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# Persuasive computing: Feeling peer pressure from multiple computer agents

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ABSTRACT

Past works on the human-computer relationship has investigated a) how computers can mediate the communication between people and b) how computer users perceive computers as social entities. However, little research has investigated how the two fields of research inform, challenge, and integrate with each other. By combining the Computers are Social Actors paradigm and the Social Identity Model of Deindividuation Effects, the present work provides an entry point into the conversation between these two fields. Specifically, this study examines how individuals may form group relations with computer agents. An experiment using a between-subject factorial design was conducted to explore the relationship between the two theoretical frameworks. The findings suggested that sharing the same color cues with multiple computer agents would lead to users' group identification with computer agents. Group identification with computer agents would further influence group conformity, conformity intention, group attraction, and group trustworthiness. However, the degree of compliance with and trust in computer agents was contingent on how much users felt as if these agents had been real humans.


## 1. Introduction

Weiser (1991) in the early 1990s predicted that computers and machines would become ubiquitous in our lives. Though it is premature to assert that we are becoming indistinguishable from computers, we have been accustomed to viewing computers as our assistants and perceiving them as social actors (Fogg, 2002; Nass & Moon, 2000; Reeves & Nass, 1996).

This study will focus on how individuals follow suggestions from computer agents and conform to their group norms. According to Lieberman (1997), a computer agent can be defined as a program that can be regarded as a facilitator or an assistant instead of a tool. An agent should display some characteristics that people can relate to human intelligence (Lieberman, 1997). As computers have been enabled with complex algorithms to work autonomously, computer agents have advanced to work in ways that are perceived as intelligent and influential in changing people's attitude and decisions (Shinozawa, Naya, Yamato, & Kogure, 2004). An example of autonomous technologies in the 1990s could be the cognitive adaptive computer help (COACH) system. COACH system generates personalized advice based on recorded user experience and analysis of use efficiency (Selker, 1994). Another example would be *Letizia*, an autonomous interface agent for web browsing. *Letizia* provides individualized and non-coercive advice through simulating users' online searching behaviors (Lieberman, 1997).

Today's computer technologies are not limited to providing assistive help in browsing webpages. Adding to the equation was the recommendation algorithms that record and demonstrate our preferences against others (Gillespie, 2014). On *Amazon.com*, recommendation algorithms track users' interests, build models of users' preferences, and personalize customers' online shopping experience (Lops, De Gemmis, & Semeraro, 2011). Customized search engines and intelligent software agents also have been used to assist in filtering, sorting, and sharing information (Montaner, Lopez, & De La Rosa, 2003).

In addition to individualized service, computer-generated content has made a breakthrough in affecting users' judgments. Clerwall (2014) and Van Der Kaa and Krahmer (2014) found that newsreaders perceived no difference between computer writers and human journalists in their credibility and expertise. Considering that news agencies such as *Thomson Reuters* and *AP* have started to use algorithms to compile news stories (Van Dalen, 2012), it could be expected that readers will receive more robot-generated news in the future.

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Computer technologies are also taking humans' social roles in part and attempting to become effective in informing and assisting humans. Some computer programs have been designed to be cooperative and to act as tutors and secretaries (Bocionek, 1995; Clarke & Smyth, 1993; Viadero, 2010). As people are becoming reliant on these computer agents in their daily decision making (e.g., Google Now, Microsoft Cortana), this study will specifically examine how individuals engage with computer agents in group discussion and how computer agents as group members may exert social influence on individuals' decision making.

There will be theoretical implications for studying computer agents' social influence on individuals. First, research on the Computers are Social Actors (CASA) paradigm suggests that individuals perceive computers as social actors through the cues of language use, voice, praise, and so on (Nass & Moon, 2000; Nass, 2004). However, less research has centered on whether individuals may succumb to “peer pressure” from multiple computing sources (Fogg, 2002). By examining the social dynamics of computer agents, this study can contribute to the research gap in the CASA research.

Second, the Social Identity Model of Deindividuation Effects (SIDE) suggests that lack of individuating cues in group communication may lead individuals to shift their personal identity to group identity. Group members may thus exert social influence on individuals through salient group identity or norms (Reicher, Spears, & Postmes, 1995; Spears & Postmes, 2015). However, most SIDE research has been conducted in the context of computer-mediated communication (CMC) where group members are presumed to be humans. It remains unknown whether the SIDE model can be applied to human-computer interaction. By applying computer agents as group members, this study will have the potential to expand the theoretical scope of SIDE from traditional CMC to human-computer interaction (HCI).

## 2. Literature review

### 2.1. The CASA paradigm

Clifford Nass and his colleagues proposed the CASA paradigm in the 1990s. They conducted a series of experiments about how people apply social rules in interpersonal communication to HCI (Nass, Fogg, & Moon, 1996). They found that individuals' interaction with computers is social and natural (Nass et al., 1996). Nass and Moon (2000) used mindlessness to explain the CASA paradigm. Mindlessness occurs when individuals spontaneously react to the social cues displayed by computers and neglect the asocial ones (Nass & Moon, 2000). Based on the CASA paradigm, Reeves and Nass (1996) proposed the idea of “media equation” and argued that individuals treat media as real people.

Past works on CASA suggested that individuals treat computers with politeness. Nass, Steuer, and Tauber (1994) found that when participants were asked by a computer to evaluate the performance of another computer they interacted with, participants tended to be more critical of the computer they used (Nass et al., 1994; Reeves & Nass, 1996). The CASA paradigm also suggests that human-sounding speech from computers can generate stereotyped gender differences and personalities (Nass & Moon, 2000). Specifically, a computer with a female voice was perceived as more convincing and friendly, while a computer with a male voice was perceived as more competent (Nass, Moon, & Green, 1997). Morishima, Nass, Bennett, and Lee (2001) later corroborated the result that a male voiced computer was viewed as more credible than a female-voiced one.

Nass and Lee (2001) focused on users' perception of computers' personalities. They suggested that when a computer was installed with an extroverted artificial voice that featured higher volume, higher speech rate, higher frequency, and wider pitch range, extroverted participants were more attracted to the computer than introverted participants. The experiment result was consistent with interpersonal communication findings that people are more attracted to those with similar personalities to their own (Nass & Lee, 2001). The role of voice in displaying personalities has been replicated in the Lee and Nass (2005) study where participants reported stronger social presence when the perceived personality of the computer voice matched the perceived personality of the texts displayed on the computer.

Individuals also perceive computers as tutors. Bracken and Lombard (2004) assessed children's response to computers' feedback. Their research suggested that praise from computers was positively related to children's recall test performance, recognition test performance, and children's perceived ability to complete the task.

The CASA Paradigm further posits that computer users can form team relations with computers and perceive them as teammates. Nass et al. (1996) manipulated participants' sense of team identity by informing participants whether their performances were dependent on a computer's performance. Nass et al. (1996) found that the participants who were dependent on a computer's performance were more cooperative, more open to influence, and more likely to perceive the computer's information as credible. Nass et al. (1996) thus argued that an individual can be teamed up with a computer and demonstrate similar attitudes and behavior in collaboration with humans.

In addition to computers, prior research has suggested that individuals can share the same identity with robots. In Eyssel and Kuchenbrandt (2012)'s study, participants were informed of two robots' names (a German name vs. a Turkish name). They found that the participants who had the same nationality with the robots were more likely to evaluate the robots' performances as positive. Kuchenbrandt, Eyssel, Bobinger, and Neufeld (2013) further used a minimal group approach to studying human robot interaction. They only told the participants whether they were on the same team as the robot NAO. Results suggested that the participants in the same-team condition reported more support to the robot NAO than those in the different-team condition.

Based on these studies, it can be postulated that individuals can form group relations with computers. However, most prior research has centered on how an individual can form group relationship with a single computer. Less research has centered on how an individual may collaborate with multiple computing sources and how these multiple computing sources impose peer pressure on the individual (Fogg, 2002). Considering that now media users have been exposed to multiple computing agents in their daily lives (e.g., chat-bots, voice assistants, online forum robots), examining the persuasive effects of multiple computing agents would have both theoretical and practical implications.

### 2.2. The Social Identity Model of de-individuation effects (SIDE)

SIDE is a model that combines social identity theory and deindividuation theory (Diener, 1979; Festinger, Pepitone, & Newcomb, 1952; Le Bon, 2009; Reicher et al., 1995; Tajfel, 1970; Turner, Hogg, Oakes, Reicher, & Wetherell, 1987). This model postulates that factors such as anonymity that were found to predict deindividuation effects in previous studies can actually reinforce the salience of group identity and enhance individuals' conformity to group norms (Postmes, Spears, & Lea, 1998; Spears & Postmes, 2015). According to Postmes et al. (1998), the salience of the group identity will be accentuated when individual cues are absent and cues to a shared identity become conspicuous.

Although SIDE originates from social psychology, it has been applied in CMC research. Specifically, SIDE posits that anonymity, which could be understood as lack of social cues, can interact with group norms in fostering social influence in a mediated environment (Spears & Postmes, 2015). In SIDE, anonymity and group immersion are two key factors in predicting group conformity. Anonymity can help reduce individuals' accountability for their behavior, whereas submergence in group can lower individuals' sense of individual identity (Spears & Postmes, 2015). Lee (2006) pointed out that when participants received less individuating information about the other communication partners in a CMC context, they perceived these communication partners to have more in common with themselves.

### 2.2.1. Visual similarity

Although SIDE researchers have corroborated that visual anonymity could positively predict group-based self-categorization (Lea, Spears, & de Groot, 2001), the concept of anonymity has not been clearly defined. Lea et al. (2001) argued that anonymity could be categorized into nominal anonymity (i.e., lack of name or personal identifier), biographical anonymity (i.e., lack of personal details), and domiciliary anonymity (i.e., lack of traceable address). Anonymity also could refer to lack of physical appearances or dissociation of real identity and online identity (Morio & Buchholz, 2009).

Though researchers have not reached consensus on the definition of anonymity, Spears and Postmes (2015) argued that the key to understanding SIDE is not about the amount of information blocked in CMC, but about the visual representation of group members. That is, anonymity should refer to the degree to which information source is unidentifiable (Hollenbaugh & Everett, 2013). In past work, anonymity could enhance individuals' conformity to group norms because the visual representation of group members was homogenous (Lee, 2004a). Kim and Park (2011) confirmed that uniform visual appearances can reinforce the deindividuation effects and group identification. Lee (2004a) also found that uniform representation can engender depersonalization and conformity to group norms. Kim (2009) further noted that similar avatars can add to the formation of group identity.

Though it remains unknown whether visual similarity can lead humans to perceive computer agents rather than real people as their group members, at least Reeves and Nass (2002) noted that sharing the same color cue can group one human participant and one computer together. Reeves and Nass (2002) found that when participants were assigned to the same team condition where they wore a blue wristband and interacted with a computer labeled as "blue team," they felt resemblance to the computer and perceived it as more friendly. Therefore, based on prior research on the roles of group identity in the SIDE model and the cues sharing in the CASA paradigm, it is hypothesized that

**H1**. *Sharing the same color cues with multiple computer agents will lead to individuals' group identification with computer agents.*

### 2.2.2. Interdependence

Interdependence is another factor that may constitute individuals' sense of group identity (Brown, 1984; D. W. Johnson & Johnson, 2005). Interdependence occurs "when the outcomes of individuals are affected by each other's actions" (D. W. Johnson & Johnson, 2005). D. W. Johnson and Johnson (2005) introduced social interdependence theory and argued that stronger interdependence such as common goals, common outcomes, and interpersonal bonds can lead to higher level of group identity.

Consistent with social interdependence theory, Bruer, Eys, Evans, and Wilson (2015) used multilevel analysis and found that outcome interdependence at both individual and team levels can positively predict athletes' perception of social identities. Kim (2009) compared the effects of need for uniqueness and interdependent self-construal on group identity. She found that interdependent self-construal can lead to group identity and conformity intention. Similarly, Mackie (1986) found that when participants focused on their group performances, they would be more likely to experience attitude polarization. Thus, interdependence may play a significant role in in-group attitude polarization.

Individuals not only form group relations with humans, they may also perceive computers as group members. Considering that Nass et al. (1996) and Kuchenbrandt et al. (2013) corroborated that individuals can be in favor of in-group computers and robots, it is postulated that establishing interdependence with computer agents should enhance users' group identification with computer agents. Additionally, research has indicated that goal interdependence can moderate the relationship between intergroup similarity and intergroup attitudes (Brown, 1984; Costa-Lopes, Vala, & Judd, 2012), but there is limited research on how interdependence moderates the impact of members' visual similarities on their group identification. Thus, this study proposes the following hypothesis and research question.

**H2**. *Interdependence with multiple computer agents will lead to group identification with computer agents.*

**RQ1**. *How will interdependence with computer agents moderate the relationship between color cues sharing and group identification?*

### 2.2.3. Group identity and group influence

The salience of group identity has been associated with group conformity and other outcomes (Lee, 2006). Kim (2009) suggested that higher group identification leads to higher conformity intention. Kim and Park (2011) found that group identification can lead to group members' conformity to group norms. Walther, De Andrea, Kim, and Anthony (2010) used SIDE to examine the effects of anti-marijuana videos and the online comments posted to the videos. Walther et al. (2010) found that the valence of the comments interacted with readers' identification with comment posters in affecting their anti-marijuana evaluations. Supportive comments more positively shaped people's perceptions of anti-murijuana messages.

Group identification may also predict other factors. Carr, Vitak, and McLaughlin (2011) manipulated personal profiles on Facebook and found that in-group members were perceived as more socially attractive than out-group members. Postmes et al. (1998) found that de-individuated group members were more susceptible to group norms and they reported higher in-group favoritism and higher social attraction of the group.

Apart from group conformity and social attraction, Lee and Nass (2002) suggested that unanimous opinions from four human communication partners evoked higher trustworthiness than those from only one communication partner. Flanagin, Hocevar, and Samahito (2014) examined user-generated web content and found that individuals evaluated similar others as more credible even if the identity of the information source was not completely disclosed. Thus, based on previous literature, it is hypothesized that:

**H3**. *Individuals' group identification with multiple computer agents will positively predict their conformity intention.*

**H4**. *Individuals' group identification with multiple computer agents will positively predict their group conformity.*

**H5**. *Individuals' group identification with multiple computer agents will positively predict group attraction.*

**H6**. *Individuals' group identification with multiple computer agents will positively predict group trustworthiness.*

### 2.3. Social presence

Individuals may experience social presence when they feel the pressure from group members. Presence could relate to the way that computer agent is displayed to others (Li, 2015; Li, Kizilcec, Bailenson, & Ju, 2016). Lee (2004b) conceptualized social presence as "a psychological state in which virtual social actors (para-authentic or artificial) are experienced as actual social actors in either sensory or non-sensory ways" (p. 37). Biocca, Harms, and Burgoon (2003) described social presence as "a transient phenomenological state that varies with medium, knowledge of the other, content of the communication, environment, and social context" (p. 469).

Lombard and Ditton (1997) distinguished two types of social presence: presence as social within medium and medium-as-social-actor presence. Presence as social actor within medium refers to the idea that media users respond to the social cues presented by the characters within medium (Lombard & Ditton, 1997). This type of social presence originates from parasocial interaction where users react to television anchormen or protagonists (Horton & Wohl, 1956). Medium-as-social-actor presence refers to individuals' responses to the medium itself. When a medium itself presents social cues, individuals are likely to perceive it not as a medium but as a real person.

In the current study, individuals are expected to perceive computer agents as real people. Thus, the term social presence is used as it described the phenomenon that people fail to notice the role of technology and feel that they are interacting with actual social entities (ISPR, 2000). On top of that, medium-as-social-actor presence will be used in hypotheses and research questions as this term specifically describes individuals' perception of media technologies per se as social entities.

#### 2.3.1. Group identity and presence

The sense of being with others has been examined in relation to social cues in the CMC context (Culnan & Markus, 1987; Kiesler, Siegel, & McGuire, 1984; Short, Williams, & Christie, 1976; Valacich, Dennis, & Nunamaker, 1992; Walther & Parks, 2002; Walther, 1996; Walther, 2007; Walther, Van Der Heide, Ramirez, Burgoon, & Pena, 2015). Although Kramer, der Putten, and Hoffmann (2015) suggested that the more social cues computers can present, the more likely they are to elicit social behaviors, the tenets of the SIDE model may imply a different view. Lack of individual social cues may actually increase rather than decrease social presence (Rogers & Lea, 2005). Rogers and Lea (2005) conducted two case studies and found that shared social identity with group collaboration could elicit strong social presence of group members. They explained that cues as to group membership can generate a feeling of affiliation with the group and immerse the individuals into the group discussion environment. However, compared with humans, it remains unknown whether individuals will perceive multiple computer agents to have strong social presence in an anonymous group discussion context. Thus, the second research question is:

**RQ2**. *How will group identification with multiple computer agents predict medium-as-social-actor presence?*

#### 2.3.2. Social presence as a mediator

Rogers and Lea (2005)'s research also suggested that social presence had positive influence on group cohesion, evaluation of team members, and group performance. The findings may indicate that social presence plays a mediating role in the relationship between group identification and social influence. However, limited research has explored the mediating role of medium-as-social-actor presence in small group communication. For example, Lee and Nass (2002) compared peer pressure from computers and humans. They found that unlike human-human interaction, unanimous opinions from four computer agents did not influence individuals' compliance. However, Lee and Nass (2002) did not examine the role of medium-as-social-actor presence in the relationship between computer agents' group norms and individuals' compliance. It is likely that individuals may only yield to the peer pressure of computer agents when they perceive the computer agents as real people.

Despite the research gap in medium-as-social-actor presence as a mediator in SIDE research, social presence in prior research has been associated with the perceived attractiveness and the usability of the technologies (Shin, 2013). Salem, Eyssel, Rohlfing, Kopp, and Joublin (2013) conducted an experiment with Honda's humanoid robot (Asimo year 2000 model) and found that the robots' demonstration of human-like gestures increased their likability and participants' willingness to further communicate with them in the future. Thus, if group identification can be found to predict medium-as-social-actor presence, it is likely that presence can be a mediator between group identification and social attraction.

Social presence has also been related to trustworthiness. D. Shin and Shin (2011) examined participants' purchasing behavior in virtual shopping malls. They found that social presence can strongly predict customers' trust toward virtual shopping malls. Similarly, Hassanein and Head (2007) found that social presence can positively predict participants' trust toward shopping websites. Thus, designing strong social presence may help build trust in media technologies in the context of CMC. As the role of medium-as-social-actor presence in the relationship between group identity and group influence has largely been overlooked in prior literature, the following research questions are proposed. The research model is showed in Fig. 1.

**RQ3**. *How will medium-as-social-actor presence mediate the relationship between group identification and conformity intention?*

**RQ4**. *How will medium-as-social-actor presence mediate the relationship between group identification and group conformity?*

**RQ5**. *How will medium-as-social-actor presence mediate the relationship between group identification and group attraction?*

**RQ6**. *How will medium-as-social-actor presence mediate the relationship between group identification and group trustworthiness?*

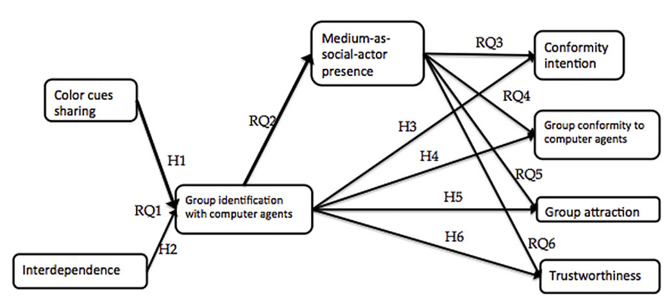


**Fig. 1.** Research model.

## 3. Method

### 3.1. Participants

A total of 73 undergraduate students from a public university in Northeast United States volunteered to participate in the experiment. Recruitment announcements were made in undergraduate classes. All participants received extra credit for their participation. They were also informed of the possible benefits and risks of the experiment. Those who majored or minored in computer science were excluded from the study due to their expertise on programming. After data cleaning, 72 participants' responses were included. The study sample included 37 male students (51.4%) and 35 female students (48.6%). Participants' age ranged from 18 to 30. The average age of the participants was 20.34 years old ($SD = 1.89$).

### 3.2. Research design and procedures

The experiment used a 2 (same color cues vs. different color cues) X 2 (interdependence vs. non-interdependence) between-subject factorial design. A discussion portal was designed for the experiment in the form of a purely text-based software (Fig. 2). It was created in batch file and looked similar to a DOS operating file. Participants were told that they would interact with three computer programs in the discussion portal. To avoid leading participants to think of these computer programs as humans, the term "computer programs" rather than "computer agents" were used during the experiment. In addition, the computer programs used in the experiment were disembodied. When they provided information, their statements would be void of any anthropomorphic language such as self-referential statements (Nass & Steuer, 1993) and exaggerated tones (Zhao, 2003).

In the discussion portal, participants were first asked to choose one color from blue, green, red, and yellow to represent their identity in the portal. In the same color conditions, three computer programs were programmed to choose the same color as participants' choice to represent their identity. In the different color conditions, the three computer programs chose the different colors

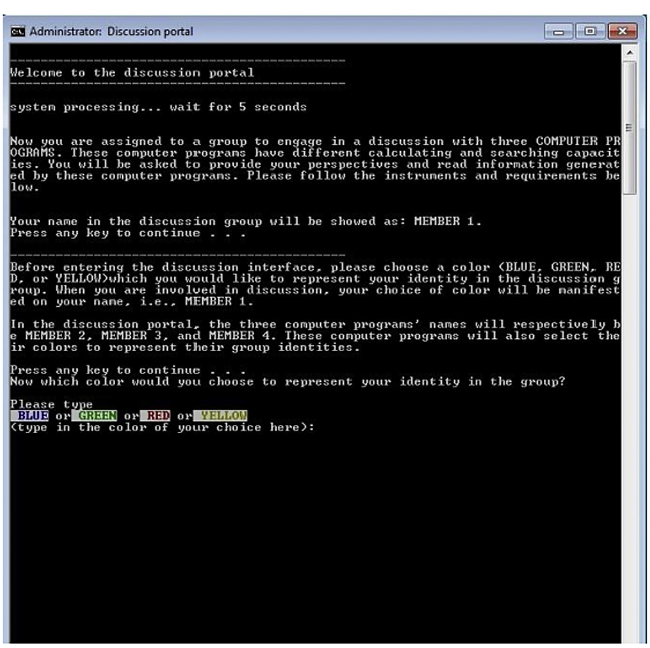


**Fig. 2.** An interface of the discussion portal.

from participants' choice as their identity colors. For example, if a participant chooses the blue color for its identity, the three computer programs will choose red, yellow, and green respectively. To control for the visual cues, no other individuated information was presented in the discussion portal. The participants' identity was showed as "member 1" in the discussion portal. The computer programs' identities were manifested as "member 2," "member 3," and "member 4."

In the interdependence conditions, participants were told in the discussion portal that they would receive the same evaluation as the computer programs. The evaluation would provide all group members a same score. In contrast, participants in the non-interdependence conditions were told that they would be evaluated based on their own performance. Participants would receive their score independent of other group members' performances.

Designs from past works on CMC and HCI were adapted for the experiment (Kim & Park, 2011; Lee, 2006; Melin, Castillo, & Kacprzyk, 2016; Muñoz-Arteaga, Calvillo-Moreno, Ochoa-Zezzatti, Santaolaya-Salgado, & Álvarez-Rodríguez, 2010; Ochoa, González, Moriel, Arreola, & García, 2017). On arriving at the lab, participants first received consent forms and were informed that their responses would be kept confidential. After signing the consent forms, they were randomly assigned to one of the four conditions: 1) same color and interdependence, 2) same color and non-interdependence, 3) different color and interdependence, and 4) different color and non-interdependence. They were told that they would participate in discussion with three computer programs to test the usability of these programs. They were informed that the programs had different calculating and searching capacities. Participants were also told that they would discuss with these computer programs about three choice-dilemma scenarios. The scenarios were retrieved from Lee (2006)'s study (Appendix A).

Before the experiment, participants were first asked about their demographic information and computer use experience. Then they were asked to choose a color and were told whether or not they would work interdependently with the computer programs. After participants saw the color choices made by the computer programs and knew that computer programs would receive the same evaluation rule as the participants, they were asked to complete the measure for group identification. To avoid priming effects, questions about group identification were asked together with other questions such as computer usage.

Next, participants were asked to read and respond to the first of the three choice dilemma scenarios. Participants need to report on a six-point scale ranging from "Definitely should do A" to "Definitely should do B." They were also asked to write a short argument to support their choices. After that, each computer program would respond to the same scenario. The three computer programs were programmed to make decisions that were opposite to those of the participants. By using a pre-programmed discussion manuscript, the computer programs should generate the same conformity pressure on each participant (Kim & Park, 2011). For example, if a participant chooses "Should do A," the three computer programs will opt for "Should do B," "Probably should do B," and "Definitely should do B." The three computer programs provided their short arguments one by one at different speeds. This is to let participants believe that these computer programs had different calculating capabilities and had processed opinions from other computer programs. Then participants were required to respond to the same scenario again and make their final choice. After the first choice-dilemma scenario, participants were asked to participate in discussion in the next two choice-dilemma scenarios. Finally, participants were asked to fill out the measures for dependent variables and other control variables.

### 3.3. Measures

#### 3.3.1. Group identification

The measure of group identification was adapted from measures of group identification and team perception (Kim & Park, 2011; Nass et al., 1996). Participants were asked to report on six seven-point Likert-type items (1 = strongly disagree, 7 = strongly agree). The responses to the measure were summed and averaged to form the index ($M = 4.34$, $SD = 1.26$, $\alpha = .89$). The items include "I have a lot in common with the computer programs in the group" and "I find it easy to identify with the computer programs in the group."

#### 3.3.2. Medium-as-social-actor presence

The measure of medium-as-social-actor presence was adapted from previous research on CASA (Lee, Park, & Song, 2005; Lee, Peng, Jin, & Yan, 2006). Participants were asked to report on six seven-point items (1 = Not at all, 7 = Very much). The responses to the measure were summed and averaged to form the index ($M = 4.28$, $SD = 1.12$, $\alpha = .80$). The items include "How much did you feel as if you were interacting with an intelligent being?" and "How much did you feel as if you and the computer programs were communicating with each other?"

#### 3.3.3. Conformity intention

Conformity intention was adapted from the Kim and Park (2011) measure of conformity intention and the Nass et al. (1996)'s measure of openness to influence. Participants were asked to report on eight seven-point Likert-type items (1 = strongly disagree, 7 = strongly agree). The responses to the measure were summed and averaged to form the index ($M = 3.76$, $SD = 1.21$, $\alpha = .90$). The items include "I am willing to agree with these computer programs" and "I am willing to follow their opinions."

#### 3.3.4. Group conformity

Measure of group conformity was adapted from the Lee (2006) study. Group conformity was operationalized as the change of participants' opinions. After reading other computer programs' statements, participants were asked to make their final decision on a six-point scale ranging from "Definitely should do A" to "Definitely should do B." The differences between their initial choices and final choices were coded. For example, if participants shifted from "Definitely should do A" to "Probably should do B," their score would be coded as 3. If participants changed from "Probably should do A" to "Probably should do B," their score would be coded as 2. If participants did not change their mind or inclined toward the opposite of group norms, their score would be coded as 0, meaning that the participants did not conform to group norms. The scores for three scenarios were summed and averaged ($M = .64$, $SD = .67$, $\alpha = .22$).

#### 3.3.5. Group attraction

Measure of group attraction was adapted from previous measures of social attraction and group attraction (Carr et al., 2011; Lea et al., 2001; Lee & Nass, 2002; McCroskey & McCain, 1974). It measured the degree to which participants found group members attractive. Participants were asked to report how well each adjective described their group members on a seven-point Likerty-type scale (1 = strongly disagree, 7 = strongly agree). The responses to the measure were summed and averaged to form the index ($M = 3.88$, $SD = 1.05$, $\alpha = .88$). The items include "I find these computer programs friendly" and "I find these computer programs pleasant."

#### 3.3.6. Trustworthiness

Measure of group trustworthiness was adapted from the previous measure of trust (Hassanein & Head, 2007; Lee & Nass, 2002). Participants were asked to report on four seven-point Likert-type items (1 = strongly disagree, 7 = strongly agree). The responses to the measure were summed and averaged to form the index ($M = 4.14$, $SD = 1.30$, $\alpha = .87$). The items include "I find these computer programs trustworthy" and "I find these computer programs reliable."

The measures above were adapted from the measures in previous research. These measures had predictive validity and content validity. They also had face validity as they reflected what the study seeks to examine.

#### 3.3.7. Demographic information and control variables

Participants were asked about their age, gender, and college year. Variables such as computer usage, risk taking tendencies (Meertens & Lion, 2008), knowledge about programming language, and attitude toward computers (e.g., I feel comfortable using computers) were used as control variables.

### 3.4. Data analysis

SPSS 20.0 was used to examine the hypotheses and research questions. Frequencies and Mahalonobis distance were used to examine outliers and multivariate outliers. Correlation, tolerance values and VIF were used to test the collinearity. Variables that were not normally distributed were log transformed to adjust skewness and kurtosis (Field, 2009). T-tests suggested that the missing values were not systematically missing. T-tests were used to examine H1 and H2. Process in SPSS (Hayes, 2013) was used to do mediation and moderation analysis for H3 to H6 and RQ1 to RQ6. The commands for plotting graphs, bootstrapping direct and indirect effects, and 95% of confidence intervals were used.

## 4. Results

To test if sharing the same color cues with multiple computer agents will lead to individuals' group identification with computer agents (H1), T-tests suggested that participants in the same color conditions ($M = 4.68$, $SD = 1.23$) reported significantly higher group identification with computer agents than those in the different color conditions ($M = 3.99$, $SD = 1.21$), $t\,(70) = 2.42$, $p < .05$. Thus, H1 was supported.

To test if interdependence with computer agents will lead to individuals' group identification with computer agents (H2), T-test suggested that participants who worked interdependently with computer programs ($M = 4.29$, $SD = 1.37$) were not significantly different in their group identification with computer agents than those who worked independently ($M = 4.40$, $SD = 1.16$), $t\,(70) = -.37$, $p > .05$. Interdependence with computer agents did not lead to group identification. Thus, H2 was rejected. The results from T-tests were showed in Table 1.

To examine the interaction between color cues sharing and interdependence with computer agents (RQ1), moderation analysis suggested that controlling for gender, computer usage, knowledge about programming language, and attitude towards computers, color sharing and interdependence did not interact with each other in predicting group identification with computer agents, $B = .57$, $p > .05$, $LLCI = -.62$, $ULCI = 1.75$. The results suggested that collaborating with computer agents would not influence the effects of color sharing on group identification.

RQ2 asked about the effects of users' group identification with computer agents on medium-as-social-actor presence of computer agents. Results from regression analysis suggested that controlling

**Table 1**
Results from T-tests for different conditions.

| | Same color | Different color | *t*-test (df) | Same evaluation | Different evaluation | *t*-test (df) |
|---|---|---|---|---|---|---|
| | M (SD) | M (SD) | | M (SD) | M (SD) | |
| Group identification | 4.68 (1.23) | 3.98 (1.21) | 2.42* (70) | 4.29 (1.37) | 4.40 (1.16) | −.37 (70) |
| *N* of participants in each condition | 37 | 35 | | 36 | 36 | |

Note: * means $p < .05$. *M* means the mean for group identification. *SD* means standard deviation. *N* means the sample size for each condition, df means degree of freedom.

for gender, computer usage, attitudes toward computers, and programming language knowledge, group identification with computer agents positively predicted medium-as-social-actor presence, $B = .45$, $p < .001$. The result indicated that the more participants felt about their group identity, the more likely they would perceive computer agents as social actors.

Mediation analyses were used to examine the rest of the hypotheses and research questions. H3 hypothesized that group identification with computer agents would lead to conformity intention. RQ3 asked how medium-as-social-actor presence would mediate the relationship between group identification and conformity intention. H3 was supported. Results suggested that controlling for gender, computer usage, attitude towards computers, knowledge about programming language, and risk taking tendencies, the total effects of group identification on conformity intention was significant, $B = .47$, $p < .001$, $LLCI = .23$, $ULCI = .72$. Group identification with computer agents had direct effects on conformity intention, $B = .36$, $p < .05$, $LLCI = .08$, $ULCI = .65$. In addition, the indirect effect of group identification with computer agents on conformity intention through medium-as-social-actor presence was not significant, $B = .11$, $LLCI = -.02$, $ULCI = .26$. Therefore, group identification with computer agents had direct effects on participants' willingness to conform to group norms.

H4 hypothesized that group identification with computer agents would lead to actual conformity behavior. RQ4 asked how medium-as-social-actor presence would mediate the relationship between group identification and conformity to group norms. H4 was supported. Results suggested that controlling for the same control variables, the total effects of group identification on conformity was significant, $B = .04$, $p < .05$, $LLCI = .01$, $ULCI = .08$. Though group identification with computer agents did not have direct effects on group conformity, $B = .02$, $p > .05$, $LLCI = -.02$, $ULCI = .06$, group identification with computer agents had indirect effects on group conformity through medium-as-social-actor presence, $B = .02$, $LLCI = .00$, $ULCI = .04$. The results suggested that group identification would influence participants' actual conformity behavior indirectly.

H5 postulated that there would be positive influence of group identification with computer agents on group attraction. RQ5 asked how medium-as-social-actor presence would mediate the relationship between group identification and group attraction. H5 was supported. Results suggested that controlling for the control variables, the total effects of group identification on group attraction was significant, $B = .40$, $p < .001$, $LLCI = .20$, $ULCI = .60$. In addition, group identification with computer agents had both direct effects on group attraction, $B = .27$, $p < .05$, $LLCI = .05$, $ULCI = .49$, and indirect effects on group attraction through medium-as-social-actor presence, $B = .13$, $LLCI = .03$, $ULCI = .26$. The results suggested that group identification with computer agents would lead to perceived attractiveness of the group both directly and indirectly.

H6 hypothesized that group identification with computer agents would positively influence the trustworthiness of group members. RQ6 asked how medium-as-social-actor presence would mediate the relationship between group identification and group trustworthiness. H6 was supported. Results suggested that controlling for all the control variables, the total effects of group identification on group trustworthiness was significant, $B = .29$, $p < .05$, $LLCI = .01$, $ULCI = .58$. Though group identification with computer agents did not have direct effects on trustworthiness of computer agents, $B = .07$, $p > .05$, $LLCI = -.24$, $ULCI = .38$, group identification with computer agents had indirect effects on group trustworthiness through medium-as-social-actor presence, $B = .22$, $LLCI = .08$, $ULCI = .39$. The results suggested that group identification would increase the credibility of the computer programs indirectly. The results of the mediation analyses were showed in Table 2. The results of the effects of group identification on group influence were showed in Table 3.

## 5. Discussion

This study attempts to examine how the SIDE model could be applied to CASA research. Specifically, this study seeks to understand whether sharing the same group identity cues and working interdependently with computer agents could lead to the same group influence as predicted in the SIDE model. The findings suggest that even the minimal color cues can lead to users' identification with group members. The findings also indicate that group identification would exert influence on users' attitude change. Users have the tendency to conform to unanimous group norms even exhibited by computer agents. In addition, users' group identification with computer agents could lead to perceived credibility and attraction of the group members. However, the degree of conformity and trust in computer agents depends on how much users feel as if these agents were real humans.

The study suggests that sharing the same color cues could help users form the same group identity with computer agents. The

**Table 2**
The influence of group identification on group influence through presence.

| Effect type | *B (SE)* | 95% of Confidence interval | |
|---|---|---|---|
| | | LLCI | ULCI |
| **Total effects of group identification on dependent variables** | | | |
| Conformity intention | .47 (.12)* | .23 | .72 |
| Group conformity | .04 (.02)* | .01 | .08 |
| Group attraction | .40 (.10)* | .20 | .60 |
| Group trustworthiness | .29 (.14)* | .01 | .58 |
| **Direct effects of group identification on dependent variables** | | | |
| Conformity intention | .36 (.14)* | .08 | .65 |
| Group conformity | .02 (.02) | −.02 | .06 |
| Group attraction | .27 (.11)* | .05 | .49 |
| Group trustworthiness | .07 (.16) | −.24 | .38 |
| **Indirect effects of group identification on dependent variables through presence** | | | |
| Conformity intention | .11 (.07) | −.02 | .26 |
| Group conformity | .02 (.01)* | .00 | .04 |
| Group attraction | .13 (.06)* | .03 | .26 |
| Group trustworthiness | .22 (.08)* | .08 | .39 |

Note: *means significant effect. *B* means unstandardized effect. *SE* means standard error. LLCI means lower level confidence interval. ULCL means upper level confidence interval. The variable group conformity is log transformed. The effects of control variables have been controlled.

**Table 3**
The effects of group identification on group influence controlling for control variables.

| Predictor | Social Presence | Conformity intention | Group Conformity | Group attraction | Group trustworthiness |
|---|---|---|---|---|---|
| | B (SE) | B (SE) | B (SE) | B (SE) | B (SE) |
| Gender | .11 (.28) | .22 (.30) | .04 (.04) | −.26 (.25) | −.24 (.36) |
| Computer usage | −.48 (.54) | −.50 (.58) | −.10 (.08) | .03 (.48) | −.16 (.69) |
| Knowledge | .02 (.83) | 1.53 (.91) | −.11 (.13) | 1.28 (.74) | 1.05 (1.06) |
| Computer attitude | .59 (.57) | −.08 (.62) | −.10 (.09) | .50 (.50) | −.36 (.73) |
| Risk taking tendencies | – | .32 (.19) | .04 (.03) | −.13 (.16) | .19 (.23) |
| **Group identification** | .45 (.11)$^{***}$ | .47 (.12)$^{***}$ | .04 (.02)$^{*}$ | .40 (.10)$^{***}$ | .29 (.14)$^{*}$ |
| $R^2$ | .22$^{**}$ | .23$^{*}$ | .17 | .30$^{**}$ | .10 |
| *F (df1, df2)* | 3.50 (5, 59) | 2.90 (6, 57) | 1.92 (6, 58) | 4.10 (6, 57) | .39 (6, 58) |

Note: $^{*}$means $p < .05$, $^{**}$means $p < .01$, $^{***}$means $p < .001$, *SE* means standard error, *B* means unstandardized coefficient, *df* means degree of freedom, $R^2$ means the variance accounted by all the predictor variables. The gender was coded in the way that 0 was for male and 1 was for female. Computer usage, attitudes toward computer, programming knowledge, and group conformity were log transformed for normal distribution. Before transformation, attitude toward computer was negatively skewed. The other variables were positively skewed.

finding corroborated prior research on SIDE in that individuals switch their attention to their group identity in the context of group discussion (Spears & Postmes, 2015). Meanwhile, the results supported the perspective that anonymity does not necessarily refer to absence of individual social cues. Visual similarities would send the same social beckoning signals as anonymity itself in shaping group membership (Hollenbaugh & Everett, 2013). Additionally, computer agents were disembodied in the experiment. Users could not access any social cues other than texts and colors. The finding suggests that even these minimal cues could enable users to identify with computer agents, which is consistent with the results from previous human-robot studies (Kuchenbrandt et al., 2013).

Though previous research indicated that interdependence would enable a user to form team relationship with a computer (Nass et al., 1996), in this study, interdependence did not lead to group identification with multiple computing agents. Despite the contradictory findings, the difference in the group size between this study and the Nass et al. (1996) study could be a key factor in explaining the rejection of the hypothesis. Both Messick (1973) and Olson (2009) argued that as the number of group members increases, group members' contribution to public interest would decrease. Dawes (1974) also mentioned that there is an inverse relationship between group size and group members' willingness to cooperate. Considering that the experiment involved one human participant and three computer agents, it is likely that the participants were less enthusiastic about contributing to group performance and were less willing to share responsibilities with computer agents.

It is also possible that seeing computer agents select colors to represent their group identity might have, to some extent, overshadowed the manipulation of interdependence. The automaticity and the visual effects of color selection may have distracted users' attention to the text-based instructions on working with computer programs. Future research could embed an example of receiving the same score or different scores to ensure that users notice the manipulation.

Group identification with multiple computer agents had influence on both users' attitude change and behavioral change. The findings are consistent with the tenets of the SIDE model, where deindividuation increases group discussants' compliance with uniform group norms (Postmes et al., 1998). Specifically, the results suggested that group identification would directly influence users' conformity willingness. Users' perception of these computer agents would not affect the relationship between group identification and conformity intention. The results indicate that as long as users sense the group identity, they would be willing to listen to group members' suggestions whether or not these group members are humans.

Compared to users' conformity intention, group identification influenced users' actual conformity behavior indirectly through medium-as-social-actor presence. The findings have two implications. First, they corroborate Rogers and Lea (2005)'s argument that lack of social cues may not lead to lower social presence. Instead, there could be an inverse relationship between individuated social cues and social presence in an anonymous group discussion environment where individuals shift their attention from individual cues to group cues and feel stronger social presence of the group members.

Second, though group identification with computer agents could directly influence users' attitude, users' actual behavior would not change unless they perceive these computer agents to be intelligent and appear to have human characteristics. The finding confirmed that presence could be a mediating factor in affecting users' perception of technologies. It is consistent with Lee et al. (2006)'s finding that social presence would mediate the relationship between perceived social robots' personalities and their attraction. It also corroborated Shin and Choo (2011)'s finding that social presence could influence individuals' attitude and behavioral intention in human-robot interaction.

Medium-as-social-actor presence also mediated the relationship between group identification and group trustworthiness. That means only when users perceive multiple computer agents to be close to humans will they suspend their disbelief (Duffy & Zawieska, 2012) and build trust in these computer agents. The findings could add to the current SIDE scholarship in that the extent to which users feel the presence of others would bridge the relationship between identification with group members and users' concession to group norms. Most previous SIDE research only centered on computer-mediated communication between humans, in which participants would assume that they were interacting with real people. The present work provides a prospect for examining the mediating role of social presence both in the context of CMC and HCI.

This study can contribute to the current communication scholarship in three aspects. First, this study builds on prior CASA research and further supports the perspective that interpersonal communication rules could be applied to HCI (Nass & Moon, 2000; Nass et al., 1994). This study responds to Fogg (2002)'s proposal to examine how a computer user may yield to peer pressure from multiple computing sources. This study could be added to the CASA literature, as it shows that computer users not only can form group relationship with multiple computer agents, but also can perceive these computer agents as credible, friendly, and attractive group members.

Second, this study contributes to the expansion of the theoretical scope of the SIDE model. The SIDE model has been applied in

CMC research where communicators are assumed to be humans. In this study, the SIDE model provides its theoretical prospect for accounting for group discussion between humans and computer agents. In addition, prior research suggested that peer pressure from computer agents would not affect users' choices (Lee & Nass, 2002). However, the role of social presence was overlooked, and that is where this study can offer new insights into SIDE research. It is found that users apply social rules to the discussion with computer agents when these computer agents behave and react like real people.

Third, this study envisions the possibility of combining CMC and HCI in explaining the emerging use of computer agents in media platforms such as robots in online forums, chat-bots in social media, voice assistants in computer systems, and robot journalists in news agencies. These applications have already exposed people to an environment where information sources are unidentifiable. Thus, examining how CMC and HCI inform each other in the communication field could help us understand users' psychological processing and behavioral changes during the interaction with computing sources in different mediated environments. Sundar, Jia, Waddell, and Huang (2015) noted that research on CMC is more related to the imperfection of the medium, while research on HCI is more associated with the imperfection of human brain. Thus, the conversation between the two fields should benefit the scholarship in better understanding the way humans respond to the social cues of computing sources.

Apart from its contribution to theory building, the findings shed light on practical and ethical implications. For example, in order to achieve better user experience and work efficiency in interacting with multiple computer agents (e.g., Web assistants, voice assistants, etc.), researchers could consider using the same identity cues to form group relations among users and computer agents. Based on customers' interests and profile information, virtual assistants such as the Gatebox (Margolin, 2016) can be personalized and be embedded with the same identity cues.

Further, as medium-as-social-actor presence mediated the relationship between group identification and conformity behavior, in the future, researchers can consider reinforcing the social characteristics of computer agents to lead users to perceive them as intelligent beings. The results implied that a computer agent can be human not only in its appearances but also in its perceived intelligence (i.e., the automaticity and the spontaneous responses of the computer agents). To sway computer users' attitudes or behaviors, designers or programmers can apply multiple computer agents that have human characteristics.

Meanwhile, if designers or researchers create a presence-evoking technology that is likely to influence users' opinions, they should be mindful of the potential risks. As was indicated in previous studies, users could not distinguish twitter bots from human Twitter accounts (Edwards, Edwards, Spence, & Shelton, 2014), and thus it would be perilous to manipulate users' presence experience for any negative outcomes. As computer agents or bots have already been widely used for online communities or customer reviews and will be increasingly adopted in the future, website managers or designers should be fully aware of the persuasive effects of multiple computer agents.

## 6. Conclusions and future directions

Though it may be still early to claim that we are now in the ubiquitous computing age (Weiser, 1991), undeniably, computer agents have been applied in many media technologies. These media technologies include but are not limited to voice assistants in mobile applications, personal assistants on health-related websites, bots in social media, review comments on shopping websites, and computer-controlled agents in video games. The current study examines computers' perception of these computer agents and seeks to bridge the gap between a CMC theory (i.e. SIDE) and a HCI theory (i.e., the CASA paradigm). Within the context where social presence is studied, the current study can contribute to both the SIDE model and the CASA paradigm. It suggested that individuals may succumb to the peer pressure from multiple computing agents that are perceived to be intelligent.

Despite the theoretical and practical implications, the study has limitations. First, the text-based discussion portal may lead to high internal validity while sacrificing external validity. In the future, researchers could examine the same research questions in other media environments such as video gaming and virtual reality.

Second, the experiment sample was recruited from a public university in Northeast United States. Researchers could attempt to recruit a more representative sample to test the replicability of the results.

Apart from that, researchers in the future could also explore how other CMC theories such as social information processing theory (Walther, 1996) and hyper-personal communication model (Walther & Parks, 2002; Walther, 2007) may inform users' responses to computing sources. In addition, when looking into users' submission to group pressure, researchers could investigate 1) how computer agents' group size influences the peer pressure, 2) how computer agents' inconsistent suggestions influence users' conformity intention and behavior, and 3) how visual dissimilarities among computer agents affect users' presence experience and attitude change.

## Appendix A. Choice-dilemma scenarios

### Scenario 1

Ms. E., a college senior, has studied the piano since childhood. She has won amateur prized and given small recitals, suggesting that she has considerable musical talent. As graduation approaches, she has the choice of taking a medical school scholarship to become a physician, a profession that would bring certain financial rewards, or entering a conservatory of music for advanced training with a well-known pianist. She realizes that even upon completion of her piano studies, success as a concert pianist would be not assured.

A: Ms. E should take the scholarship to become a physician.

B: Ms. E should enter the conservatory of music for advanced training.

### Scenario 2

Mr. G is a surgeon with a well-established surgical practice. He is married and has three children, one of which is just starting college. During a backyard session of football, he seriously dislocated his shoulder. Although the shoulder was properly reset at the time, the dislocation produced some nerve damage and he has been experiencing a great deal of pain ever since. An operation is available that will relieve the pain if completely successful, but the operation also poses a risk of producing a permanent decrement in manual dexterity. The decrement in dexterity is normally inconsequential, but in his case, it could prevent him from continuing his surgical practice.

A. Mr. G should take the operation

B. Mr. G should not take the operation.

### Scenario 3

Mr. D, a married man with two children, has a steady job that pays him about $60,000 per year. He can easily afford the necessities of life, but few of the luxuries. His father, who died recently, carried a $40,000 life insurance policy. He would like to invest this money in stocks. He is well aware of the secure "blue-chip" stocks and bonds that would pay approximately 6% on his investment. On the other hand, he has heard that the stocks of a relatively unknown Company X might double their present value if a new product currently in production is favorably received by the buying public. However, if the product is unfavorably received, the stocks would decline in value.

A. Mr. D should invest in Company X.

B. Mr. D should invest in "blue-chip" stocks.

## References


Biocca, F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence, 12*, 456–480.

Bocionek, S. R. (1995). Agent systems that negotiate and learn. *International Journal of Human-computer Studies, 42*, 265–288.

Bracken, C. C., & Lombard, M. (2004). Social presence and children: Praise, intrinsic motivation, and learning with computers. *Journal of Communication, 54*(1), 22–37.

Brown, R. J. (1984). The effects of intergroup similarity and cooperative versus competitive orientation on intergroup discrimination. *British Journal of Social Psychology, 23*, 21–33.

Bruer, M. W., Eys, M., Evans, M. B., & Wilson, K. (2015). Interdependence and social identity in youth sport teams. *Journal of Applied Sport Psychology, 27*, 351–358.

Carr, C. T., Vitak, J., & McLaughlin, C. (2011). Strength of social cues in online impression formation: Expanding SIDE research. *Communication Research, 40*, 261–281.

Clarke, A., & Smyth, M. (1993). A co-operative computer based on the principles of human co-operation. *International Journal of Man-machine Studies, 38*, 2–22.

Clerwall, C. (2014). Enter the robot journalist: Users' perceptions of automated content. *Journalism Practice, 8*, 519–531.

Costa-Lopes, R., Vala, J., & Judd, C. M. (2012). Similarity and dissimilarity in intergroup relations: Different dimensions, different processes. *Revue Internationale de Psychologie Sociale, 25*(1), 31–65.

Culnan, M. J., & Markus, M. L. (1987). Information technologies. In F. M. Jablin, L. L. Putnam, K. H. Roberts, & L. W. Porter (Eds.), *Handbook of organizational communication: An interdisciplinary perspective* (pp. 420–443). Newbury Park, CA: Sage.

Dawes, R. M. (1974). *Formal models of dilemmas in social decision making*. Oregon Research Institute.

Diener, E. (1979). Deindividuation, self-awareness, and disinhibition. *Journal of Personality and Social Psychology, 37*, 1160–1171.

Duffy, B. R., & Zawieska, K. (2012). Suspension of disbelief in social robotics. In *2012 IEEE Ro-Man: The 21st IEEE International Symposium on Robot and Human Interactive Communication* (pp. 484–489). IEEE.

Edwards, C., Edwards, A., Spence, P. R., & Shelton, A. K. (2014). Is that a bot running the social media feed? Testing the differences in perceptions of communication quality for a human agent and a bot agent on Twitter. *Computers in Human Behavior, 33*, 372–376.

Eyssel, F., & Kuchenbrandt, D. (2012). Social categorization of social robots: Anthropomorphism as a function of robot group membership. *British Journal of Social Psychology, 51*, 724–731.

Festinger, L., Pepitone, A., & Newcomb, T. (1952). Some consequences of deindividuation in a group. *Journal of Abnormal and Social Psychology, 47*, 382–389.

Field, A. (2009). *Discovering statistics using SPSS*. Sage Publications.

Flanagin, A. J., Hocevar, K. P., & Samahito, S. N. (2014). Connecting with the user-generated web: How group identification impacts online information sharing and evaluation. *Information, Communication, & Society, 17*, 683–694.

Fogg, B. J. (2002). *Persuasive computers using technology to change what we think and do*. San Francisco, CA: Morgan Kaufman Publishers.

Gillespie, T. (2014). The relevance of algorithms. In T. Gillespie, P. J. Boczkowski, & K. A. Foot (Eds.), *Media technologies: Essays on communication, materiality, and society* (pp. 167–193). MIT Press.

Hassanein, K., & Head, M. (2007). Manipulating perceived social presence through the web interface and its impact on attitude towards online shopping. *International Journal of Human-computer Studies, 65*, 689–708.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Press.

Hollenbaugh, E. E., & Everett, M. K. (2013). The effects of anonymity on self-disclosure in Blogs: An application of the online disinhibition effect. *Journal of Computer-mediated Communication, 18*, 283–302.

Horton, D., & Wohl, R. R. (1956). Mass communication and parasocial interaction. Observations on intimacy at a distance. *Psychiatry, 19*, 215–229.

International Society for Presence Research. (2000). *The concept of presence: Explication statement*. Retrieved from http://ispr.info/about-presence-2/about-presence/.

Johnson, D. W., & Johnson, R. T. (2005). New developments in social interdependence theory. *Genetic, Social, and General Psychology Monographs, 131*, 285–358.

Kiesler, S., Siegel, J., & McGuire, T. W. (1984). Social psychological aspects of computer-mediated communication. *American Psychologist, 39*, 1123–1134.

Kim, J. (2009). I want to be different from others in cyberspace: The role of visual similarity in virtual group identity. *Computers in Human Behavior, 25*, 88–95.

Kim, J., & Park, H. S. (2011). The effect of uniform virtual appearance on conformity intention: Social identity model of deindividuation effects and optimal distinctiveness theory. *Computers in Human Behavior, 27*(3), 1223–1230.

Kramer, N. C., der Putten, A. M. R., & Hoffmann, L. (2015). Social effects of virtual and robot companions. In S. S. Sundar (Ed.), *The handbook of the psychology of communication technology* (pp. 137–159). UK: John Wiley & Sons, Inc.

Kuchenbrandt, D., Eyssel, F., Bobinger, S., & Neufeld, M. (2013). When a robot's group membership matters. *International Journal of Social Robot, 5*, 409–417.

Le Bon, G. (2009). *Psychology of crowds*. Sparkling Books.

Lea, M., Spears, R., & de Groot, D. (2001). Knowing me, knowing you: Anonymity effects on social identity processes within groups. *Personal and Social Psychology Bulletin, 27*, 526–537.

Lee, E. J. (2004a). Effects of visual representation on social influence in computer-mediated communication: Experimental tests of the social identity model of deindividuation effects. *Human Communication Research, 30*, 234–259.

Lee, K. M. (2004b). Presence explicated. *Communication Theory, 14*(1), 27–50.

Lee, E. J. (2006). When and how does depersonalization increase conformity to group norms in computer-mediated communication? *Communication Research, 33*, 423–447.

Lee, E. J., & Nass, C. (2002). Experimental tests of normative group influence and representation effects in computer-mediated communication: When interacting via computers differs from interacting with computers. *Human Communication Research, 28*, 349–381.

Lee, K. M., & Nass, C. (2005). Social-psychological origins of feelings of presence: Creating social presence with machine-generated voices. *Media Psychology, 7*, 31–45.

Lee, K. M., Park, N., & Song, H. (2005). Can a robot be perceived as a developing creature? Effects of a robot's long-term cognitive developments on its social presence and people's social responses toward it. *Human Communication Research, 31*, 538–563.

Lee, K. M., Peng, W., Jin, S. A., & Yan, C. (2006). Can robots manifest personality? An empirical test of personality recognition, social responses, and social presence in human-robot interaction. *Journal of Communication, 56*, 754–772.

Li, J. (2015). The benefit of being physically present: A survey of experimental works comparing copresent robots, telepresent robots, and virtual agents. *International Journal of Human-computer Studies, 77*, 23–37.

Lieberman, H. (1997). Autonomous interface agents. In *Proceedings of the ACM SIGCHI conference on human factors in computing systems* (pp. 67–74). ACM.

Li, J., Kizilcec, R., Bailenson, J., & Ju, W. (2016). Social robots and virtual agents as lecturers for video instruction. *Computers in Human Behavior, 55*, 1222–1230.

Lombard, M., & Ditton, T. (1997). At the heart of it all: The concept of presence. *Journal of Computer-mediated Communication, 3*(0). http://dx.doi.org/10.1111/j.1083-6101.1997.tb00072.x.

Lops, P., De Gemmis, M., & Semeraro, G. (2011). Content-based recommender systems: State of the art and trends. In *Recommender systems handbook* (pp. 73–105). US: Springer.

Mackie, D. M. (1986). Social identification effects in group polarization. *Journal of Personality and Social Psychology, 50*, 720–728.

Margolin, M. (2016, December 14). *Japanese company's answer to Amazon Echo: Anime holograms with "comforting" personalities for the lonely*. ISPR. Retrieved from https://ispr.info/2017/03/09/japanese-companys-answer-to-amazon-echo-anime-holograms-with-comforting-personalities-for-the-lonely/.

McCroskey, J., & McCain, T. (1974). The measurement of interpersonal attraction. *Speech Monographs, 41*, 261–266.

Meertens, R. M., & Lion, R. (2008). Measuring an individual's tendency to take risks. The risk propensity scale. *Journal of Applied Social Psychology, 38*, 1506–1520.

Melin, P., Castillo, O., & Kacprzyk, J. (2016). *Nature-inspired design of hybrid intelligent systems*. Springer.

Messick, D. M. (1973). To join or not to join: An approach to the unionization decision. *Organizational Behavior and Human Performance, 10*(1), 145–156.

Montaner, M., Lopez, B., & De La Rosa, J. (2003). A taxonomy of recommender agents on the Internet. *Artificial Intelligence Review, 19*, 285–330.

Morio, H., & Buchholz, C. (2009). How anonymous are you online? Examining online social behaviors from a cross-cultural perspective. *AI & Society, 23*, 297–307.

Morishima, Y., Nass, C., Bennett, C., & Lee, K. M. (2001). Effects of gender of computer-generated speech on credibility. In *Proceedings of the auditory research meeting* (Vol. 31, pp. 557–562).

Muñoz-Arteaga, J., Calvillo-Moreno, E. A., Ochoa-Zezzatti, C. A., Santaolaya-Salgado, R., & Álvarez-Rodríguez, F. (2010). Use of agents to realize a federated searching of learning objects. In *Trends in practical applications of agents and multiagent systems* (pp. 1–8). Berlin Heidelberg: Springer.

Nass, C. (2004). Etiquette quality: Exhibitions and expectations of computer politeness. *Communications of the ACM, 47*, 35–37.

Nass, C., Fogg, B. J., & Moon, Y. (1996). Can computers be teammates? *International Journal of Human Computer Studies, 45*, 669–678.

Nass, C., & Lee, K. M. (2001). Does computer-synthesized speech manifest personality? Experimental tests of recognition, similarity attraction, and consistency attraction. *Journal of Experimental Psychology: Applied, 7*, 171–181.

Nass, C., & Moon, Y. (2000). Machines and mindlessness: Social responses to computers. *Journal of Social Issues, 56*, 81–103.

Nass, C., Moon, Y., & Green, N. (1997). Are machines gender neutral? Gender-stereotypic responses to computers with voices. *Journal of Applied Social Psychology, 27*, 864–876.

Nass, C., & Steuer, J. (1993). Voices, boxes, and sources of messages: Computers and social actors. *Human Communication Research, 19*, 504–527.

Nass, C., Steuer, J., & Tauber, E. R. (1994). Computers are social actors. *Human Factors in Computing Systems, 94*, 72–78.

Ochoa, A., González, S., Moriel, E., Arreola, J., & García, F. (2017). Improving decision-making in a business simulator using TOPSIS methodology for the establishment of reactive stratagems. In *Nature-inspired design of hybrid intelligent systems* (pp. 809–819). Springer: International Publishing.

Olson, M. (2009). *The logic of collective action*. Harvard University Press.

Postmes, T., Spears, R., & Lea, M. (1998). Breaching or building social boundaries? SIDE effects of computer mediated communication. *Communication Research, 25*, 689–715.

Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. New York: Cambridge University Press.

Reeves, B., & Nass, C. (2002). *The media equation: How people treat computers, television, and new media like real people and places* (2nd ed.). CA: CSLI Publications.

Reicher, S. D., Spears, R., & Postmes, T. (1995). A social identity model of deindividuation phenomena. *European Review of Social Psychology, 6*(1), 161–198.

Rogers, P., & Lea, M. (2005). Social presence in distributed group environments: The role of social identity. *Behavior & Information Technology, 24*, 151–158.

Salem, M., Eyssel, F., Rohlfing, K., Kopp, S., & Joublin, F. (2013). To err is human(-like): Effects of robot gesture on perceived anthropomorphism and likability. *International Journal of Social Robot, 5*, 313–323.

Selker, T. (1994). COACH: A teaching agent that learns. *Communications of the ACM, 37*, 92–99.

Shin, D. H. (2013). Defining sociability and social presence in social TV. *Computers in Human Behavior, 29*, 939–947.

Shin, D. H., & Choo, H. (2011). Modeling the acceptance of socially interactive robotics: Social presence in human-robot interaction. *Interaction Studies, 12*, 430–460.

Shinozawa, K., Naya, F., Yamato, J., & Kogure, K. (2004). Differences in effect of robot and screen agent recommendations on human decision-making. *International Journal of Human-computer Studies, 62*, 267–279.

Shin, D. H., & Shin, Y. J. (2011). Consumers' trust in virtual mall shopping: The role of social presence and perceived security. *Journal of Human-computer Interaction, 27*, 450–475.

Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. London: Wiley.

Spears, R., & Postmes, T. (2015). Group identity, social influence, and collective action online: Extensions and applications of the SIDE model. In S. S. Sundar (Ed.), *The handbook of the psychology of communication technology* (pp. 23–46). UK: John Wiley & Sons, Inc.

Sundar, S. S., Jia, H., Waddell, F., & Huang, Y. (2015). Toward a theory of interactive media effects (TIME): Four models for explaining how interface features affect user psychology. In S. S. Sundar (Ed.), *The handbook of the psychology of communication technology* (pp. 47–86). UK: John Wiley & Sons, Inc.

Tajfel, H. (1970). Experiments in intergroup discrimination. *Scientific American, 223*, 96–102.

Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., & Wetherell, M. S. (1987). *Rediscovering the social group: A self-categorization theory*. Oxford: Blackwell.

Valacich, J. S., Dennis, A. R., & Nunamaker, J. F. (1992). Group size and anonymity effects on computer-mediated idea generation. *Small Group Research, 23*, 49–73.

Van Dalen, A. (2012). The algorithms behind the headlines: How machine-written news redefines the skills of human journalists. *Journalism Practice, 6*, 648–658.

Van Der Kaa, H. A. J., & Krahmer, E. J. (2014). Journalist versus news consumer: The perceived credibility of machine written news. In *Proceedings of the computation and journalism conference. New York*.

Viadero, D. (2010, January 5). *Scholars test emotion-sensitive tutoring software*. Education Week. Retrieved from http://ispr.info/2010/02/08/scholars-test-emotion-sensitive-tutoring-software/#more-1516.

Walther, J. B. (1996). Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. *Communication Research, 23*(1), 3–43.

Walther, J. B. (2007). Selective self-presentation in computer-mediated communication: Hyperpersonal dimensions of technology, language, and cognition. *Computers in Human Behavior, 23*, 2538–2557.

Walther, J. B., De Andrea, D., Kim, J., & Anthony, J. C. (2010). The influence of online comments on perceptions of anti-marijuana public service announcements on YouTube. *Human Communication Research, 36*, 469–492.

Walther, J. B., & Parks, M. R. (2002). Cues filtered out, cues filtered. In M. L. Knapp, & J. A. Daly (Eds.), *Handbook of interpersonal communication* (pp. 529–563). Sage.

Walther, J. B., Van Der Heide, B., Ramirez, A., Burgoon, J. K., & Pena, J. (2015). Interpersonal and hyperpersonal dimensions of computer-mediated communication. In S. S. Sundar (Ed.), *The handbook of the psychology of communication technology* (pp. 3–22). UK: John Wiley & Sons, Inc.

Weiser, M. (1991). The computer for the 21st Century. *Scientific American, 256*, 94–110.

Zhao, S. (2003). Toward a taxonomy of copresence. *Presence, 12*, 445–455.