An Investigation of Conversational Agent Relevance, Presence, and Engagement

Completed Research

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Abstract

Conversational agents (CAs) are becoming an integral component of many personal and business interactions. Despite the prevalence of CAs in modern life, there are many factors related to the social nature of the interaction between CAs and humans that remain uninvestigated. This research uses Social Presence Theory to examine the effect of CA conversational relevance on perceptions of humanness and engagement. We performed a laboratory experiment in which participants interacted with a CA that gave either conversationally relevant or nonrelevant responses. Our results indicate that people perceive CAs that give conversationally relevant responses to be more humanlike and more socially present, ultimately leading to higher engagement than CAs that give nonrelevant responses.

Keywords

Automated conversation agents, humanness, relevance, engagement

Introduction

Conversational agents (CAs, or colloquially "chatbots") are becoming an increasingly prevalent IT artifact in daily life. Modern CAs have the capability to replace expensive human-human interactions with human-computer interactions in a wide variety of settings including healthcare (Bickmore and Picard 2005), education (Fridin and Belokopytov 2014; Rodrigo et al. 2012), and personal assistants (such as Siri and Alexa). These CAs provide an enhanced level of convenience and service in a cost effective, efficient, customizable, and reliable manner. To this end, companies are increasingly investing in CA technology to supplement their existing customer interaction platforms (Lin and Chang 2011). For example, within only six months of launching their chatbot development platform, Facebook reported that over 34,000 CAs had been deployed to assist users in subscription services, to facilitate transactions, and to provide general customer service (O'Brien 2016). Despite this rapid proliferation of CAs into many personal and business interactions, our understanding of how design features of CAs influence user perceptions and behaviors is nascent.

One common goal of CA research is increasing the naturalness and ease with which humans interact with CAs. Much of this research revolves around increasing the social presence of the CA, as described by Social Presence Theory (SPT, Short et al. 1976). In this research, we explore a potential antecedent to social presence—the ability of a CA to give responses that are related to user messages. We demonstrate the influence of conversational relevance in an experiment that utilizes two levels of conversational relevance—nonrelevant responses and relevant responses—to investigate the effect of CA conversational relevance on social presence, perceived humanness and engagement. In this, we seek to answer the following research question:

> *RQ: How does the conversational relevance of CA responses affect a) perceived partner engagement and b) perceived humanness of the CA?*

To answer this question, we use Social Presence Theory to develop a research model that describes the influence of conversational relevance on perceived humanness and partner engagement. We describe a laboratory experiment that was used to test the hypotheses, and examine the results and their implications.

Theoretical Development

Social presence is "the sense of human contact embodied in a medium" (Gefen and Straub 1997, p. 390), or a sense of connection with another individual through the medium (Schultze 2010). Social presence theory describes this as a function of the salience of the other person in the interaction (Short et al. 1976). Often the strength of social presence is related to the richness of the communication medium, but other factors can influence that sense of connection as well. Prior research has demonstrated that representations of physical and behavioral characteristics such as gender, demeanor, dress (Nunamaker, Derrick, Elkins, Burgoon, & Patton, 2011), similarity (Pickard et al. 2013), and likability (e.g., Gratch, Wang, Gerten, Fast, & Duffy, 2007; Huang, Morency, & Gratch, 2011; Nunamaker, Derrick, Elkins, Burgoon, & Patton, 2011) affect how humans perceive and interact with the CA. Information systems that exhibit social presence have been shown to facilitate trust (Gefen and Straub 2004), enjoyment and perceived usefulness (Hassanein and Head 2007), and self-efficacy beliefs (Baylor 2009).

As computers have become more human-like, both due to technological advances and because users attribute human-like qualities to their devices—for example, giving one's computer a name, or attributing personality traits to it—we find that computers are often perceived as and interacted with as social actors, much like we would interact with another human (Nass et al. 1994). In traditional interpersonal communication between humans, participants typically follow conversational norms such as the maxim of relation (Grice 1975), which suggests that conversation partners will respond appropriately to one another during the conversation. This ability of a communicant to create responses that are contingent on the messages they have received may be described as *conversational relevance*. In the current study, we explore the influence of conversational relevance on two potentially important aspects of social presence: perceived humanness and engagement.

We posit that one outcome of increased conversational relevance is an increase in the perceived *humanness* of the CA—that is, the degree to which a person believes that a CA might be human (Kirakowski et al. 2007). Perceived humanness is a measure of how well the CA is able to pass as a human in conversation. A CA with high conversational relevance will provide on-topic follow-up questions or statements based on input from the user. A CA with low conversational relevance, on the other hand, will fail to adhere to the maxim of relation, frequently changing topics or responding with off-topic questions or comments. CAs that demonstrate conversational relevance by providing appropriate responses within an appropriate response time, responding to questions, and following appropriate conversational norms are seen as more human, whereas CAs that fail to do these things are evaluated as less human (Kirakowski et al. 2007).

H1: Increased conversational relevance results in higher perceived partner humanness.

While increasing the perceived humanness of a CA is a worthwhile and interesting goal—and one of the oldest goals of artificial intelligence (Turing 1950)—in many applications the value of perceived humanness may be limited (Hayes and Ford 1995). For example, while few users have any expectation that Siri or Alexa, two popular digital personal assistants, are human, this does not diminish the utility of those systems. Rather, these systems rely on *engagement*—the perceived ability of the CA to communicate well by acting and responding to user input appropriately (Holtgraves et al. 2007). The goal of engagement is not to convince people that the CA is human, but is rather to be a good conversational partner and give an appropriate (even if not human-like) response (Demeure et al. 2011). CAs that respond appropriately to user inputs are considered better at communicating (Kirakowski et al. 2007), and give the perception that the system has understood the user's input (Sundar et al. 2016). The conversational ability of the agent creates a great sense of personal connection with the conversational partner. This creates a natural flow of conversation that is more engaging for the user (Koufaris 2002). When a communication partner gives inappropriate responses and is not able to maintain the flow of the conversation, however, people feel less engaged with their conversation partner (Kang et al. 2008).

H2: Increased conversational relevance results in higher perceived partner engagement.

While we believe conversational relevance will directly influence perceived humanness and engagement by creating an interaction that more closely mimics regular human communication, we believe that more variance in this relationship can be explained by accounting for the social presence of a more responsive CA. When a CA responds in a way that adheres to conversational norms, such as the maxim of relation, the perception of social presence is facilitated. The CA is considered more salient and engaged in the conversation. In addition to the direct influence of increasing conversational relevance, we propose that the perception that the CA is more socially present will further influence perceptions of humanness and engagement, thus partially mediating those relationships.

H3. *Increased conversational relevance results in higher perceived social presence.*

H4. *Social presence leads to higher (a) perceived humanness and (b) partner engagement.*
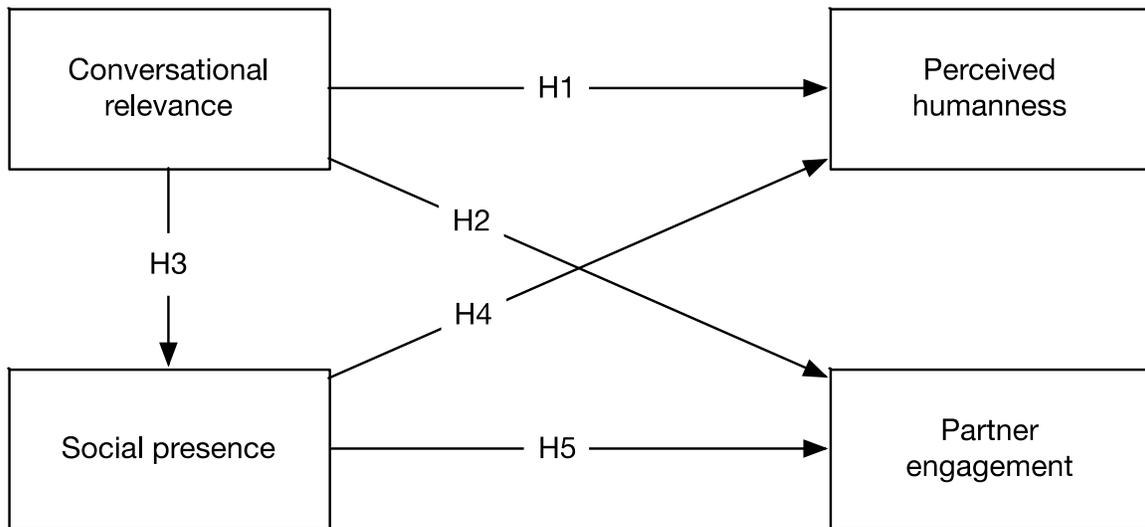
Our full research model is presented in Figure 1.

Figure 1. Research Model

Method

For the experiment, 112 students were recruited to participate in the experiment from an upper level MIS course at a large public university in the United States. Technical issues with the system resulted in data from five participants being corrupted. Additionally, four participants reported that they failed to follow directions. In total, data from 103 participants (51 male, 52 female) were used in the final analysis.

Upon arrival at the lab, the participants completed an online survey capturing demographic information and computer use behavior. Instructions on the computer described that they would be interacting with either a computer or a human via chat, and that they would be shown, and asked to describe, a series of images which their chat partner cannot see. The images used were from the International Affective Picture System (Lang et al. 1999). While the instructions refer to the potential of interacting with a human, all participants in fact interacted with a chatbot. The participants were then shown example screenshots of the interface. After the brief tutorial, participants clicked a link that took them to the chat interface (Figure 2).

In the experiment, the CA was operationalized as a chatbot that asked questions about a series of images displayed to participants. The chatbot followed a conversation stream in which it asked each participant two base questions with each image: "Please describe the contents of the image" and "How does the image make you feel." After participants responded to each base question, the chatbot asked a follow-up question. In the relevant response condition, the chatbot processed the participant's statement using natural language processing techniques and, using a corpus of anticipated responses developed by the research team, responded with a follow-up question related to the participant's input. In the nonrelevant response condition, the same generic follow-up questions were asked each time. Figure 2 shows samples of both relevant and nonrelevant conversation pulled from participant interactions. Note the difference in follow-

up questions for the relevant agent. Figure 3 shows an example of the full experimental interface. After participants responded to all the questions for an image, a system message appeared directing them to click a button to bring up the next image. Following the chat interaction, participants took a post-experiment survey where they rated the social presence, engagement, and humanness of their conversation partner.
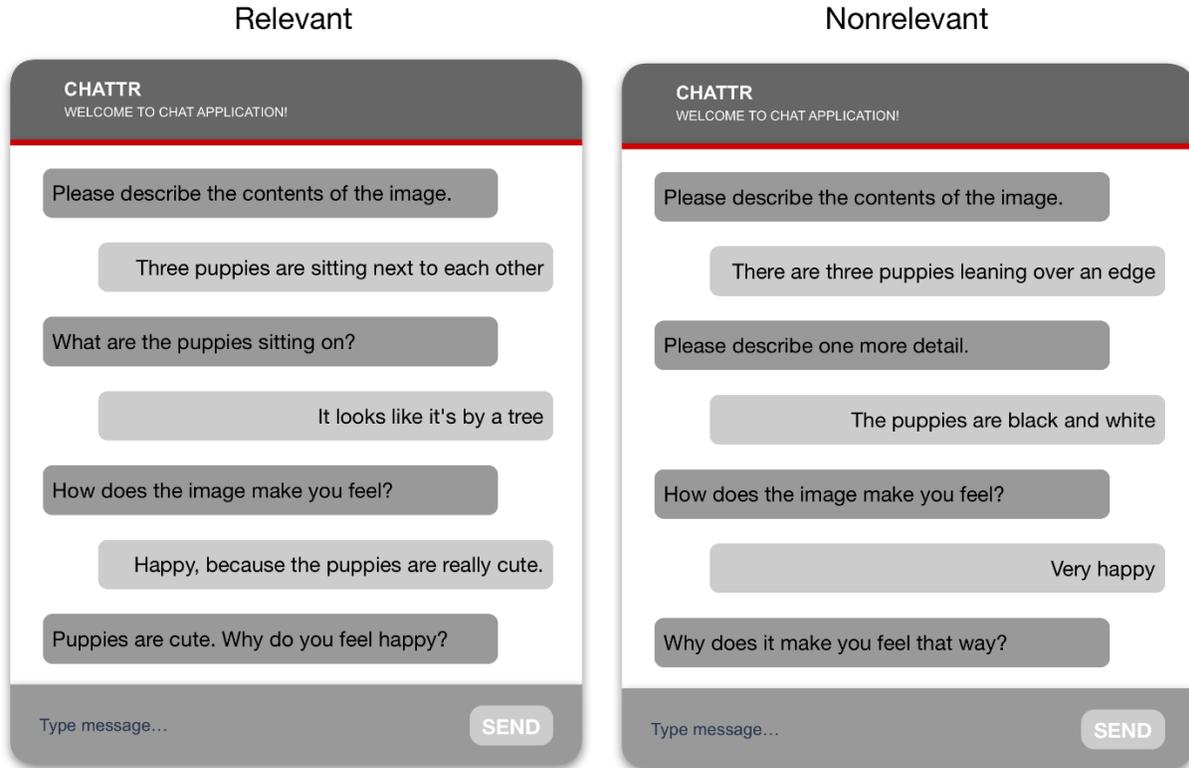
Relevant

Nonrelevant

CHATTR
WELCOME TO CHAT APPLICATION!

Please describe the contents of the image.

Three puppies are sitting next to each other

What are the puppies sitting on?

It looks like it's by a tree

How does the image make you feel?

Happy, because the puppies are really cute.

Puppies are cute. Why do you feel happy?

Type message…   SEND

CHATTR
WELCOME TO CHAT APPLICATION!

Please describe the contents of the image.

There are three puppies leaning over an edge

Please describe one more detail.

The puppies are black and white

How does the image make you feel?

Very happy

Why does it make you feel that way?

Type message…   SEND

Figure 2. Examples of Relevant and Nonrelevant Conversation about an Image of Puppies

Analysis and results

In the post-experiment survey, partner engagement was measured using six variables (skilled, polite, engaging, responsive, thoughtful, friendly) on a Likert-like scale from 1-7. Social presence was measured using four variables (sociable, warmth, personal, and sensitive) on a bi-polar scale from 1 (low social presence) - 5 (high social presence) (Perse et al. 1992). Perceived humanness was reported via a single-item measure, "My chat partner was…", with the following six options: "Definitely computer", "probably computer", "not sure, but guess computer", "not sure, but guess human", "probably human", and "definitely human." Convergent validity was acceptable for both constructs, with Cronbach's alphas of 0.91 and 0.80, respectively. We also tested discriminant validity to ensure that scale items for partner engagement and social presence measure distinct constructs. A scree plot reveled that there were two constructs. Exploratory factor analysis was used to group the items into their respective constructs (Table 2). One item, "My chat partner was skilled," did not load well with the other partner ratings and was dropped. Descriptive statistics of the study's variables are presented in Table 3.
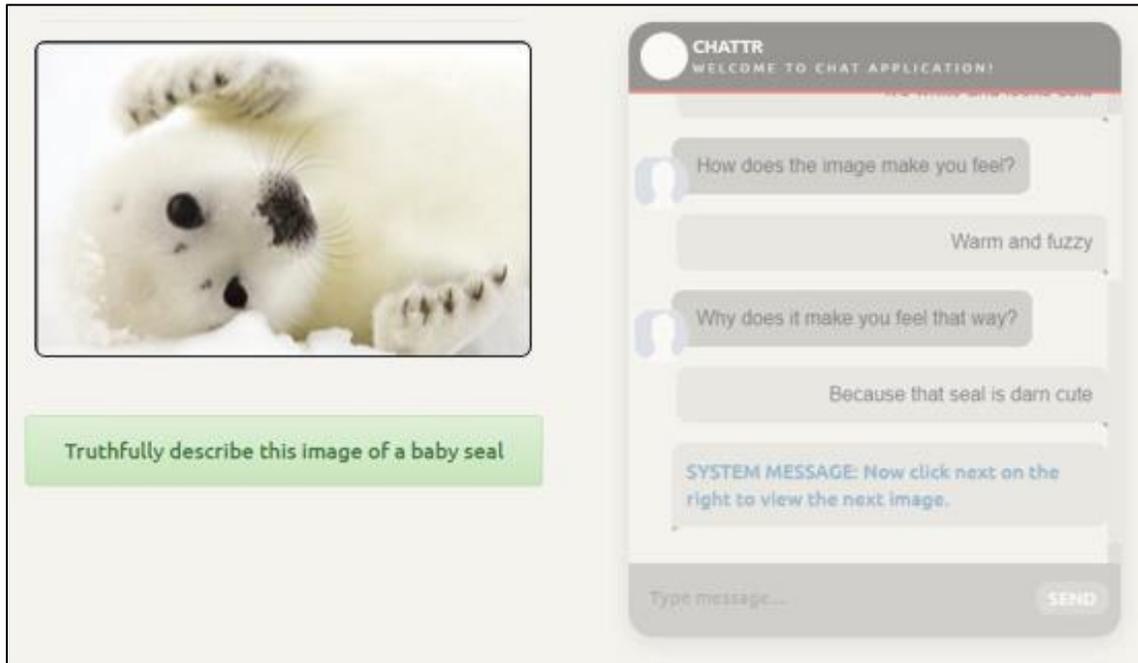
Figure 3. Sample Interface (Darker bubbles are text from the CA)[1]

Item	Partner Engagement	Social Presence
My chat partner was polite	0.71	
My chat partner was engaging	0.66	
My chat partner was responsive	0.69	
My chat partner was thoughtful	0.85	
My chat partner was friendly	0.81	
The interaction was sociable…unsociable		0.66
The interaction was warm…cold		0.70
The interaction was personal…impersonal		0.85
The interaction was sensitive…insensitive		0.66

Table 2: Factor loadings

Structural equation modeling (SEM) was used to analyze the data within the research model (Figure 3). We found that participants in the relevant condition rated the chat partner higher (M=2.18, SD=1.17) than participants in the nonrelevant condition (M=1.57, SD=0.84). Thus, hypothesis 1, that conversational relevance has a direct effect on perceived humanness, was supported (p=.01). Hypothesis 2 stated that conversational relevance increases perceived partner engagement. Participants in the relevant condition rated partner engagement similarly (M=4.97, SD=0.93) to participants in the nonrelevant condition (M=4.41, SD=1.32), thus hypothesis 2 was not supported directly (p=.10). However, as proposed in hypotheses 3 and 4, we expect that the effect of conversational relevance works through the construct of social presence and should therefore have a mediated relationship on perceived humanness and partner engagement. To this end, we find that perceptions of partner social presence are higher for those in the

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[1] "baby harp seal" by CaroLa is licensed under CC BY 2.0 / Resized and included in website interface

relevant condition (*M*=3.18, *SD*=0.76) than in the nonrelevant condition (*M*=2.77, *SD*=0.92), thus lending support to hypothesis 3 (*p*=.01).

	Construct	N	M	SD	CA	CR	AVE	1	2	3	4
1	Conversational relevance	NA	NA	NA	NA	NA	NA	-			
2	Social presence	4	2.97	0.87	0.81	0.81	0.72	0.24	**0.85**		
3	Perceived humanness	1	1.86	1.05	NA	NA	NA	0.29	0.27	-	
4	Partner engagement	6	4.68	1.18	0.86	0.86	0.74	0.24	0.40	0.33	**0.86**
	N = Number of items; M = Mean; SD = Standard Deviation; CA = Cronbach's alpha; CR = Composite reliability; AVE = Average variance extracted; Square root of AVE on diagonal										

Table 3. Descriptive statistics

Hypotheses 4 and 5 describe the relationship between social presence, perceived humanness, and engagement. Both hypothesis 4, that social presence increases perceived humanness, and hypothesis 5, that social presence increases partner engagement, were supported (*p*=.02 and *p*<.001, respectively). The combination of support for hypotheses 3, 4, and 5 show that social presence at least partially mediates the effect of conversational relevance on perceived humanness and partner engagement. A summary of hypothesis support is shown in Table 4.
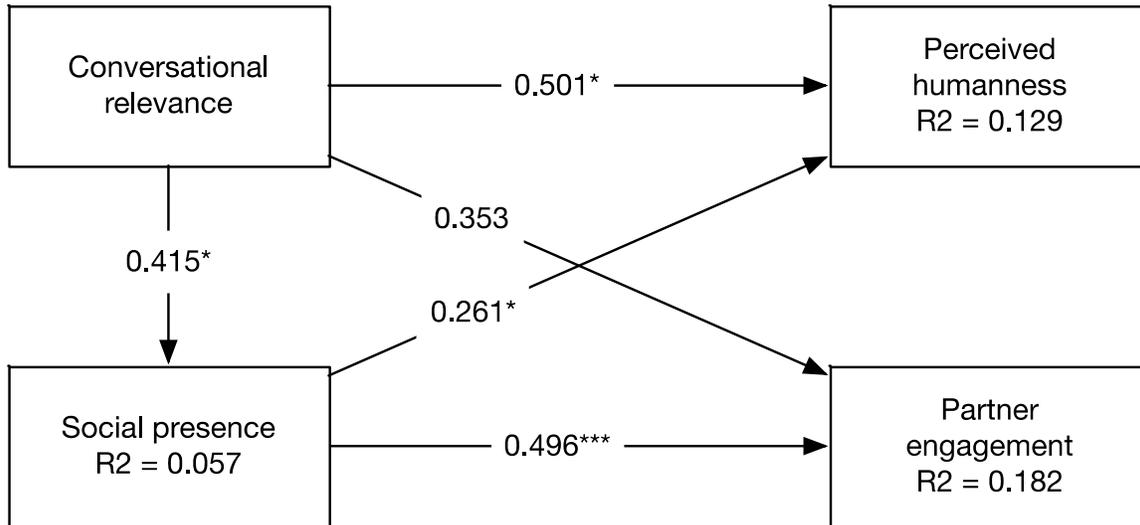

Figure 4: Study 1 results

* p<.05; ** p<.01; *** p<.001

Hypotheses	Support?
H1. Conversational relevance increases perceived humanness	Yes
H2. Conversational relevance increases partner engagement	No
H3. Conversational relevance increases social presence	Yes
H4. Social presence increases perceived humanness	Yes
H5. Social presence increases partner engagement	Yes

Table 4. Overview of Results

Discussion

In this paper, we have examined the effect of conversational relevance on perceptions of humanness and engagement. Our findings suggest that CA relevance increases perceptions of both humanness and engagement, and that this relationship is driven by a perception of social presence with the conversation partner. As illustrated by the support of H1, increasing the relevance of CA responses, even in small ways, drives the illusion that people are interacting with a human. In addition to the support for H1, additional analysis revealed that four people in the relevant condition (8%) believed their chat partner was human (rating above the midpoint of the bipolar scale), while only one in the nonrelevant condition believed the same (2%). In the nonrelevant condition, 34 were certain their chat partner was a computer (63%), while only 18 in the relevant condition (37%) had the same conviction.

While increasing perceptions of humanness is a common goal in CA research, as previously discussed, perceiving a chatbot as human does not necessarily provide value in many contexts. We suggest that engagement is a reasonable and potentially highly useful measure for evaluating CAs. Engaging chatbots are considered more useful, more enjoyable to interact with, and build rapport more successfully (Gratch et al. 2007; Huang et al. 2011). When people perceive that their conversation partner is able to understand what they say, they develop a greater sense of connection, thus driving engagement. As with humanness, we find significantly higher perceptions of engagement with the relevant chatbot compared to the nonrelevant chatbot. Based on these results, we have supporting evidence that small changes in conversational agent capability can significantly improve the perceptions people have of the chatbot.

Implications and future research

The current results provide evidence of the social presence effect of adding relevant communication to a text-based CA, and highlight how easy it is to increase the perception of humanness of a chatbot. Significant changes in user perceptions of the CA resulted from small cues indicating the chatbot understood the conversation. It is worth noting that while the current chatbot leveraged basic natural language processing techniques to craft answers that were relevant to the conversation at hand, this ability was rather rudimentary. Regardless, even our relatively limited relevant chatbot fooled four participants into thinking it was human, and introduced doubt in many others. Given the limited nature of the chat interaction, it is plausible that a more sophisticated chatbot could foster even greater perceptions of engagement and humanness. Further refinement of the current CA could be accomplished by using the chat logs to understand areas where the chat agent failed to match user input and adjusting the corpus of responses accordingly. Additionally, integrating analysis of behavioral responses, such as changes in response latency and pause time, or linguistic analysis, could provide additional cues a chatbot might use to craft its message.

There are also a number of limitations in this research and the analysis. First, there is potential that the results of the humanness and engagement ratings may be biased since participants were not aware they would be evaluating the humanness of their chat partner—thus they were not specifically looking for indicators that their partner was or was not human. Unlike the Turing Test, where judges know their task is to distinguish between computers and humans, our participants were left in the dark. However, such a scenario does more closely resemble real-world interactions, thus a covert test like the one presented here may be a more reasonable evaluation of conversational intelligence (Burden et al. 2016). Similarly, our humanness results were perhaps benefitted by the limited nature of our conversations. Prior work has demonstrated that limited conversations may actually facilitate perceptions of humanness, since there are fewer opportunities for the CA to give non-human responses (Shieber 2014). However, such a scenario may not reflect real-world use.

Our experimental manipulation of conversational relevance accounts for only $R^2 = .06$ for social presence, indicating that other factors besides relevance have a strong effect on that perception. Since our manipulation was the only difference between any of the agents, further analysis and potential future research will examine what drives the perception of social presence. We believe it is likely that personality differences in how people relate to technology may drive different perceptions. There may also be an element of expectancy, with some participants believing the CA to be a human from the start, while others begin with the assumption they are interacting with a computer. Future research can further examine the personality and chatbot design factors that influence perceived social presence.

Our conversational agent was limited by its restricted setting. Our users arrived and interacted with the CA for a single session lasting approximately 30 minutes, then answered the survey questions. Users might perceive the system in a very different way with repeated interactions with the conversational agent. The CA was also the one asking the questions, which is different from many interactions with CAs such as personal assistants where the users direct the conversation. Further research is needed to investigate the role of social presence and engagement in different types of CA interaction.

Conclusion

This research applies Social Presence Theory to explain the impact of conversational relevance on perceptions of the CA. We proposed and tested a model demonstrating how relevance and social presence affect perceived humanness and engagement. Our results show that people perceive CAs that give more conversationally relevant responses to be both more humanlike and more engaging than those that do not. While this is an intuitive finding, our findings quantify the impact of a modest improvement in conversational relevance and pave the way for future research to investigate the incremental improvements of additional features to increase humanness and engagement to positively influence perceptions of CAs and change the way people interact with computer systems.

Acknowledgements

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