The Influence of a Peripheral Social Robot on Self-Disclosure

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Abstract—**Previously, our lab has hypothesized that a peripheral social robot may be able to help uphold the dignity of Parkinson's patients who are stigmatized by their caregivers. The presence of a robotic agent is liable to influence the patient-caregiver relationship. Patient self-disclosure is a key element of a healthy patient-caregiver relationship. This new study examined how the apparent attentiveness of a peripheral robot influences personal disclosure during a scripted interview. The study did not draw from a patient-caregiver population and was conducted as a Wizard of Oz study. The attentiveness of the robot did not make a difference in the interviewees' depth of disclosure. Self-report measures indicated a difference between the attentive robot condition and the other two conditions when participants were asked if they felt like the robot was listening to them.**

I. INTRODUCTION

The act of disclosing personal or intimate information about oneself can have positive psychological effects for the discloser if the act is received appropriately [7, 10]. When a disclosure recipient responds to the disclosure with care, support, and understanding, the discloser feels accepted and his/her self-esteem is bolstered [7, 10]. Patients who are chronically ill often have profound feelings of loneliness and abandonment [35]. Zinn [35] advises physicians who are treating chronically ill patients that allowing them to tell their "illness narratives" to an empathetic listener is critical to combatting these negative feelings. It is intrinsically "healing" for the patients to feel understood and to "be connected" to other people [35].

We are particularly interested in the relationship between a patient with Parkinson's disease and the patient's caregiver. Patients with Parkinson's disease may suffer from a condition known as an expressive mask; this condition limits a patient's expressivity across all nonverbal communication channels [33]. This lack of nonverbal expressivity has been shown to lead caregivers to attribute negative stereotypes to the patients, for example, viewing patients as less extroverted, more neurotic, and less cognitively competent [33, 34]. The caregivers treat these patients differently; they stigmatize them because of these inappropriately attributed negative qualities [34]. Researchers suggest that caregivers could avoid these misattributions by just listening to patients talk about their "daily enjoyments and frustrations" [34]. It can be difficult, however, for caregivers to overcome the biases that arise due to patients' inexpressive nonverbal behavior [34].

We have hypothesized that a peripheral social robot might be able to help prevent stigmatization in an interaction between a Parkinson's patient and the patient's caregiver by keeping a partial theory of mind of the patient and of the caregiver, recognizing norm violations in the relationship, and using subtle nonverbal cues to alert the caregiver to the fact that he/she is misunderstanding the patient [1, 26]. The robot would not speak or act on behalf of the patient; rather the robot would be a peripheral tool to ensure the patient is understood, and therefore treated, properly. The patient must openly express himself/herself to the caregiver; disclosure is vital for the formation and upkeep of relationships [7, 10].

People's willingness to self-disclose is influenced by a variety of personal (e.g. [16, 18, 27]), relational (e.g. [7, 10]), and environmental (e.g. [19, 25]) factors. The introduction of a social robotic agent is an important environmental change with the potential to influence personal disclosure; there is an additional social presence in the interaction. People become more controlling over their behaviors in the presence of attentive humans [11]. An artificial agent's responsiveness to conversation has been shown to make it more "human-like" [12]. This study examines how the apparent attentiveness of a peripheral social robot influences personal disclosure in a dyadic human relationship. If the presence of a robot lowers individuals' self-disclosure or comfort during interactions, its utility within the context of our project is limited.

II. RELATED WORK

Situational factors that influence self-disclosure had to be considered when designing the experiment and will be considered when selecting a social robotic agent. This section begins by briefly reviewing research related to these factors before summarizing work on humans' treatment of computers and robots as social actors. We conclude by discussing research where technology's influence on self-disclosure is specifically addressed.

A. Self-disclosure

A person may elect to share personal information for a variety of reasons, e.g., wanting to relate to the present company or needing feedback about a recent life event [7]. The act of disclosing is not often taken lightly; it is often very carefully considered [10]. At times, however, people spontaneously disclose in response to questions or self-disclosure by others [10]. Each group member's personality will help to dictate the extent to which personal disclosure occurs in an interaction [16, 18, 27]. There are people who generally tend to share more personal information [18]; there are those who are very sensitive to the potential pitfalls of sharing intimate information and forming intimate bonds

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[27], and there are those who actively conceal negative personal information and thoughts [16]. Separate from the openness of the discloser is the receiver's personality; some people are better at or more prone to elicit personal information from others [18]. Researchers speculate that gender influences disclosure; questions exist, however, as to when and how gender matters [7].

The relationship between the two people interacting is also important in determining what one discloses [7, 10]. The relationship is in part defined by what can be acceptably disclosed and discussed [7, 10]. The topic and valence of a disclosure generally relate to the intimacy of the disclosure [13]; certain relationships, however, may have unique restrictions on what can be discussed [7]. One may share more with someone she likes [7]. One needs to trust the person who receives the disclosure [7, 10, 15].

Researchers [7, 10] discuss the importance of regulating a personal boundary when deciding whether or not to disclose to another person. The deciding factor of whether to open this boundary or not is often how vulnerable the user is to ridicule, punishment, etc., after parting with this information [7, 10]. The privacy computer-mediated communication affords increases personal disclosure because it seems to prevent the user from being vulnerable after the release of personal information [14, 15]. The "mere presence" of a person can change someone's behavior [11]. People are more controlling of their behaviors when someone who is attentive is nearby; they conform their behavior to match the norm [11]. If the person present is clearly inattentive, the effects associated with the social presence are lessened [11]. The presence of additional people heightens a discloser's vulnerability when sharing personal information; self-disclosure decreases with increasing group size [30].

The environment can also influence personal disclosure. When someone is highly self-aware and in public, spontaneous disclosure tends to decrease; whereas, high self-awareness in a private setting tends to increase spontaneous personal disclosure [14]. The spacing of a room as well as interpersonal distance can influence disclosure; certain environmental variables can increase disclosure in one topic while decreasing disclosure in another [25]. Factors such as a room's lighting can also influence disclosure [19].

B. Technology and Social Presence

Researchers are still working to understand the nature of interactions between social technology and users of this technology [4, 8, 17, 23]. There has been much research (e.g. [4, 23]) that seems to show people have an automatic social response to technology that is congruent with how they would respond to a person. This behavior appeared even when users were well aware that they were interacting with a technological artifact [4, 23]. It is clear, however, that there is not an automatic transfer of certain social behaviors when interacting with machines [20]. Morkes et al. [20] proposed that there is a continuum of socialness, and computers fall lower on the continuum than people. Only certain social behaviors, those that are deeply ingrained and automatically activated, would be mindlessly transferred [23].

Fischer [8] rejected the mindless transfer of behaviors and proposed that people treat robots as social actors in situations where they understand social behaviors are required. Fischer [8] does concede that her study could not rule out mindless transfer of certain behaviors "in the moment" and more measured behavior when reflecting on the true nature of the interaction partner. Certain studies (e.g. [8, 17]) have found individual differences in treating technology as a social actor and gender differences in treating technology as a social actor [8, 12]. Lohse [17] found that two humans interacting with a robotic agent implicitly reach an agreement on the socialness of a robotic partner.

Sirkin et al. [31] found individual differences in the treatment of a robotic ottoman as a social actor. The ottoman offered people a place to put their legs; it used motion and slight nudges/bumps as its means for communication. Many participants were willing to rest their legs on the ottoman; however, there were some who did not want to cause the ottoman "indignity" by resting their legs on it [31]. The vast majority of participants seemed to indicate that the ottoman seemed like a pet and ascribed intentionality to it; however, the majority also conceded that it was a robotic stool and were able to rest their feet on it [31]. The amount of socialness ascribed to agents varies widely; it is important to make explicit how to communicate with the agent [31].

Hoffman et al. [12] present one of the few papers with a peripheral robotic agent and a human dyad. A robotic lamp was tasked with curtailing conflict between married couples; it used strictly nonverbal cues [12]. The robot was attributed social and emotional capabilities. Participants gazed at the robot, but they did not refer to it verbally [12]. This seems to suggest such an agent could guide a relationship without being a distraction [12].

Our study is also concerned with how a peripheral robot's presence influences the behavior exhibited within a human dyad. If a robot is to be a helpful peripheral tool for married couples or in patient-caregiver relationships, it is important for the robot to influence the relationships only when norm violations occur. The relationships should be allowed to develop naturally if they are healthy. Our study examined a humanoid robot's influence on self-disclosure during an interview. It evaluated an interviewee's comfort with the interview environment and the interviewer. It is important for a peripheral robot not to be disruptive to dyads [12]. It is also important that members in close dyadic relationships can open up to each other. Self-disclosure is important in the development and maintenance of close relationships [7, 10]

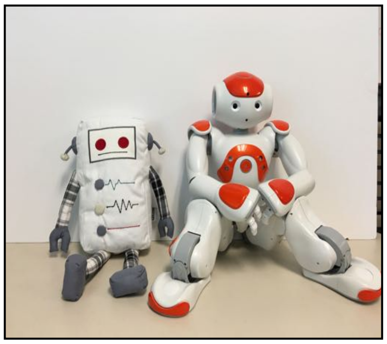
C. Technological Agents and Self-disclosure

There have been several studies involving different technologies that show how varied social presence can influence personal disclosure [3, 22, 28]. Bailenson et al. [3] found in technologically mediated dyadic human interactions that the behavioral and form realism of the avatars influenced verbal and nonverbal disclosure. In this study, the avatars represented a human social presence; there have been additional studies that deal with disclosure and autonomous agents directly.

Powers [28] found that people self-disclosed significantly less to an embodied robotic agent (whether collocated or projected on a life-size screen) than a virtual agent (whether on a computer screen or projected on a life-size screen) who asked them personal questions. Self-disclosure in this study was computed as a word count [28], which may not be a good indicator of disclosure intimacy [10]. People may speak a lot to "give the appearance of disclosing intimately" without revealing a great deal about the self [10].

Mumm and Mutlu [22] found that when a participant liked a robotic interviewer more, the participant disclosed more. Disclosure was measured as the number of personal questions, out of seventeen, the participant answered [22]. This is consistent with humans disclosing more to interaction partners they like [7]. There was no difference in disclosure between the mutual gaze (where the robot attended to the face of the participant) and averted gaze conditions [22]. Gaze was a means of manipulating "distance" between the participant and agent, not social presence; the robot was already an interviewer [22].

Figure 1. The stuffed robot and the Aldebaran Nao used in the study.



III. STUDY DESIGN AND METHOD

This study used a between-subject design with three independent conditions to test how the apparent attentiveness of a robot influences personal disclosure. It was modeled after previous studies examining how certain environmental changes influence self-disclosure (e.g. [19, 25). It was formatted as an interview where a scripted interviewer (one of the experimenters) asked personal questions of a participant. The interview proceedings followed a script discussed below. The interview took place with either an attending Aldebaran Nao[1] present, a static Aldebaran Nao present, or a stuffed robot present. The stuffed robot as well as the Nao appear in Figure 1. In the attending condition, an experimenter controlled the Nao (Wizard of Oz) using Aldebaran's Choregraphe[2] software. The experimenter moved the Nao's head in a slow and controlled manner to gaze at the interviewer and interviewee as each began to speak. The experimenter was located outside of the office. She could see and hear the interview that was taking place via a live video stream.

As noted above, how individuals treat a robotic agent as a social actor is not entirely clear [8, 23, 31]. A person seems to use familiar interaction techniques with a robot, but the robot does not seem to be equivalent to a person or animal as a social actor [31]. The "mere presence" of an attentive human changes a person's behavior [11], and there is less disclosure in larger social groups [30].

Head movements rendered in real time have been shown to increase the co-presence of people interacting in virtual environments [2]. When the peripheral lamp robot, discussed above, showed responsiveness to the participant's conversations, it was rated as being more "human-like" [12]. The robot showed interest in the conversation by attending between the dyad members [12].

The stuffed robot shown as part of Figure 1 serves as a control; it is clearly a stuffed toy that cannot show attention. The static Nao robot, though a programmable robot with anthropomorphic qualities, will not give indications of attentiveness or social intelligence. The attending Nao shows attention to each conversant through head gaze; its apparent social intelligence is the highest of the three conditions and is clearly separate from the other two conditions. This leads to the following hypotheses:

1. There will be a significant decrease in self-disclosure across all sections of the interview when the robot is attending between the two members of the dyad (compared to the other two conditions).

2. There will be a significant difference in the impression of the interviewee with regard to the interviewer, robot, as well as the environment when the robot is attending between the dyad members (when compared to the other two conditions).

3. There will be no significant differences between the static robot condition and the stuffed robot condition in disclosure or in impressions.

A. *Participants*

There were 50 participants recruited for this study. The participants were recruited using flyers on the Georgia Tech campus as well as email mailing lists related to Georgia Tech. The participants were all over the age of 18 years. They were compensated with a $15 Amazon gift card. There were technical errors in five trials in the attending robot condition. These cases were excluded from analysis. There was one case in the static robot condition where the interviewer was previously acquainted with the interviewee; this case was also excluded. The remaining 44 participants (24 females, 20 males; mean age 25.16, SD 9.19), all of whom were strangers to the interviewer, were included. There were 13 participants in the attending Nao group, 15 in the static Nao group, and 16 in the stuffed robot group.

B. *Procedure*

Each participant was randomly assigned to one of the three experimental conditions. The participants were greeted in the lobby of a Georgia Tech research building by one of the experimenters. She led them to a cleared off desk just outside of a professor's office where the interview would take place. The participants were asked to read over and sign the consent form as well as complete surveys measuring certain predispositions.

Each participant was shown into the office where the interviewer was already waiting with the cameras running (to avoid making the interviewee overly self-aware [14]). The interviewer followed a script, which was practiced in

[1] https://www.aldebaran.com/en
[2] http://doc.aldebaran.com/1-14/software/installing.html

the weeks leading up to the study. After the interview concluded, the participant was asked to fill out self-report measures and complete a short English proficiency measure. The participant was left alone in the office to fill out these measures. Subsequently, the participant was debriefed.

Interview Section	Main Questions
Entertainment/ Work	Q1: What do you occupy yourself with when you are not working or what are your hobbies?
	Q2: What do you do for work and what are some of your favorite aspects of your work?
	Q3: What are your least favorite aspects of your work? Are there moments that stand out as particularly bad?
Home Life/ History	Q4: Are you able to talk with your familhy and friends to lessen stress or receive support?
	Q5: Would you be able to describe a time in your life when you weren't stressed or when you were very happy?
	Q6: Would you describe a time in your life that was particularly sad or depressing?
Interpersonal Relationships	Q7: What is your most memorable or most ideal date night or night out with friends?
	Q8: Can you talk about a specific time when a romantic partner or close friend saw you through a situation that made you feel valued?
	Q9: Have you ever felt mistreated or uncared for by a loved one, and, if you have, why did you feel this way?
Stressor Section	Q10: Can you talk about an experience that caused you to question your competence at something?
	Q11: Do you follow a ceratin faith and if so have you experienced instances where you have quesitoned your faith?
	Q12: Did you ever feel pressured into doing something that made you feel ashamed?

Table 1: These are the twelve "main" questions that were asked during the interview. These questions are divided into four sections. The first three sections are divided by topic. The stressor section has a question from each of the three previous topics. In this section, the interviewer used rapport-damaging behaviors

C. *Interview Script*

The script begins with an introduction section. During this section, the interviewer introduces himself as well as the robot. The interviewer introduces himself as a Ph.D. student who is associated with the study and will be asking the participant some personal questions. The robot is introduced as a helper to the interviewer with the name "Robbie". The interviewer explicitly said that the robot was an "instrument" that would be present during the interview. The interviewee was asked to hold his/her questions until after the interview.

The remainder of the script includes four sections with personal questions. Each section contains three "main" questions. These questions are shown in Table 1.

In the first three of these sections, the interviewer attempts to use nonverbal behaviors described by Tickle-Degnen [32] that encourage optimal rapport with the interviewee. After the interviewee answers a "main" question, the interviewer asks a follow-up question. Attention is important to rapport; the script contains conditional follow-up responses that vary based on the topic of the interviewee's response and his/her language to show the interviewer is attentive [6**,** 29].

The "main" questions in these first three sections are drawn from a designated topic. Howell and Conway [13] ranked the intimacy of certain topics. The script's first three sections involving questions are organized such that the questions are drawn from increasingly more intimate topics (entertainment and work to home life and history to interpersonal relationships).

The fourth section with questions introduces "stressors" into the interaction. This section examines whether rapport-damaging practices are amplified or dampened for the different conditions in our study. The interviewer is not confrontational during this portion of the interview; he is deliberately distant and distracted (e.g. looking at his phone and allowing for long silences) [6, 32]. It is damaging to the relationship to be inattentive [32]. Howell and Conway [13] note that information with a negative valence is often the most difficult and intimate to disclose. This final section had the interviewer asking multiple negative questions.

D. *Interview Environment*

The interview took place in a professor's office. The office has numerous characteristics that promote self-disclosure. It offers large windows and blinds that allow for interviews to take place in low, natural lighting [5, 9, 19]. Further, it offers comfortable, soft furniture and a "decorated" environment with pictures and adornments, making it feel more home-like [5, 9]. The seating arrangement allowed the interviewer to sit a comfortable distance from the interviewee with a coffee table between the two; the physical divide is important to promote disclosure when more intimate topics are discussed [25]. See Fig. 2.

Figure 2. Interview environment. The interviewer is seated in the armchair on the right. All interviewees were seated across from him on the couch.

E. *Measurements*

The dependent measurements (variables) can be divided into two separate groups. The first group of measurements examine whether there were fundamental differences between the three groups that might influence our hypotheses irrespective of the experiment conditions.

This study used two different surveys, with permission, to assess the interviewees' predispositions to disclosure. First, a scale developed by Pilkington and Richardson [27] that measures the "risk" a person sees in getting close to others was used. A person sees "risk" in getting close to someone when there is a lack of trust or strong fear of being hurt [27]; trust and a willingness to take this "risk" of potentially being rejected are critical factors to consider when regulating the privacy boundary [7, 10]. The other measure was a scale developed by Larson and Chastain [16]. This survey measured a person's tendency to conceal negative information about the self. Each section in the interview contained at least one question where an answer of negative valence was expected.

The Negative Attitudes towards Robots Scale (NARS) developed by Nomura et al. [24] was used with permission. It was important to understand if one group had disproportionality more people who feared or disliked the idea of social robots when entering the study.

The interview was conducted in English; therefore, differences in disclosure between groups could have resulted from English proficiency differences. Four questions that appear as part of an exam for testing English proficiency at Georgia Tech's Language Institute were given to participants after the interview (these were used with permission).

The nonverbal behavior of the interviewer was rated using a scale developed based on the work of Tickle-Degnen [32]. This four-point Likert scale ranged from low rapport to optimal rapport. The scale was reviewed and approved by a rapport expert. A rating was given for each of the twelve "main" questions during the interview. The data were analyzed by considering the average rating within each section of the interview as well as the summed total of the ratings across the entire interview. The video coding procedure is described in detail below.

The other group of measures is directly related to the hypotheses of the study; these measures can be divided into objective measures, self-report measures, and video ratings measures. The objective measures are the number of times the interviewee referenced the self and the time duration in seconds between when the interviewer finished asking a "main" question and when he began to ask the next "main" question. These were recorded for each "main" question by an experimenter viewing the recordings of the interviews. The summed totals of both measures for the whole interview were analyzed as well as the average duration and number of self-references within each interview section.

The self-report measures were meant to assess the interviewee's comfort during the interview with the interviewer, environment, and robot. The interviewee was asked four questions with respect to each of these dimensions; the response was a rating on a five-point Likert scale (the ratings ranged from strongly disagree to strongly agree). The four questions regarding the interviewer were: "To me the interviewer seemed trustworthy," "The interviewer seemed understanding," "I felt safe sharing with the interviewer," and "I felt the interviewer cared about what I was saying" (Cronbach's $\alpha = 0.83$). The four questions regarding the interviewee's comfort with the environment were: "The environment felt spacious," "I felt comfortable in my surroundings," "I felt safe speaking about personal matters in this environment," and "I would describe the environment as warm" ($\alpha = 0.80$). Finally, the four questions regarding the robot were: "The robot seemed to be listening to what I was saying," "I felt uncomfortable speaking in front of the robot," "I found it hard not to gaze at and speak to the robot," and "I would have preferred for another human to be monitoring this interaction rather than a robot" ($\alpha = 0.43$). The internal consistency on the first two sets of questions ($\alpha > .7$) meant that the average of the four responses could be analyzed for each participant as an indication of that participant's comfort with the environment and interviewer. The four robot questions were analyzed separately for each participant. Miwa and Hanyu [19] and Okken et al. [25] took similar approaches with their univariate analyses.

A video coder generated the final measures used in the analysis. The coder used the same four-point scales as Solano and Dunnam [30] (with permission) to rate both the intimacy of the participant's verbal disclosures as well as the expressiveness of the interviewee's nonverbal behavior. A rating for both verbal intimacy and nonverbal expression were given for each of the twelve "main" questions in the interview. The data were analyzed by considering the average rating for the verbal and nonverbal scales within each section of the interview as well as the summed total of the ratings across the entire interview.

The video coding occurred as follows. Initially, two untrained coders, who were unaware of the study hypotheses, rated all 50 of the interviews on the three scales noted above. The inter-rater reliability (Pearson's r) fell below the required threshold of .7. Therefore, all of the ratings were thrown out. A third coder who was unaware of the study hypotheses was recruited and one of the original coders was retained. These two coders were trained, and they coded six videos independently. The level of agreement did not reach the .7 thresholds for any scale; therefore, they spoke independent of the experimenters to clarify their discrepancies on their understandings of the scales. The third coder rated all fifty videos; a twenty percent subset (ten) of the videos was chosen for the retained coder to ensure the reliability of the ratings. The agreement on this subset on the verbal intimacy scale was $r = .771$. The agreement on this subset on the nonverbal expressiveness scale was $r = .676$. The agreement on the scale for the interviewer's nonverbal rapport-enabling behavior was $r = .936$. The ratings of the new coder were used for the analysis. This procedure was suggested and approved by an expert.

IV. Results

Since disclosure may be influenced by gender [2] and the genders may respond to the same technological agent differently [8, 12], gender was examined within each of our three conditions for each of the dependent measures related to the hypotheses. If there was a gender difference within a condition, the three conditions were compared for that dependent measure with the genders separated as well as grouped. If no gender difference existed within each of the three conditions, the genders were analyzed as a single group.

A. Group Differences

A one-way analysis of variance (ANOVA) revealed no significant difference between the three groups on the self-concealment measure designed by Larson and Chastain [16], the English proficiency questions, the nonverbal rapport-building behavior of the interviewer within any section of the interview or across the interview, nor on any of the three subscales of the NARS ($p > 0.05$). The difference between the groups on the scale measuring risk in intimacy, designed by Pilkington and Richardson [27], approached significance, $F(2, 41) = 3.221$, $p = .0502$, (attending condition, mean = 27.385, $\sigma^2 = 116.090$; static condition, mean = 30.133, $\sigma^2 = 65.410$; stuffed robot, mean = 22.25, $\sigma^2 = 57$). Here σ^2 is the group's variance on the measure. A Games-Howell post hoc test revealed a significant difference ($p < .05$) between the static robot condition group and the stuffed robot condition group. There was not a significant difference between the attending robot group and the other two groups ($p > .05$).

Dependent Measure	Stuffed Robot	Static Robot	Attending Robot
Entertainment and Work – Intimacy of Disclosure	2.0 $\sigma^2 = 0$	2.0 $\sigma^2 = 0$	2.0 $\sigma^2 = .019$
Home Life and History – Intamcy of Disclosure	2.125 $\sigma^2 = .072$	2.178 $\sigma^2 = .030$	2.256 $\sigma^2 = .077$
Interpersonal Relationships – Intimacy of Disclosure	2.104 $\sigma^2 = .055$	2.089 $\sigma^2 = .039$	2.205 $\sigma^2 = .084$
"Stressor" Section - Intimacy of Disclosure	1.771 $\sigma^2 = .129$	1.844 $\sigma^2 = .046$	1.821 $\sigma^2 = .104$
Summed Ratings Across Interview - Intimacy of Disclosure	24.846 $\sigma^2 = 4.474$	24.333 $\sigma^2 = .810$	24.846 $\sigma^2 = 4.0$
Entertainment and Work – Nonverbal Affective Rating	3.042 $\sigma^2 = .072$	2.911 $\sigma^2 = .103$	2.949 $\sigma^2 = .108$
Home Life and History – Nonverbal Affective Rating	2.979 $\sigma^2 = .037$	2.911 $\sigma^2 = .039$	3.077 $\sigma^2 = .132$
Interpersonal Relationships – Nonverbal Affective Rating	2.899 $\sigma^2 = 055$	2.889 $\sigma^2 = .058$	3.026 $\sigma^2 = .064$
"Stressor" Section – Nonverbal Affective Rating	2.5 $\sigma^2 = .163$	2.533 $\sigma^2 = .251$	2.462 $\sigma^2 = .158$
Summed Ratings Across Interview – Nonverbal Affective Rating	34.25 $\sigma^2 = 3.933$	33.733 $\sigma^2 = 8.781$	34.538 $\sigma^2 = 10.436$

Table 2: This table summarizes the self-disclosure results. Each "main" question was rated on two four-point scales, one measuring verbal intimacy and one measuring nonverbal affective behavior. The mean and variance (σ^2) of these ratings for each condition for each section are reported. Also the ratings across the interview for these scales were summed. The mean and variance (σ^2) of the summed ratings are reported.

B. Objective Measures

A series of one-way ANOVAs revealed no significant differences between the three groups for the number of self-references within individual sections of the interview nor the number of self-references across the entire interview. A one-way ANOVA found a significant difference between the three groups in the average length of time between when one "main" question was finished being asked and the next "main" question started to be asked in the home life and history section of the interview, $F(2, 41) = 3.486$, $p = .04$ (attending condition, mean = 101.795, $\sigma^2 = 3010.343$; static condition, mean = 77.756, $\sigma^2 = 814.960$; stuffed condition, mean = 63.688, $\sigma^2 = 950.214$). A Games-Howell post hoc test revealed no significant differences between the pairs of groups ($p > .05$). The attending robot condition had a variance that was more than three times the variance of the other two conditions, which violates the equal variance assumption of the ANOVA. The ANOVAs done on the data from the other interview sections revealed no significant differences between groups in these sections; there was also no significant difference between groups when comparing the duration of all twelve questions ($p > .05$).

C. Self-disclosure Ratings

A series of one-way ANOVAs found no significant differences between the groups when analyzing disclosure intimacy ratings within the sections of the interview nor when analyzing the summed total of the ratings across the interview ($p > .05$). There was a significant gender difference found when analyzing the summed nonverbal ratings within the attending robot condition, $F(1, 11) = 6.049$, $p = .032$ (males, mean = 32.2, $\sigma^2 = 6.7$; females, mean = 36, $\sigma^2 = 7.714$). Three one-way ANOVAs were run to compare the three groups with respect to summed nonverbal expressive ratings, one where only males from the three groups were included, one with only females from the three groups were included, and one with the genders combined. In all three cases, the ANOVA revealed no significant difference between the three groups ($p > .05$). There were no significant differences between the groups within the sections of the interview with respect to the nonverbal ratings ($p > .05$). The results are summarized in Table 2.

Self-Report Measure	Stuffed Robot	Static Robot	Attending Robot
*Robot seemed to be listening.	2.25 $\sigma^2 = 1.667$	2.333 $\sigma^2 = .952$	3.75 $\sigma^2 = .568$
Uncomfortable speaking in front of robot.	1.875 $\sigma^2 = 2.117$	2.0 $\sigma^2 = .571$	2.0 $\sigma^2 = 1.273$
Hard not to gaze at the robot.	2 $\sigma^2 = 2$	2.6 $\sigma^2 = 1.686$	2.583 $\sigma^2 = 1.901$
Would have preferred for another human to be present rather than the robot.	1.667 $\sigma^2 = .606$	2.333 $\sigma^2 = 1.095$	1.875 $\sigma^2 = 1.317$
Comfort with Interviewer	3.406 $\sigma^2 = .541$	3.7 $\sigma^2 = .502$	3.692 $\sigma^2 = .637$
Comfort in Environment	3.875 $\sigma^2 = .892$	3.95 $\sigma^2 = .305$	3.961 $\sigma^2 = .278$

Table 3: This table summarizes the results for the self-report conditions. It reports the mean and variance (σ^2) of the ratings within each condition for each of the robot questions. The comfort with the interviewer and comfort in environment rating for an individual were the average of the four interviewer and environment questions. This reports the mean and the variance (σ^2) within the three conditions for these values. *$p = .001$.

D. Interviewee Impressions

A series of one-way ANOVAs revealed no significant differences between the three groups on the environment and interviewer self-report measures ($p > .05$). Note that one participant in the attending Nao condition did not answer the self-report measures asking about the robot. The analyses were done with the data from the other twelve participants in the attending robot condition.

A one-way ANOVA found a significant difference between groups for the question asking if the participant felt like the robot was listening, $F(2, 40) = 8.293$, $p = .001$ (attending condition, mean = 3.75, $\sigma^2 = .568$; static condition, mean = 2.333, $\sigma^2 = .952$; stuffed condition, mean = 2.25, $\sigma^2 = 1.667$). A Games-Howell post hoc test revealed a significant difference between the attending robot condition and the static robot condition as well as between the attending robot condition and the stuffed robot condition ($p < .05$). There was no significant difference between the static Nao condition and the stuffed robot condition.

The second self-report question about the robot, which asked the participant if he/she felt uncomfortable speaking in front of the robot, had a significant gender difference within the static Nao condition $F(1, 13) = 5.909$, $p = .030$ (males, mean = 1.667, $\sigma^2 = .25$; females, mean = 2.5, $\sigma^2 = .7$). Three one-way ANOVAs were run to compare the three groups with respect to the measure looking at how comfortable the interviewees were to speak in front of the robot, one with only the males from the three groups, one with only the females from the three groups, and one with the genders combined. In all three cases, the ANOVA found no significant difference between the three groups.

A series of one-way ANOVAs revealed no significant differences between groups on the final two robot questions. The self-report measure results are summarized in Table 3.

E. Gender Differences Summary

The only two conditions where a gender difference was found with respect to the self-disclosure ratings, the objective measures, or the self-report measures were made explicit above. Males and females were analyzed separately for these dependent measures. There was no significant difference between the three groups for males or females.

V. DISCUSSION

The data did not support our first hypothesis. There was not a significant difference in self-disclosure between our three conditions. As noted above, the "mere presence" of another person can cause someone to exercise further control over his/her behavior [11], and self-disclosure tends to decrease in groups of increasing size [30]. People seem to regulate their behavior, to fit norms, in the presence of others because they want to avoid social pitfalls and potential ridicule [11]. The naturalness of a patient-caregiver interaction would be restricted with a third-party human presence. The attending robot had more of a social presence than the other two robots. It was listening (mean = 3.75, 4 = agree), and the others were not (means = 2.25, 2.333, 2 = disagree) according to the self-report measures above. This social presence, however, did not seem to influence the interviewees' comfort when it came to speaking openly.

Participants in this study did not see a difference in the level of risk between the three conditions when self-disclosing. This is a positive result for our work moving forward. A robotic agent that is tasked with helping a patient-caregiver dyad recognize norm violations should not hurt the development of a close and healthy relationship. Self-disclosure is an important part of such relationships [7, 10]; a third-party human would negatively affect disclosure [30].

The second hypothesis was also not generally supported. There were no significant differences between the groups in how comfortable the participants rated the environment and the interviewer. This is another important indication that a social robotic agent may be able to alert a human dyad to norm violations in their relationship without otherwise influencing the natural development of the relationship. The participants generally seemed to indicate that they were comfortable with both the interviewer and environment. Five out of the six ratings of the environment and interviewer fell between 3.5 and 4 where a rating of 4 was agreement with a statement that indicated comfort. The rating that fell below 3.5 was the rating of the interviewer in the stuffed robot condition (mean = 3.406; 3 = Unsure).

The participants gave an explicit indication that they were comfortable talking in front of any of the agents. They disagreed when asked if they were uncomfortable speaking in front of the robots (means = 1.875, 2, 2; 2 = disagree). Also they indicated that they preferred the presence of the agents versus that of another human. They disagreed with the statement that they would have preferred for another human to be monitoring the interaction (means = 1.667, 2.333, 1.875; 2 = disagree). One participant made this feeling explicit in his/her comments. The participant said that he/she would have preferred to talk "exclusively to the robot" because he/she would be "more confident" that his/her "secrets" would not become "fodder for conversation". The participants' comfort opening up in front of the social robotic agent means that robotic agents may be better tools than humans, in certain cases, for ameliorating relationship difficulties in human dyads.

The reason participants were equally comfortable with the attending robot's presence may in part stem from the way in which the agent was introduced to the participants. Sirkin et al. [31] discussed the importance of making explicit how a person interacting with a robot is meant to communicate with the robot. The "metaphor" a person uses to understand a robotic agent may guide how he/she behaves and communicates with the robot [31]. The agent in every condition in this study was introduced as an instrument of the experimenter. This says to the participant that they do not need to communicate with the agent, and it is simply a tool. The stuffed robot condition and static Nao condition do not give indications of social intelligence other than certain aspects of their physical appearance. As expected, they are treated as objects to ignore. The third hypothesis, that there would be no significant differences between these two conditions was confirmed. The attending robot condition is not a static object, but it does not challenge how the robot was introduced. The participant treats the attending Nao as a monitoring presence, similar to the cameras recording the interview. The agent may be doing some task for the interviewer, but the agent is not socially responsive to what the interviewee is saying. The robot is not judging, etc. The participants' treatment of the robot may change if the robot seemed to be socially responsive to what he/she was saying.

Finally, this study had limitations. The study was completed with a small population. This population was drawn largely from the Georgia Tech community. The participants may have had more of a familiarity with robots than the community at large. A similar study with an older population would be beneficial to understand how the presence of a social robot might influence the disclosure of a Parkinson's patients with their caregivers. The study was limited by using a single programmable robotic platform that displayed very limited social behaviors. More complex social cues may have altered participants' treatment of the robot.

VI. CONCLUSIONS AND FUTURE WORK

Participants disclosed equally as much in front of an attending Nao robot as a static Nao robot and a stuffed robot. As discussed above, this is an indication that they felt no greater risk disclosing in front of the attending Nao (i.e. it would not reveal their information nor disapprove of them).

The attending Nao robot did not give social responses when the interviewee was answering the interview questions. Perhaps, if the robot responded to the interviewees' disclosures, the interviewees would not have continued to treat the agent as a tool. This notion is being tested in an ongoing extension to this study in our lab.

In the future, we plan to examine the influence of a Nao robot that gives social cues through bodily kinesics. The R25 platform from Robokind[3] has a more human-like appearance; its facial expressions can be made to mimic human expressions of emotion. (See Fig. 3). This platform can more easily provide social responses to the interviewees' disclosures. Morphology has also been shown to influence people's treatment and feelings toward robotic agents, for example Mori's "Uncanny Valley" [21]. This study is being extended with two additional conditions using the R25. In one condition, the R25 will attend between the interviewer and interviewee. This will allow a direct comparison between the two morphologies. In the second condition, the R25 will smile and frown in response to positive and negative disclosures of the interviewee to see if this changes how the interviewee treats the agent.

Figure 3. Robokind's R25 Platform. Happy, neutral, and sad facial expressions (from left to right) are shown.

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