM | PIIT | PU | PE |
| **$R^2_{excluded}$** | 0.055 | 0.034 | 0.633 | 0.669 |
| **$f^2$** | 0.004 | 0.006 | 0.399 | 0.289 |
| **Effect size** | small | small | large | large |

Based on these results, four key observations are made. First, the degree of user perception on the usefulness and enjoyment of an interface agent are strong factors that influence individual intentions whether to utilize this technology. This is demonstrated by a very high R-square value of 76% and large effect sizes of the related links. It seems that people who find an agent more enjoyable also tend to perceive it more useful. Second, the levels of computer playfulness and PIIT do not affect the perception of an animated interface agent's usefulness. Even though some individuals interact with computers playfully, and they are highly innovative in the domain of IT, they do not find interface agents to be more useful. In addition, no relationship between playfulness and perceived enjoyment was found. Third, people, who exhibit a high degree of PIIT, tend to enjoy the technology under investigation to a lesser extent. These findings contradict prior non-agent MIS studies. A possible explanation of this phenomenon is that the use of animated interface agents in MS Office is mandatory. When highly innovative individuals are forced into using technology that they do not necessarily wish to employ, they may perceive this task as being less enjoyable. Another explanation may be that highly experienced users (who formed the study's sample population) are just simply reluctant to ask for assistance they do not need. Last, the animation predisposition construct behaved as expected, and it showed the desired psychometric and predictive properties.

## 6. Discussion, implications and conclusions

The purpose of the study was to investigate end-user adoption of animated interface agents incorporated in commonly utilized work applications. For this, a TAM-based model was constructed and empirically tested with real-life users of animated interface agents in one particular work application environment, MS Office. The suggested model is based on the existing literature, and it employs the animation predisposition construct specifically targeted to agent technologies. Only reliable and valid research instruments were applied in this study.

With respect to the model, several key observations were made. First, both perceived usefulness and perceived enjoyment are important factors influencing a user's decision whether to utilize an animated interface agent in MS Office applications. Consistent with previous MIS investigation, the present study demonstrates a positive association between perceived enjoyment and perceived usefulness of interface agents. Second, data analysis (table 3) reveals a very low level of perceived usefulness (3.34 out of 7) and enjoyment (3.32 out of 7) with this technology, which undermines usage intentions (3.13 out of 7) towards animated agents. As such, the means of these constructs were below average. Presently, computer users neither find interface agents useful nor do they enjoy utilizing them. Indeed, MS Agents provide very little extra functionality to the conventional help user interface. As a result, these interface agents actually may be intruding into a user's activities and only serve to annoy and bewilder the users they were designed to help. Zhang (2000) came to a similar observation in the study of the effects of animation on information seeking performance. An empirical investigation demonstrated that animation as a secondary stimulus, especially the one that utilizes bright colours, actually deteriorates viewer information seeking performance. In the case of animated interface agents in MS Office applications, it is suggested that they may be serving to divert the attention of users and offer little in return.

Second, contrary to the initial proposition, the investigation found no relationship between PIIT and PU, and discovered a negative association between PIIT and PE. Originally, it was proposed that generally highly innovative individuals would tend to explore all features and functions of any new software technology, including agent-based ones, and they should perceive agents to be more useful and enjoyable. In fact, those individuals did not find animated interface agents more useful, but perceived them to be less enjoyable. Thus, it is argued that experienced users are reluctant to use an assistant agent. Another explanation of this finding would be that more innovative individuals may be more familiar with MS Office and MS Agents than their less innovative counterparts, and as a result, are more inclined to be annoyed by these animated interface agents than they are to enjoy them.

Last, the study's results demonstrate that the degree of a person's predisposition towards watching animated films is an important determinant of the perception of the human–agent interaction process. That is, users who generally enjoy watching animation also tend to perceive animated interface agents to be more enjoyable.

This investigation is important for both theory and practice. With respect to theory, it is one of the first methodologically sound attempts to explore the field of agent-based computing. The study applies a relatively new construct that may lay the foundation for the development of other frameworks, models, and instruments targeted to user adoption decisions regarding agent-based computer technologies. It demonstrates a new approach to the investigation of a totally unknown area aiming to improve the quality of contemporary research on the user acceptance of software agents. The investigation highlights the importance of addressing user-specific traits as a major determinant of the perception of the HCI process.

Regarding practice, the project reveals that individuals associate animated interface agents in MS Office applications with animated film characters. The implementation of agents in the form of animated characters may benefit computer users who are predisposed towards watching and enjoying animated films. This implies that agent designers may capitalize on this feature by including such agents in a variety of everyday work application, such as personal productivity software (Bontis and DeCastro 2000). For example, they may embed the look and feel of animated movie characters evoking positive viewer emotions in end-user agent interfaces as a means of increasing adoption and use of such applications and software.

The field of agent-based computing is in the early stage of development. MS Agent is one of the first technologies realized in the form of an end-user commercial product. Although the levels of perceived usefulness and enjoyment as well as usage intentions towards MS Office agents are low, the contribution of the Persona Project at Microsoft Research should be acknowledged. First, it pioneered an untapped area of agent-based computing and generated a strong body of knowledge that may be successfully utilized by future researchers and practitioners. Second, Microsoft developed agent technology that is widely utilized in independent research initiatives. Third, it created an awareness of agent technologies among computer users. By embedding interface agents in most contemporary Office packages, Microsoft familiarized people with an imminent emergence of agents. In spite of currently negative user perceptions of interface agents, future marketers will be able to capitalize on this awareness by emphasizing the benefits of animated interface agents once developers are able to deliver really useful agent technologies. However, in order to achieve commercial success with interface agents, designers should put more emphasis on value-added features, realize functionality that goes beyond traditional direct-manipulation interfaces, and respect individual differences and preferences by allowing users to opt-out from using this technology.

## References


Adams, D.A., Nelson, R.R. and Todd, P.A., 1992, Perceived usefulness, ease of use, and usage of information technology: A replication. *MIS Quarterly*, **16**, pp. 227 – 247.

Agarwal, R. and Karahanna, E., 2000, Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, **24**, pp. 665 – 694.

Agarwal, R. and Prasad, J., 1998, A Conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research*, **9**, pp. 204 – 215.

Agarwal, R., Sambamurthy, V. and Stair, R.M., 2000, Research report: The evolving relationship between general and specific computer self-efficacy – An empirical assessment. *Information Systems Research*, **11**, pp. 418 – 430.

Anandarajan, M., Simmers, C. and Igbaria, M., 2000, An exploratory investigation of the antecedents and impact of internet usage: An individual perspective. *Behaviour and Information Technology*, **19**, pp. 69 – 85.

Atkinson, M. and Kydd, C., 1997, Individual characteristics associated with World Wide Web use: An empirical study of playfulness and motivation. *Communications of the ACM*, **28**, pp. 53 – 62.

Bart, C., Bontis, N. and Taggar, S., 2001, A model of mission statements and firm performance. *Management Decision*, **39**, pp. 19 – 35.

Bhattacherjee, A., 2001, Understanding information systems continuance: An expectation – confirmation model. *MIS Quarterly*, **25**, pp. 351 – 370.

Bontis, N., 1998, Intellectual Capital: An exploratory study that develops measures and models. *Management Decision*, **36**, pp. 63 – 76.

Bontis, N., 2004, National Intellectual Capital Index: A United Nations initiative for the Arab Region. *Journal of Intellectual Capital*, **5**, pp. 13 – 39.

Bontis, N., Crossan, M.M. and Hulland, J., 2002, Managing an organizational learning system by aligning stock and flows. *Journal of Management Studies*, **39**, pp. 437 – 469.

Bontis, N. and Decastro, A., 2000, First World Congress on Electronic Commerce: Review and commentary. *Journal of Internet Research*, **10**, pp. 365 – 373.

Bontis, N. and Fitz-Enz, J., 2002, Intellectual Capital ROI: A causal map of human capital antecedents and consequents. *Journal of Intellectual Capital*, **3**, pp. 223 – 247.

Bourdeau, L., Chebat, J.-C. and Couturier, C., 2002, Internet consumer value of university students: E-mail-vs.-Web users. *Journal of Retailing and Consumer Services*, **9**, pp. 61 – 69.

Bozionelos, N. and Bozionelos, G., 1999, Playfulness: Its relationship with instrumental and expressive traits. *Personality and Individual Differences*, **26**, pp. 749 – 760.

Bradshaw, J.M., 1997, An Introduction to software agents. In *Software agents*, J.M. Bradshaw (Ed.), pp. 3–46 (Menlo Park, CA: The AAAI Press/The MIT Press).

Burgoon, J.K., Bonito, J.A., Bengtsson, B., Cederberg, C., Lundeberg, M. and Allspach, L., 2000, Interactivity in human – computer interaction: A study of credibility, understanding, and influence. *Computers in Human Behavior*, **16**, pp. 553 – 574.

Cavazza, M., Charles, F. and Mead, S.J., 2002, Character-based interactive storytelling. *IEEE Intelligent Systems*, **17**, pp. 17 – 24.

Chin, W.W., 1998, The Partial Least Squares approach for Structural Equation Modeling. In *Modern methods for business research*, G.A. Marcoulides (Ed.), pp. 295–336 (Mahwah, N.J.: Lawrence Erlbaum Associates).

Chin, W.W., 2001, *PLS-Graph User's Guide, Version 3.0* (Houston, TX: Soft Modeling Inc.).

Choi, H., Choi, M., Kim, J. and Yu, H., 2003, An empirical study on the adoption of information appliances with a focus on interactive TV. *Telematics and Informatics*, **20**, pp. 161 – 183.

Cohen, J., 1988, *Statistical power analysis for the behavioral sciences*, (Hillsdale, NJ: Lawrence Erlbaum Associates).

Csikszentmihalyi, M., 1975, *Beyond boredom and anxiety*, (San Francisco, CA: Jossey-Bass Publishers).

Csikszentmihalyi, M., 1990, *Flow: The psychology of optimal experience*, (New York: Harper & Row).

Davis, F.D., 1989, Perceived usefulness, perceived ease of use and user acceptance of information technology. *MIS Quarterly*, **13**, pp. 319 – 340.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R., 1992, Extrinsic and intrinsic motivation to use computers in workplace. *Journal of Applied and Social Psychology*, **22**, pp. 1111 – 1132.

Dehn, D.M. and Van Mulken, S., 2000, The impact of animated interface agents: A review of empirical research. *International Journal of Human – Computer Studies*, **52**, pp. 1 – 22.

De Souza Dias, D., 1998, Managers' motivation for using information technology. *Industrial Management & Data Systems*, **98**, pp. 338 – 342.

Detlor, B., 2004, *Towards knowledge portals: From human issues to intelligent agents* (Dordrecht, The Netherlands: Kluwer Academic Publishers).

Fornell, C. and Larcker, D.F., 1981, Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, **18**, pp. 39 – 50.

Geary, W.R., 2000, The creation of RICO: Law as a knowledge diffusion process. *Crime, Law and Social Change*, **33**, pp. 329 – 367.

Gefen, D. and Straub, D., 2000, The relative importance of perceived ease of use in IS adoption: A study of e-commerce adoption. *Journal of the Association for Information Systems*, **1**, pp. 1 – 28.

Gefen, D., Straub, D. and Boudreau, M.-C., 2000, Structural Equation Modeling and Regression: Guidelines for research practice. *Communications of the Association for Information Systems*, **4**, pp. 1 – 77.

Glynn, M.A. and Webster, J., 1992, The adult playfulness scale: An initial assessment. *Psychological Reports*, **71**, pp. 83 – 103.

Hackbarth, G., Grover, V. and Yi, M.Y., 2003, Computer playfulness and anxiety: Positive and negative mediators of the system experience effect on perceived ease of use. *Information & Management*, **40**, pp. 221 – 232.

Harman, H.H., 1967, *Modern factor analysis*, (Chicago: University of Chicago Press).

Hendrickson, A.R., Massey, P.D. and Cronan, T.P., 1993, On the test-retest reliability of perceived usefulness and perceived ease of use scales. *MIS Quarterly*, **17**, pp. 227 – 230.

Hess, T.J., Rees, L.P. and Rakes, T.R., 2000, Using autonomous software agents to create the next generation of decision support systems. *Decision Sciences*, **31**, pp. 1 – 31.

Hirschman, E.C., 1980, Innovativeness, novelty seeking, and consumer creativity. *The Journal of Consumer Research*, **7**, pp. 283 – 295.

Hornby, G.S. and Pollack, J.B., 2001, Evolving L-systems to generate virtual creatures. *Computers & Graphics*, **25**, pp. 1041 – 1048.

Hurt, H.T., Joseph, K. and Cook, C.D., 1977, Scales for the measurement of innovativeness. *Human Communication Research*, **4**, pp. 58 – 65.

Igbaria, M., 1996, A motivational model of microcomputer usage. *Journal of Management Information Systems*, **13**, pp. 127 – 143.

Igbaria, M., Schiffman, S.J. and Wieckowski, T.J., 1994, The respective roles of perceived usefulness and perceived fun in the acceptance of microcomputer technology. *Behaviour and Information Technology*, **13**, pp. 349 – 361.

JOHNSON, W.L., RICKEL, J.W. and LESTER, J., 2000, Animated pedagogical agents: Face-to-face interaction in interactive learning environments. *International Journal of Artificial Intelligence in Education*, **11,** pp. 47 – 78.

KARAHANNA, E., AHUJA, M., SRITE, M. and GALVIN, J., 2002, Individual differences and relative advantage: The case of GSS. *Decision Support Systems*, **32,** pp. 327 – 341.

KEEBLE, R.J. and MACREDIE, R.D., 2000, Assistant agents for the world wide web intelligent interface design challenges. *Interacting with Computers*, **12,** pp. 357 – 381.

KITCHENHAM, B.A. and PFLEEGER, S.L., 2002, Principles of survey research part 5: Populations and samples. *Software Engineering Notes*, **27,** pp. 17 – 20.

KODA, T. and MAES, P., 1996, Agents with faces: The effect of personification. In *Proceedings of the 5th IEEE International Workshop on Robot and Human Communication*, Tsukuba, Japan, pp. 189 – 194.

KOUFARIS, M., 2002, Applying the Technology Acceptance Model and flow theory to online consumer behavior. *Information Systems Research*, **13,** pp. 205 – 223.

LASHKARI, Y., METRAL, M. and MAES, P., 1994, Collaborative interface agents. In *Proceedings of the Twelfth National Conference on Artificial Intelligence*, AAAI Press, Seattle, Washington, pp. 444 – 450.

LEE, W.J., KIM, T.U. and CHUNG, J.-Y., 2002, User acceptance of the mobile Internet. In *Proceedings of the First International Conference on Mobile Business*, Mobiforum, Athens, Greece.

LEGRIS, P., INGHAM, J. and COLLERETTE, P., 2003, Why do people use information technology? A critical review of the technology acceptance model. *Information & Management*, **40,** pp. 191 – 204.

LESTER, J.C., CONVERSE, S.A., KAHLER, S.E., BARLOW, S.T., STONE, B.A. and BHOGA, R.S., 1997, The persona effect: Affective impact of animated pedagogical agents. In *Proceedings of the Conference on Human Factors in Computing Systems*, The ACM Press, Atlanta, Georgia, pp. 359 – 366.

LEWIS, W. (Jr), 1999, *Technology beliefs, belief antecedents, and IT usage: A study of the World Wide Web*, Doctoral Dissertation. Florida State University, Tallahassee, FL, p. 174.

LIEBERMAN, H., 2001, Interfaces that give and take advice. In *Human–Computer Interaction in the New Millennium*, J.M. Carroll (Ed.), pp. 475–484 (New York: The ACM Press).

LIEBERMAN, H. and SELKER, T., 2003, Agents for the user interface. In *Handbook of Agent Technology*, J.M. Bradshaw (Ed.), pp. 1 – 21 (The MIT Press).

LIEBERMAN, J.N., 1977, *Playfulness: Its relationship to imagination and creativity*, (New York: Academic Press).

LIMAYEM, M., KHALIFA, M. and FRINI, A., 2000, What makes consumers buy from Internet? A longitudinal study of online shopping. *IEEE Transactions on Systems, Man, and Cybernetics*, **30,** pp. 421 – 432.

MAES, P., 1994, Agents that reduce work and information overload. *Communications of the ACM*, **37,** pp. 31 – 40.

MAES, P., 1995, Artificial life meets entertainment: Lifelike autonomous agents. *Communications of the ACM*, **38,** pp. 108 – 114.

MAES, P. and KOZIEROK, R., 1993, Learning interface agents. In *Proceedings of the Eleventh National Conference on Artificial Intelligence* (Washington DC: The MIT Press), pp. 459 – 465.

MALONE, T.W., 1982, Heuristics for designing enjoyable user interfaces: Lessons from computer games. In *Proceedings of the Conference on Human Factors and Computing Systems* (Gaithersburg, Maryland: ACM Press), pp. 63 – 68.

MARAKAS, G.M., JOHNSON, R.D. and PALMER, J.W., 2000, A theoretical model of differential social attributions toward computing technology: When the metaphor becomes the model. *International Journal of Human – Computer Studies*, **52,** pp. 719 – 750.

MATHIESON, K., 1991, Predicting user intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior. *Information Systems Research*, **2,** pp. 173 – 191.

MCBREEN, H.M. and JACK, M.A., 2001, Evaluating humanoid synthetic agents in e-retail applications. *IEEE Transactions on Systems, Man, and Cybernetics*, **31,** pp. 394 – 405.

MIDGLEY, D.F. and DOWLING, G.R., 1978, Innovativeness: The concept and its measurement. *The Journal of Consumer Research*, **4,** pp. 229 – 242.

MIDGLEY, D.F. and DOWLING, G.R., 1993, A longitudinal study of product from innovation: The interaction between predispositions and social messages. *The Journal of Consumer Research*, **19,** pp. 611 – 625.

MIRANDA, F.R., KÖGLER, J.E. (Jr), HERNANDEZ, E.D.M. and NETTO, M.L., 2001, An artificial life approach for the animation of cognitive characters. *Computers & Graphics*, **25,** pp. 955 – 964.

MOON, J.-W. and KIM, Y.-G., 2001, Extending the TAM for a World-Wide-Web context. *Information and Management*, **38,** pp. 217 – 230.

MÜLLER, W., SPIERLING, U., ALEXA, M. and RIEGER, T., 2001, Face-to-face with your assistant. Realization issues of animated user interface agents for home appliances. *Computers & Graphics*, **25,** pp. 593 – 600.

NASS, C., STEUER, J., TAUBER, E. and REEDER, H., 1993, Anthropomorphism, agency, and ethopoeia: Computers as social actors. In *Proceedings of the Joint International Conference on Human-Computer Interaction and Human Factors in Computing Systems Conference* (Amsterdam, The Netherlands: The ACM Press), pp. 111 – 112.

NUNNALLY, J.C., 1978, *Psychometric theory*, (New York: McGraw-Hill).

PERSON, N.K., CRAIG, C., PRICE, P., HU, X., GHOLSON, B. and GREASSER, A.C., 2000, Incorporating human-like conversational behaviors into AutoTutor. In *Proceedings of the Workshop on Achieving Human-like Behavior in the Interactive Animated Agents at the Agents 2000 Conference* (Barcelona, Catalonia, Spain: The ACM Press), pp. 85 – 92.

PODSAKOFF, P.M. and ORGAN, D.W., 1986, Self-report in Organizational Research: Problems and prospects. *Journal of Management*, **12,** pp. 531 – 544.

POTOSKY, D., 2002, A field study of computer efficacy beliefs as an outcome of training: The role of computer playfulness, computer knowledge, and performance during training. *Computers in Human Behavior*, **18,** pp. 241 – 255.

RIST, T., ANDRÉ, E. and MÜLLER, J., 1997, Adding animated presentation agents to the interface. In *Proceedings of the 2nd International Conference on Intelligent User Interfaces* (Orlando, Florida: ACM Press), pp. 79 – 86.

ROEHRICH, G., 2002, Consumer innovativeness: Concepts and measurements. *Journal of Business Research*, **57,** pp. 671 – 677.

ROGERS, E.M., 1962, *Diffusion of Innovations*, (New York: Free Press).

ROGERS, E.M., 1995, *Diffusion of Innovations*, (New York: Free Press).

SEGARS, A.H. and GROVER, V., 1993, Re-examining perceived ease of use and usefulness: A confirmatory factor analysis. *MIS Quarterly*, **17,** pp. 517 – 525.

SERENKO, A., 2004, The development of an instrument to measure animation predisposition of users of animated agents in MS Office applications. In *Proceedings of the Administrative Sciences Association of Canada Conference*, Quebec, Canada.

SERENKO, A. and DETLOR, B., 2003, Agent toolkit satisfaction and use in higher education. *Journal of Computing in Higher Education*, **15,** pp. 65 – 88.

SERENKO, A. and DETLOR, B., 2004, Intelligent agents as innovations. *AI & Society*, **18,** pp. 364 – 381.

SERENKO, A. and TUREL, O., 2005, Temporal structural stability of MIS research instruments: Reconsideration of the Computer Playfulness Scale. In *Proceedings of the Administrative Sciences Association of Canada Conference*, Toronto, Canada, pp. 128 – 142.

STARBUCK, W.H. and WEBSTER, J., 1991, When is play productive? *Accounting, Management and Information Technologies*, **1,** pp. 71 – 90.

SUBRAMANIAN, G.H., 1994, A replication of perceived usefulness and perceived ease of use measurement. *Decision Sciences*, **25,** pp. 863 – 874.

Suzuki, N., Ishii, K. and Okada, M., 1998, Talking Eye: Autonomous creature as accomplice for human. In *Proceedings of the 3rd Asia Pacific Conference on Computer Human Interaction*, IEEE Computer Society, Shonan Village Center, Japan, pp. 409 – 414.

Szajna, B., 1994, Software evaluation and choice: Predictive validation of the technology acceptance instrument. *MIS Quarterly*, **18,** pp. 319 – 324.

Szajna, B., 1996, Empirical evaluation of the revised Technology Acceptance Model. *Management Science*, **42,** pp. 85 – 92.

Takeuchi, A. and Naito, T., 1995, Situated facial displays: Towards social interaction. In *Proceedings of the CHI'95 Conference on Human factors in Computing Systems* (Denver, Colorado, US: ACM Press), pp. 450 – 455.

Taylor, S. and Todd, P., 1995a, Assessing IT usage: The role of prior experience. *MIS Quarterly*, **19,** pp. 561 – 570.

Taylor, S. and Todd, P., 1995b, Understanding information technology usage: A test of completing models. *Information Systems Research*, **6,** pp. 144 – 176.

Teo, T.S.H., Lim, V.K.G. and Lai, R.Y.C., 1999, Intrinsic and extrinsic motivation in Internet usage. *Omega: International Journal of Management Science*, **27,** pp. 25 – 37.

Thatcher, J.B. and Perrewe, P.L., 2002, An empirical examination of individual traits as antecedents to computer anxiety and computer self-efficacy. *MIS Quarterly*, **26,** pp. 381 – 396.

Tornatzky, L.G., Fleischer, M. and Chakrabarti, A.K., 1990, *The processes of technological innovation*, (Lexington, Massachusetts: Lexington Books).

Van Der Heijden, H., 2003, Factors influencing the usage of websites: The case of a generic portal in The Netherlands. *Information & Management*, **40,** pp. 541 – 549.

Venkatesh, V., 1999, Creation of favorable user perceptions: Exploring the role of intrinsic motivation. *MIS Quarterly*, **23,** pp. 239 – 260.

Venkatesh, V., 2000, Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the Technology Acceptance Model. *Information Systems Research*, **11,** pp. 342 – 365.

Venkatesh, V. and Davis, F.D., 1996, A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences*, **27,** pp. 451 – 481.

Venkatesh, V. and Davis, F.D., 2000, A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science*, **46,** pp. 186 – 204.

Venkatesh, V., Speier, C. and Morris, M.G., 2002, User acceptance enablers in individual decision making about technology: Toward an integrated model. *Decision Sciences*, **33,** pp. 297 – 316.

Webster, J. and Martocchio, J.J., 1992, Microcomputer playfulness: Development of a measure with workplace implications. *MIS Quarterly*, **16,** pp. 201 – 226.

Woszczynski, A.B. and Whitman, M.E., 2004, The problem of common method variance in IS research. In *The handbook of information systems research*, M.E. Whitman, and A.B. Woszczynski (Eds), pp. 66–77 (Hershey, PA: Idea Group Publishing).

Yager, S.E., Kappelman, L.A., Maples, G.A. and Prybutok, V.R., 1997, Microcomputer playfulness: Stable or dynamic trait? *Communications of the ACM*, **28,** pp. 43 – 52.

Zhang, P., 2000, The effects of animation on information seeking performance on the World Wide Web: Securing attention or interfering with primary tasks? *Journal of the Association for Information Systems*, **1,** pp. 1 – 28.

## Appendix A

### Questionnaire

**A.** The following questions ask you how you would characterize yourself when you use personal computers. For each adjective listed below, please indicate the number that best matches a description of yourself *when you interact with computers*.

1. Spontaneous.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

2. Unimaginative.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

3. Flexible.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

4. Creative.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

5. Playful.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

6. Unoriginal.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

7. Uninventive.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

**B**. The questions below ask you to describe your behaviours in the context of *information technologies*. Information technologies are computer systems concerned with all aspects of managing and processing information. Information technologies include personal computers, software applications, telecommunications networks (e.g. the Internet and email), etc.

Please indicate the number that best matches you opinion.

1. If I heard about a new information technology, I would look for ways to experiment with it.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

2. Among my peers, I am usually the first to try out new information technologies.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

3. In general, I am hesitant to try out new information technologies.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

4. I like to experiment with new information technologies.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

**C.** To which extent do you agree or disagree with the following statements with respect to animated films? An animated film is a movie where characters are drawn by animators/artists or created by computer technologies (i.e. no human actors present on the screen). The examples of animated films are Tom and Jerry, Lion King, Shrek, Ice Age, Chicken Run, or Toy Story.

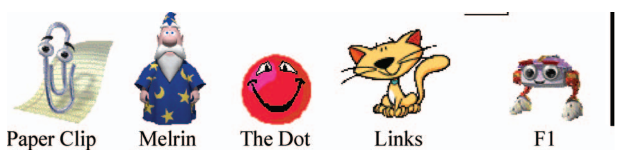
1. I like watching animated films.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

2. I wish I could watch animated films more often than I presently do.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

3. Watching animated films is an enjoyable part of my leisure activities.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

4. When I hear about a new animated film, I wish I could watch it soon.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

**D.** The following questions pertain to your experience with Microsoft® (MS) Animated Agents. An MS Animated Agent is an interactive character that pops up when you use a help menu in MS Word, Excel, or Outlook. Below are examples of Animated Agents:




Answer these questions based on your overall past experience with MS animated agents. If you have never experienced MS animated agents, skip this page.

1. Using animated agents improves my performance in the MS help system.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

2. Using animated agents in the MS help system increases my productivity.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

3. Using animated agents enhances my effectiveness with the MS help system.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

4. I find animated agents useful in the MS help system.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

5. I find using animated agents to be enjoyable.
unlikely neutral likely
1 2 3 4 5 6 7

6. Using animated agents is:
unpleasant pleasant
1 2 3 4 5 6 7

7. I have fun using animated agents.
unlikely neutral likely
1 2 3 4 5 6 7

8. Assuming I have a choice whether to utilize animated agents in the MS help system, I intend to use them.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

9. Given that the usage of animated agents in the MS help system is optional, I predict that I would use them.
strongly disagree neutral strongly agree
1 2 3 4 5 6 7

**E.** Demographic information:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Your age: | under 20 | 20–25 | 26–30 | 31–35 | 36–40 | 41–45 | over 45 |

Your gender: male female