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The Role of Social Presence in Interactive Agent-Based Persuasion

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This investigation examines the extent to which interactive social agent technology can influence social presence, information processing, and persuasion. Specifically, it looks at how interactive media using virtual agents can increase the sensation of social presence, or the extent to which a person feels "with" a mediated being. Using logic based on the Heuristic Systematic Model (HSM), social presence is posited to impact indicators of heuristic and systematic processing, leading to changes in attitude and intention toward a health issue. A 2 × 2 between subjects experiment was conducted (N = 125) with manipulations of interactivity (interactive or not) and source attractiveness (attractive or unattractive). Results of causal model tests suggest that interactive agents facilitate social presence leading to increased message processing, which in turn affects both attitude and behavioral intentions toward the issue of healthy blood pressure. Contrary to expectations, however, social presence with an unattractive source did not impede attitude and intentions. These findings are interpreted in light of presence, new media, and HSM scholarship.

The astounding growth in the past decade of computerized media technology, major examples of which being the Internet and virtual reality (VR), has generated a great deal of interest in the potential for such devices to affect persuasion (e.g., Fogg, 2003). These technologies promise to surpass the persuasive success of traditional media like television through unique features

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that allow users to exert greater control over communication processes. *Interactivity* is the most prominent of these features. Today's computer-based technologies give users the ability to interact with mediated people and objects in a manner conducive to the experience of *presence*, "the perceptual illusion of nonmediation" (Lombard & Ditton, 1997). Understandings of presence are central to logic explaining the effects of many new interactive technologies and have already been applied to research on persuasion in computer-generated virtual environments (e.g., Grigorovici, 2003; Guadagno, Blascovich, Bailenson, & McCall, 2007; Li, Daugherty, & Biocca, 2002). However, few studies have addressed the role of presence in new media persuasion situations involving mediated *sources*, that is, people and other beings who communicate (persuasive) messages. Given the important role of source characteristics in prior research on persuasion, its possible influence on persuasion through new media is difficult to overlook. This investigation examines the potential for information processing and persuasion to be influenced by presence-inducing interactive media sources.

A focus on characteristics of source has played a substantial part both in traditional persuasion research, and, coincidentally, in the design of new media hardware and software. In the former, a sizeable body of literature has accumulated about the effects of source characteristics such as credibility, liking, perceived similarity, and physical attractiveness (see O'Keefe, 2002 for a review). When these characteristics are perceived, sources are generally believed to have stronger effects on persuasion. In the latter case, consideration of source attributes is a central feature of research on new technologies such as videoconferencing systems. These machines are being designed to bring people in remote locations "together" through communication media by creating a sense of *social presence*. The concept of social presence, simply understood as the feeling of being "with" another mediated being, has become a major concern among developers of new media technology because it is believed to enhance the effectiveness of mediated interpersonal and group interactions (Biocca, Harms, & Burgoon, 2003). Because high levels of social presence have the ability to improve social exchanges and strengthen source cue effects (Lombard & Ditton, 1997; Skalski & Tamborini, 2004), technology developers are interested in identifying features that increase the potential for social presence. One of the most striking examples of an application thought capable of enhancing social presence is social agent technology.

Social agents are defined here as computer software programs that both perform functions in an "intelligent" way (e.g., helping users on their own initiative) and possess the ability to interact with humans in a social way (Lieberman & Selker, 2002; Thórisson, 1996). One well known example of a social agent is *Clippit*, the animated paperclip assistant in Microsoft's *Word* program. The idea behind social agents such as Clippit is to support computer users by allowing them to obtain information through (personal) human-like channels instead of (impersonal) machine-like channels. This type of technology can also be used for persuasion. Huang (1999) discusses the potential for social agents to positively affect persuasion in health contexts based on their interactivity and ability to convey a sense of social presence. He argues that animated computer characters such as social agents foster more careful information processing and positive change in attitude and intention. Research findings from studies employing the Heuristic-Systematic Model (HSM) (Eagly & Chaiken, 1993) offer evidence consistent with this claim. HSM research suggests that source cues can affect attitude change by prompting heuristic or systematic processing of persuasive messages, and Skalski and Tamborini (2004) argue that this effect should be influenced by characteristics of presence-inducing technology such as vividness and interactivity.

The present study attempts to extend recent work examining the effects of new media on persuasion within the HSM framework by looking at how interactivity and social presence affect information processing and persuasion in a health context. Specifically, it will look at social presence with a social agent. Social agents, by virtue of their ability to interact with computer users, are proffered to instill a greater sense of social presence than nonsocial agents (e.g., media sources that do not respond to the user). Subsequently, social presence is expected to affect the processing of information in a persuasive message to influence resulting attitude and behavioral intention regarding health issues.

The Heuristic-Systematic Model (HSM)

The HSM has played a central role in research on persuasion by explicating the underlying mental processes responsible for changes in attitude and intention. The model has been used in recent studies to address health communication issues such as risk perception (Trumbo, 2002) and is applied to the issue of high blood pressure in the present investigation. High blood pressure affects one in three U.S. adults, leading to health problems ranging from stroke to heart failure (American Heart Association, n.d.). Changing attitudes and intentions in favor of preventing high blood pressure may be possible through successful applications of persuasion models such as the HSM, and both persuasive outcomes are important. *Attitudes* represent how individuals evaluate issues such as health problems, and more positive attitudes toward dealing with issues such as health problems are expected to relate to action (Perloff, 2003). These may include behavioral *intention*, or the readiness of an individual to perform a given behavior (such as diagnosing and fixing health problems), which is assumed to be a direct antecedent of behavior (Ajzen, 2002).

Like the Elaboration Likelihood Model (ELM) (Petty & Cacioppo, 1981), the HSM is a dual-process model of persuasion. It identifies two concurrent modes of social information processing—heuristic and systematic—and attempts to specify conditions that trigger or govern each (Todorov, Chaiken,

& Henderson, 2002). Systematic processing is a "comprehensive, analytic orientation to information processing in which perceivers access and scrutinize a great deal of information for its relevance to their judgment task" (Eagly & Chaiken, 1993, p. 326). Heuristic processing is thought of as a "more limited mode of information processing that requires less cognitive effort and fewer cognitive resources than systematic processing" (p. 327). This type of processing involves focusing on a subset of available information that enables the use of simple decision rules (i.e., cognitive heuristics) to reach decisions. Unlike the ELM, the HSM specifies that the two modes of processing can co-occur and simultaneously exert an effect on judgments (Chen & Chaiken, 1999). As the authors of this paper adopt a similar position on processing mode co-occurrence, the HSM is used here instead of the ELM.

The HSM allows processing modes to work together for or against persuasive outcomes. In some circumstances, heuristic processing may work against the use of systematic processing and bias targets toward the use of heuristic cues such as source attractiveness (a focus of this investigation) to guide their judgments. For example, if a message about blood pressure has unclear arguments about the importance of getting a checkup, or if a source is very salient, message recipients may be swayed by a negative source cue (e.g., unattractiveness) away from having a more favorable attitude or intention toward a checkup. If the implications of processing modes are congruent, however, the two can have an additive effect on attitude and intention (Todorov, Chaiken, & Henderson, 2002). This might happen, for example, when a positive source cue (e.g., an appealing person or agent) is added to a persuasive message, in which case the message content and heuristic source cue might exert a greater impact on persuasion than either of the two elements separately. As these examples demonstrate, several different types of processing-based outcomes are possible within the HSM framework, giving the model more explanatory power than the ELM and similar dual-process models (see Chen & Chaiken, 1999, for a discussion).

Since systematic processing demands more cognitive resources, Chaiken and Eagly (1983) believe that it might be constrained or disrupted by situational or individual factors that reduce processing ability. These can include distraction, time pressure, and communication modality (Todorov, Chaiken, & Henderson, 2002), the latter of which is of central importance here. The concept of modality has long been used to account for the role of media in persuasion research based on the HSM and other perspectives (Chaiken & Eagly, 1983; Corston & Colman, 1997). The reason for modality effects on persuasion has traditionally been conceptualized as a function of the ability of certain modalities to make communicator cues affecting judgments more salient (Eagly, 1992). However, the usefulness of "modality" as a way to distinguish media influence is becoming increasingly problematic due to technological advancements that have occurred in recent years. Skalski and Tamborini (2004) note that differences exist not only between modalities (e.g., TV and print), but also within modalities (e.g., TV screen size and resolution) along media attributes likely to account for differences in outcomes of persuasive messages. Importantly, these differences are accentuated in new media technologies like VR and the Internet. Such changes in technology call for new concepts to account for the effects of media on information processing, persuasion, and other exposure outcomes. The present study focuses on the concept of *social presence,* particularly as it applies to message sources.

Conceptualizing Social Presence

Briefly stated, *social presence* is the sense of "being with" another located in a media environment (Biocca, Harms, & Burgoon, 2003). In the context of mediated communication, contemporary thinking about social presence can be traced to the work of Short, Williams, and Christie (1976), who defined the concept as "the degree of salience of the other person in [an] interaction and the consequent salience of the interpersonal relationships" (p. 65). Importantly, this definition suggests that social presence is more than just a dichotomous "here or not" judgment and instead exists along a continuum affected by factors such as individual perception and communication technology. The work of Short et al. (1976) on social presence has been adopted by scholars interested in comparing the appropriateness of different forms of media for types of social interaction (e.g., Rice, 1993; Walther, 1996). Ultimately, it seems concerned with the best ways to use media for social purposes.

Recent work on social presence has taken a more user-centered approach (vs. technology-centered approach) consistent with contemporary notions of presence as a psychological state (Lee, 2004; Lombard, 2000). In contrast to the work of Short et al. (1976), which focuses on user perceptions of a medium's ability to make others salient, this work examines the actual perceived salience of others based on attributes of communication media (Nowak, 2001). As a result, development of current social presence "theory" focuses on two fundamental issues: (1) the *technology* question, that is, how do changes in properties of media interfaces affect social presence, and (2) the *psychological* question, that is, how do humans attribute social presence to mediated representations (Biocca, Harms, & Burgoon, 2003). In the latter case, Biocca et al. contend that the concept of social presence connects to several psychological constructs, such as co-presence, psychological involvement, and behavioral engagement. Co-presence, for example, refers to the basic sensory awareness of another and is considered a necessary pre-condition for social presence, dating back to work by Goffman (1959) and elaborated upon more recently by Zhao (2003) and Biocca, Harms, & Burgoon (2003). A full discussion of social presence dimensions is beyond the scope of this work, but nevertheless, it is important to highlight the complexity of the concept to help improve the status of social presence theory and research, as the present study endeavors to do.

In line with recent, more psychological-oriented thinking, this investigation adopts the definition of social presence by Lee (2004), who defines it as a state in which virtual "social actors are experienced as actual social actors" (p. 45). According to Lee, social presence occurs when technology users lose awareness of either the para-authenticity of mediated human sources or the artificiality of nonhuman social actors. In a videoconference, for example, social presence would occur if a person appearing in video form (a mediated human source) was thought of as being in the same room to some extent or degree instead of as "para-authentic" or not really "there," even though they appear on a screen in human form. However, social presence can also occur in response to "nonhuman social actors" such as animated virtual characters, when the nonhuman social actors are perceived as real and present in the same location instead of as "artificial" or computer-generated representations of beings. As this definition implies, social presence is mainly a function of individual perception. However, the role of technology in creating a sense of presence must not be overlooked. Examination of technology's role in this process shows how the concept of modality can be reconsidered in presence-related terms.

Media Technology and Presence: Prior Work and Unanswered Questions

Presence has been mainly thought of as a likely outcome of exposure to advanced media technologies such as VR, but accumulating evidence suggests that it can be felt in response to *any* medium, ranging from television (Bracken, 2005) to video games (Schneider, Lang, Shin, & Bradley, 2004) to the Internet (Bente, Rüggenberg, & Krämer, 2005). Steuer (1995) identifies two dimensions along which communication technologies vary in their potential to induce presence: vividness and interactivity.[1] *Vividness*, according to Steuer, refers to "the ability of a technology to produce a sensorially rich mediated environment" (p. 41). *Interactivity* refers to "the degree to which users of a medium can influence the form and content of the media environment" (p. 41). The dimensions of vividness and interactivity shift the research focus in this area from the use of many different categories of modality to the use of two continuous variables that distinguish characteristics of technology.

[1]Although Steuer (1992) writes about telepresence specifically, we believe his explication of dimensions determining telepresence apply to social presence as well. Logical and empirical evidence suggest that more vivid and interactive sources will create more social presence for the same reasons that more vivid and interactive environments create telepresence. This logic is consistent with Lombard and Ditton's (1997) seminal work on presence, which includes a discussion of media form variables determining presence in general, including spatial and social dimensions, that is consistent with Steuer's work.

Notably, the dimensions of vividness and interactivity are consistent with a human-centered presence approach, since each dimension is discussed in terms of how it might affect the sensorimotor functions of users.

In line with contemporary new-media scholarship (e.g., Li, Daugherty, & Biocca, 2002; Steuer, 1995), Skalski and Tamborini (2004) replicated parts of Chaiken and Eagly's (1983) experiment on modality effects and extended this work by reconsidering modality in terms of variance in media vividness and resulting feelings of social presence. To manipulate vividness, the authors exposed subjects to a videotaped, source-delivered persuasive message on a small-, medium-, or large-screen television (with a print message included as a control). They then measured subjects' levels of experienced social presence, information processing, and attitude toward the position of the message. Results were consistent with explanations that vividness increased social presence, as expected, and that social presence affected both systematic and heuristic processing leading to attitude. However, an alternative hypothesis suggests that the observed change in social presence was driven mainly by the difference between the print and television conditions, and not by the screen-size induced vividness. Skalski and Tamborini suggested that replication manipulating media interactivity would provide a better test of the model. Toward this end, the present study examines the extent to which interactivity affects the processing of persuasive-message content. Given the abundance of interactive media now in existence, the role of this type of technology in persuasion remains an important unanswered question. We begin to examine this question by determining whether or not interactivity with a mediated source can increase social presence and information processing affecting attitude change, and end by positing a model of these relationships.

Interactive Social Agent Technology and Persuasion

Interactivity is a key feature of many new media technologies, including video games and the Internet. In a recent review of the interactivity literature, Lee, Park, and Jin (2006) defined interactivity in media user terms, as the "perceived degree that a person in a communication process with at least one more intelligent being can bring a reciprocal effect to other participants of the communication process by turn taking, feedback, and choice behaviors" (p. 263). This definition gets at the subjective perception of interactivity, but as Lee et al. establish, several other authors have defined interactivity in terms of technology (e.g., Biocca, 1998) or setting (e.g., Rafaeli, 1988). Given the many inconsistencies in the interactivity literature and general problems with defining this concept, this study will focus on interactivity at the individual and technology levels. Examining interactivity at the individual level overcomes problems associated with *how* interactive media are used. For example, instant messaging programs can be used with lower or higher levels of interactivity depending on the extent to which users take advantage of emoticons and other interactive features in addition to text.

Recent discussions of interactivity are mainly a function of advances at the technology level, but in simpler technology terms, interactivity can be thought of as the extent to which a user can be a receiver and sender instead of just a receiver (Vorderer, 2000). The degree to which media provide technological interactivity is an important consideration both from a theoretical and empirical standpoint, since researchers can manipulate features of interactive media to induce levels of interactivity within individuals. The present study examines the effects of manipulations of the social capabilities of interactive media. According to Heeter (1989), the *most* interactive media are those which respond to the needs and characteristics of users in a natural, human-like fashion. Such media should create a stronger sense of social presence because the feedback they provide more closely simulates face-to-face interaction, the mode of interaction considered to be the standard for communication exchanges (Durlak, 1987). Thus, people who use media that allow them to interact with a source are expected to feel greater senses of perceived interactivity and social presence than those who passively absorb source-communicated information.

One explanation for this comes from recent work emphasizing interactive behavior, that is, behavioral engagement, as a determinant of social presence (Biocca, Harms, & Burgoon, 2003). Behavioral engagement can include face-to-face talking, text chatting (perhaps considered a new media manifestation of talking), and a host of other nonverbal communication behaviors (see Burgoon & Hoobler, 2002, for a discussion of nonverbals). Looking at such a wide variety of interactive behaviors is a rather recent development in empirical work exploring the link between interactivity and social presence. Prior to the mid-1990s, most social presence research dealt with limited, low-bandwidth interactive media, thereby limiting engagement to text-based verbal behavior and a narrow range of nonverbal behavior (Biocca, Harms, & Burgoon, 2003). In recent years, the possibilities for behavioral engagement have expanded considerably. High-bandwidth web sites, immersive VR technology, computer games, and other new technological developments have opened up a variety of new-media interaction forms with the potential to create strong social-presence experiences. One such recent development, and the focus of this research, is social-agent technology.

Social agents are autonomous software "creatures" that possess some interaction "knowledge" as a result of programming and can therefore engage in social interaction with people on some level (Thórisson, 1996). Computerized social agents might be useful in persuasion and other contexts for several, interconnected reasons. Research on Human-Computer Interaction (HCI) argues that humans, as a result of evolution, are hard-wired to respond to computers as people (Reeves & Nass, 1996). Social agents can facilitate this natural inclination, as demonstrated in subsequent research suggesting that people experience more presence in response to computers that include visual representations such as social agents (Nowak & Biocca, 2003). Social agents are also helpful because they can perform tasks for humans at low cost and in user-friendly fashion (Lieberman & Selker, 2003). Once an agent is programmed, it can quickly communicate vast amounts of information just as if the information was communicated by an actual human source. This makes them particularly valuable to organizations looking to provide information. Moreover, since social agents interact with users and induce behavioral engagement, they have an inherent ability to stimulate social presence in a manner that makes them valuable from the standpoint of information processing and persuasion (Huang, 1999).

HYPOTHESIZED RELATIONSHIPS

The present study attempts to extend the work of Skalski and Tamborini (2004) on social presence and persuasion by stimulating social presence through varying forms of social agent-produced interactivity instead of screen size-produced vividness. This is done by using a social agent in place of a human videotaped source and manipulating the degree of interactivity found in the social agent. The use of an interactive agent is expected to instill a higher level of social presence than that observed in Skalski and Tamborini's one-way persuasive communication exchange. A corpus of evidence by Reeves and Nass (1996) shows that people tend to respond to computers as if they were human, and social agents should help to exploit this natural tendency by "putting faces" on computer technologies. This study posits that interactivity increases social presence, which affects information processing leading to changes in attitude and intention. The expected relationships are explained below and form the hypothesized path models tested here.

First, because interactive media more closely match real-life social interactions than passive media, a medium with an interactive social agent should create a stronger sense of social presence than a medium with a passive social agent (i.e., one that does not interact with the user). This increase in social presence can be attributed to the interactive agent's ability to increase the *perception* of interactivity, in line with Lee et al.'s (2006) definition of the concept:

H1: Perceived interactivity relates positively to social presence.

Social presence is expected to have a direct effect on indicators of heuristic processing, specifically source thoughts, as demonstrated in past research (Skalski & Tamborini, 2004). In the present study, since greater attention should be called to the source as a function of interactivity-induced social presence, the heightened levels of presence anticipated here are expected to lead to even more source-related thinking. When subjects feel they are "with" a source, the source information is expected to create a stronger "mental model" or impression of the entity (Biocca, Harms, & Burgoon, 2003), leading this information to affect judgments.

The HSM literature frequently characterizes the source of a message as a type of *heuristic* cue that can affect message judgments independent of the quality of persuasive arguments (e.g., Todorov, Chaiken, & Henderson, 2002). In other words, sources should be regarded as features of a persuasion situation leading people to engage in *heuristic processing* instead of systematic processing, in most circumstances. Although there is some controversy over the measurement of heuristic processing, given its largely unconscious nature (see Todorov, Chaiken, & Henderson, 2002, for a review), source thoughts are most often viewed as evidence for heuristic processing (Chaiken & Eagly, 1983; Skalski & Tamborini, 2004), since thoughts about source attributes are routinely unrelated to judgment tasks. Occasionally, source thoughts may indicate systematic processing. This would be true when source thoughts are relevant to judgments at hand. For example, if an unattractive source is used to communicate information about a beauty product, thoughts about source appearance (e.g., "the product does not appear to have worked on this source") could indicate systematic processing due to the connection between attractiveness and judgments about beauty product effectiveness. Alternatively, if an unattractive source is used to communicate information about a product or issue unrelated to source characteristics, such as tax reform, thoughts about the source are more likely to indicate heuristic processing because source cues communicate nothing about the important issues surrounding the federal tax code.

In the present study, we used issues related to the risks and treatment of problems associated with high blood pressure, presuming that source attributes have very little connection to these issues. If source characteristics have an effect on attitude in response to a blood pressure message, the effects would almost certainly be due to the use of simple decision rules or cognitive heuristics about the source, that is, heuristic processing, and not systematic consideration of persuasive message content. This is especially true given that the source in this study was a nonhuman agent that would be unaffected by blood pressure and related issues such as diet and exercise.

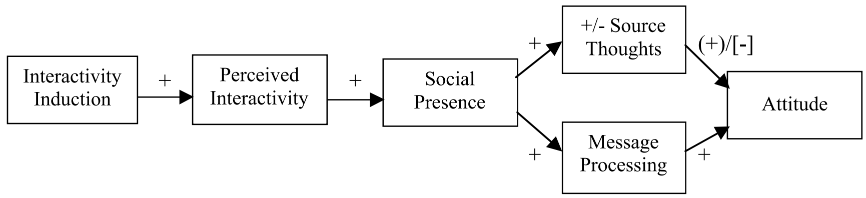
The specific attribute of the source that was manipulated was physical attractiveness. Past research suggests that source attractiveness may serve as a heuristic or peripheral cue affecting persuasion, with more attractive sources leading to more positive attitudes than less attractive ones (Chaiken, 1979; Perloff, 2003). The psychological reason for this difference should simply be a function of heuristic processing: attractive sources generate more positive thoughts about the source, whereas unattractive sources generate more negative ones. Given the aforementioned difficulty with measuring heuristic processing, we are hesitant to call source thoughts "heuristic processing," but we believe they serve as indicators of this type of processing. As a result, physical attractiveness was chosen in this study as a source characteristic that may, as a function of social presence, exert an influence over source thoughts and persuasion independent of persuasive message content. The nature of this influence is represented in the following:

H2: Social presence with an attractive source increases positive source thoughts.
H3: Social presence with an unattractive source increases negative source thoughts.

Social presence should also facilitate systematic processing, in the form of message processing. As suggested by Huang (1999), when media users become more involved in a media experience as a result of interactivity, they should become motivated to pay more attention to message arguments, which is symptomatic of systematic processing. Although this might seem at odds with the idea that interactivity-induced social presence will lead to more heuristic processing in the form of source thoughts, the HSM does specify that processing modes can co-occur (Chaiken & Maheswaran, 1994) under certain conditions. Skalski and Tamborini (2004) suggest that interactive media and social presence may affect both types of processing, given the potential for sources that seem "present" to make users attend more to the source *and* the message than they would during passive media experiences. This should reveal itself in the following fashion:

H4: Social presence relates positively to message processing.

The manner in which source thoughts influence attitude is the distinguishing factor between the two hypothesized models. The effect of source thoughts on attitude is expected to vary depending on whether the source is attractive or unattractive. When the message is presented by an attractive source, the heuristic processing of positive source information should have a positive effect on attitude. In contrast, when the same message is presented by an unattractive source, the heuristic processing of negative source information is expected to bias positive systematic processing (as suggested by Chaiken, Liberman, & Eagly, 1989). In our case this should lead to a less favorable attitude toward the health issue promoted by the source, even when positive message processing occurs. Observations showing differences in the paths from source thoughts to attitude provide important evidence of the underlying processes being investigated. If only an attractive source was used, a positive path from source thoughts to attitude could be interpreted as showing simply that social presence always has a positive influence on information processing and persuasion. However, observing paths from



Note. Path signs show model predictions. Signs in parentheses are for the attractive-source model only. Signs in brackets are for unattractive-source model only. Signs with no parentheses apply to models for both source types.

FIGURE 1 Expected relationships for attractive and unattractive source.

source thoughts to attitude that differ as a function of source attractiveness would show the potential of social presence to disrupt persuasion in some instances, as when heuristic processing (in the form of source thoughts) and systematic processing have independent and conflicting effects on attitude. Therefore:

H5: Positive source thoughts in response to an attractive source relate positively to attitude.
H6: Negative source thoughts in response to an unattractive source relate negatively to attitude.

The final path in the two models indicates that the effect of message processing is expected to be a function of persuasive message valence. Typical messages in a persuasive health context contain strong statements supporting the adoption of the stated health position. Given a message that contains positive arguments for being more aware of a health issue, message processing should lead to a more favorable attitude toward the health issue promoted:

H7: Message processing relates positively to attitude.

The complete model of expected relationships for both attractive and unattractive sources is shown in Figure 1.

A final hypothesis examines the impact of study variables on behavioral intention.[2] Consistent with the logic for attitudinal effects presented above, message processing should also lead to greater behavioral intention, in the form of signing up to be tested for the health problem of interest:

H8: Message processing relates positively to behavioral intention.

[2]Behavioral intention was not included in the hypothesized model because it is a nominal variable and violates an assumption of OLS regression modeling, i.e., that all outcome variables are interval or ratio level (Hayes, 2005).

METHODS

Overview

A 2 × 2 between subjects factorial design was used in this study, with source attractiveness (attractive or unattractive) as the first factor and interactivity (interactive or non-interactive) as the second. The outcome variables included measures of social presence, source thoughts, message processing, attitude, and behavioral intention.

Participants

A total of 125 undergraduate students (mean age = 21.56) enrolled in introductory courses at a large Midwestern university were recruited for this study and given course credit for their participation. Participants, 42 of whom were male,[3] were stratified by sex and randomly assigned to one of the four experimental conditions. The non-interactive, attractive-source condition had 32 subjects, and the other three conditions each had 31 subjects.

Procedure

The experiment followed a scripted procedure. Upon arriving at a research laboratory, participants filled out a consent form and pre-survey. Then they were told that they would view and give their reaction to a "randomly selected" health message to be communicated through new media technology. All participants were exposed to the same relatively easy to understand message advocating the importance of paying attention to their blood pressure. Participants were seated four feet in front of a $6' \times 6'$ screen and asked to put on a pair of headphones, through which they would hear the communicator. Then the researcher went behind the screen and started the message, which was rear-projected onto the screen in a 50-inch window. The on-screen source for the message was one of four versions a social agent named "Cardia," who appeared in a Window on the screen at normal human size. Cardia was varied in two ways: (1) attractive versus unattractive, and (2) interactive versus non-interactive. Immediately following exposure to the persuasive message, participants completed (in order) a thought-listing measure and then measures of social presence, message processing, attitude toward the position advocated in the speech, attitude toward the communicator, perceived interactivity, and behavioral intention.

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[3]Unexpectedly, the sample of participants used in this investigation was disproportionately female. However, results of t-tests show that ratings on key variables did *not* differ significantly by gender. The average attractiveness rating for males was 7.55 (SD = 3.44) vs. 7.92 (SD = 3.74) for females, $t(123) = -.54$, n.s., two-tailed, whereas the mean rating of interactivity for males was 6.29 (SD = 3.74) compared to 5.48 (SD = 3.67) for females, $t(123)$ = 1,16, n.s., two-tailed. Thus, this study limitation was not deemed to be a problem.

Inductions

Source attractiveness was varied with two versions of the animated source created specifically for this study using the *Poser* program by Curious Labs. The same basic source was used in both cases. In the "attractive" condition, the source appeared as a pleasant-looking woman. In the "unattractive" condition, computer programs were used to make the source sound and appear less attractive.

Interactivity was varied using the "*Wizard of Oz*" technique (Tang, 2003). Although the participant was led to believe that the message was computer controlled, it was actually controlled by a human "puppeteer" behind a screen. This human controller provided the intelligence of the source and determined what she would say by selecting response options from a message-generating software program. Participants interacted with the source in one of two different ways. In the "interactive" condition, participants were able to talk to the source and control the order in which message elements were presented by verbally selecting each of five different message categories. These participants were told by the researcher to choose the order in which they wanted to listen to all five categories by selecting them one at a time in any order they wished. In the "non-interactive" condition, the source simply discussed the categories point by point, in one-way fashion, without giving participants the ability to interact by selecting the order. All participants listened to the exact same information about blood pressure contained in the five sections. In the interactive condition, one simple addition was included as an attempt to create a stronger illusion of social presence—the source asked participants to repeat one of their category selections (as if it had difficulty hearing). Other than this, however, the experiences in the two interactivity conditions were nearly identical and ran between 4.5 and 5 minutes long, with no subject taking longer than 5 minutes.

Measures

Confirmatory factor analysis (CFA) was used to test the content validity of all multiple (three or more) item measures. Scale items were retained if they passed an internal consistency test involving a check of face validity and an examination of factor loadings and errors. Items with poor face validity and factor loadings of less than .50 and/or greater errors in association with other items than what would be expected by sampling error were dropped. All of the items except one met the criteria for factor loadings and passed the tests for error. The reliability of each scale was assessed using Cronbach's Alpha (α).

Social Presence. Social presence was measured using six items adapted from Nowak and Biocca (2003). Two of these items were judged to be inconsistent with Lee's (2004) definition of social presence since they apply more to the medium than user. Therefore they were excluded and two items were constructed to replace them: "How much did you feel like you were 'with' Cardia" and "To what extent did this feel like you were with an actual person?" Subjects indicated their agreement using a 7-point scale ranging from "not at all" to "very much." Responses to the six items were summed to create a measure of social presence (α = .91).

Source Thoughts. Replicating earlier procedures (Skalski & Tamborini, 2004), source thoughts and message thoughts (included for validation purposes) were measured by giving subjects three minutes to "list their thoughts and ideas." This commonly used thought-listing technique for assessing mental processes is adopted from Cacioppo and Petty (1981). Responses to this thought listing task were then scored by two independent coders as either source (S) oriented or message (M) oriented. In addition, coders assessed whether statements had a positive (+), negative (−), or neutral (0) valence. This allowed the creation of six composite measures representing the number of positive, negative and neutral thoughts related to both the source and the message. Because the model was set up to examine positive and negative thoughts, and since most thoughts fell into these categories (84%, or 582 out of 697), neutral thoughts were dropped from further analyses. Intercoder reliability was assessed using Lin's Concordance (Neuendorf, 2002), and results for each type are S+: r = .88; S−: r = .96; M+: r = .89; and M−: r = .81. Examples of thoughts coded into the positive and negative categories are S+, "Spokesperson was effective!"; S−, "The speaker was kind of scary looking"; M+, "The message definitely made me think about my diet"; and M−, "The level of information attempted to be conveyed about risk factors was overwhelming." Although message thoughts were considered evidence of systematic processing, they were used only for validation purposes. A separate and more direct scale was used as the measure of message processing (see below). Again following earlier procedures, source thoughts were considered as indicators of heuristic processing, given the controversy over more direct measures of heuristic thinking (Todorov, Chaiken, & Henderson, 2002).

To assure that the source thought measures were valid indicators of heuristic processing and only heuristic processing, coders were specially trained to identify instances in which the source was being treated as a heuristic cue and instances in which the source was being thought of as part of a systematic consideration of message content. If a thought mentioned the source and nothing about message content, such as "Cardia looked nice" or "Cardia spoke well," it was coded as a source thought. If a thought mentioned the source *and* information related to the judgment task, such as "Cardia was rather overweight for someone speaking about the importance of healthy eating," it would have been coded as a message thought and indicator of systematic processing. However, this type of thought was virtually nonexistent in our data, presumably because the source was a nonhuman social agent. A human source may have had appearance cues relevant to the blood pressure message, but our social agent did not, given that computerized virtual beings are unaffected by blood pressure and related issues such as diet and exercise. As a result, the source thought measure in this study was treated as a discrete indicator of heuristic processing.

Message Processing. Similar to Trumbo (2002), message processing was measured through six 7-point Likert items, adapted from work by Andrews, Durvasula, and Akhter (1990). Responses to items such as "I carefully examined the message" were summed to create a measure of message processing ($\alpha = .89$). As expected, this index related positively and significantly to positive message thoughts ($r = .34$, $p < .01$), and negatively and significantly to negative message thoughts ($r = -.33$, $p < .01$), providing some evidence for the convergent validity of the 6-item measure.[4]

Attitude Toward Blood Pressure. Attitude concerning the importance of blood pressure, which is the position advocated by the speech, was measured through six, 7-point Likert items such as "Blood pressure is an issue people should be concerned about." One item failed the initial CFA test and was dropped. The five remaining items were summed to create a measure of attitude toward blood pressure ($\alpha = .81$).

Attitude Toward the Communicator. Consistent with Chaiken and Eagly (1983), attitude toward the communicator was assessed through 15-point Likert items asking subjects to rate the speaker on the following dimensions: likable, knowledgeable, intelligent, competent, warm, pleasing, and friendly. Three new items were added (creating a total of ten) specifically tapping dimensions of attractiveness (appealing, attractive, nice looking). Scores on the pleasing, appealing, attractive, and nice looking items were used to check the attractiveness induction by summing the items to create an overall measure of source attractiveness ($\alpha = .93$). Independent samples *t*-tests on the summed scores indicated that the induction was successful. The average source attractiveness rating in the appealing condition ($M = 10.29$, $SD = 2.60$) was significantly higher than that in the unattractiveness condition ($M = 5.26$, $SD = 2.63$), $t(123) = -10.74$, $p < .01$, two-tailed. As such, separate analyses were conducted on attractive and unattractive source samples to test the hypothesized path models.

Importantly, the sources did *not* differ on any of the other dimensions. For example, a *source credibility* index was constructed using the knowledgeable, intelligent, and competent items, and there was no significant difference between the attractive source ($M = 11.90$, $SD = 2.42$) and unattractive source ($M = 12.05$, $SD = 2.31$) on this measure, $t(123) = -.35$, $p =$ n.s. These results suggest that, as intended, the two versions of Cardia differed only in perceived attractiveness, the important dimension for this study.

[4]Although the path analyses reported here used only the index measure of systematic processing, analyses using message thoughts provide similar results.

Perceived Interactivity. As another induction check, subjects used a 15-point Likert-format scale to respond to five items measuring the extent to which they felt their experience was interactive. Items included statements such as "I felt like I could respond to Cardia" and "I felt like Cardia would respond to me." These five items were summed to create a measure of perceived interactivity ($\alpha = .92$). An independent samples *t*-test indicated that the induction succeeded. Although perceived interactivity was not high in either condition, participants in the interactive condition reported significantly more interactivity ($M = 7.67, SD = 3.37$) than those in the non-interactive condition ($M = 3.86$, $SD = 2.98$), $t(123) = -6.68$, $p < .01$, two-tailed. This measure was included in the path analyses to provide a more sensitive indicator of the interactivity construct.

Behavioral Intention. Intention was measured by providing participants with an opportunity to sign up for an "actual" appointment to have their blood pressure tested. If they chose to sign up, this was counted as behavioral intention. A total of 52 participants (42%) chose to sign up for the test.

RESULTS

Table 1 shows the correlations among all measured study variables and the two inductions. Note that the correlations were corrected for attenuation due to measurement error during the analysis procedure.

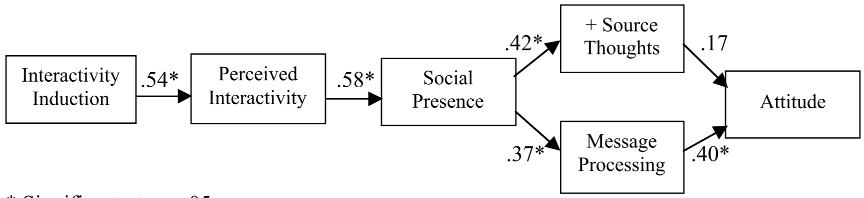
Evaluation of Models

Path analysis was performed on the hypothesized models using the least squares method. This involves estimating the sizes of the model parameters and testing the overall model fit. Parameter size was estimated by regressing each endogenous variable onto its causal antecedent, and model fit was tested by comparing estimated parameter sizes to the reproduced correlations (see Hunter & Gerbing, 1982, for a more complete description of this analysis procedure). In short, a model that is consistent with the data is one which (a) has substantial path coefficients, (b) has differences between parameter estimates and reproduced correlations (errors) that are no greater than what would be expected through sampling error, and (c) passes tests of overall model fit. Goodness of fit was initially indicated by a nonsignificant chi-square result. In addition, to address problems often apparent with sample sizes below 250, both the standardized root mean square residual (SRMR) and comparative fit index (CFI) were computed (Holbert & Stephenson, 2002). SRMR values below .10 (Kline, 1998) or close to .09 and CFI values above .95 (Hu & Bentler, 1999) are considered representative of a well-fitting model. Both attractive- and unattractive-source models were tested and the results of each test will be described in turn below.

TABLE 1 Zero-Order Correlations Between Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Age	1.00														
2. Sex**	−.12*	1.00													
3. Computer use	.03	.00	1.00												
4. Interactivity induction	.04	−.01	−.01	1.00											
5. Attractiveness induction	.09	−.03	.08	−.01	1.00										
6. Perceived interactivity	.03	−.10	−.05	.52*	.04	1.00									
7. Perceived attractiveness	.02	.05	−.06	.09	.70*	.29*	1.00								
8. Social presence	.07	−.06	−.04	.30*	.16	.65*	.39*	1.00							
9. Message processing	.03	−.16	−.16	.03	.12	.24*	.22*	.31*	1.00						
10. Positive source thoughts	.08	.10	−.10	.16	.20*	.27*	.33*	.38*	.11	1.00					
11. Negative source thoughts	−.03	−.01	−.01	−.12	−.35*	−.30*	−.45*	−.38*	−.28*	−.28	1.00				
12. Positive message thought	−.15	−.07	−.06	.11	.07	.34*	.16	.35*	.35*	.09	−.38	1.00			
13. Negative message thought	.12	.10	.04	−.04	−.11	−.31*	−.27	−.38	−.38*	−.01	.25*	−.48	1.00		
14. Attitude	.02	.17	−.12	.07	.02	.02	.17	.02	.26*	.17	−.19*	.08	.18*	1.00	
15. Behavioral intent***	−.06	−.05	.07	.04	.19*	.15	.16	.09	.21*	.14	.15	.25*	−.13	.07	1.00

*Significant at $p < .05$ for two-tailed t-test.
**Coded as a dichotomous variable with 0 = male and 1 = female.
***Coded as a dichotomous variable with 0 = did not sign up for test and 1 = signed up for test.



* Significant at $p < .05$.
Note. χ^2 (9) = 2.26, $p = .99$.

FIGURE 2 Results for attractive source.

Results for the Attractive-Source Model. Results for the attractive-source model are shown in Figure 2, and correlations used to test the model are shown in Table 2. As indicated in Figure 2, the attractive-source model fared well on all criteria for model evaluation. First, all but one of the paths was ample and significant. The interactivity induction increased perceived interactivity, with a β of .54, $P\,(.34 < \rho < .74) = .95$. Perceived interactivity, in turn, increased social presence, with a β of .58, $P\,(.38 < \rho < .78) = .95$. Social presence positively affected both positive source thoughts ($\beta = .42$, $P\,(.20 < \rho < .64) = .95$) and message processing ($\beta = .37$, $P\,(.11 < \rho < .63) = .95$). Message processing, finally, increased attitude, $\beta = .40$, $P\,(.14 < \rho < .66) = .95$. Although positive source thoughts did not significantly affect attitude ($\beta = .17$, $P\,(-.11 < \rho < .45) = .95$), this path was in the predicted direction. Moreover, even without this path, a chain of significant paths was found from the exogenous interactivity variable to the endogenous attitude variable.

Second, the differences between predicted and obtained correlations for all unconstrained bivariate relationships were examined, and none were significantly different than what would be expected through sampling error. Third, all indices for our model signify an overall good fit (χ^2 (9) = 2.26, $p = .99$; SRMR = .054; CFI = 1.0). Thus, analysis showed that this model had substantial path coefficients, produced no significant errors, and passed

TABLE 2 Zero-order Correlations Used to Calculate Parameter Estimates in Model

	1	2	3	4	5	6
1. Interactivity	*1.00*					
2. Perceived interactivity	.52*	*1.00*				
3. Social presence	.31*	.53*	*1.00*			
4. Message processing	.04	.16	.33*	*1.00*		
5. Source thoughts	.15	.28*	.40*	.08	*1.00*	
6. Attitude toward issue	.03	−.08	.04	.35*	.18	*1.00*

*indicates $p < .05$, two-tailed.
Note. Interactivity was coded such that 1 = interactive and 0 = non-interactive.

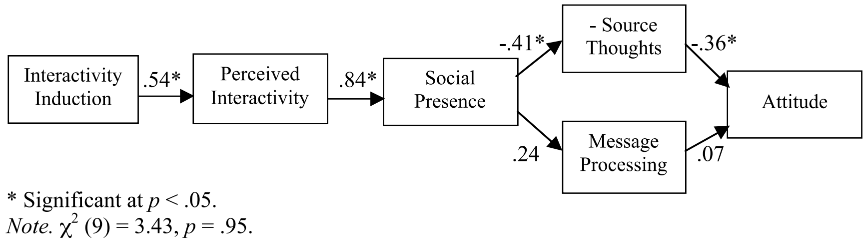


FIGURE 3 Results for unattractive source.

global goodness of fit tests. Moreover, the model showed a continuous string of paths from interactivity to attitude.

Results for the Unattractive Source Model. Results for the unattractive source model are shown in Figure 3 below, and the correlations used to calculate the model are shown in Table 3. As Figure 3 shows, the results for the unattractive-source model were generally in line with predictions, with a few notable exceptions. As expected, the interactivity induction had a positive effect on perceived interactivity, $\beta = .54$, $P\,(.34 < \rho < .74) = .95$. Perceived interactivity, in turn, increased social presence as expected, $\beta = .84$, $P\,(.72 < \rho < .96) = .95$. Social presence had a significant effect on negative source thoughts, though the direction of effect was unexpectedly negative instead of positive, $\beta = -.41$, $P\,(-.19 < \rho < -.63) = .95$. However, as predicted, negative source thoughts had a significant and inverse effect on attitude, $\beta = -.36$, $P\,(-.10 < \rho < -.62) = .95$. Of the final two paths in the model, the one from message processing to attitude was sizable and in the expected direction, though it only approached standard conventions of statistical significance, $\beta = .24$, $P\,(-.04 < \rho < .52) = .95$. The remaining path from heuristic processing to intention was in the expected direction but trivially small, $\beta = .07$, $P\,(-.23 < \rho < .37) = .95$.

The unattractive source model fared well on the other evaluation tests. None of the differences between predicted and obtained correlations for unconstrained bivariate relationships were significantly different than what

TABLE 3 Zero-order Correlations Used to Calculate Parameter Estimates in Model

	1	2	3	4	5	6
1. Interactivity	*1.00*					
2. Perceived interactivity	.52*	*1.00*				
3. Social presence	.29*	.77*	*1.00*			
4. Message processing	−.01	.27*	.22	*1.00*		
5. Source thoughts	−.16	−.43*	−.39*	−.25*	*1.00*	
6. Attitude toward issue	.12	.13	.00	.14	−.34	*1.00*

*indicates $p < .05$, two-tailed.
Note. Interactivity was coded such that 1 = interactive and 0 = non-interactive.

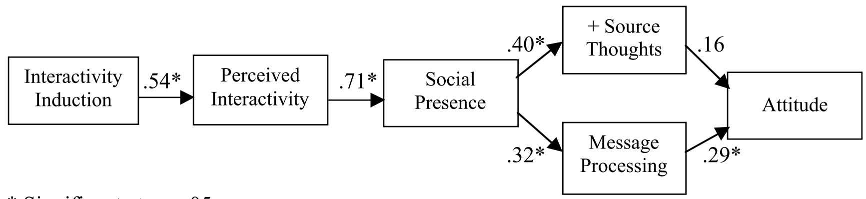


FIGURE 4 Results for combined model (N = 125).

would be expected through sampling error. In addition, tests on the model once again show a good fit (χ^2 (9) = 3.43, p = .95; SRMR = .07; CFI = .955). Given that all three tests exceeded Hu and Bentler's (1999) recommendations, and that there was an unbroken chain of links from the interactivity induction to attitude, we can make a case that the model had acceptable fit, though it was not as strong as in the attractive model. In addition, contrary to prediction, social presence had a negative instead of positive effect on negative source thoughts. This unexpected finding will be discussed later.

Results for Combined Model

Given the consistent pattern of results across the attractive and unattractive source models, the decision was made to test a final model with the combined samples in order to provide stronger and more statistically powerful evidence for the predicted relationships. The combined model results, are displayed in Figure 4.[5] As shown, the relationships in this model were ample and significant for all but one path. The interactivity induction positively affected perception of interactivity, β = .54, P (.40 < ρ < .68) = .95, and perceived interactivity had a positive effect on social presence, β = .71, P (.59 < ρ < .83) = .95. Social presence positively affected both source thoughts (β = .40, P (.24 < ρ < .56) = .95) and message processing (β = .32, P (.14 < ρ < .50) = .95). Although the path from source thoughts to attitude fell just short of standards for significance (β = .16, P (−.06 < ρ < .36) = .95), the effect of message processing on attitude was both positive and significant, β = .29, P (.09 < ρ < −.49) = .95.

The combined model easily passed the other evaluation tests. There were no errors significantly different than what would be expected through sampling error, and all tests on the model demonstrate good fit (χ^2 (9) = 2.24,

[5]Due to the apparent inverse parallelism of positive and negative source thoughts in relation to social presence (see Table 1), as well as the lack of a positive effect of social presence on negative source thoughts in the unattractive source condition, the decision was made to test the combined model using only positive source thoughts. Analyses with negative source thoughts show the same pattern, only in the opposite direction.

p = .99; SRMR = .035; CFI = 1.00). The combined model also had an unbroken chain of links from the interactivity induction to attitude.

Results for Behavioral Intention Outcome

To address the final hypothesis, a logistic regression analysis was conducted on the full data set with behavioral intention set as the dependent variable. The independent variables were entered in two blocks, with age, gender, and prior computer use in Block 1 and the remaining Table 1 variables in Block 2. The overall model had a nonsignificant Hosmer and Lemeshow chi-square statistic (χ^2 (8) = 11.02, p = .20), a sign of a predictive model (Hair, Anderson, Tatham & Black, 1998). Only one variable emerged as a significant predictor of behavioral intention, however: positive message thoughts, β = .30 ($p < .05$). The scale measure of message processing was not a significant predictor, but given that positive thoughts about the message indicate message processing, this provides some support for the prediction that message processing relates positively to behavioral intention.

DISCUSSION

This study set out to determine the influence of interactive sources on social presence, information processing, and persuasion within the HSM framework. The results generally support the logic advanced in this study. They suggest that interactivity, induced through an interactive source, *can* create greater perceptions of social presence governing information processing and resultant attitude and behavioral intention.

Interactive Media, Interactivity, and Social Presence

Regardless of the type of source subjects viewed in this study, the interactivity induction increased perceived interactivity, leading to higher levels of social presence. This happened even with the token interactivity manipulation used in this study (i.e., slightly changing the manner in which the information was presented). This finding foreshadows the exciting potential of media technology allowing people to interact socially, which can range from advanced two-way video conferencing systems to much simpler technologies displaying less realistic versions of social beings. Participants in this study felt more interactivity and social presence even when they could only respond to social agents in rudimentary ways, despite being told that the agents were computer controlled. Such a finding is consistent with the HCI work of Reeves and Nass (1996), and as agents continue to improve in intelligence and appearance, they should create even greater senses of interactivity and social presence.

Social Presence and Source-Related Thinking

As expected, social presence increased positive source thoughts in response to an attractive source, suggesting that more attention was called to the source and its positive attributes when subjects felt present. Contrary to prediction but not difficult to understand, social presence decreased negative source thoughts about an unattractive source. Regardless of the type of source, social presence produced beneficial judgments, increasing positive source thoughts and decreasing negative source thoughts. One possible explanation for the unexpected finding for the unattractive source is that social presence may, in certain contexts, produce feelings of social closeness and intimacy that supplant the influence of physical attractiveness in determining source appeal. Research by Lombard (1995) has demonstrated that larger TV screen sizes lead people to have more favorable responses to mediated others. Social presence may mediate this relationship by producing a "connection" between the user and source that would not exist without the connection, even if the source is a computer agent. If a source behaves socially but happens to be unattractive, individuals who feel present with that source might be less critical of the source's appearance, leading them to think less negative thoughts. If social presence has this type of effect on source thoughts indicative of heuristic processing, it suggests that physical appearance might be less important in some interactive, high presence-inducing new media environments than it was with traditional media.

The effect of physical appearance and social presence on outcomes of interactive media exposure may not always be positive, however. In some contexts, such as violent video game play, feeling socially present with a virtual character may lead to negative emotional responses and a low level of social closeness. Therefore, these findings are not meant to be a sweeping statement about the positive benefits of social presence responses to new media. Rather, the observed effects may be confined to "positive" message environments such as those with useful and beneficial health information, like the one in the present study. They may also be limited to agents and other virtual characters, which are (obviously) less realistic than humans. The parallel findings for attractive and unattractive sources in this research, finally, should not be taken as evidence that the appearance of virtual characters has consistently similar effects on social presence. Research by Nowak and Biocca (2003) reveals that the anthropomorphism of a virtual human's appearance has an influence on social presence, with less anthropomorphic characters (perhaps surprisingly) increasing social presence reactions. Given the imaginative range of possibilities for physical appearance in virtual worlds, further research on this variable can advance our understanding of the role played by physical appearance in social exchanges through a variety of interactive media types, including health websites, online social networks, instant messaging programs, and online video games.

Social Presence, Message Processing, and Persuasion Outcomes

Both the attractive source and combined models produced a significant path from social presence to message processing. This suggests that perceived presence causes greater focus on what the source is saying and points to the value of increasing social presence in persuasion settings that are source-driven or in any other context in which careful attention to messages is important. This relationship did not appear in the unattractive source model, but it may simply owe to the large path from social presence to source thoughts. It seems likely that the unusual nature of the unattractive source pulled variance away from message processing (and to source thoughts) in the unattractive condition. If this is the case, it reinforces the need to consider the appearance of social agents and other mediated sources when constructing interactive messages.

Finally, and most important from a persuasion standpoint, the attractive and combined model results show that message processing indicators had a positive effect on attitude. Since message-related thinking is directly relevant to the attitudinal and behavioral outcomes of interest, the importance of such thoughts to persuasion makes intuitive sense. From a persuasion standpoint, this finding directs attention toward the need for variables that increase message processing, such as social presence.

Overall Implications of the Models

Considered together, the models in this study support the notion that interactivity in new media can alter the way information is processed and shape persuasion. Although other studies have found that interactive media increase attitude and behavioral intention (e.g., Kinzie, Schorling, & Siegel, 1993; Van Tassel, 1988), these studies differ from the present one in at least two important respects. The present study (1) offers greater insight into the cognitive mechanisms underlying these effects, and (2) varies only the interactive nature of the source instead of varying the amount of information imparted by interactive media (e.g., hyperlinked web pages). Both findings are valuable, for the following reasons.

First, the models in this study provide new insights into the underlying cognitive mechanisms that explain *why* interactive media can increase persuasion. In doing so, the research increases the potential for the prediction and control of desirable persuasive outcomes by identifying key variables in the process of persuasion. Much of the credit for this explanatory power lies in the rooting of these models in the HSM, which explicates how cognitive, motivational, and situational factors such as source attractiveness can affect information processing styles (Perloff, 2003). The present research adds to this literature by showing how the attractiveness of computerized sources like agents and avatars can perhaps mimic the "real-world" attractiveness findings from earlier HSM-based persuasion studies (e.g., Chaiken, 1979), though the detrimental effect of unattractiveness on attitude was not as pronounced in this study when receivers were able to interact with an agent/source. This finding calls attention to an even greater contribution of this study from an HSM standpoint, the addition of interactivity and social presence to the mix of variables already considered to be determinants of processing mode (Todorov, Chaiken, & Henderson, 2002). Although social presence has recently been linked to the HSM (Skalski & Tamborini, 2004), this study is the first to look at interactivity-induced social presence within the HSM framework. The findings suggest that social presence is not a cognitive impairment to processing because it increases the motivation for message processing, which is a key indicator of systematic processing.

A second important difference between this and other work looking at the persuasive effects of interactive media is the use of an interactive *source* as opposed to some other form of interactivity. Although interactivity may seem like a simple concept, Vorderer (2000) discusses how recent advances in computing technology have resulted in many, sometimes ambiguous definitions of the term. The advent of the Internet, for example, has focused much attention on interactivity as it applies to web sites (e.g., Sundar, Kalyanaraman, & Brown, 2003), mostly involving the surfing of hyperlinked web pages. This type of interactivity is different than the more classical, communication-oriented interactivity looked at in this study, based on the idea of social interaction. As a result, these findings may be limited to source-centered technologies and not easily generalized to other interactive media or interactivity types (see Lee et al., 2006, for a review of the interactivity literature).

Concerns about the applicability of these findings to all forms of interactivity illustrate the need for a broader "theory" of interactivity that attempts to unify the different manifestations of the concept. At the same time, the findings in this study refocus our attention on traditional understandings of interactivity in terms of social interaction and show its potential importance in new media. The technology used in this study provides a new arena in which to examine the transactional nature of communication and points to the future of interactive media technology.

Limitations and Conclusion

As with most studies, several issues with the procedures in this study raise reason for concern. These include issues related to the message and inductions. First, the blood pressure issue used in this study was one that subjects had a favorable attitude toward. Future research investigating the processes under investigation here would benefit from a message topic toward which subjects are not as favorably inclined. A second message-related limitation concerns the applicability of these results to other persuasion messages.

Because the components of the model in this study are not specific to blood pressure, however, there is no reason to expect that this model would not work with other persuasive messages.

Another set of limitations has to do with the weak inductions in this study. In the case of interactivity, the induction led to low perceived interactivity and social presence values. This was not entirely unexpected, however, due to the subtlety of the interactivity induction discussed earlier. To maximize control in this study and keep the conditions as close as possible, there were only slight differences between the two interactivity conditions, which unfortunately limited their potential to induce interactivity.

More potent results might be expected from technology allowing for greater interaction, which will become more common in coming years as agent technology grows in sophistication. Future agents may be programmed with enough information to answer just about any question a person would have, particularly about a specific subject area like blood pressure. In doing so, they can approach the social interaction capability of a real expert like a doctor. As technologies continue to improve in vividness and interactive capability, the role of social presence will become increasingly important from both a theoretical and practical standpoint. This study advances our understanding of both determinants of social presence and its effects.

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