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Research Article

Designing Interfaces with Social Presence: Using Vividness and Extraversion to Create Social Recommendation Agents*

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Abstract

Interfaces now employ a variety of media-rich, social, and advanced decision-making components, including recommendation agents (RA) designed to assist users with their tasks. Social presence has been identified as a key consideration in website design to overcome the lack of warmth, social cues, and face-to-face interaction, but few studies have investigated the interface features that may increase social presence. Recent research on RAs has similarly acknowledged social presence as a key factor in the design of online RAs and in building trust in this technology, but there has been limited empirical work on the topic. In this study an experiment was conducted to explore how social technology cues, media capabilities, and individual differences influence social presence and trust in an RA. RA personality (extraversion), vividness (text, voice, and animation), and computer playfulness were found to influence social presence, with social presence serving in a mediating role and increasing user trust in the RA. Vividness also had a moderating effect on the relationship between RA extraversion and social presence such that increased levels of vividness strengthen this relationship.

Keywords: *Recommendation agent, decision aid, social presence, vividness, personality, multimedia, computer playfulness, trust, decision making*

* Ping Zhang was the accepting senior editor. This article was submitted on October 18, 2008 and went through two revisions.

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1. Introduction

Interface design has advanced to support end-user decision making through interfaces that are media-rich and highly interactive. Interfaces now regularly employ sound, pictures, video, and animation. More recent enhancements include socializing or personalizing the interface (Hassanein and Head, 2007; Lee and Nass, 2005), in many cases through the incorporation of recommendation agents (RAs) or decision aids that provide assistance and advice to online consumers (Wang and Benbasat, 2005). While the sophistication of interfaces and RAs continues to grow, many questions remain about how social, multimedia interface characteristics influence user perceptions and behaviors with technology.

Social presence, the feeling of warmth and sociability conveyed through a medium, has recently been identified as a key variable in establishing a connection between a website and its visitors (Hassanein and Head, 2007; Kumar and Benbasat, 2006). Recent studies have shown that perceptions of social presence affect user trust in websites (Gefen and Straub, 2004; Hassanein and Head, 2007; Kumar and Benbasat, 2002) and serve as an enabler for trust-building cues (Gefen and Straub, 2003). Researchers have noted that "the potential importance of social presence raises the question of how a website can be designed to increase social presence" (Gefen and Straub, 2004 p. 418). Yet little empirical research has been conducted to determine what interface features can be used to increase the perceived social presence of websites (Hassanein and Head, 2005/6; Hassanein and Head, 2007).

Social presence has been similarly suggested as a key factor to consider in the design of online RAs, as the social cues and content conveyed can lead to increased trust, involvement, and satisfaction in the RA (Kumar and Benbasat, 2002; Qui and Benbasat, 2005a). But again, few studies have been conducted to identify ways to increase social presence (Kumar and Benbasat, 2006; Qui and Benbasat, 2005a). In an extensive review of RA research, Xiao and Benbasat (2007) developed a conceptual model of RA characteristics, use, and various outcomes. Social aspects of RAs, however, have received little attention in the literature and, thus, were not included in their model. Vividness, a media capability and potential determinant of social presence, was specifically excluded from the RA model due to a lack of empirical investigation and inconsistent results (Xiao and Benbasat, 2007). RAs are widely used in practice and are the subject of several recent studies on trust in technology (Wang and Benbasat, 2005; 2007; 2008). The social aspects of these technologies warrant further attention.

The goal of this paper is to address this gap in the literature and investigate the key antecedents to social presence in environments where communication occurs between a user and technology, such as an RA or a website. Two streams of research, media theories and the Computers are Social Actors paradigm (CASA), suggest similar categories of antecedents to perceived social presence—social cues, media capabilities, and individual differences. Research on media synchronicity theory acknowledges the influence of media capabilities and cues by describing social presence as an outcome of a communication process that "may be moderated by the media's capability to deliver certain cues in a certain way" (Dennis et al., 2008, p. 586). Media capabilities and cues are, thus, essential categories of antecedents to social presence, with the potential for both main and moderating effects. Other media theories note that perceived social presence and related media perceptions may vary based on individual differences (Carlson and Zmud, 1999; Rice, 1993; Short et al., 1976). The CASA paradigm investigates how users perceive social cues manifested by technology within various media channels (Nass et al., 1995), and similarly suggests that the key categories of antecedents to the perceived social presence of technology are media characteristics, social technology cues, and individual differences (Lee and Nass, 2005). We use this social technology framework to guide our study of social presence.

In this paper, we propose a research model that identifies vividness (media capability), RA personality (social technology cue), and computer playfulness (individual difference) as determinants

of social presence, and subsequently, trusting beliefs in the RA. We conduct an experiment in which levels of vividness (text, voice, and animation) and RA personality (extraversion, introversion) are manipulated to evaluate the effects on social presence. This study contributes to research on social presence, trust, and RAs by 1) examining how forms of media capabilities, social cues, and individual differences (i.e., media vividness, RA extraversion, and computer playfulness) influence the perceived social presence of technology, 2) testing a proposed moderating effect of vividness on the relationship between RA extraversion and social presence, and 3) investigating how social presence influences trusting beliefs with RAs and serves in a mediating role.

The next section of the paper presents the theoretical foundation, research model, and hypotheses. We then describe the research methodology, a controlled laboratory experiment with a decision aid application, and report the findings. Finally, we discuss the implications of the results and future research opportunities.

2. Theory and Hypotheses

The concept of social presence was initially explored by Short, Williams, and Christie (1976) as a way to characterize a user's subjective experience with a communication medium based on how closely the medium emulates face-to-face interaction. Social presence was originally defined as "a quality of the communications medium" that is important in understanding person-to-person telecommunications (Short et al., 1976, p. 65). Face-to-face communication was posited to provide the highest level of social presence in this context, whereas computer-mediated communication, such as e-mail, was associated with lower levels of social presence due to the decreased capacity of the medium to convey social cues such as facial expressions, gestures, and sounds (Rice, 1993; Sia et al., 2002; Straub and Karahanna, 1998).

Social presence has more recently been conceptualized as the warmth, sociability, and feeling of human contact that can be conveyed through a website, as a communication medium (Gefen and Straub, 2003; Gefen and Straub, 2004; Hassanein and Head, 2005/6). While interface features such as customer support chat (Qui and Benbasat, 2005a) and message boards (Cyr et al., 2007) can convey social presence through computer-mediated interaction with other humans, social presence is more often conveyed through "imaginary interactions generated automatically by a computer" (Hassanein and Head, 2005/6). Most websites do not facilitate direct interaction with another human, but this does not mean that a website, or any technology, cannot convey social presence (Gefen and Straub, 2004). Feelings of social presence in an interface can be instilled through technology by simulating a sense of interacting with others (via recommendation agents, socially rich text, picture content, personalization, etc.) (Hassanein and Head, 2005/6; 2007; Pavlou et al., 2007).

Social presence has been recognized as a central concept in interface design as researchers explore how media can be used to overcome physical distance and the lack of human assistance (Hassanein and Head, 2007). Research has shown that technology can manifest social presence, and that perceptions of social presence serve in a mediating role, influencing other technology-related perceptions such as usefulness (Karahanna and Straub, 1999), enjoyment (Hassanein and Head, 2004), involvement and arousal (Fortin and Dholakia, 2005), and trust (Gefen and Straub, 2003; Gefen and Straub, 2004). The social presence of a website is believed to be a key factor in building initial trust in e-commerce, where there is no person-to-person interaction and few trust-building cues. Pavlou, Liang, and Xue (2007) recommended that businesses build trust in their websites by investing in technologies that enhance social presence, such as virtual advisors and decision aids. While recent research has investigated the relationship between website social presence and trust (Gefen et al., 2003; Gefen and Straub, 2004; Hassanein and Head, 2005/6; Hassanein and Head, 2007), relatively few empirical studies have manipulated interface features to increase social presence and have investigated the downstream effects on trust.

Table 1: Empirical Studies of Social Presence in websites and Online Ads

Variables that Influence Social Presence (IVs)	*Variables Influenced by Social Presence (DVs)*	*Form of Presence/ Context*	*Study*
Website - Experimental			
– None, manipulated socially rich text & pictures, but no determinants of social presence included in model	– Perceived Usefulness – Trusting Beliefs – Enjoyment	– Social Presence – Apparel and headphone website	Hassanein & Head (2005/6)
– None, manipulated socially rich text & pictures, but no determinants of social presence included in model	– Perceived Usefulness – Trusting Beliefs – Enjoyment	– Social Presence – Apparel website	Hassanein & Head (2007)
– Support for recommendations – Support for customer reviews	– None	– Social Presence – Amazon music web pages	Kumar & Benbasat (2006)
– Multiple synthetic voices reading book reviews vs. single voice	– Personal/public opinion of books – website credibility	– Co-presence, involvement, voices – Book website	Lee & Nass (2004)
– Personality match/consistency of voice reading book review – Extraversion	– None	– Co-presence, involvement – Book website	Lee & Nass (2005)
– Computer-generated voice – Animation	– None	– Social Presence, Telepresence – LiveHelp agent for camera website	Qui & Benbasat (2005a)
Website - Survey			
– None	– Perceived Usefulness – Trust	– Social Presence – Travelocity website	Gefen & Straub (2003)
– None	– Trusting Beliefs	– Social Presence – Amazon/Travelocity websites	Gefen & Straub (2004)
– None	– Information Privacy Concerns – Information Security	– Social Presence – Book and prescription websites	Pavlou, Liang, & Xue (2007)
Online Advertising - Experimental			
– Agent (voice & animation) vs. text	– Attitude toward advertisement – Revisit Intention	– Social Presence, Telepresence – Apparel website	Choi, Miracle, & Biocca (2001)
– Interactivity: clickable map, choices – Vividness: audio/video on web page	– None	– Telepresence – Movie, music, apparel, food websites	Coyle & Thorson (2001)
– Interactivity – Vividness	– Involvement with ad – Arousal with ad	– Social Presence – Banner ad/website for surge protector	Fortin & Dholakia (2005)
– 3D vs. 2D advertisements	– Brand Attitude, Product Knowledge – Purchase Intention	– Telepresence – Video camera website	Li, Daugherty, & Biocca (2002)

Table 1 provides a summary of empirical studies that have assessed the social presence (or telepresence[1]) conveyed by an interface. We included online advertising studies to provide a more comprehensive review of social presence. The table includes 1) the proposed independent variables (IVs) that influence social presence, 2) any proposed dependent variables (DVs) influenced by social presence, 3) the specific operationalization of presence, and 4) the context of the study.

As shown, few studies have investigated social presence as both an IV and a DV, addressing the mediating role of social presence. Only two of the studies have considered the effect of agents on social presence, and neither study was in a decision- making context. The results of the two agent-based studies also provide inconsistent results, with Qui and Benbasat (2005a) finding no relationship between the use of agents (voice and/or animation) and social presence, and Choi, Miracle, and Biocca (2001) finding significant results. Last, of the studies that addressed trust, none of the research models incorporated interface characteristics that may influence social presence, considered the mediating role of social presence, or employed agents.

Our research model, shown in Figure 1, addresses the gaps in the literature described above. The model includes social technology cues (RA personality), media/interface capabilities (vividness), and an individual difference (computer playfulness) as determinants of social presence, and investigates the mediated effects on trusting beliefs. Trusting beliefs was operationalized as a second-order, reflective construct with the three first-order, reflective dimensions of benevolence, competence, and integrity based on existing conceptualizations (McKnight et al., 2002a; McKnight et al., 2002b; Serva et al., 2005).[2] In order to assess the nomological validity of the model, two trust-related constructs were also included for control purposes. The following sections review the relevant theory and literature and provide support for the hypothesized relationships.

2.1. Determinants of Social Presence

While past research has provided insight on the relationship between the social presence of an interface and trust, this research focuses on the determinants of social presence. Given the conceptualization of social presence as a subjective quality of the communications medium as perceived by the user (Short et al., 1976), media theories and CASA suggest three categories of determinants that would influence these perceptions—*social technology cues*, *media capabilities*, and *individual differences* (Dennis et al., 2008; Lee and Nass, 2005; Rice, 1993). Social presence theory similarly suggests that perceptions of social presence will differ based on media capabilities and user awareness and understanding of these capabilities (Short et al., 1976). We used these three categories of social presence determinants as a social technology framework to theoretically guide the selection of constructs and proposed relationships in our research model. Social technology cues represent a category of determinants unique to the interaction between technology and users, as compared to the computer-mediated interactions between two individuals, with the technology providing cues that create perceptions of social presence. A necessary condition for social presence in this context is that users perceive these cues and respond as if the technology were human.

[1] While social presence is defined as the perceived ability of a medium to convey feelings of human warmth and sociability, telepresence, a related concept, is defined as a sense of "being there" and conveys a feeling of being transported to a technology-mediated environment (Steuer, 1992).

[2] A second-order reflective conceptualization suggests that an over-arching construct exists (trusting beliefs or trustworthiness), representing the belief that a trustee will act in a manner that is beneficial for the trustor (McKnight et al., 2002a; Serva et al., 2005). As reflective first-order dimensions, competence, benevolence, and integrity share a commonality such that there is a consistency in the trustor's perceptions of these underlying beliefs, as documented by the high reported correlations among these first-order constructs (Serva et al., 2005). While a second-order formative representation could also be justified conceptually as the benevolence, competence and integrity of a trustee could theoretically differ, high correlations among constructs are undesirable in a formative context and can destabilize the model (Diamantopoulos and Winklhofer, 2001; Petter et al., 2007).

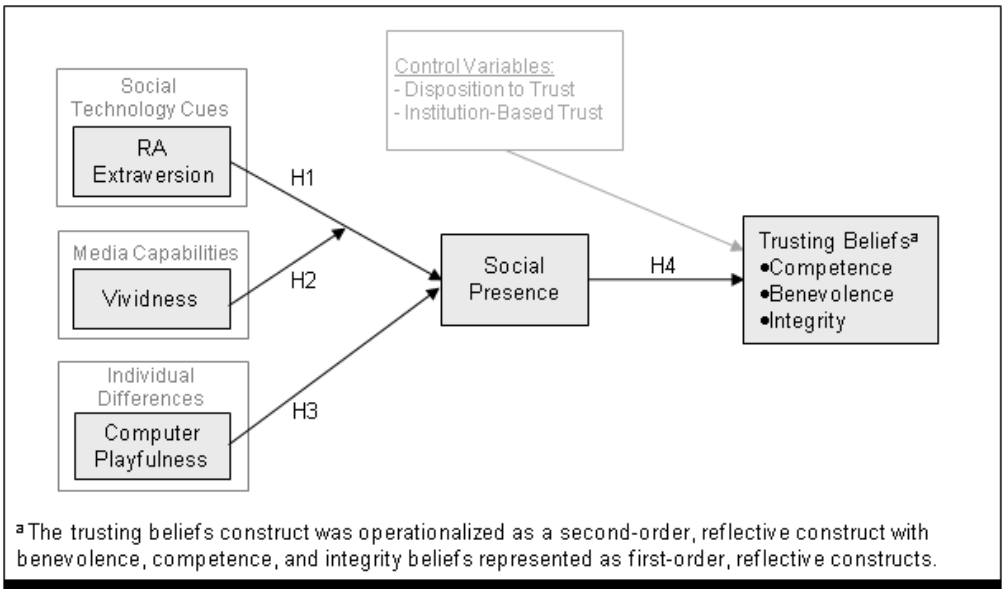

Figure 1: Research Model - RA Social Presence and Trusting Beliefs

Research has demonstrated that social cues rendered by technology can make people respond as if the technology were a social actor (Tung and Deng, 2006), generating perceptions of social presence similar to those that would be generated if the user were interacting with another human. The CASA paradigm has shown in a series of studies that users respond in a social manner to technology that exhibits humanlike cues (Nass and Moon, 2000). Other researchers have noted that adoption of technologies can be improved if the technology is conveyed as a social actor (Kumar and Benbasat, 2002), and the interaction is more similar to an interpersonal interaction (Pavlou et al., 2007). In the case of an RA, we propose that the technology can provide social cues, creating a more social experience for the user. The following sections address the determinants of social presence in an RA. We use media theories that conceptualize social presence and the circumplex model of interpersonal behavior (i.e., personality) to theoretically support the proposed relationships.

2.2. Social Technology Cues—The Effect of RA Extraversion

In this study, we investigate how RA personality (extraversion) serves as a social technology cue to influence the perceived social presence of an RA. Recent research on social presence with technology has investigated the influence of personality and socially rich text and pictures in an e-commerce setting. Lee and Nass (2005) found that an extraverted voice reading a book description, as compared to an introverted voice, resulted in increased perceptions of social presence. Hassanein and Head (2005/6; 2007) found that socially rich text and pictures increased perceptions of social presence with online shopping. Other studies have investigated the effects of personality and social cues but not in relation to perceived social presence.

Extraversion, one of the Big Five personality dimensions (Goldberg, 1981), together with agreeableness, has been argued to be most relevant to the context of social interactions and is included as a factor in a two-dimensional, circumplex model of interpersonal behavior (Wiggins and Pincus, 1989), where it ranges from extraversion to introversion. Extraversion is a commonly studied personality trait because it can be recognized in both verbal and nonverbal cues (Brown, 2003; Kenny et al., 1992; Lippa and Dietz, 2000) and, thus, can be manifested through different media channels—text, voice, and animation. Using verbal and nonverbal cues, human–computer interaction (HCI) researchers have created interfaces that successfully exhibit an extraverted personality, and users of these interfaces have responded with social behaviors (Isbister and Nass, 2000; Nass and Moon, 2000). Studies have found that users are able to perceive personality cues conveyed in many forms of media, including text only (Moon and Nass, 1996; Nass and Moon, 2000), voice (Nass and Lee, 2001), and animation (Isbister and Nass, 2000; Nass and Moon, 2000).

An extraverted personality is associated with characteristics such as sociableness, outgoingness, and enthusiasm, while in comparison, an introverted personality (located opposite of extraversion on the circumplex model of interpersonal behavior) is more shy, inward, and unrevealing (Trapnell and Wiggins, 1990). Extraverted individuals are less timid and hesitant in their communications with others and, thus, take part in more social interactions with others (Eysenck and Eysenck, 1985). This increased ability to connect socially is closely aligned with the conceptualization of social presence in social presence theory—a sense of sociability and human warmth (Short et al., 1976). An RA that exhibits a more extraverted personality will be perceived as more social, outgoing, and enthusiastic by a user and as a result will increase user perceptions of social presence. Thus:

Hypothesis 1: Recommendation agent extraversion will be positively related to user perceptions of social presence.

2.3. Media Capabilities—The Moderating Effect of RA Vividness

Vividness is a media capability that may serve as a key determinant of social presence (Lombard and Ditton, 1997; Steuer, 1992). Social presence theory notes that media capabilities influence perceived social presence (Short et al., 1976), and greater vividness is associated with increased media capabilities. Multimedia vividness "refers to the ability of a technology to produce a sensorially rich mediated environment" (Steuer, 1992, p. 80) and is determined by the depth and breadth of the media. Breadth represents the number of different sensory channels utilized by the media, for example the use of channels that convey visual, auditory, or olfactory cues. In contrast, depth represents the resolution or detail of a particular sensory channel (Steuer, 1992).

We investigated vividness in this study, as more vivid media convey more social cues, and conflicting research results suggest the need for further investigation of this media characteristic. Media vividness is believed to influence perceptions of social presence (Lombard and Ditton, 1997; Steuer, 1992) and other technology-related perceptions (Coyle and Thorson, 2001; Jiang and Benbasat, 2005; Qui and Benbasat, 2005a), as increased vividness involves more human senses and can provide additional information cues. While there is growing research interest in the effect of interface vividness on social presence, the empirical research on this relationship has yielded inconsistent results. Some studies have found a significant effect between forms of vividness and social presence (Choi et al., 2001; Fortin and Dholakia, 2005), while others report an insignificant effect (Coyle and Thorson, 2001; Qui and Benbasat, 2005a). Research on the relationship between vividness and other technology perceptions is also mixed, with some studies reporting that enhanced vividness had effects on attitudes (Coyle and Thorson, 2001; Jiang and Benbasat, 2005) and flow (Coyle and Thorson, 2001; Qui and Benbasat, 2005a), and others reporting insignificant or mixed effects on attitudes (Peng et al., 2004), involvement (Hess et al., 2006), and trust (Qui and Benbasat, 2005b).

We propose a moderating effect for vividness and the social cues conveyed that may clarify some of these inconsistencies. Increased vividness provides information of greater breadth and depth, allowing a user to better discern the social cues presented in the interface and increasing user perceptions of social presence. This depiction of vividness is consistent with the concept of symbol sets in Media Synchronicity Theory (MST), which represents the different ways in which information can be conveyed by a medium (e.g., visual, verbal, written words, etc.) (Dennis et al., 2008). The redundant use of symbol sets to convey information can improve information processing, as users are more likely to discern cues that are conveyed in multiple formats (Severin, 1967). In addition, some forms of information, such as warmth and enthusiasm, may be better conveyed through one symbol set over another (e.g., video vs. written words) (Dennis et al., 2008). Thus, the use of additional symbol sets, providing greater vividness, may increase perceived social presence, while less vivid or more basic symbol sets may not adequately convey social cues and could result in low or no perceptions of social presence.

Research has alluded to this potential moderating effect as the "media's capability to deliver certain cues in a certain way" (Dennis et al., 2008), but to our knowledge, this effect has not been empirically tested. In this study, we explore how different levels of media vividness allow a user to perceive the

social cues (e.g., personality characteristics) embedded in an RA. For example, if RA extraversion increases social presence, then greater levels of vividness (e.g., voice and animation) would enhance the effect of extraversion on social presence. However, if RA introversion decreases social presence, then greater levels of vividness may enhance the effect of introversion, resulting in lower perceived social presence. In this study, social cues are presented by endowing the RA with extraverted personality traits, and vividness should increase the effect that RA extraversion has on social presence. Thus:

> *Hypothesis 2: Interface vividness will moderate the relationship between RA extraversion and user perceptions of social presence, such that greater levels of vividness will strengthen this relationship.*

2.4. Individual Differences—Computer Playfulness

Social presence theory notes that user perceptions of social presence will differ based on an individual's awareness and understanding of media capabilities (Short et al., 1976), and social presence researchers have similarly conceptualized social presence as differing across individuals. Individual differences such as a willingness to suspend disbelief, prior experience with the medium, cognitive style, gender, age, and mood have been suggested as potential determinants of perceived social presence, but limited research has been conducted on this topic (Lee and Nass, 2005; Lombard and Ditton, 1997; Steuer, 1992). From a technology perspective, several individual differences have been identified that influence perceptions of technology, including computer playfulness (CP) (Webster and Martocchio, 1992), computer anxiety (Heinssen et al., 1987), computer self-efficacy (Compeau and Higgins, 1995), and personal innovativeness (Agarwal and Prasad, 1998). In this study, we investigated CP as a potential determinant of perceived social presence due to the close association with other technology-related traits and the novel aspects of this construct that make it well suited for understanding social interactions with technology, as discussed below.

CP is defined as an individual difference reflecting the degree of cognitive spontaneity in computer interactions (Webster and Martocchio, 1992). Early research on this construct found it to be associated with factors such as anxiety, competence, efficacy, involvement, and satisfaction (Webster and Martocchio, 1992). Later research confirmed the effect of CP on technology beliefs, such as perceived ease of use, and on technology use (Anandarajan et al., 2000; Zhang, 2000). Through its effect on user beliefs and attitudes, CP has implications for how users respond to interfaces.

CP describes how individuals differ in their inclination to be spontaneous, creative, and imaginative in their interactions with technology (Webster and Martocchio, 1992). Users will feel an increased sense of presence if they are willing to get into the experience (Lombard and Ditton, 1997), and spontaneous, creative users are more likely to do so. In the case of an RA that exhibits personality traits, individuals who are more playful in their interactions with technology should respond to the social cues provided by the RA in a spontaneous, inventive manner and be more willing to suspend disbelief in this context, resulting in increased perceptions of social presence. An individual with greater creativity and imagination should find it easier to perceive the warmth and sociability in an RA. CP has also been shown to increase flow and immersion with technology (Agarwal and Karahanna, 2000) and, thus, should influence an individual's perceptions of presence in a technology context. Therefore, we posit that computer playfulness will enhance user perceptions of social presence when interacting with an RA. Thus:

> *Hypothesis 3: CP will be positively related to user perceptions of social presence.*

3. Social Presence and Trust

Social presence is conceptualized as how closely the medium emulates face-to-face interaction (Short et al., 1976), with more social cues conveying increased perceptions of social presence. In a technology-mediated environment, it is challenging to establish trust due to the lack of social cues and warmth conveyed, but increasing the social presence of the technology may help to build trust.

Recent research in e-commerce has proposed a relationship between the perceived social presence of a website and trust (Cyr et al., 2007; Gefen and Straub, 2003; 2004; Hassanein and Head, 2005/6; 2007). The inclusion of social cues on a website (e.g., social text, audio, pictures, video, animation) may facilitate the building of initial online trust. Some researchers have also suggested that perceived social presence mediates the effect of social technology characteristics on trust (Kumar and Benbasat, 2002), but this relationship has not been empirically tested.

Trust was initially defined and operationalized in the context of interpersonal relationships, where the trusting parties were human. Just as how social presence has been applied to the interaction between humans and technology (e.g., RAs and websites), trust has also been applied to human interaction with technology. More recent research has addressed trust in technology (Corritore et al., 2003; Li et al., 2008; McKnight, 2005) and has applied theoretical models of trust to examine how humans make trust-related decisions regarding technological artifacts such as online RAs (Komiak and Benbasat, 2006; Wang and Benbasat, 2005; 2007; 2008). In a technology context, trust is defined as the willingness of the trustor to depend upon the actions and results provided by a software application (McKnight, 2005). Such studies have established the nomological validity of studying trust in a technology context and have shown it to be an important determinant of behavioral intentions.

Gefen and Straub (2003) suggested three reasons for the relationship between social presence and trust based on the conveyance of social cues. First, it is easier to hide and engage in untrustworthy activity when fewer social cues are conveyed. Media that convey more social presence may be viewed as more transparent, and as a result (barring information to the contrary), as more trustworthy. Second, past research has shown that trust develops when a trustee behaves as expected. Increased social presence—because it conveys more information to the trustor—may lead users to believe they can make such assessments more easily, again enhancing trust. Finally, trust may increase when the trustor perceives more investment in the relationship and concludes that the trustee has more to lose from untrustworthy behavior (Williamson, 1993). The social presence of a website provides trust-building cues specific to the site that are not addressed by other known determinants of trusting beliefs (e.g., disposition to trust and institution-based trust). Thus, website social presence serves as an antecedent to trusting beliefs, just as website quality served as a determinant of trusting beliefs in prior studies of trust (McKnight et al., 2002a; McKnight et al., 2002b). A similar relationship would also be expected in the context of online RAs. As an RA conveys more social cues, increasing perceptions of social presence, a user's trusting beliefs toward the RA should also increase. Therefore, we hypothesize:

> *Hypothesis 4: Perceptions of social presence will be positively related to user trusting beliefs in a recommendation agent.*

In order to assess the nomological validity of the proposed research model, we measured two known antecedents to trusting beliefs, disposition to trust and institution-based trust, as control variables. Prior studies of social presence and trust in technology have excluded one or both of these constructs. Disposition to trust is an individual difference variable conceptualized as the willingness of an individual to "depend on others across a broad spectrum of situations and persons" (McKnight et al., 2002a, p. 339). Institution-based trust represents the structural conditions that will increase the likelihood of a satisfactory outcome between a trustee and trustor (McKnight et al., 2002a). For the purposes of this research, we focused on the situational normality aspect of institution-based trust, such as whether the RA environment is appropriate and favorable for doing the task at hand. Thus, a user who trusts decision-making software, in general, should have positive beliefs in an RA, as an instance within the broader class of decision-making software.

4. Research Method

We conducted a laboratory experiment using a 2 x 3, between-subjects research design. We developed the experimental application, a decision aid, with three levels of multimedia vividness (text only-T; text and voice-TV; text, voice, and human animation-TVA) and exhibited two personality types

(extraverted, introverted). The social nature (personality) of the application was conveyed through the instructions provided by the RA. These instructions included an initial tutorial for using the decision aid and ongoing guidance while using the decision aid.

We conducted a pilot study with 282 different subjects several months before the full data collection to refine the experimental manipulations and assess the measurement properties of the scales. The subjects were enrolled in an undergraduate business course and completed the full study along with the survey questions. We made minor adjustments to the personality and vividness treatments based on the results.

5. Subjects

Subjects in the full data collection phase were randomly assigned to one of the six treatment conditions. We conducted the study in an experimental lab with 550 undergraduate business students taking an introductory information systems course. The average age of the subjects was 20.6, and there were 355 (64.5 percent) males. Subjects received course credit, approximately 1 percent of their final grade, for participating in the study, and were provided with other options for earning extra credit. The subjects participating in the study represented 74 percent of the total enrolled in the undergraduate course. Participating subjects had similar demographic characteristics (age and gender) to those who elected not to participate in the study.

6. Experimental Task

The decision aid provided support for the decision task of choosing an apartment by providing a comparison matrix of 10 apartments and eight apartment features. We selected the context of apartments because it is particularly relevant to college-age subjects. Similar decision-making support can be found on apartment hunting websites (e.g., Apartment Finder 2008) and in many other product and service evaluation contexts (BizRate, 2008; CNET, 2008). We modeled our experimental application after these real-world applications and other decision-making studies (Hess et al., 2006; Todd and Benbasat, 1992; Todd and Benbasat, 1999). We reviewed local newspapers and apartment websites to determine a realistic range of values for the apartment features.

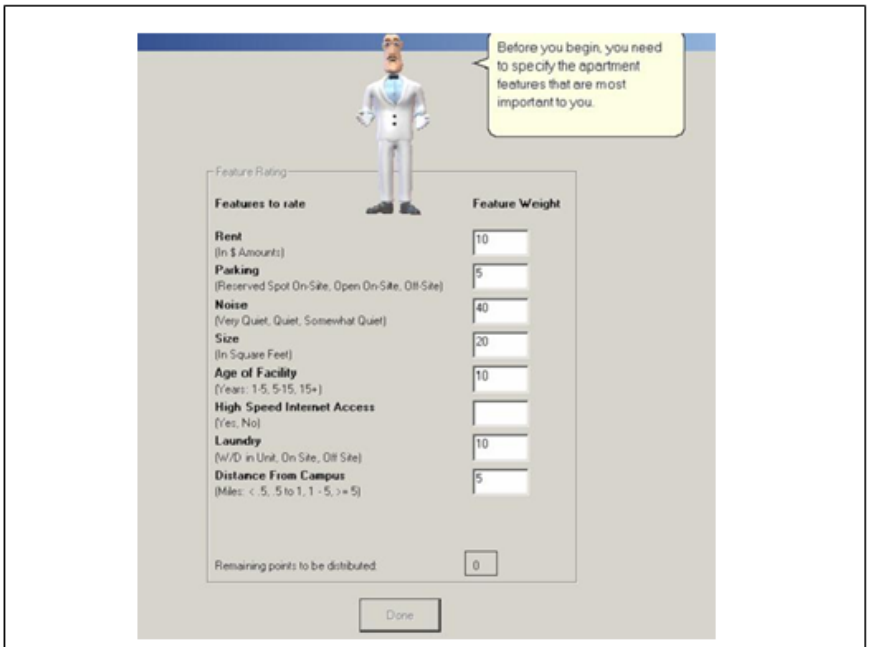

Figure 2: Screenshot of Feature-Weighting Interface (TVA Treatment)

The subjects were first asked to weight the importance of the eight apartment features by allocating 100 points among these features (see Figure 2). They were then presented with the comparison matrix (see Figures 3 and 4), in which the apartments were sorted based upon the subjects' previously specified weighting of apartment features. Additional functionality enabled the subjects to sort the apartments based on apartment features, hide/show apartments, change the ordering of the apartment features, and hide/show apartment features.

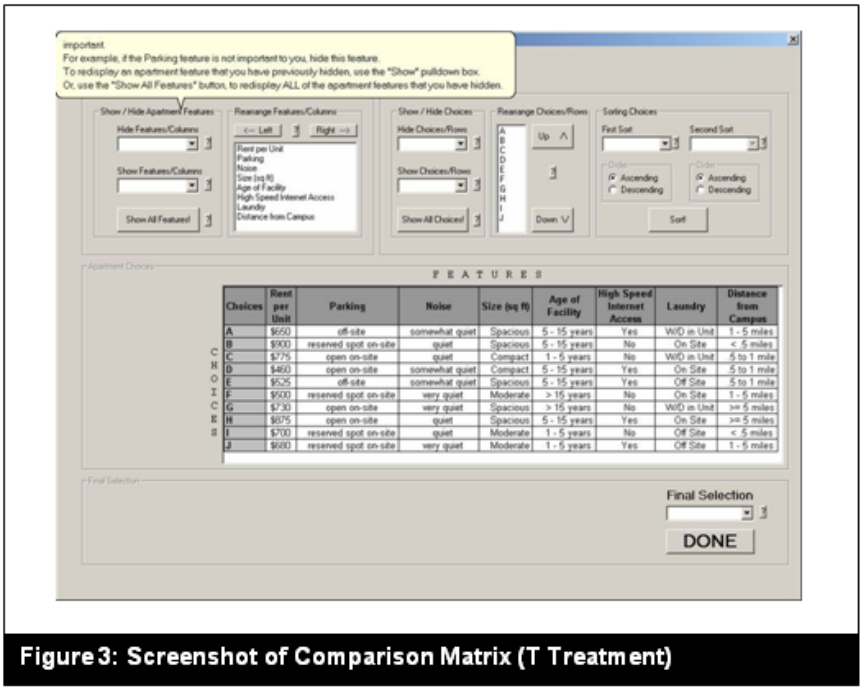

Figure 3: Screenshot of Comparison Matrix (T Treatment)

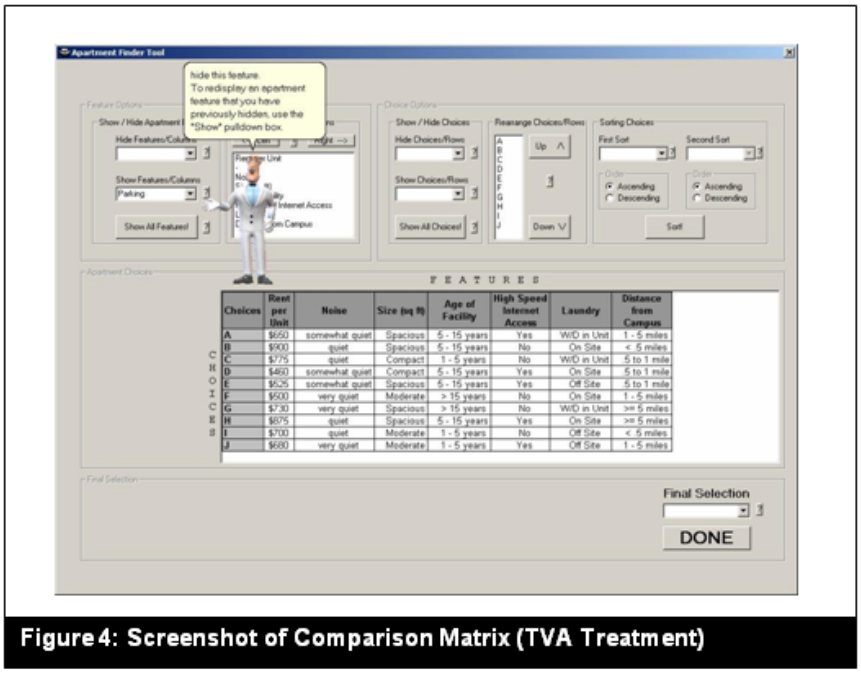

Figure 4: Screenshot of Comparison Matrix (TVA Treatment)

7. Treatment Conditions

We provided the same decision-making task and support in all treatments. We implemented the three levels of vividness (T, TV, TVA) and the expression of personality type (extraverted, introverted) in the decision aid by using Microsoft Agent Technology. Narrated instructions for using the decision aid and guidance while using the decision aid were provided through this technology and were varied by treatment as described below. The programming interface for the agent technology provided options for changing the loudness, pace, range of frequency, and word emphasis with the text-to-speech (TTS) engine and for creating agent gestures and movement. We operationalized the two personality treatments across the three levels of vividness as shown in Table 2 based on the personality literature and past studies of technology-based personality. In manifesting personality characteristics, care was taken to manifest extraversion (and introversion) at all levels of vividness to present a consistent representation of personality. Past research has shown that users notice inconsistent personality characteristics in verbal and nonverbal cues (Ekman et al., 1980; Lee and Nass, 2005), which can lead to contradictory conclusions (Isbister and Nass, 2000).

Table 2: Operationalization of Personality Characteristics and Vividness

Vividness	*Extraversion*	*Introversion*
Text	• Outgoing, enthusiastic, positive statements	• Timid, inward, impersonal statements
Voice	• Faster pace (165 words per minute) • Greater range of frequency • Higher pitch (85 hertz) • Volume (60,000) – max of 65,000	• Slower pace (130 words per minute) • Smaller range of frequency • Lower pitch (50 hertz) • Volume (26,000)
Animation	• Larger, expressive gestures such as arm movements	• Smaller, less expressive gestures such as head nods

7.1. Vividness

The base level of vividness (text only - T) was represented by the display of text within text balloons in the interface and used the visual channel of the medium. Subjects in the text and voice treatment (TV) were provided with these same text balloons, but they also heard a computer-generated voice speaking the text as it was displayed. Thus, two media channels, visual and auditory, were used in the TV treatment, providing greater breadth in vividness. Subjects in the text, voice, and animation (TVA) treatment were provided with a human animation that gestured and changed facial expressions as it spoke with the same computer-generated voice and text balloons. The TVA treatment manifested both breadth and increased depth in vividness, as two media channels were used and greater detail in the visual media channel was provided through the animation. Screenshots of the T and TVA treatments were shown in Figures 3 and 4, respectively.

7.2. Personality

The personality traits of extraversion and introversion were manifested in the recommendation agent by varying the phrasing (word choice) of the text, the computer-generated voice, and the physical gestures of the animation. Personality research has shown that extraverted individuals are more outgoing and revealing in their communications and actions (Eysenck and Eysenck, 1985; Lippa and Dietz, 2000; Wiggins, 1979). Their word and phrasing choices reflect these characteristics, as they tend to use positive, informal, short phrasing with more pronouns and self-references (Gill and Oberlander, 2002). Extraverts also tend to speak more loudly and quickly and have a greater range of voice frequency than introverted individuals (Aronovitch, 1976; Scherer, 1978). In addition, extraverted individuals are more expressive and gesture and move more frequently (Albright et al., 1988; Ekman et al., 1980; Eysenck and Eysenck, 1985). As previously noted, existing HCI research has successfully manifested such traits in computer-based personalities by similarly varying word choice, voice, and movement (Isbister and Nass, 2000).

In the current study, the treatment employing the extraverted RA used more outgoing, direct language

across all levels of vividness. For example, the extraverted script included the statements: "*Before you use the tool, I'm going to give you a brief tutorial. After the tutorial, you will use the tool to help you pick the best apartment*." The introverted script provides the same information in a more hesitant, impersonal manner: "*Before you use the tool, you will be given a brief tutorial. After the tutorial, you may use the tool to assist you in finding a suitable apartment*." When voice is present (TV and TVA), the extraverted computer-generated voice speaks more loudly and quickly and has a greater frequency range than the introverted voice, as shown in Table 2. In the TVA treatment, the extraverted animation makes more expansive gestures such as arm movements and small side-to-side movements, while the introverted animation makes smaller gestures such as nods and hand movements. While the same information content was used in all treatments, the manner in which the information was conveyed was altered (consistent with past CASA research on personality). Both the extraverted and introverted scripts are provided in Appendix B.

7.3. Experimental Procedure

The subjects were first provided with a narrated tutorial of the decision task and were then guided through the use of the decision aid. The delivery of information was in keeping with the subjects' assigned treatment condition. During the tutorial portion of the experiment, the subjects were unable to use the decision aid, but the features were fully demonstrated. Upon completion of the tutorial, the subjects were presented with the feature weighting form and asked to specify their preference for each apartment feature by allocating 100 points among the features, as previously shown in Figure 2. The subjects were required to allocate all 100 points before they could proceed. The decision aid then provided the comparison matrix form as previously shown in Figures 3 and 4. The subjects were encouraged to use the comparison matrix functionality and were asked to select their preferred apartment. After the subjects selected an apartment, we administered a survey to assess perceptions of the decision aid.

7.4. Measures

We adapted the measurement scales in the survey from existing scales, and they are included in Appendix A. We assessed the measurement of perceived RA extraversion using a 5-item, 8-point adjective scale (Wiggins, 1979), and this scale provided a manipulation check of the two personality treatments. Computer playfulness was assessed using a 4-item, 7-point adjective scale (Webster and Martocchio, 1992). We adapted all trust-related measures from McKnight et al. (2002), and they were assessed with 7-point Likert-type scales. We assessed social presence using the original, 4-item semantic scale established by Short et al. (1976). This measure utilizes adjective pairs such as personal/impersonal, social/unsocial for assessing the social cues conveyed through the RA.

7.5. Data Analysis

We recruited a pool of 550 subjects in order to use SEM with maximum likelihood estimation in AMOS 16 (Arbuckle, 2007) to test the measurement properties and the hypothesized relationships in our research model. A larger sample was collected in order to perform multiple-group analysis and test the proposed interaction effect. We first provide descriptive statistics and a manipulation check of treatment personality. We then establish the reliability, convergent validity, and discriminant validity of the constructs using the measurement model in AMOS. A series of statistical analyses are performed, including a structural regression model, to test the hypotheses and provide insight into the proposed and alternative relationships.

7.6. Descriptive Statistics and Personality Manipulation Check

We provide descriptive statistics for each measured construct in Table 3 for each of the six treatments. We conduct a manipulation check of RA extraversion using analysis of variance (ANOVA), as shown in Table 4. After completing the experiment, subjects were asked to assess the personality of the RA using the 5-item scale previously discussed (Wiggins, 1979). The results show that subjects did accurately perceive the personality of the RA as more or less extraverted for each level of vividness.

Table 3: Descriptive Statistics by Treatment

Constructs	Treatment Mean (Std Dev)					
	Extraverted			Introverted		
	Text	TV	TVA	Text	TV	TVA
RA Extraversion	4.67(1.24)	4.67(1.06)	5.31(1.28)	4.25(1.42)	3.84(1.59)	4.29(1.35)
Computer Playfulness	4.71(1.22)	4.80(1.05)	4.97(1.07)	4.72(0.97)	4.65(1.26)	4.74(1.19)
Social Presence	4.27(1.27)	4.26(1.20)	4.85(1.26)	3.92(1.27)	3.36(1.48)	3.74(1.45)
Institution-based Trust	5.07(1.29)	4.96(1.24)	5.21(1.11)	5.07(1.26)	4.98(1.23)	4.80(1.08)
Disposition to Trust	5.29(1.42)	5.23(1.10)	5.39(1.19)	5.25(1.15)	5.43(1.18)	5.12(1.24)
Trusting Beliefs - Benevolence	5.32(1.25)	5.11(1.09)	5.39(1.14)	5.33(1.07)	5.36(1.37)	5.13(1.05)
Trusting Beliefs - Integrity	5.27(1.24)	5.06(1.13)	5.44(1.02)	5.43(0.94)	5.47(1.17)	5.20(1.04)
Trusting Beliefs - Competence	5.24(1.21)	5.06(1.19)	5.49(1.10)	5.38(1.12)	5.24(1.32)	5.17(1.03)

Table 4: Manipulation Check for Perceived RA Extraversion

	Treatments			
Personality Treatments	Text	Text-Voice	Text-Voice-Animation	All levels
Extraverted	4.67	4.67	5.31	4.88
Introverted	4.25	3.84	4.29	4.13
p-value	.029	.000	.000	.000

7.7. Measurement Model

We perform confirmatory factor analysis on the measurement model to assess construct reliability, convergent validity, and discriminant validity. Within the measurement and structural regression models, trusting beliefs were represented as a second-order reflective construct, with benevolence, competence, and integrity beliefs represented as first-order reflective constructs (McKnight et al. 2002; Serva et al. 2005). The first-order belief constructs are measured with the items shown in Table 5. We assess the reliability of all constructs in the model using composite reliability scores[3] calculated from standardized factor loadings (Werts et al., 1974) and find them to be greater than the recommended threshold of .7 (Hair et al., 1998), as shown in Table 5. We assess the convergent and discriminant validity of the constructs and find them to be acceptable[4] by examining the standardized loadings for each indicator, overall fit statistics for the measurement model, and the average variance extracted (AVE)[5] for each construct compared to other construct correlations, as described in Tables 5 and 6.

Common method bias (CMB) is a potential concern, as we measure several constructs using self-reported survey data. RA extraversion and vividness were treatment conditions and thus were not susceptible to CMB. We first conduct a Harman's single-factor test (as described in Podsakoff et al., 2003), and 1) more than one factor emerged from the unrotated solution, and 2) the first factor did not explain a majority of the variance (36 percent), suggesting that CMB was not substantially present. Second, we conduct a marker variable approach as shown in Table 7 (see Lindell and Whitney (2001) and Malhotra, Kim, and Patel (2006) for additional details). A marker variable is used to parcel out the potential effect of CMB from correlations between independent and dependent variables. In the absence of a theoretically unrelated variable, we select the variable with the smallest correlation for each dependent variable as a marker construct and conservatively assume that it represents CMB. We identified disposition to trust as the marker construct for each dependent construct (social

[3] Calculated as $(\Sigma\lambda_i)^2/[(\Sigma\lambda_i)^2 + \Sigma Var(\varepsilon_i)]$ where λ_i is the indicator loading and $Var(\varepsilon_i) = 1 - \lambda_i^2$).

[4] The second-order reflective representation of trusting beliefs was further validated by comparing the model fit statistics with 1) a three construct, first-order representation of trusting beliefs, and 2) a single construct representation of trusting beliefs. The fit statistics for the second-order model were the same or better than these alternative models, and correlations among the first-order dimensions support a second-order model.

[5] Calculated as $(\Sigma\lambda_i^2)/[(\Sigma\lambda_i^2) + \Sigma Var(\varepsilon_i)]$, where λ_i is the indicator loading and $Var(\varepsilon_i) = 1 - \lambda_i^2$).

presence and trusting beliefs). The correlation of the marker construct was assumed as method variance and parceled out from the other correlations. We also perform sensitivity analyses with 95 percent and 99 percent confidence intervals of the marker correlation. All constructs have significant corrected correlations and sensitivity analyses. Based on these assessments, CMB does not appear to have a serious influence on the results[6].

Table 5: Measurement Model Results

Items	Standardized Loadings	Composite Reliabilities	Items	Standardized Loadings	Composite Reliabilities
cp1	.614	.834	tbb1	.902	.847
cp2	.662		tbb2	.884	
cp3	.872		tbb3	.608	
cp4	.818		tbi1	.891	.907
sp1	.846	.893	tbi2	.920	
sp2	.809		tbi3	.810	
sp3	.802		tbc1	.825	.918
sp4	.828		tbc2	.904	
it1	.857	.939	tbc3	.929	
it2	.951		tbc4	.767	
it3	.935		*Trusting Belief Dimensions*		n/a
dt1	.849	.847	Competence	.861	
dt2	.761		Benevolence	.913	
dt3	.804		Integrity	.825	
CFI	.970		AGFI	.910	
NFI	.942		RMSEA	.043 (.038 - .048)	
GFI	.929		χ^2 / df	2.015 (df = 277)	

cp=computer playfulness, sp=social presence, it=institution-based trust, dt=disposition to trust, tbb=trusting beliefs benevolence, tbi=trusting beliefs integrity, tbc=trusting beliefs competence

Note: All standardized loadings were significant at p<.0001 and > .7 as recommended (Hair et al., 1998), except for two items from the cp scale and one item from the tbb scale with loadings > .6. These items were retained to preserve the content validity of these existing scales and because other measures of construct validity were acceptable. Fit statistics were all acceptable with CFI, NFI, GFI, and AGFI >.9, RMSEA <.05, and the ratio of χ2/df < 3:1.

Table 6: Average Variance Extracted (AVE) and Construct Correlations

	AVE	RAE	V	CP	SP	DT	IT	TB
RA Extraversion (RAE)	n/a	n/a						
Vividness (V)	n/a	.027	n/a					
Computer Playfulness (CP)	.561	.058	.062	**.749**				
Social Presence (SP)	.675	.293	.091	.294	**.822**			
Disposition to Trust (DT)	.648	.017	-.007	.112	.059	**.805**		
Institution-Based Trust (IT)	.838	.054	-.017	.272	.248	.114	**.915**	
Trusting Beliefs (TB)	.749	-.026	.002	.382	.369	.208	.587	**.865**

Note: Square root of AVE in bold on the diagonal. The AVE for each construct was > .5 as recommended (Fornell and Larcker, 1981), The square root of the AVE for each construct was also > the correlations with other constructs as recommended (Anderson and Gerbing, 1988).

[6] An unmeasured latent method construct assessment was also conducted in PLS, as documented by (Liang et al., 2007; Vance et al., 2008), and provided additional assurance that CMB did not significantly influence results. A recent assessment of post-hoc tests for assessing CMB suggests that both the marker variable and the unmeasured latent construct approaches have weaknesses in assessing CMB (Richardson et al., 2009).

Table 7: Common Method Bias Assessment – Marker Variable Analysis						
		CP	SP	DT	IT	TB
Trusting Beliefs	Correlation		.372*	.207 [a]	.588*	
	Corrected correlation		.208*		.480*	
	95% Sensitivity Analysis		.121*		.423*	
	99% Sensitivity Analysis		.091*		.403*	
Social Presence	Correlation	.294*		.059 [a]		
	Corrected correlation	.250*				
	95% Sensitivity Analysis	.177*				
	99% Sensitivity Analysis	.152*				
* p < 0.05, [a] = Marker correlation, CP=Computer Playfulness, SP=Social Presence, DT=Disposition to Trust, IT=Institution-Based Trust, TB=Trusting Beliefs						

7.8. Hypotheses Testing and Structural Regression Model

In testing our hypotheses, we first provide an analysis of covariance to assess the main and interaction effects of computer playfulness, vividness, and RA extraversion on social presence. We then present the structural regression model results and provide an assessment of the hypothesized relationships within the full research model. Last, the results of a multiple group analysis in AMOS, using the same structural regression model, offer additional support for the hypothesized treatment interaction between RA personality and vividness.

Analysis of Covariance

We perform an analysis of covariance on part of the research model to investigate the effect of computer playfulness, the RA personality treatment (extraverted, introverted), and vividness (T, TV, TVA) on perceptions of social presence. The results, shown in Table 8, support the hypothesized relationships, with all main effects and the interaction effect being significant. In addition, there was a significant main effect from vividness to social presence as suggested by past research and previously discussed. A graph of the means for the personality and vividness treatments (shown in Figure 5) clearly depicts the ordinal nature of the interaction. With an ordinal interaction, one treatment is always ordinally superior to the other, and the regression lines do not cross as in crossover (nonordinal) interactions. As shown in Figure 5, the more extraverted RA always results in greater social presence. Unlike crossover interactions, when ordinal interactions are present, the main effects of the treatments can be interpreted (Jaccard, 1998; Meyer, 1991; Rosnow and Rosenthal, 1991).

Table 8: ANCOVA Results for Social Presence						
Source	Sum of Squares	df	Mean Square	F	Sig	Effect size (f)[a]
Computer Playfulness	50.219	1	50.219	30.408	.000	.237
RA Extraversion	77.445	1	77.445	46.894	.000	.293
Vividness	18.381	2	9.191	5.565	.004	.143
RA Extraversion x Vividness	12.320	2	6.160	3.730	.025	.117
R Squared = .157 (Adjusted R Squared = .148) [a] Effect size f was calculated using the formula = sqrt(eta2/(1-eta2)) (Rosenthal & Rosnow 1991)						

Structural Regression Model

We initially run the structural regression model with all hypothesized relationships except the interaction between RA extraversion and vividness. Model results, including standardized path loadings, variance explained in each endogenous construct (squared multiple correlations), and fit statistics, are shown in Figure 6. All hypothesized effects were significant at p < .001, and the model fit was acceptable with CFI, NFI, and GFI > .9, AGFI of almost .9 (.897), RMSEA < .05, and the ratio of chi-squared to degree of freedom < 3:1.

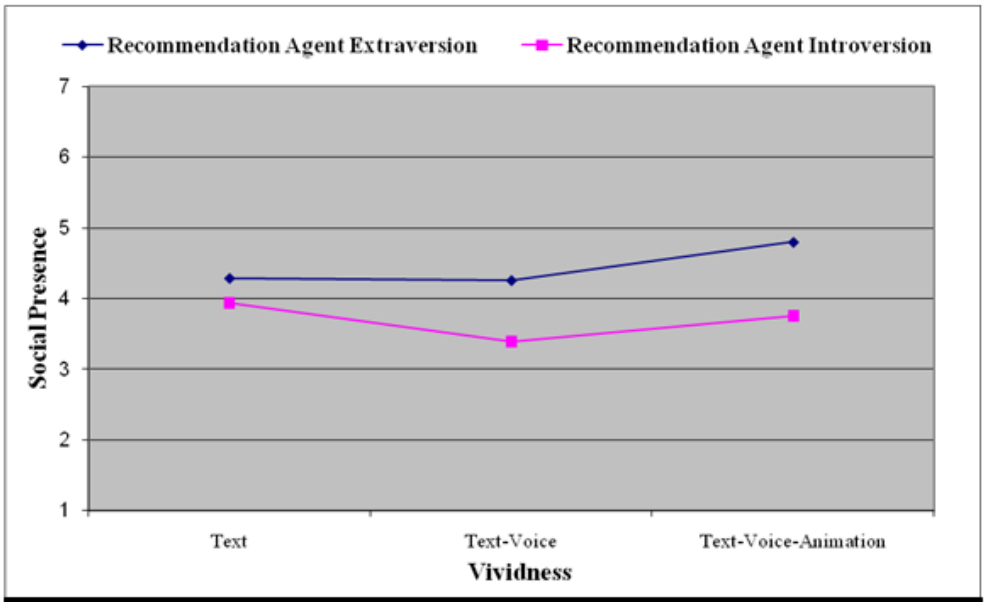

Figure 5: The Effect Of RA Personality And Vividness On Social Presence

Within this model, RA extraversion was represented by a single, categorical item coded to represent the two treatment categories of extraversion and introversion. While covariance-based SEM (the approach used in AMOS) typically estimates latent constructs with multiple items, a single item, such as gender, may be appropriate when there is only one item and there is little measurement error (Gefen et al., 2000). In our case, there was only one item, a representation of the actual personality treatment, and there was no measurement error. The use of a categorical variable with less than five categories, rather than a continuous variable, has also been shown to result in the underestimation of factor loadings and factor correlations when the variable exhibits a high degree of skewness (Byrne, 2001). However, in the case of our categorical treatment variable, skewness was not an issue, as the subjects were approximately balanced between the two categories (279 extraverted, 271 introverted).[7]

Multiple Group SEM Analysis

We use a multiple-group analysis approach to test the moderating effect of vividness on the relationship between RA extraversion and social presence within the proposed research model. This approach, as described by Byrne (2001), involves specifying three-subject groups, one for each treatment of vividness (T, TV, TVA), and uses the same structural regression model previously shown in Figure 6 for each group. Across these three groups, the same factor loadings, error terms, covariances, and path weights are freely estimated, with the exception of the path from RA extraversion to social presence. This one path weight is constrained to be equal across the three treatment groups. We then generate structural regression model results for two models: a constrained model, where the path weight between RA extraversion and social presence is constrained to be equal across all treatment groups, and the default model, where this path weight is freely estimated. We use the chi-squared statistic to assess whether the models are different. A significant chi-squared statistic means that the models are different and the path weight from RA extraversion to social presence is different across treatment groups.

[7] To provide additional assurance of the results obtained using a categorical variable, we tested an alternative model using a 5-item continuous scale as a surrogate for the personality treatment. The alternative model included the same constructs and relationships shown in Figure 6. The only change was the use of a 5-item scale to measure perceived RA extraversion. This scale was also used in the personality treatment manipulation check (Table 4) and is provided in Appendix A. The fit statistics for the alternative model were acceptable with CFI=.96, NFI=.93, GFI=.91, AGFI=.90, RMSEA=.045, and χ^2/degrees of freedom < 3:1. All hypothesized relationships were also significant in this model.

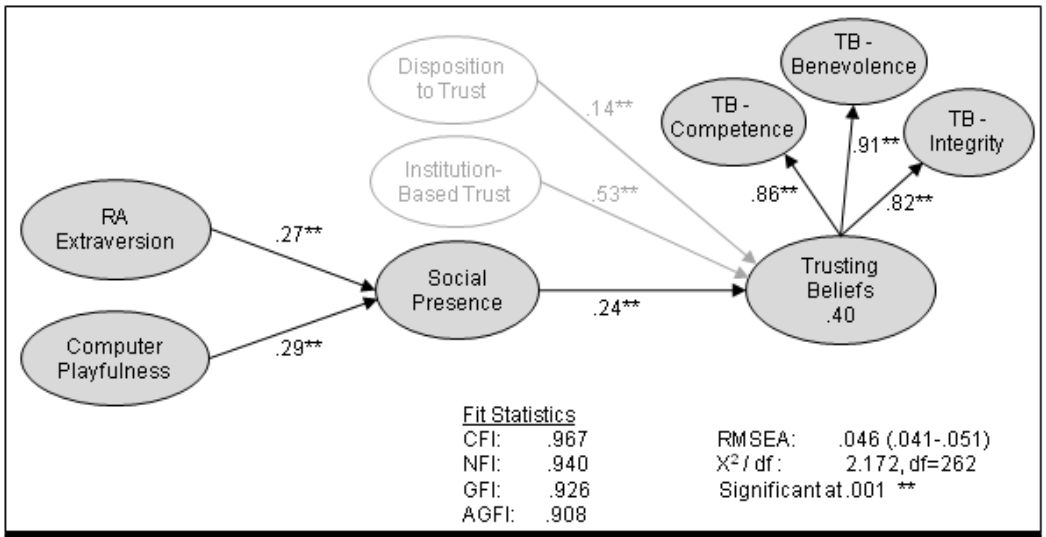

Figure 6: Structural Regression Results

The results for the multiple group analysis, presented in Table 9, support the hypothesized moderating relationship of vividness. The chi-squared statistic for the model comparison is 7.879 with two degrees of freedom and is significant at a p-value of .019. The path weights for the effect of RA extraversion on social presence increased with each level of vividness as hypothesized (T = .125, TVA = .299, TVA = .377). All significant paths in the structural regression model presented in Figure 6 remain significant in the multiple group analysis. Goodness-of-fit statistics for the unconstrained default model are also provided in Table 9. The statistics for CFI, RMSEA, and the ratio of chi-squared to degrees of freedom are above the recommended thresholds; however, the NFI, GFI, and AGFI statistics are below the recommended thresholds due to a lower sample size per group (the original sample of 550 was separated into three groups).

Table 9: Test for Moderating Effect of Vividness Using Multiple Group (Treatment) Analysis Technique in SEM

	Vividness Treatments		
	T N=197	T-V N=178	T-V-A N=175
Standardized Regression Weights			
RA Extraversion ⇒ Social Presence	.125	.299	.377
Fit Statistics			
Model Comparison: $\chi 2$ = 7.879, df = 2, p-value = .019			
Goodness-of-fit statistics for default (unconstrained) model			

CFI	.951	AGFI	.818
NFI	.880	RMSEA	.033 (.030-.036)
GFI	.853	Chi-sq/df	1.598

Post Hoc Analysis of Vividness Treatments

We conduct a Tukey's post hoc test on the three vividness treatments (Table 10), and it suggests that social presence significantly differs only between the TV and TVA treatments. Evaluating the vividness levels by personality treatment, however, provides better insight. For the introverted treatments, social presence could be expected to decrease, as increased vividness amplifies these less sociable, noticeable cues. The main effect of vividness, however, could counteract these introverted cues through the social aspects of voice and animation. These counteracting effects are evident in the decrease in social presence between the T and TV introverted treatments, followed by

an increase when animation is added. The extraverted treatment means provide a more stable pattern of increasing levels of social presence. These results further emphasize the importance of considering both the main and moderating effects of vividness.

Table 10: Post Hoc Tests of Vividness Effects on Social Presence

Vividness Treatment	Comparison Treatment	Extraverted			Introverted			Combined		
		mean	diff.	p-value	mean	diff.	p-value	mean	diff.	p-value
T	TV	4.26	-.01	1.00	3.92	.57	.016	4.09	.26	.140
TV	TVA	4.27	-59	.004	3.36	-.39	.171	3.83	-.49	.001
TVA	T	4.85	-.58	.004	3.74	.18	.656	4.32	-.23	.214

Additional Analysis of Alternative Models

We conduct several tests to address alternative representations of the research model, including tests for mediating effects. Given the difficulties of assessing the mediating effects of experimental treatments (with greater than two levels) and treatment interactions through dummy variables in regression, we run an ANCOVA to assess the direct effect of the experimental treatments on trusting beliefs. The results show that the experimental treatments do not have a significant relationship with trusting beliefs (RA Extraversion: F=2.48, p-value=.12; Vividness: F=.39, p-value=.68; Interaction: F=1.65, p-value=.19). We conduct a one-way analysis of variance and Tukey's post hoc test on the six treatments and trusting beliefs, and there is no significant effect on trusting beliefs, while these treatments were previously shown to have significant effects on social presence (Table 8). In order to test the mediating role of social presence between computer playfulness and trusting beliefs, we conduct a Sobel test (MacKinnon et al., 1995). The Sobel test statistic[8] of 4.46 is significant at $p < .000$ (Preacher and Leonardelli, 2003), indicating mediation.

Past research in the CASA paradigm has also investigated the effect of personality similarity (Lee and Nass, 2003; Nass et al., 1995) and complementarity (Isbister and Nass, 2000), and suggests that individuals will prefer other individuals or technology that exhibit personality traits similar (Byrne and Griffitt, 1969) or complementary to their own personality traits. In order to assess whether personality similarity/complementarity influenced social presence, rather than just RA extraversion, we administered a pre-survey prior to the experiment to assess subjects' level of extraversion using the same scale used to assess the extraversion of the RA (Wiggins, 1979). An ANOVA with subjects categorized as extraverted/introverted based on their survey responses shows that perceptions of social presence do not differ based on the match or mismatch of the user personality and the assigned personality treatment (F=.208, p-value=.649).

Table 11: Summary of Hypothesis Testing and Results

Hypotheses	Analysis	Results
H1: RA extraversion will be positively related to user perceptions of social presence.	SEM	Supported
	ANCOVA	Supported
H2: Interface vividness will moderate the relationship between RA extraversion and user perceptions of social presence, such that greater levels of vividness will strengthen this relationship.	SEM – multi-group analysis	Supported
H3: CP will be positively related to user perceptions of social presence.	SEM	Supported
	ANCOVA	Supported
H4: Perceptions of social presence will be positively related to user trusting beliefs in a recommendation agent.	SEM	Supported

[8] Calculated as z-value = $a*b/\text{SQRT}(b^2*s_a^2 + a^2*s_b^2)$ where a = raw (unstandardized) regression coefficient for the association between IV and mediator; s_a = standard error of a; b = raw coefficient for the association between the mediator and the DV (when the IV is also a predictor of the DV); and s_b = standard error of b.

In summary, all hypotheses were supported, as shown in Table 11. We also conducted additional analyses and no alternative research models were supported.

8. Discussion

This research examined how RA extraversion, vividness, and user computer playfulness influenced perceptions of social presence and, as a result, the trustworthiness of the RA (trusting beliefs). All hypotheses associated with the research model were supported. We found RA extraversion and computer playfulness to positively influence perceptions of social presence. Interface vividness had a positive, direct effect on social presence, and we found it to moderate (strengthen) the effect of RA extraversion on social presence. These findings suggest that increased vividness can influence perceptions of social presence by 1) creating a more sociable, warm environment (main effect) and 2) amplifying the social cues conveyed through the interface (moderating effect). We found social presence to positively influence trusting beliefs, and to serve in a mediating role within the proposed research model. Last, the nomological validity of the model was supported, as the hypothesized relationships were significant even in the presence of two known antecedents to trusting beliefs (disposition to trust and institution-based trust).

8.1. Theoretical and Practical Contributions

This research makes a number of theoretical and practical contributions to our understanding of the factors that can increase perceived social presence and consequently play a role in the trustworthiness of an RA. There are three central theoretical contributions. First, this research proposes social presence as a key construct in understanding user responses to technology and as a means for improving user responses. Second, this research helps clarify how vividness can have main and moderating effects on constructs such as social presence, shedding light on previously inconsistent results regarding the effect of vividness. Third, this study contributes to research on trust by supporting the relationship between social presence and trusting beliefs in an RA context and empirically testing the mediating role of social presence. Two practical implications are also made. First, our research illustrates what type of personalities may be manifested within interfaces and lead to greater perceptions of social presence. Second, we address the appropriate levels of vividness necessary to accurately convey the social cues embedded in an interface.

Our first theoretical contribution is to frame and support social presence as an important construct to consider in understanding user reactions to an RA, and to technology in general. This study explains how to increase perceptions of social presence by describing three categories of determinants (social technology cues, media capabilities, and individual differences) and by instantiating each of these determinants in an experimental context with an RA. While past research has measured perceptions of social presence in a website (Gefen et al., 2003; Gefen and Straub, 2004), only a few studies have manipulated interface design features to increase social presence, with inconsistent results (Choi et al., 2001; Coyle and Thorson, 2001; Fortin and Dholakia, 2005; Qiu and Benbasat, 2005). Our research advances the literature by demonstrating that vividness (a media capability) and RA extraversion (a social cue) can be manipulated to increase the perceived social presence of an RA. These results can be extended to the social presence of technology in general, and provide a social technology framework for investigating how other *media capabilities* and *social cues* may increase social presence. Research on computer playfulness (e.g., Webster and Martocchio, 1992) was advanced, as this individual difference variable was shown to explain how individuals differ in their perceptions of social presence. Individuals with low computer playfulness may have lower perceptions of social presence, and thus, may not respond as positively to social technology.

Our second theoretical contribution addresses the role that media vividness plays in the formation of social presence, and specifically, the interaction between media vividness and social technology cues provided through media. The results of our study support both main and moderating effects of media vividness and may explain past inconsistent results. Levels of vividness, or symbol sets, may create a perception of social presence without conveying specific social cues, but these effects tend to be modest (Fortin and Dholakia, 2005) or in the correct direction, but insignificant (Coyle and Thorson, 2001). For example, the use of both animation and voice as compared to just text may increase

perceived social presence regardless of whether any social cues (e.g., friendliness or personality) are conveyed through the animation (Choi et al., 2001), while the differences between text and voice may be marginal. The quality or realism of different levels of vividness, for example computer synthesized voice or faceless animations, may also influence results (Qiu and Benbasat, 2005). Efforts to increase the perceived social presence of technology should consider both the types of channels used and the number of channels used (i.e., redundancy), along with the social cues conveyed through these channels. In our study, social cues were conveyed in every channel, and thus, the moderating effect amplified the social cues, enhancing (in the case of RA extraversion) or detracting (in the case of RA introversion) from the main effect of vividness on social presence. The study of moderating effects, in general, is an important contribution to research as these effects often explain inconsistencies in past research while providing a modest improvement in explanatory power (Sun and Zhang, 2006). Future work should continue this research and investigate how different channels and other media capabilities may influence social presence.

Our third theoretical contribution involves the testing of the relationship between social presence and trusting beliefs in an experimental, decision-making context where social cues and vividness were varied. We conducted this empirical investigation within a comprehensive nomological network of trust-related constructs and showed that social presence is a significant determinant of trusting beliefs even in the presence of other known determinants of trusting beliefs. The results also supported the mediating role of social presence and suggest that vividness and social cues do not directly influence trust. Extending the research model beyond social presence enhances the contribution of the study for designing more trustworthy RAs, and interfaces in general. Future research should investigate whether social presence mediates the effect of other media capabilities, such as interactivity, on downstream variables such as trusting beliefs.

Our first practical implication relates to what types of personalities should be manifested by RAs to lead to greater perceptions of social presence. Our research confirms early findings on website audio — a computerized voice that conveys an extraverted personality will be perceived as having greater social presence (Lee and Nass, 2005) — and extends this finding to the use of written words and animation. Businesses seeking more favorable user reactions to an RA may want to imbue the RA with more extraverted characteristics, since extraverted personalities are positively related to user perceptions of social presence. As discussed earlier, a more extraverted personality tends to be viewed as more sociable and revealing. Organizations trying to increase the social presence of RAs, websites, or other technology, should consider conveying extraverted personality features within the various media channels employed by the technology.

Our second practical implication focuses on providing the appropriate level of media vividness to create positive reactions in users. Given that characteristics such as RA extraversion may enhance social presence, an RA that better portrays such extraversion should stand a better chance of increasing social presence. While RA extraversion can be conveyed with a low level of media vividness (text only), more vivid media provide additional capability to convey social cues in the interface. In this case, design implications are clear. A medium that is more vivid—that is, that conveys more cues and better quality cues—will increase the effect that these cues have on perceived social presence, and thus downstream behavioral outcomes such as trust.

8.2. Limitations and Future Research

As with all studies, there are limitations and opportunities for future research. While we examined one media capability (vividness), which we believed to play a significant role in the creation of a more social interface, a limitation of the study is that we did not address other media capabilities, such as interactivity. Interactivity refers to “the extent to which users can participate in modifying the form or content of a mediated environment in real time” (Steuer, 1992, p. 80). We controlled and implemented a low level of interactivity in the experimental application (i.e., reciprocal communication and product interactivity were not provided) in order to better assess the resulting social presence from different levels of vividness and RA personality. Future research should investigate the effects of both vividness and interactivity on social presence, with a goal of isolating and comparing differing levels of

vividness and interactivity as well as potential interactions between the two constructs.

While computer playfulness was shown to be a key individual difference that can influence perceptions of social presence, other individual characteristics may explain additional variance. Further, more insight into the main and moderating effects of vividness could be provided by using a different experimental design in which vividness is increased but the additional channels are not utilized for conveying other social cues (e.g., personality). Future research could also investigate the long-term effect that increased levels of social presence have on user reactions to an RA with extended use. At some point, more social cues and enhanced media capabilities may become distracting and have a detrimental effect on user perceptions and performance. An investigation of the boundary levels for social presence could be insightful. Last, this study could be extended to a more diverse group of users, where age and computer experience are more varied.

9. Conclusion

Building on past research on social presence, this study examined the effect that RA personality and increased levels of vividness have on user perceptions of social presence. Further, the effect of a user's computer playfulness on social presence was also investigated. In support of our hypothesized relationships, both user computer playfulness and RA personality were shown to influence social presence and downstream trusting beliefs in a decision-making context. As hypothesized, media vividness was shown to have a moderating effect on the relationship between RA personality and social presence rather than just a direct effect on social presence. We believe that this research provides a theoretically grounded model for explaining how more socially present and trustworthy RAs can be designed to augment human decision making, and suggests future conceptual and empirical research in this domain.

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APPENDIX A: SURVEY ITEMS

(All items were 7 pt scales anchored with Strongly Disagree/Strongly Agree unless noted below).

Extraversion: (8 pt adjective scale anchored with Extremely Inaccurate / Extremely Accurate). For each word below, please use the rating scale to describe how accurately the word describes the Apartment-Finder decision aid that you just used.

1. Outgoing 2. Vivacious 3. Enthusiastic 4. Cheerful 5. Perky

Computer Playfulness: For each adjective listed below, please click on the response that best matches a description of yourself when you interact with computers.

1. Spontaneous 2. Flexible 3. Creative 4. Playful

Social Presence: (7 pt adjective scale anchored with the following adjective pairs). Please click on the response that best represents your feelings about the ApartmentFinder Decision Aid.

1. cold / warm
2. insensitive / sensitive
3. impersonal / personal
4. unsociable / sociable

Disposition to Trust (Trusting Stance subcomponent)**:** Please click on the response that best represents your feelings about other people.

1. I usually trust people until they give me a reason not to trust them.
2. I generally give people the benefit of the doubt when I first meet them.
3. My typical approach is to trust new acquaintances until they prove I should not trust them.

Institution-Based Trust (Situational Normality subcomponent)**:** Please click on the response that best represents your feelings about decision-making software.

1. I feel good about how things go when I use software to assist in decision-making tasks.
2. I am comfortable making decisions using decision-making software.
3. I feel at ease using decision-making software to help me make decisions.

Trusting Beliefs: (Benevolence, Integrity, and Competence subconstructs). Please click on the response that best represents your feelings about the ApartmentFinder Decision Aid.

b1. I believe that the ApartmentFinder Decision Aid would act in my best interest.
b2. If I required help, the ApartmentFinder Decision Aid would do its best to help me.
b3. The ApartmentFinder Decision Aid is interested in my well-being.
i1. The ApartmentFinder Decision Aid is truthful in its dealings with me.
i2. I would characterize the ApartmentFinder Decision Aid as honest.
i3. The ApartmentFinder Decision Aid is sincere and genuine.
c1. The ApartmentFinder Decision Aid is competent and effective in providing apartment selection advice.
c2. The ApartmentFinder Decision Aid performs its role of giving apartment selection advice very well.
c3. Overall, the ApartmentFinder Decision Aid is a capable and proficient apartment selection advice provider.
c4. In general, the ApartmentFinder Decision Aid is very knowledgeable about apartments.

APPENDIX B: TREATMENT SCRIPTS

Note: The italicized text represents animation descriptions that specify the gestures made by the animation treatment during various parts of the script.

EXTRAVERTED SCRIPT

INTRODUCTION (text appears in initial splash form): *Greet animation*. Welcome to the Apartment Finder Tool. I am going to assist you in selecting an apartment. *Blink animation.* Local apartment data has been gathered and this tool will help you select an apartment, based upon your apartment preferences. After you have reviewed the various alternatives, you will select the apartment that best meets your needs.

TUTORIAL: *Explain animation*. Before you use the tool I'm going to give you a brief tutorial. After the tutorial, you will use the tool to help you pick the best apartment.

Feature-Weighting Form: *Move agent to top of screen, Show animation.* Before you begin, you need to specify the apartment features that are most important to you. To do this, allocate 100 points among the 8 apartment features. *Gesturedown animation*. However, each feature does not need to receive points. *Movedown animation*. The total at the bottom will tell you how many points you have remaining. *Blink animation.* As an example, I have allocated points to some of the features as shown. Based on how I assigned points in this example, the Noise feature is most important, while the Internet Access feature is not important at all. *Gesture animation.* After the tutorial, you will assign points based on your own opinions. When you are finished allocating points, click the "Done" button.

Comparison-Matrix Form: *Moveup animation.* I'm now going to show you how to use our apartment finder tool. Shown on this screen are 10 different apartment alternatives. Each apartment has different characteristics. *Alert animation.* The Apartment Finder Tool I am showing you provides many different functions for sorting and viewing the apartment choices. If you follow my instructions, this tool will help you select the apartment that is best for you.

- Hide / Show Apartment Features: *Move animation and gesture.* The "Hide" pulldown box allows you to hide an apartment feature. You need to hide features that are not important to you so you can better focus on features that are very important. For example, if the Noise feature is not important to you, hide this feature. To redisplay an apartment feature that you have previously hidden, use the "Show" pulldown box. *Redisplay Noise feature in matix.* Or, use the "Show All Features" button, to redisplay ALL of the apartment features that you have hidden.

- Rearrange Apartment Features: *Move animation and gesture.* The "Rearrange Apartment Features" buttons allow you to change the order in which the apartment features are presented. For example, if Size is an important feature to you, move the Size column Left by clicking on the "Left" button, so that Size appears as the first column in the grid. If Size is not important, move the Size column to the Right side of the grid.

- Hide / Show Apartment Choices: *Move animation and gesture.* The "Hide" pulldown box allows you to hide an apartment alternative. Hide apartments that do not interest you so you can better focus on the apartments that best meet your needs. For example, if apartment J does not meet your needs, you need to hide this apartment. To redisplay an apartment alternative that you have previously hidden, use the "Show" pulldown box. *Redisplay apartment J in matrix.* Or, use the "Show All Apartments" button, to redisplay ALL of the apartment choices that you have hidden.

- Rearrange Apartment Choices: *Move animation and gesture.* The "Rearrange Apartment Choices" buttons allow you to change the order in which the apartment alternatives are presented. For example, if apartment D is your first choice, move apartment D up by clicking on the "Up" button

so that it appears as the first row in the grid. If apartment D is not one of your favorites, move apartment D down, by clicking on the "Down" button.

- Sorting: *Move animation and gesture.* The sorting function allows you to sort the apartment alternatives. Use the "First Sort" pulldown box to select the feature that is most important to you and then sort the apartment choices in ascending or descending order by this feature. For example, if you would like to sort the apartment choices from the lowest to the highest Rent, select the Rent feature from the pulldown box, click the Ascending option, and then click the "Sort" button. *Move animation and gesture.* The "Second" pulldown box allows you to specify what you believe is the second most important apartment feature. You cannot select a Second Sort feature, until you have specified a First Sort feature.

- Final Selection: *gesture.* When you have finished hiding, arranging, and sorting the Apartment Choices, you need to rank order the remaining apartments with the best one in the first row. Then select this apartment from the Final Selection pulldown box and click on the "Done" button. *Moveup animation to top of screen.* If you have a question about any of the features that have just been described, just ask me by clicking on the question mark button next to that feature. *Congratulate animation.* You have finished the Tutorial! Now let's get to it! *END TUTORIAL – subject returns to the blank weight form and is now able to interact with the application.*

EXPERIMENT:
Feature-Weighting Form *Announce animation.* You may now use the Apartment Finder Tool!

Comparison-Matrix Form *Movedown and explain animation*. You now need to sort, move, and hide apartments and features to be sure that you select the best apartment. When you are done, order the remaining apartments with the best apartment in the first row. Then select the best apartment in the "final selection" pulldown box!

Note: The scripts for the various matrix features listed above will execute during the use of the comparison matrix if the user clicks on a '?' button next to the feature.

INTROVERTED SCRIPT

INTRODUCTION (text will appear in initial splash form): *Greet animation*. Welcome to the Apartment Finder Tool. This tool may assist you in selecting an apartment. *Blink animation.* Local apartment data has been gathered, and this tool may help you select an apartment based upon your apartment preferences. After you have reviewed the various alternatives, you will be asked to select the most suitable apartment.

TUTORIAL: *Explain animation*. Before you use the tool, you will be given a brief tutorial. After the tutorial, you may use the tool to assist you in finding a suitable apartment.

Feature-Weighting Form: *Show animation. As little movement as possible.* First, you will be asked to specify the apartment features that seem important to you. Allocate 100 points among the 8 apartment features. *Lookupleft animation*. But remember, you do not need to assign points to all features. *Lookupleft animation*. The total at the bottom will display how many points you have remaining. *Blink animation.* As an example, points have been allocated to some of the features as shown. Based upon the points assigned in this example, the Noise feature might be most important while the Internet Access feature may not be important. *Lookupleft animation.* When you are finished allocating points, you may click the "Done" button.

Comparison Matrix Form: *Same position –as little movement as possible.* There are 10 apartment alternatives. Each apartment has different characteristics. *Alert animation.* The Apartment Finder Tool provides many different functions for sorting and viewing the apartment choices. Using these different functions may help you find an apartment that is suitable.

- Hide / Show Apartment Features: *Lookleft animation – don't move agent.* The "Hide" pulldown box will allow you to hide an apartment feature. You may want to hide features that are not as important to you, so you can focus on features that are more important. For example, if the Noise feature is not very important to you, you may want to hide this feature. *Lookleftblink animation*. To redisplay an apartment feature that you have previously hidden, you may use the "Show" pulldown box. *Redisplay Noise feature in matrix.* Or, you may use the "Show All Features" button to redisplay all of the apartment features that you have previously hidden.

- Rearrange Apartment Features: *Lookleft animation.* The "Re-arrange Apartment Features" buttons allow you to change the order in which the apartment features are presented. For example, if Size is an important feature to you, you may want to move the Size column Left by clicking on the "Left" button, so that Size appears as the first column in the grid. If "Size" is not important, you may want to move the Size column to the Right side of the grid.

- Hide / Show Apartment Choices: *Lookleftblink animation.* The "Hide" pulldown box will allow you to hide an apartment alternative. You may want to hide apartments that do not appeal to you, so you can better focus on the apartments that meet your needs. For example, if apartment J is not suitable, you may want to this apartment. To redisplay an apartment alternative that you have previously hidden, you may use the "Show" pull down box. *Redisplay apartment J in matrix.* Or, you may use the "Show All Apartments" button to redisplay all of the apartment choices that you have previously hidden.

- Rearrange Apartment Choices: *Lookleft animation.* The "Re-arrange Apartment Choices" buttons may allow you to change the order in which the apartment alternatives are presented. For example, if apartment D is your first choice, you may want to move apartment D up, by clicking on the "Up" button, so that it appears as the first row in the grid. If apartment D does not seem suitable for you, you may want to move it down, by clicking on the "Down" button.

- Sorting: *Lookleft animation.* The sorting function will allow you to sort the apartment alternatives. The "First Sort" pulldown box will allow you to select the feature that seems most important to you, and will then sort the apartment choices in ascending or descending order by this feature. For example, if you would like to sort the apartment choices from the lowest to the highest Rent, you may select the Rent feature from the pulldown box, click the Ascending option, and then click the "Sort" button. *Lookleftblink animation.* The "Second Sort" pulldown box will allow you to specify the apartment feature that seems most important to you after the "First Sort" feature. You may select a Second Sort feature after you have selected a First Sort feature.

- Final Selection: *Lookleft animation.* When you have finished hiding, arranging, and sorting the apartment choices and features, please rank order the remaining apartments with your favorite in the first row. Then select this apartment from the "Final Selection" pulldown box. After you have selected an apartment, you may click on the "Done" button. *Alert animation.* If you have a question about any of the functions that have just been described, you may click on the question mark button next to the feature. You have finished the Tutorial. *END TUTORIAL – subject returns to the blank weight form and is now able to interact with the application.*

EXPERIMENT:
Feature-Weighting Form A*nnounce animation.* You may now use the apartment finder tool.

Comparison Matrix Form You may now sort, move, or hide apartments. When you are finished, please order the remaining apartments with your favorite in the first row. Then select this apartment from the "final selection" pulldown box.

Note: The scripts for the various matrix features listed above will execute during the use of the comparison matrix if the user clicks on a '?' button next to the feature.

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