Robots as New Media: A Cross-Cultural Examination of Social and Cognitive Responses to Robotic and On-Screen Agents

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ABSTRACT

Social responses to lifelike characters can significantly alter human evaluations of technology. This study tested the differences between a picture of an on-screen character interacting in three different contexts (retail purchase, health advice, reading survey) versus a three-dimensional robot conducting the same interactions off screen. A laboratory experiment (n=72) was conducted in the US and replicated in Japan which tested differences in social evaluations, credibility, and memory. Results showed significant interactions between nationality and embodiment across a range of social and cognitive responses including perceived credibility, perceived surveillance, memory, and valence. These results are interpreted within technological and cultural contexts.

INTRODUCTION

Social scientists love to classify things, and media technologies are no exception. McLuhan's (1964) famous classification of media as "hot" or "cold" varied across the dimensions of definition and participation but applied, for example, to all of television or all reading. How should classifications handle media enabled by computers? A computer can serve as a movie theater, radio, telephone, and printing press simultaneously.

This study is about media characters that can be either represented on a screen (e.g., familiar television portrayals or intelligent computer agents) or actual physical objects (e.g., robots) that exist in the same environment with users. How should these robots fit among classifications of communication technologies?

One way of answering this question is to compare robots with other media. While experiencing traditional media like a movie, for example, someone might say that an action movie kept him or her "on the seat of my pants," or that a romance was an "emotional rollercoaster." The feeling of "being there" has been an important concept for communication researchers as well, since it most certainly contributes to the social, cognitive, and emotional effects of media that our field seeks to address. When characters and their interactions leave the screen and enter the physical world of the audience, is the sense of "being there" heightened?

Steuer (1992) used the concept of tele-presence to define "the experience of presence in an environment by means of a communication medium." While the focus of Steuer's discussion was specifically geared towards the virtual reality technology of the early 90's, it serves as a useful starting point for conceptually thinking about the role of robots as a mediated communication experience.

According to Steuer, there are two sets of variables that influence tele-presence. The first, *vividness*, refers to the sensorial richness of a particular mediated environment. We can look at robots in a couple of different ways along this dimension. Aesthetically speaking, today's robots are primitive when judged alongside the computer-generated graphics and special effects that make up any large-budget movie. They are still bulky, stiff, noisy, and fragile.

On the other hand, a robot is able to move beyond the confinement of a two-dimensional screen and inhabit the same physical realm that viewers inhabit. From a viewer's perspective, this ability would seem to be a radical departure from the vividness of the television or movie screen. Imagine the difference between watching a music video and sitting in the front row of a Rolling Stones concert or seeing a televised rendition of *Romeo and Juliet* on PBS as opposed to a live performance by the Royal Shakespearean Theater Company. Granted, live performances have the capability to engage senses beyond the scope of television or the movies, but perhaps the distinction remains significant with respect to the eyes and ears alone. For this reason, it seems worthwhile to question how much of a distinction exists between content that is on the screen as opposed to the same content appearing in the same physical realm as the viewer. This experiment examines this distinction, and how it affects a variety of viewer responses.

The second technological variable influencing telepresence is *interactivity*, defined as "the extent to which users can participate in modifying the form and content of a mediated environment in real time" (Steuer, 1992, 84). Here, the difference between a robot and any on-screen character may be less clear. Even with increasingly powerful microprocessors and advances in artificial intelligence and robotic engineering, robots have a limited repertoire of movements, gestures, and speech. Currently, robots (other than those that carry sophisticated computers) do not have interactive capabilities beyond those of a sophisticated on-screen agent. It seems possible, however, that perhaps vividness and interactivity are correlated in such a way that users perceive robots to be more interactive than on-screen agents because they are more vivid than counterparts represented on a television screen or a computer monitor. The significance of the structural difference between a robot and an on-screen agent has yet to be addressed empirically.

Structural/Content Features of Media

There is a growing literature which shows that structural features of media can have a profound effect on the way messages are processed (Lang, 2000). Early work in this area has primarily dealt with television and radio, but has recently addressed new media. Newer technologies are particularly interesting because they blur the distinction between interpersonal and mass communication through techniques like hiding audience size, personally targeting messages, and creating a greater sense of intimacy (Beniger, 1987). The question proposed here is whether the ability to leave the screen and interact in three-dimensional space qualifies as a structural feature. And if it does, can this feature change how media experiences are interpreted and remembered?

Lang's (2000) limited capacity information-processing model defines media as distinct sets of structural features used to present audio or visual information. The viewer in this model is described as an information processor with limited cognitive resources. As a result, what any viewer takes from media is governed by mental activity. Viewers makes some decisions consciously; for example, the processing goals for studying a textbook may differ wildly from the goals for watching a favorite sitcom. Because of different goals, people are likely to construct different mental representations of similar stimuli resulting in different cognitive outcomes.

On the other hand, some processing decisions are demanded by media stimuli and made with no conscious intent on the part of the viewer. For example, certain structural features of media have been shown to elicit orienting responses in viewers. The orienting response is an automatic response to novel or meaningful stimuli that is manifested through a set of physiological changes in the body. By eliciting orienting responses, structural features may help determine which sensory information is encoded into working memory (Ohman, 1979). Structural features of television such as cuts, edits, videographics, and movement have all been shown to elicit orienting (Reeves, Thorson, Rothchild, McDonald, Hirsch & Goldstein, 1985; Lang, 1990; Thorson & Lang, 1992;

Lang, Gieger, Strickwerda, & Sumner, 1993). Similar effects have been found for structural features of radio such as voice changes and sound effects (Potter, Lang, & Bolls, 1997; 1998). More recent research suggests that structural features of computer-mediated information can also elicit orienting, although in slightly different ways than television or radio (Lang, Borse, Wise & David, 2002).

In sum, this line of research demonstrates that the form of a particular medium has important consequences for how its message is processed and ultimately whether it is remembered. The study presented here is not about orienting per se, but this literature may still be relevant because it demonstrates how the structural difference between on-screen and robotic agents may lead to differences in the amount of effort given to thinking about media.

It seems obvious that the content of a particular message would also influence how it is processed. In general, we assume that people pay more attention at a scary movie than an insurance seminar, but we also allow some variance attributable to individual interests (e.g., those shopping for insurance). Research looking at pictures (Lang, 1995) and films (Gross & Levenson, 1995) show that there is some media content that demans attention regardless of interests. The interactions designed for this study were not meant to be particularly emotional, but rather to represent a subset of contexts that have some real-world significance within the realm of human-computer interaction. In spite of this, it is possible that different contexts will elicit different emotional responses from users, which could influence social evaluations of the interactive agent either directly or by interacting with other factors.

Social Responses/Media Equation

One of the central themes in human-computer interaction research has been how and to what degree people personify computers and attribute human-like qualities to computer functions. Particular emphasis has been placed on the social aspects of human responses to different communication technologies. This research has demonstrated that the relationship between humans and media technologies is fundamentally social, meaning that social dynamics and constraints usually associated with interpersonal relationships apply to mediated interactions as well (Reeves & Nass, 1996). Similar to the earlier discussion of media structural features, this line of research has never been applied to agents that can interact in the same physical dimension as a human. It seems intuitively logical that the leap from on-screen to off-screen would represent a substantial difference in the social responses that an agent could elicit. On the other hand, if the contention that mediated life and real life are equal is correct, we would expect to see no affective or social difference between on-screen and three-dimensional media.

Japan/US Differences

If we accept the hypothesis that people automatically treat computers as social actors, it logically follows that people must also unconsciously apply their culture-specific norms and preferences during computer interactions. Several cross-cultural studies have addressed this issue and found evidence supporting this hypothesis. For instance, Katagiri and colleagues (Katagiri, Nass, & Takeuchi, 2001) examined whether Japanese and American people respond to a computer as a social entity and how the culturally different norms of reciprocity play a role in this response. This was accounted for in terms of the individualism/collectivism dichotomy, one of the most frequently applied criteria in cross-cultural studies.

In a collectivist culture, such as Japan, people generally associate with others on a group basis, and people's behaviors are strongly influenced by the considerations of affiliating groups (Nakane, 1970). In an individualist culture like the U.S., people associate with others on a more individual basis; group considerations do not play as significant a role in people's behaviors (Trandis, 1990). Katagiri et al. (2001)'s experimental results confirmed this cultural distinction in that Americans tended to respond individually to computers, whereas Japanese people respond collectively

Research Questions

In sum, the possibility of robots as media suggest a need to explore how on-screen versus embodied interactive agents affect cognitive and social responses. Does content become any more arousing, more engaging, and more memorable when it is communicated via robots rather than with 2D on-screen representations? How might this structural change interact with cultural differences between American and Japanese participants? These are the primary research questions addressed by the following experiment.

EXPERIMENTAL METHODS

Participants

A total of 72 participants took part in this experiment. There were two different data collection periods, with 36 participants in each period. The first period of data collection took place in the United States at a large western university. These participants consisted of a mixture of undergraduate students, graduate students, university support staff, and members of the general public. The second period of data collection took place at NTT Communication Science Laboratories in Kyoto, Japan. These participants were recruited from the general public. The gender ratios of each participant pool were identical (56% male and 44% female).

Experimental Design

The experiment was a mixed, two-by-three design. The between-subject factor was Embodiment (2D on-screen agent, 3D robot agent) and the within-subject factor was Scenario (retail sales, nutrition and diet, reading survey). Participants in the 3D condition interacted with the robot itself. Participants in the 2D condition interacted with a video image of the robot projected onto a television monitor. The two different levels of Embodiment are shown in Figure 1 below.

Figure 1

Two-Dimensional Embodiment (On-Screen Agent) **Three-Dimensional Embodiment (Robot)**

The Scenario factor consisted of three different contexts for interaction. In the Retail Sales condition, the robot wore a clerk's outfit and asked the participant a series of questions pertaining to the purchase of a set of kitchen knives. In the Reading Survey condition, the robot was outfitted in a coat and tie and asked questions dealing with the participant's reading preferences. In the Nutrition and Health condition, the robot was outfitted with a doctor's lab coat and asked questions about basic nutrition. The order of presentation was randomized to balance order effects. Figure 2 shows the robot in each of the three roles.

**Figure 2. Robot's Three Social Roles:
Retail Sales, Reading Survey, Nutrition and Health.**

Stimulus Material

The robot was developed by NTT Cyber Space Laboratories, and modified by the NTT Communication Science Laboratories. The robot's voice in the U.S. portion of the experiment was a web-based text-to-speech (TTS) synthesizer developed by Rhetorical Systems. The Japanese voice was created with a different TTS synthesizer, so there were noticeable differences between the voices across different tonal qualitites. A different voice was used for each of the three scenarios. The voice used in the Commerce and

Education scenarios were male, and the voice used in the Health condition was female. The 2D condition used a live video feed of the robot shot in an adjacent soundproof room.

Procedure

Upon arriving at the lab, participants read and signed an informed consent statement. The experimenter then attached two electrodes to the palm of the participant's non-dominant hand for the collection of physiological data. On the experimenter's command, the participant pressed the "Enter" button on the button box to begin the scenario.

The robot began the scenario with a short introduction and then began to ask questions. Each scenario consisted of nine questions, and each question had two possible responses. When presenting each question, the robot made a statement endorsing one of the two possible responses. When the robot had finished asking the question and presenting the two choices, these choices appeared on the button box display. The participant indicated his/her choice by pressing the corresponding button, and then pressed the "Enter" button to send the selection to the computer.

If the participant's choice matched the robot's suggestion, the robot raised its arms and nodded with approval while responding with a positive statement. If the participant's choice did not match the robot's suggestion, the robot bowed and shook its head slowly while responding with a negative statement. This continued until all questions were answered.

At the completion of each interaction, the experimenter gave the participant a questionnaire. As the participant completed the questionnaire, the experimenter changed the robot's costume in another room. The experimenter then returned the newly outfitted robot and began the next scenario. This entire process was repeated for all three scenarios.

When the participant had completed the final questionnaire, the experimenter removed the electrodes, and administered the recognition test. Upon completion of this test, participants were debriefed and dismissed.

Dependent Measures

Liking/SAM

Liking was measured using two different self report instruments. A 12-item questionnaire was adopted from Rickenberg and Reeves (2000) and slightly modified for this study. Participants were instructed to report their degree of agreement with each statement on a ten-point Likert scale. A factor analysis was conducted to determine the underlying clusters of items that contributed to the variance found among participants' responses.

Self-report responses were also measured using SAM, the Self-Assessment Manikin. SAM uses pictographic forms, and has been shown to be a reliable instrument for assessing emotional responses (Bradley & Lang, 1994).

Credibility

Credibility was assessed using McCroskey's (1974) source credibility scale. This instrument is a 15-item semantic differential that measures credibility across 5 dimensions: Sociability, Extroversion, Competence, Composure, and Character. This instrument has been used numerous times in previous research and has been shown to have both face and construct validity. We computed indices for each of the dimensions mentioned above, as well as an overall index of credibility based on all 5 dimensions.

Recognition Memory

Recognition memory was evaluated using a 24-item forced choice recognition test. Each item asked the participant to determine whether the robot did or did not make a statement during the scenarios. There were 8 statements for each scenario, 4 that did occur and 4 foils that did not occur.

RESULTS

Emotional Responses

Factorial analyses of variance (ANOVA) were conducted for each of the three SAM scales. Significant interaction effects between Nationality and Embodiment were found in Valence ($F(1,68)=3.89$, $p<.05$) (See Figure 3). The interaction reflects the fact that US participants rated the 3D Embodiment considerably higher ($M=6.41$, $s.d.=.28$) than the 2D Embodiment ($M=5.57$, $s.d.=.27$), while Japanese rated the 2D Embodiment more highly ($M=5.94$, $s.d.=.27$) than 3D ($M=5.69$, $s.d.=.27$).

Results also showed a main effect of Nationality on both SAM arousal ($F(1,68)=5.84$, $p<.05$) and SAM dominance ($F(1,68)=6.15$, $p<.05$). US participants self-reported greater emotional arousal level ($M=4.01$, $s.d.=.20$) than Japanese participants ($M=3.32$, $s.d.=.20$), whereas Japanese participants reported higher ratings on the dominance scale ($M=5.11$, $s.d.=.18$) than US participants ($M=4.49$, $s.d.=.18$).

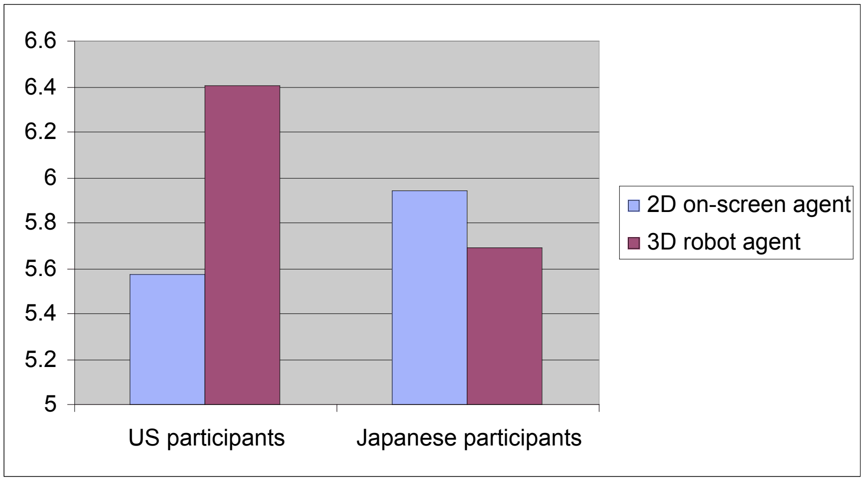

Figure 3. Valence rating by Embodiment and Nationality

Liking

Two different self-report instruments were used to evaluate participants' emotional responses to the robot and on-screen agent. For the 11-item questionnaire, a factor analysis with varimax rotation was conducted to determine the common underlying item clusters. Three factors emerged which accounted for 64.97% of the variance between individual items. The first factor, "Enjoyment" (Eigenvalue=3.26), consisted of five items related to the overall enjoyment of the experience ("enjoyed talking with the character," "enjoyed working with the character," "felt like the character and I were a team," "the character was in the way" [negative loading], and "wanted to stop the interaction" [negative loading]).

The second factor, "Surveillance" (Eigenvalue=2.50), consisted of four items relating to how much attention each character seemed to be paying to the participants' actions ("seemed to be watching me," "seemed to make judgements about me," "seemed to offer options based on my choices," and "seemed to be recording my answers."). The third factor (Eigenvalue=1.39) consisted of the two remaining items ("character seemed condescending," and "character seemed fairly active"). Because there was no intuitive connection between these items, this factor was dropped from further analysis.

A multivariate ANOVA revealed a significant interaction effect between Embodiment and Nationality on Surveillance ($F(1,68)=10.80$, $p <.005$) (See Figure 4). US participants rated the 2D Embodiment (*M*=19.64, *s.d.*=.96) as exhibiting greater Surveillance than the 3D Embodiment (*M*=15.14, *s.d.*=.96). On the other hand, Japanese participants perceived greater surveillance from the 3D Embodiment (*M*=18.34, *s.d.*=.96) than the 2D Embodiment (*M*=15.14, *s.d.*=.96).

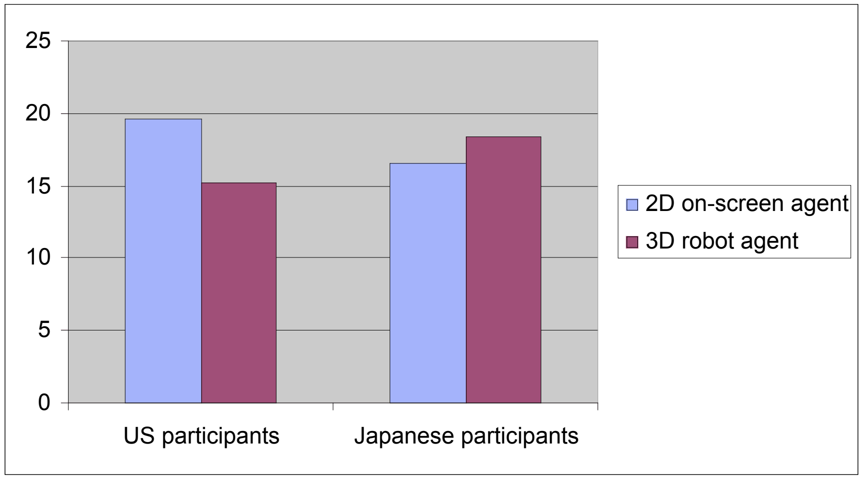

Figure 4. Surveillance rating by Embodiment and Nationality

Credibility

The ANOVA produced a significant main effect of Nationality, ($F(1, 68)=66.09$, $p<.001$) on Source Credibility (see Figure 5). Source Credibility ratings were higher for the US participants ($M=69.60$, *s.d.*=6.7) than the Japanese participants ($M=59.76$, *s.d.*=3.1) across all 5 dimensions of Sociability, Extroversion, Competence, Composure, and Character. We found no significant main effects of Embodiment on Source Credibility.

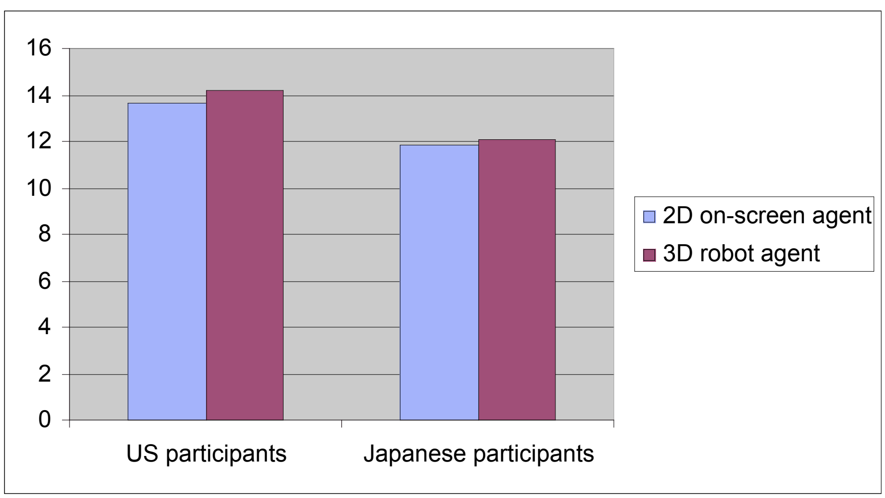

Figure 5. Source credibility by Embodiment and Nationality

Recognition Memory

A significant main effect of Nationality was found on the recognition memory test ($F(1, 68)=5.82$, $p < .05$). US participants remembered more information from the interaction ($M=19.75$, *s.d.*=.37) than Japanese participants ($M=18.50$, *s.d.*=.37). This difference in recognition score appears to be a function of both Source Credibility and Surveillance. A further correlation analysis showed a significant positive correlation between Source credibility and Recognition memory, $r=.26$, $p<.05$. US participants who perceived the agent as being more credible remembered more information from the interaction. A correlation matrix between the dependent variables also yielded a significant negative correlation, $r=-.29$, $p<.05$. When combined together, the multiple correlation coefficient of Source Credibility and Surveillance in predicting memory was $R=.39$, $p<.005$.

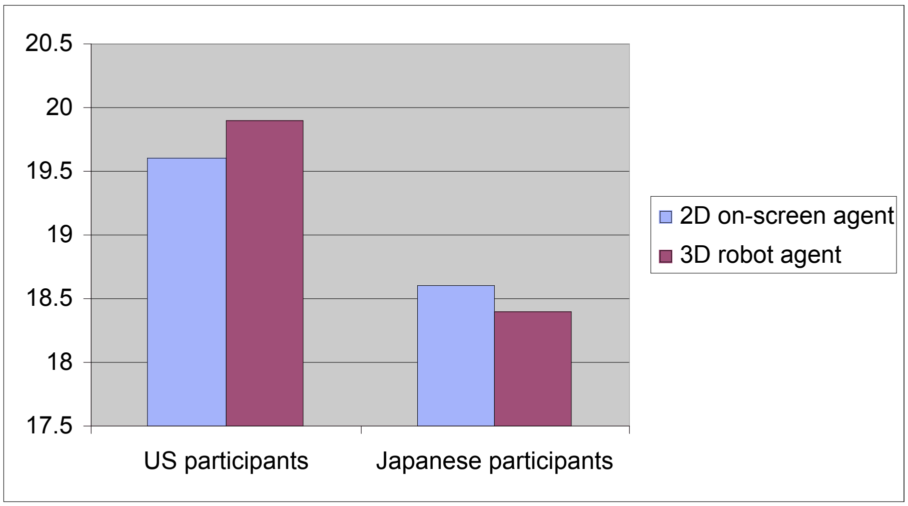

Figure 6. Recognition memory by Embodiment and Nationality

Discussion

These results show that the embodiment of an agent character should be carefully selected granting consideration also in which the agent is going to be introduced. The self-report valence scale reveals that the 3D robot agent was better liked among US users than its 2D on-screen counterpart, while the opposite was true for Japanese users. The fact that nationality had significant effects on both arousal and dominance evaluations supports the idea that emotional responses vary widely based on cultural background.

An intriguing result involves the concept of “Surveillance.” We expected that 3D robots would make users feel more like they were being watched than 2D on-screen counterparts, but the data show that it was not the case with US users (the difference in surveillance rating across 2D and 3D condition was not statistically significant for Japanese users). It may be that an agent untethered to a computer is trusted more than a computer agent that has the familiar recording capabilities tied to a machine. This would include prominently the ability of a computer to store and disseminate personal information.

Although not statistically significant, both US and Japanese users rated the 3D robot agent more highly in terms of source credibility than 2D on-screen agent. However, US users perceived the agent substantially more credible than Japanese users, and it appeared consistently so in all 5 sub-indices of source credibility. The different recognition test results seem to stem from its strong positive correlation with source credibility: American users who perceived the source to be more credible remembered more information from the interaction than Japanese users who perceived the source to be less credible.

There are both cultural and stimulus-driven explanations for these differences between American and Japanese participants. One important difference in the experimental setup between the United States and Japan involved the use of different text-to-speech synthesizers. Because of technical limitations in the Japanese synthetic speech engine, the Japanese voices sounded less natural than the English voices. This variation in quality of the robot's voice may have contributed to differences in source credibility and memory scores, since acoustic features of speech have been shown to play a critical role is determining affiliation (Nass & Najmi, 2002). Secondly, the interaction scripts were originally designed for American participants. Cultural differences in topical content and treatment may have further contributed to the perception of the interactive robot as an outsider to Japanese participants.

The phrasing of any character's utterances has been shown to play an important role in establishing each character as a genuine representative of the culture they portray. Markus and Kitayama (1991) suggested that while Americans may value autonomy and internal consistency, these cultural traits may be present to a much smaller degree in Asian cultures. Individualistic cultures also emphasize reasons for feeling, thinking, and acting in terms of individual attributes rather than external social forces. In contrast, collectivist cultures such as Japan think of individual thought in terms of social relationships (Miller, Kozu, & Davis, 2001). The scenarios constructed in this experiment included statements of individualization. It is possible that the difference in source credibility and memory ratings stem partially as well from this type of utterances.

Gestures also transmit meaning in everyday dialogue. Cassell (2000) recognizes cultural variability even among those gestures intended to represent a common metaphor, which our robot used frequently to illustrate choices and express emotional content. Even the simplest head nod that our robot executes could have been interpreted as formal assent, as a sign of attentive listening, as a turn-taking confirmation, and as a formal negative, depending on the cultural context in which it is used. Lastly, the patterns of interaction vary dramatically across cultures. Perhaps for a society with such hierarchical values and structure as the Japanese, our West-coast robot should have exercised greater deference in approaching the participants, particularly given the fact that its Japanese voice alluded to a younger embodiment.

In spite of individual and cultural differences, however, there are interesting and strong reactions to media characters that jump off the screen. And importance of the differences is only likely to increase. Technology companies, often in partnership with traditional media properties, are increasing the number of robot characters available commercially. This extension of "new media" into a category quite obviously different from traditional screens – in television, film, and computing – should be an extension as relevant to communication studies as any other influence that is more closely tied to familiar displays.

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