Medical Interviewing with a Robot instead of a Doctor

Who do we trust more with sensitive information?

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ABSTRACT

Patients often do not trust their physicians with confidential, private information. They are worried about judgment, and ultimately this leads to poorer health outcomes. Physicians also do not listen to specific groups of people, biasing healthcare decisions. It may, therefore, be helpful to complement or delegate some of a physician's tasks to a robot. People are more willing to disclose private information to robots, which they find unbiased without negative judgment [2]. Robots can ask all relevant questions regardless of sex, gender, or sexual orientation [11]. This proposal explores the use of robotics within medicine, evaluating patient trust and information disclosure, to supplement and promote unbiased healthcare provider decisions. The experiment will employ a physician to conduct 90 patient interviews between three groups (G) using the standardized Brown Interview Checklist, either with (G1) or without (G2) a proxy robot. Patients interviewed by the robot will be split between those aware (G2a) or unaware (G2b) that a physician will be controlling the robot. We hypothesize that using a physical robot will improve information disclosure with less stress, and perhaps even off-load physician workload for more targeted and appropriate healthcare decisions.

KEYWORDS

Human Robot Interaction; Information Disclosure; Medical Interview; Doctor-Patient Relationship

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1 Background

Evidence suggests that people who disclose relevant health information, receive better medical and social support, and leads to better overall public health. For example, patients who disclosed their HIV status to their healthcare providers had better treatment adherence, which can ultimately lead to better public health with the reduced risk of transmission [35]. Honest patient disclosure is essential to the doctor-patient relationship and can significantly impact care [23]. When patients disclose incorrect or inaccurate symptoms (i.e. physical injuries/abuse, STI), health behaviors (i.e. sexual orientation, drug use), thoughts or feelings (i.e. suicidal), clinical decisions may be unhelpful or harmful.

The lack of full disclosure of a patient's symptoms can be detrimental to the patient. Patients from vulnerable groups are less likely to disclose information to their clinicians for fear of stigmatization [21, 23]. This particularly impacts women who are more likely to experience depression, suicidal thoughts, and sexual assault [5, 6]. In surveys involving over 4500 patients, it was reported that patients often withheld information for fear of negative judgment and embarrassment [23]. Patients who were sicker or suffering from chronic conditions were significantly more likely to withhold information, indicating that those with the greatest need for medical care would lead to compromised health outcomes [23]. These results support a belief in the medical community that patients lie to their physicians [1, 30, 33]. Such an attitude is not conducive to developing a trusting patient-physician relationship that is essential for adequate healthcare.

Building and repairing patient-physician trust is thus fundamental in improving preventative medical outcomes, adherence to therapeutic strategies, and overall population health [37]. While medical education curricula are adapting to raise trust during patient interviewing, advancements in automation and robotics within the medical field provides unique opportunities for bettering patient health through robotic-patient interactions. Researchers have vastly improved social skills within elements of the Human Robot Interface (HRI) to have a more natural conversation and providing a safe environment where people can be more honest with disclosing information [4, 14–16, 27, 34].

1.1.1 Human Robot Interface Literature. The impact of using robots in the context of doctor-patient relationship is largely unexplored. However, the feasibility has been demonstrated in other contexts involving non-medical information disclosure. For example, Lucas et. al demonstrated that virtual agents (VA) can elicit increased willingness for subjects to disclose information without feeling negative judgment [27]. This was advantageous over traditional computer-administered interviewing, based on the greater rapport subjects felt within these "face-to-face" interviews [17, 34]. Additionally, VA provided a more complex/dynamic interview than computerized questionnaires. Therefore, to improve information disclosure, increased aspects of anonymity (to reduce the feeling of judgement) and rapport building (to improve

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trust/willingness to share) are important criteria to consider when creating tools to help with patient interviewing.

Efforts to improve rapport building within HRI have led to more humanoid traits and specific features for robots, which are more likely to build rapport more easily than VA. Trust towards robots is influenced by different factors, such as the creation of good rapport, its physical appearance and more [2, 14, 20, 25, 28, 39]. Furthermore, Bickmore et. al demonstrated that the combination of nonverbal skills with techniques to demonstrate empathy, social dialogue and reciprocal self-disclosure can increase trust and rapport between human and computer dyads [5].

While research in medical interviewing has shaped medical student training in symptomatic and health information gathering [8, 9, 13] it has not accounted for the implementation of robotics. Similarly, HRI has investigated healthcare delivery in the medical domain to some extent [6, 12, 26, 29, 31, 36] but not with a focus on medical interviewing, enhancing information disclosure and building or repairing patient-physician trust. Thus, the integration of a social robot for the specific task of health information gathering may be beneficial for both patients and doctors.

2 Key Research Questions

Therefore, within this proposal, we aim to utilize a physical sophisticated humanoid robotic agent as a proxy in conducting medical interviews in direct comparison to doctor-patient dyads to measure information disclosure, trust, and stress of the patient. **Does a robot improve the medical interview process/increase the rate of relevant medical information disclosure?**

2.1.1 Combined Medical and Engineering Background. As an MD/PhD candidate, I can approach this unique HRI challenge from the perspectives of both a doctor and researcher. The long-term vision of this research is to determine the extent to which new technologies (i.e. robotics) can be utilized to increase the efficiency and effectiveness of healthcare delivery. My earlier work explored (1) how to objectively evaluate the extent of problems doctors/patients face, and (2) how we can augment/ address those problems with technological innovations (assistive devices, mobile brain imaging and new physical therapies).

2.1.2 Past Work. Consistent with the neuroergonomic approach [3], I (via a comprehensive and multisensory approach including portable neuroimaging, electrocardiography, electrodermal sensing, accelerometry) evaluated traditional and "smart" wheelchairs, gathering one of the largest patient cohorts out in real-world scenarios [18]. I applied a similar approach evaluating a new targeted physical therapy to 86 children (diagnosed from 1118) with a motor coordination disorder [19].

3 Research Approach and Methodology

Ninety patient interviews (ages 18-65) randomly assigned to be either by physician (G1 - 30), or a robot controlled by a physician (G2 - 60). However, for patients that are interviewed by a robot, half will be led to believe that a physician is controlling the robot (G2a) and the other half will be led to believe that the robot is autonomous (G2b – without physician input).

3.1.1 Robotic Interface. The "Pepper Robot" developed by Softbank Robotics will be used as a proxy by the physician.

3.1.2 Experimental Procedures. Each interview will be 20 minutes, and encompass questions generated from the Brown Interview Checklist (Fig. 1). The patient will be briefed that the information while confidential, will be shared with other physicians and in the electronic medical record. This is to ensure a typical patient interview, as well as reduced confounding factors in terms of information disclosure. Additionally, patients will be wearing electrodermal activity sensors (EDA) to measure stress, while cameras will be measuring facial and body expression/movements, along with audio recordings for transcription of the dialogue.

3.1.3 Analytical Methodology. After interviews, patients will fill out questionnaires that measure fear of self-disclosure [10], and impression management [24]. Recorded video will be analyzed along with facial analysis using the Computer Expression Recognition Toolbox (CERT) to evaluate willingness to express sadness (generally more sadness represents more willingness for self-disclosure) [27]. Dialogue transcripts will be evaluated for information disclosure using a weighted indexing design [7, 38] quality, scope, and quantity of information.

3.1.4 Interview Methodology. Each patient interview will use the standardized Brown Interview Checklist, specifically within the Key Content Areas of History of Present Illness, Understanding the Patient's Perspective, Past Medical History, Family History, Psychosocial and Behavioral History, and Functional Status. The physicians that will be employed for the interviews will be 2nd and 3rd-year family medicine residents, to allow consistent and experienced medical interviewing strategies.

3.1.5 Ethical Considerations. By working with patients and highly private medical data, unique ethical considerations are needed. G1 is being interviewed by a physician, while G2 is being interviewed by a physician via a robot. G2b is being deceived into believing the robot is conducting the interview, and relaying it to a physician, while in reality the robot is a proxy for the interview with a physician. The study will be ethically designed with oversight via IRB approval to assess the potential risk for all groups.

Further assessment and mitigation of the impact to the researchers and physicians collecting medically private information via the robot will be undertaken. This includes adequately preparing the physicians/researchers for potential stressful events and providing opportunities for feedback during pilot testing/redesign, immediate debriefing of participants to minimize the duration of negative social interactions, and a debriefing period for the physicians/researchers to voice concerns/stress throughout testing [32]. Furthermore, each group will have the interview with oversight via a physician at all times.

4 Predictions/Expected Results

We predict that G2b patients will feel less judgement and stress and disclose information that may have been withheld from a human doctor. We believe that using a physical robot over VA will produce stronger results via greater influence and more favorable responses according to a review of over 30 studies utilizing both physical and VA [25]. This study may have profound implications for both the HRI and medical communities and has potential for more efficient healthcare distribution via the physician, leading to more trust between the patient and the medical system.

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REFERENCES

[1] Agaku, I.T. et al. 2014. Concern about security and privacy, and perceived control over collection and use of health information are related to withholding of health information from healthcare providers. *Journal of the American Medical Informatics Association*. 21, 2 (2014), 374–378. DOI:https://doi.org/10.1136/amiajnl-2013-002079.

[2] Aroyo, A.M. et al. 2018. Trust and Social Engineering in Human Robot Interaction: Will a Robot Make You Disclose Sensitive Information, Conform to Its Recommendations or Gamble? *IEEE Robotics and Automation Letters*. 3, 4 (2018), 3701–3708. DOI:https://doi.org/10.1109/LRA.2018.2856272.

[3] Ayaz, H. and Dehais, F. 2018. *Neuroergonomics: The Brain at Work and in Everyday Life*. Elsevier Academic Press.

[4] Bateson, M. et al. 2006. Cues of being watched enhance cooperation in a real-world setting. *Biology Letters*. 2, 3 (2006), 412–414. DOI:https://doi.org/10.1098/rsbl.2006.0509.

[5] Bickmore, T. et al. 2005. Establishing the computer-patient working alliance in automated health behavior change interventions. *Patient Education and Counseling*. 59, 1 (2005), 21–30. DOI:https://doi.org/10.1016/j.pec.2004.09.008.

[6] Boumans, R. et al. 2019. A Feasibility Study of a Social Robot Collecting Patient Reported Outcome Measurements from Older Adults. *International Journal of Social Robotics*. (2019). DOI:https://doi.org/10.1007/s12369-019-00561-8.

[7] Bravo Urquiza, F. et al. 2009. Disclosure indices design: Does it make a difference? *Revista de Contabilidad*. 12, 2 (2009), 253–277. DOI:https://doi.org/10.1016/S1138-4891(09)70008-1.

[8] Brédart, A. et al. 2014. Interviewing to develop Patient-Reported Outcome (PRO) measures for clinical research: Eliciting patients' experience. *Health and Quality of Life Outcomes*. 12, 1 (2014), 1–10. DOI:https://doi.org/10.1186/1477-7525-12-15.

[9] Britten, N. 1995. Qualitative interviews in medical research. *British Medical Journal*. 311, 6999 (1995), 251–253. DOI:https://doi.org/10.1136/bmj.311.6999.251.

[10] Carleton, R.N. et al. 2011. Addressing revisions to the Brief Fear of Negative Evaluation scale: Measuring fear of negative evaluation across anxiety and mood disorders. *Journal of Anxiety Disorders*. 25, 6 (2011), 822–828. DOI:https://doi.org/10.1016/j.janxdis.2011.04.002.

[11] Chapman, E.N. et al. 2013. Physicians and implicit bias: How doctors may unwittingly perpetuate health care disparities. *Journal of General Internal Medicine*. 28, 11 (2013), 1504–1510. DOI:https://doi.org/10.1007/s11606-013-2441-1.

[12] Edwards, A. et al. 2017. How do patients in a medical interview perceive a robot versus human physician? *ACM/IEEE International Conference on Human-Robot Interaction*. March (2017), 109–110. DOI:https://doi.org/10.1145/3029798.3038308.

[13] Enelow, A.J. and Wexler, M. 1965. The medical interview. *Medical times*. 93, 11 (1965), 1192–1200. DOI:https://doi.org/10.1080/00325481.1960.11716478.

[14] Gratch, J. et al. 2007. Creating rapport with virtual agents. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. 4722 LNCS, (2007), 125–138. DOI:https://doi.org/10.1007/978-3-540-74997-4_12.

[15] Gratch, J. et al. 2014. Using social agents to explore theories of rapport and emotional resonance. *Social emotions in nature and artifact.* Oxford University Press.

[16] Hoffman, G. et al. 2015. Robot Presence and Human Honesty: Experimental Evidence. *ACM/IEEE International Conference on Human-Robot Interaction*. 2015-March, (2015), 181–188. DOI:https://doi.org/10.1145/2696454.2696487.

[17] Joinson, A.N. 2001. Self-disclosure in computer-mediated communication: The role of self-awareness and visual anonymity. *European Journal of Social Psychology*. 31, 2 (2001), 177–192. DOI:https://doi.org/10.1002/ejsp.36.

[18] Joshi, S. et al. 2019. A Cross-Sectional Study Using Wireless Electrocardiogram to Investigate Physical Workload of Wheelchair Control in Real World Environments. *Advances in Neuroergonomics and Cognitive Engineering*. Springer, Cham. 14–25.

[19] Joshi, S. et al. Revealing Cortical Activation Patterns of Novel Task Performance in Children With Low Coordination via fNIRS. *Frontiers in Human Neuroscience*.

[20] Kiesler, S. et al. 2008. Anthropomorphic interactions with a robot and robot-like agent. *Social Cognition*. 26, 2 (2008), 169–181. DOI:https://doi.org/10.1521/soco.2008.26.2.169.

[21] Lemaire, R. et al. 2011. Disclosure of Sexual Assault: Characteristics and Implications for Posttraumatic Stress Symptoms Among African American and Caucasian Survivors. *Journal of Trauma Dissociation*. 130, 6 (2011), 1514–1523. DOI:https://doi.org/10.1038/jid.2010.15.Antagonistic.

[22] Levy, A.G. et al. 2019. Assessment of Patient Nondisclosures to Clinicians of Experiencing Imminent Threats. *JAMA Network Open*. 2, 8 (2019), e199277. DOI:https://doi.org/10.1001/jamanetworkopen.2019.9277.

[23] Levy, A.G. et al. 2018. Prevalence of and Factors Associated With Patient Nondisclosure of Medically Relevant Information to Clinicians. *JAMA Network Open*. 1, 7 (2018), e185293. DOI:https://doi.org/10.1001/jamanetworkopen.2018.5293.

[24] Li, A. and Bagger, J. 2007. The Balanced Inventory of Desirable Responding (BIDR): A reliability generalization study. *Educational and Psychological Measurement*. 67, 3 (2007), 525–544. DOI:https://doi.org/10.1177/0013164406292087.

[25] 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, (2015), 23–37. DOI:https://doi.org/https://doi.org/10.1016/j.ijhcs.2015.01.001.

[26] Looije, R. et al. 2006. Incorporating guidelines for health assistance into a socially intelligent robot. *Proceedings - IEEE International Workshop on Robot and Human Interactive Communication*. (2006), 515–520. DOI:https://doi.org/10.1109/ROMAN.2006.314441.

[27] Lucas, G.M. et al. 2014. It's only a computer: Virtual humans increase willingness to disclose. *Computers in Human Behavior*. 37, (2014), 94–100. DOI:https://doi.org/10.1016/j.chb.2014.04.043.

[28] Lucas, G.M. et al. 2019. The Effectiveness of Social Influence Tactics when Used by a Virtual Agent. (2019), 22–29. DOI:https://doi.org/10.1145/3308532.3329464.

[29] Meghdari, A. et al. 2017. Conceptual design of a social robot for pediatric hospitals. *4th RSI International Conference on Robotics and Mechatronics, ICRoM 2016*. (2017), 566–571. DOI:https://doi.org/10.1109/ICRoM.2016.7886804.

[30] Palmieri JJ, S.T. 2009. Lies in the Doctor-Patient Relationship. *Prim Care Companion J Clin Psychiatry*. 11, 4 (2009), 163–8. DOI:https://doi.org/10.4088/PCC.09r00780.

[31] Van Der Putte, D. et al. 2019. A Social Robot for Autonomous Health Data Acquisition Among Hospitalized Patients: An Exploratory Field Study. *ACM/IEEE International Conference on Human-Robot Interaction*. 2019-March, (2019), 658–659. DOI:https://doi.org/10.1109/HRI.2019.8673280.

[32] Rea, D.J. et al. 2017. Wizard of Awwws: Exploring psychological impact on the researchers in social hri experiments. *ACM/IEEE International Conference on Human-Robot Interaction*. (2017), 21–29. DOI:https://doi.org/10.1145/3029798.3034782.

[33] Sankar, P. et al. 2003. Patient perspectives on medical confidentiality: A review of the literature. *Journal of General Internal Medicine*. 18, 8 (2003), 659–669. DOI:https://doi.org/10.1046/j.1525-1497.2003.20823.x.

[34] Scheutz, M. et al. 2007. First steps toward natural human-like HRI. *Autonomous Robots*. 22, 4 (2007), 411–423. DOI:https://doi.org/10.1007/s10514-006-9018-3.

[35] Shushtari, Z.J. et al. 2014. Disclosure of HIV status and social support among people living with HIV. *Iranian Red Crescent Medical Journal*. 16, 8 (2014). DOI:https://doi.org/10.5812/ircmj.11856.

[36] Stollnberger, G. et al. 2016. Designing user interfaces for different user groups: A three-way teleconference system for doctors, patients and assistants using a Remote Medical robot. *25th IEEE International Symposium on Robot and Human Interactive Communication, RO-MAN 2016*. (2016), 612–617. DOI:https://doi.org/10.1109/ROMAN.2016.7745181.

[37] Thom, D.H. et al. 2004. Measuring patients' trust in physicians when assessing quality of care. *Health Affairs*. 23, 4 (2004), 124–132. DOI:https://doi.org/10.1377/hlthaff.23.4.124.

[38] Urquiza, F.B. et al. 2010. Disclosure theories and disclosure measures. *Revista Espanola de Financiacion y Contabilidad*. 39, 147 (2010), 393–415. DOI:https://doi.org/10.1080/02102412.2010.10779686.

[39] Złotowski, J. et al. 2016. Appearance of a robot affects the impact of its behaviour on perceived trustworthiness and empathy. *Paladyn*. 7, 1 (2016), 55–66. DOI:https://doi.org/10.1515/pjbr-2016-0005.