AN ABSTRACT OF THE THESIS OF

Makenzie M. Brian for the degree of Master of Science in Robotics presented on June 3, 2019.

Title: Patient Compliance Effects on Simulated Ebola Medical Care Delivery with a Telepresence Robot

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William D. Smart

When treating highly infectious diseases, patient compliance with caregiver recommendations is crucial. Many patients who contract Ebola Virus Disease have symptoms including vomiting and severe diarrhea and die from the resulting dehydration if they do not drink enough fluids. Telepresence robots are useful in the context of Ebola treatment for performing patient interactions without further risk of contamination to care providers. As part of this Masters thesis, a study was conducted to determine if there is a difference in compliance when an individual is directed by someone using a telepresence robot compared to when they are directed by someone wearing Ebola-style personal protective equipment (PPE). This work is relevant to the compliance of patients in the treatment of Ebola for simple tasks such as reminding patients to eat and drink water where telepresence robots may be a suitable replacement for healthcare workers in the role of Ebola patient supervisor or supporter. Simple tasks are important to the survival of Ebola patients, who often perish from dehydration, and can be easily accomplished using a telepresence robot, whereas changed IV fluid or other medical tasks cannot be. The results show that there was no statistically significant difference between the subject group instructed by the person in the Ebola PPE and the subject group instructed by the person using the telepresence robot by

performing single factor ANOVAs on the resulting data. Based on these results telepresence robots may be able to replace physically present healthcare workers for some tasks.

Patient Compliance Effects on Simulated Ebola Medical Care Delivery with a Telepresence Robot

by

Makenzie M. Brian

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Makenzie M. Brian, Author

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Chapter 1: Introduction

Infectious diseases can cause massive casualties and extreme panic [4, 12]. Ebola Virus Disease is one such disease with outbreaks documented by the Centers for Disease Control and Prevention (CDC) since 1976 [5]. In 2014, an Ebola outbreak in West Africa killed 11,308 people of the 28,610 people who were infected with the disease. Patients who contract Ebola have symptoms including vomiting and severe diarrhea. There is evidence that dehydration is a major cause of death in many cases due to the massive fluid loss associated with these symptoms [8]. These infected fluids are also the primary transmission vector for further disease spread to those who are administering care in treatment units. In 2014 and early 2015, 800 health workers were infected with Ebola while aiding in treatment efforts [2].

One of the difficulties with caring for Ebola patients in remote outbreaks, such as in West Africa, is the hot and humid environment. All caregivers interacting with the patients must wear a full body protective suit. Suits cause caregivers to overheat quickly as the suits are not breathable and cannot be made to be so as this risks disease transmission. Each suit cannot be reused and must be burned once it is taken off. Additionally, the donning and doffing process is slow to avoid risking further spread of infection which can occur easily from minor errors.

One way to mitigate the spread of disease and avoid the suit issues, is to use telepresence robots to interact with patients, particularly to remind them to eat and drink regularly. This thesis aims to determine if there is a difference in compliance between individuals who are directed by a person wearing an Ebola-style personal protective equipment (PPE) and a person using a telepresence robot, where the remote user's face can be seen on a screen. If instruction via telepresence robot produces a similar or improved compliance rate as that of a co-located individual in PPE will indicate that the use of telepresence robots may reduce the infection risk among caregivers.

Telepresence robots allow an operator to navigate and communicate with people in an environment, while being seen in return via a mounted display. These robots may aid in Ebola treatment and allow medical staff to direct patients to drink water, eat, and do other basic tasks without further risk of contamination. Ebola patients, who are frequently vomiting, often die from dehydration and have trouble remembering to drink water and eat. Telepresence robots allow medical staff to interact for extended periods with patients, as the medical staff do not have to worry about overheating in the necessary PPE, avoid the extensive process of donning and doffing PPE, and limit possible contamination by avoiding close contact during interactions. This increases the amount of time the medical staff can interact with patients from several minutes per hour, after finishing necessary duties such as sanitizing and distribution of fluid bags, to hours at a time. The current evidence that exists that telepresence robots could be useful in such scenarios is anecdotal. This work seeks to find concrete support for these claims.

1.1 Objective

The purpose of this study is to see if people follow instructions differently when they are delivered by someone using a telepresence robot, compared to someone delivering them in person. This has relevance for remotely-delivered medical care, where patients are asked to take medication or perform seemingly onerous tasks. Can we do this effectively using telepresence? We are particularly interested in infectious disease settings, where a human healthcare worker would have to use personal protective equipment (PPE), but a remotely present worker would not and could be more easily disinfected if it ever needed to leave the treatment space. Though there are limitations to the generalizability of the results presented here, this dissertation begins to explore the impact telepresence robots may be able to have in infectious disease treatment. The initial hypothesis was that participants would be at least as compliant with instruction via telepresence robot as they would be with instruction from the person wearing PPE.

Chapter 2: Related Work

This section provides background information for the topics discussed in this thesis.

2.1 Current Methods for the Treatment of Ebola

Ebola treatment and other infectious disease situations can be highly volatile if not contained. The PPE used in Ebola treatment can be seen in Figure 2.1. These suits are specifically designed as impermeable and fluid-resistant materials in order to avoid any contact between the wearer and the patient's contaminated bodily fluids. Each suit must be burned after use to avoid the further spread of disease to caregivers [3]. Doffing of the PPE requires a trained observer to supervise. Doffing is significantly more risky and must occur slowly in order to avoid the spread of infection to the wearer. Each of these processes take between 45 minutes to an hour when done properly as it must be ensured that there are no openings in the suit and that all seams are sealed with tape. As many Ebola outbreaks occur in hot regions in Africa, healthcare workers can only wear the suits for short periods of time, sometimes as short as 45 minutes, before they will begin to overheat [1].

2.2 Telepresence Robots

A telepresence robot is a remotely-controlled, mobile system where the user's face can be seen on a tablet-like screen with audio capabilities. Telepresence robots are currently used for tasks ranging from attending office meetings to providing guided tours with varying levels of benefit from direct human interaction [23]. Work has also been done looking at how people interact with the telepresence robots and what features will be most useful for future designs [13, 21, 17]. The telepresence robot used for this work is the Beam as seen in Figure 2.2 and the operator's view can be seen in Figure 2.3.

Figure 2.1: This is the style of PPE used in the treatment of Ebola to prevent further spread of disease.

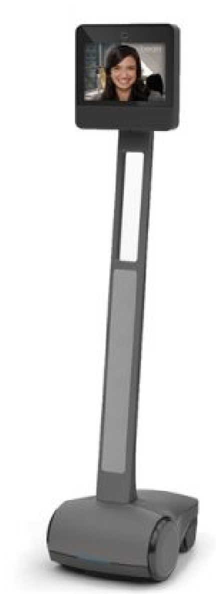

Figure 2.2: This is a Beam telepresence robot. It allows the operator to view the area in front of the robot and drive around. The operator's face can be seen on the screen.

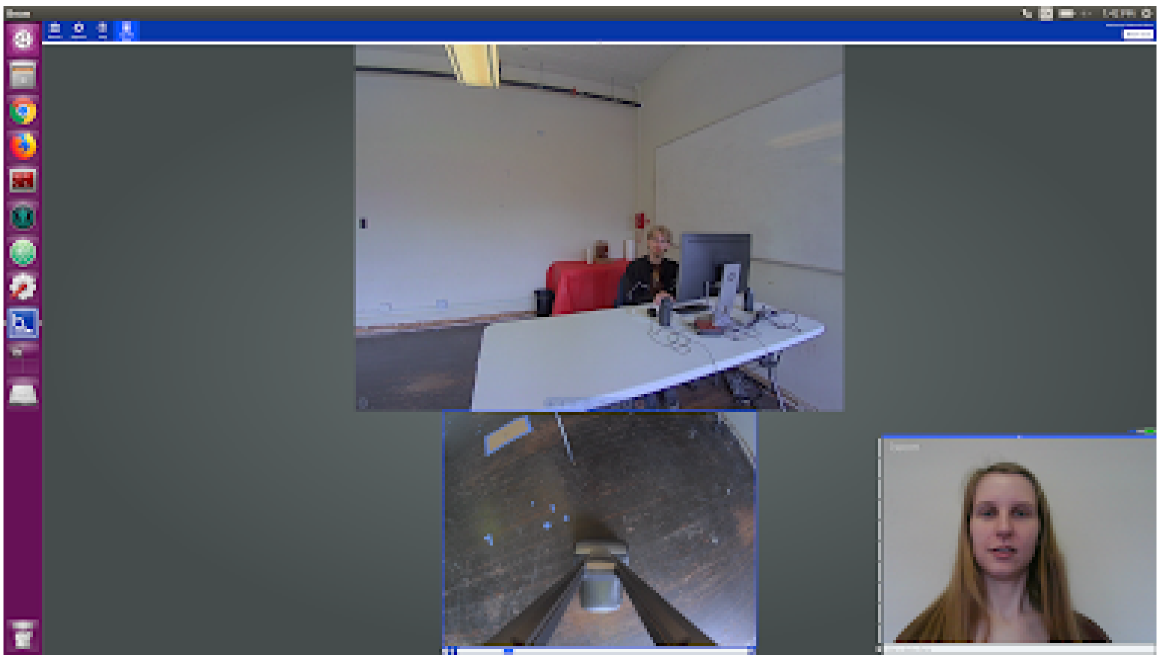

Figure 2.3: This is the operator's view from the Beam telepresence robot. The operator can drive using the arrow keys on the keyboard or by clicking on locations on the floor-view in front of the robot. It has the ability to automatically park itself on the charger when it is in view.

There are challenges to using a telepresence robot, or any robot, in remote locations. Ebola treatment units are often set up ad-hoc and as needed in the place of the highest need. For large outbreaks, this may mean setting up tents outside where there are not enough buildings. Telepresence robots work most effectively on flat flooring with a high coefficient of friction, which is not case for the ground under a tent. Battery life is also concerning. If the robots need to be in constant use, then battery charging requirements increase the number of robots needed, which increases cost and maintenance time. Specifically in West Africa and other hot regions, overheating may be an issue as most robots are not intended for extended use in extreme temperatures. One other issue may also be cleaning of the robots. For the most part, the robots could be confined to the treatment area as many models have chargers they can drive directly onto. Any further maintenance requires a human in a suit, which brings up the same issues of contamination or the human overheating while trying to troubleshoot a robot; alternatively, the robot may be sanitized to perform maintenance, but this may not be possible or quick with the amount of cracks and crevices on most robots and may cause electrical short circuits if cleaning solutions are used on the interior. A wireless internet network connection is also required to use telepresence robots in any location, which may be less convenient but is fixable for remote locations.

2.3 Theoretical Underpinnings of Compliance

Compliance is the reaction a person has in response to a request, whether the request is explicit or implied. The social influence is one of the forces behind compliance; a person's behaviors, thoughts, and feelings are often impacted by the presence, actions, or words of other people [10]. The Asch conformity experiments showed people are likely to conform to group responses, even if they are not sure they are correct, because of social normative influence [7, 6]. Forced compliance can even cause a person to shift their beliefs to be more aligned with actions they were forced to perform [14]. The Milgram experiment explored how people comply with the orders of an authority figure, even if those orders are in conflict with their own conscience [19].

Compliance in the medical field has been studied with a heavy focus on whether patients adhere to the medication prescribed by a doctor [11, 9, 22, 20]. In medical environments without constant monitoring, it is difficult to measure precisely how compliant patients are. Often, the outcome of their condition is evaluated to see if it aligns with what should have happened if they upheld the regimen the doctor advised.

Human-robot compliance may be similar to human-human compliance. There is evidence that people may be equally more honest when a robot or human is present in a monitoring capacity, even if this entity is not directly interacting with them at the time [16]. In some cases, this may be negated by the attention the robot draws or by a lack of one-on-one interaction, making people less likely to take honest actions in the presence of the robot [15].

Chapter 3: Materials and Methods

The following section provides a description of the study that was conducted, the demographics of the participants, and the methods used to analyze the results.

3.1 Materials

This was a correlational study between two groups without repeated measures. The two conditions were the method of instruction for the task: via human using telepresence robot or via human wearing PPE. The hypothesis was that participants would be at least as compliant with instruction via telepresence robot as they would be with instruction from the person wearing PPE. The aim was to replicate the scenario an Ebola patient would experience: boredom through a distracting activity, and a "drinking" exercise to combat dehydration that most Ebola patients may perish from.

Two members of the study team were needed to run a trial. They will be referred to as the first and second study team members, indicating the order in which they first appear to the participant. The first study team member took consent and facilitated the entrance and exit surveys. The second study team member wore the PPE or used the telepresence robot. This ensured the participant did not have any bias towards the second study team member when instructed to complete the task.

Upon arrival, the participant was asked if they are allergic to cocoa to ensure no adverse allergic reactions happened. If the participant was not allergic to cocoa, the first study team member guided the participant through the consent process. Once consent was obtained, the first study team member administered the pre-study questionnaire. At this point, the first study team member left the room and the the second member of the study team entered the room, either in-person or virtually using a telepresence robot. If in-person, the second study team member was wearing full PPE such as in Figure 3.1. If on the telepresence robot, the second study team

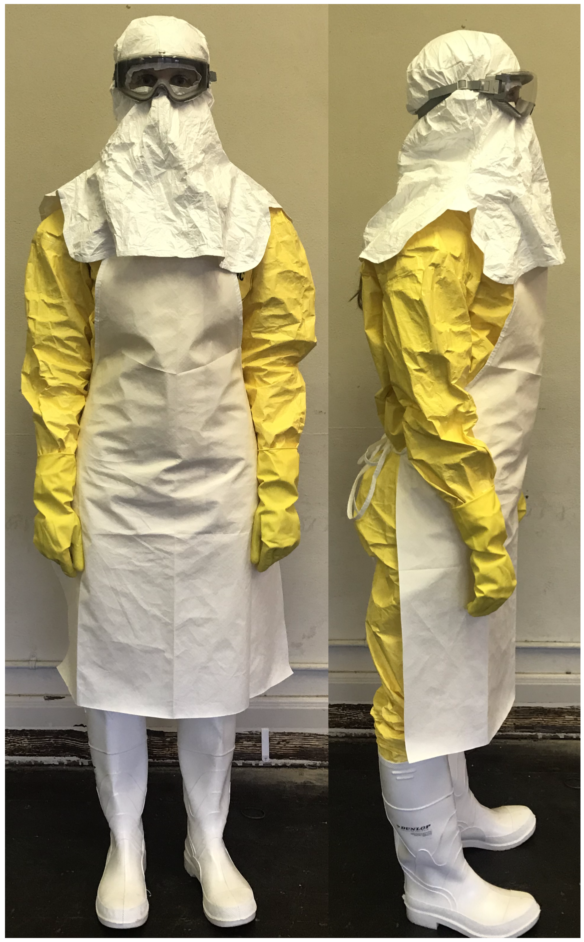

Figure 3.1: This is the Ebola PPE used for this application.

member will have already been in the room with the camera covered and the call muted so the participant did not know the robot was in use.

The second study team member described the task that is to follow. On the table behind the participant was a stack of cups and a spouted pitcher containing a cocoa powder and water mixture, as seen in Figure 3.2. The cocoa powder water served as an unpleasant drink that would not actually make the participant nauseous but did not taste pleasant as an attempt to replicate the displeasure of continuing to drink that Ebola patients experience. The task involved watching three videos. After each video, there was a series of questions on the content of the video that the participant answered by typing on the keyboard seen in Figure 3.3. An example screenshot of the participant questions can be seen in Figure 3.4. The participant watched videos and answered questions for 25 minutes in total. They were not told the duration of the task. The questions they were given were drawn from the question banks listed in Appendix A. Periodically, a timer went off with a dinging noise. This was a signal that the participant should get up and walk to the pitcher, fill a recyclable 2-ounce cup with the cocoa powder and water mixture, drink it all, throw the cup in the trash can, and sit back down to continue watching videos or answering questions. The timer was set to go off after one minute. The videos could not be paused. The second study team member started the first video and the timer. The second study team member was present for the first video and set of questions to remind the participant to drink when the timer indicated. After the participant had finished the first set of questions, the second study team member left the room as indicated on-screen to the participant as seen in Figure 3.5. If leaving via telepresence robot, the second study team member drove back to the charger and logged off, leaving the screen showing the user that the call had ended. Once the participant had completed the subsequent two videos and sets of questions, the first study team member re-entered the room, administered the post-study questionnaire, and debriefed the participant. A sheet with an overview of the study, specifically highlighting the data we did not initially tell the participants that we were collecting, was given to the participants at the end of the study. They were then asked if they would still like the data that was gathered during the participation to be used for research purposes.

3.2 Dependent Variables

The participant's answers to questions, time spent answering each question, amount of liquid (by weight) poured from the spouted pitcher, amount of liquid (by weight) thrown away, video data, and audio data, as well as answers to the pre- and post-study surveys, were recorded. The full set of survey questions can be found in the Appendix B. Compliance is determined based on how much of the unpleasant liquid participants

Figure 3.2: This table was set up with the pitcher of liquid, a stack of cups, and a covered scale. The purpose of the box was to cover the scale so participants were not able to see it.

Figure 3.3: The participant would sit facing the computer and could stand up to take drinks of the liquid when indicated.

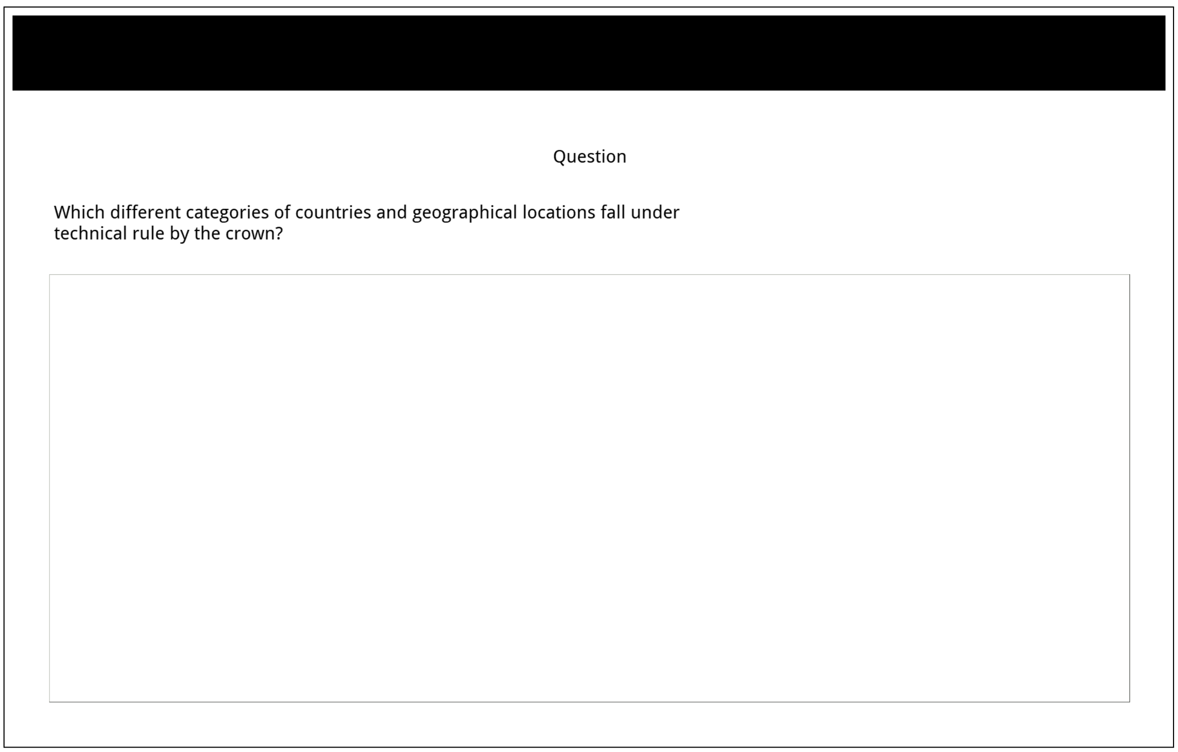

Figure 3.4: Participants answered questions about each video using the keyboard to type into a text box.

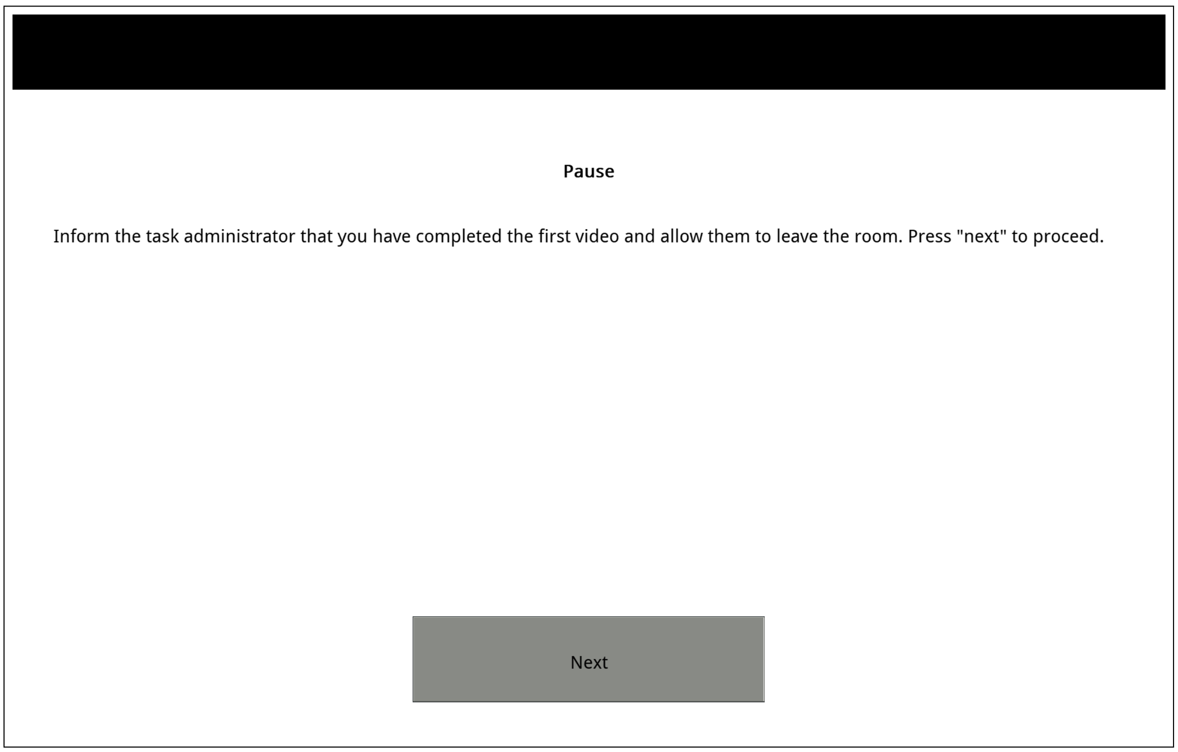

Figure 3.5: After the first video and set of questions, the participant was to inform the task administrator to leave the room.

drink and throw away during each trial. A higher amount of liquid drank and lower amount thrown away indicates higher compliance with the original instructions given to the participant.

Data were recorded for the amount of each pour from the pitcher using a laptop connected via serial USB to a the digital Dymo M25 scale. The laptop ran a Python script to log data to a CSV file every 20 seconds. As seen in Figure 3.2, the pitcher was set up on top of a scale that was covered so the participant could not see it. This system was used to record the amount of liquid drunk over the course of the experiment.

The first video that the participants watched was titled "The Difference between the United Kingdom, Great Britain and England Explained." The second video was titled "The Simple Solution to Traffic." The third video was titled "The Law You Wont Be Told." All the videos were made by Youtuber CGP Grey.

Open source software called OpenSesame was used to deliver videos and questions to the participants. OpenSesame can be used in the creation of experiments for psychology, neuroscience, and experimental economics [18]. An example question can be seen in Figure 3.4. This software allowed data to be collected on the participants answers to the questions as well as the time taken to answer each question.

3.3 Participant Demographics

Thirty convenience participants (16 female, 14 male) completed a trial for this study. The mean age was 21.53 with a standard deviation of 3.19 and ranged from 18 to 30 years old. Of this participant pool, 26 were undergraduate students and 3 were graduate students. 20 of the participants had a background in or where currently studying science or engineering. 25 participants indicated that they identified as white, 4 as Asian/Pacific Islander, and 1 as multiracial.

3.4 Methods

At least 12 participants were needed in each experimental condition. Allowing for participants who withdraw, the target was 15 participants for each condition, adding to a total of 30 participants.

For this set of data, single factor ANOVAs have established if there was a statistically significant difference between the two subject groups for the amount of liquid poured and the weight of the liquid discarded. The survey question of familiarity with robots (on a scale of 1, never seen a robot before, to 6, designs/builds robots) was compared the amount of liquid poured and discarded using the Pearson's correlation. This was only done for the participants who were instructed using the telepresence robot. The goal was to determine if there was an association between the individual's experience level with robots and compliance with robotic instruction.

The amount of time participants spent on each survey question was analyzed to see if there is a relationship between the method of instruction and time. There is a possibility participants attempted to finish faster in hopes of having to drink less liquid as they did not know there was a time limit on the task.

Additionally, the amount of liquid participants drank at each prompting was reviewed to see if there is a relationship between the method of instruction and the rate of liquid consumption. Participants may have started pouring less as the task continued.

Chapter 4: Results

This section will discuss the results of the statistical analysis as described by the Methods section. Note that three sets of participant data were excluded from the final results due to technical difficulties with data recording.

4.1 Analysis

There was not a statistically significant difference for any of the statistical tests done between the subject group instructed by the person in the Ebola PPE and the subject group instructed by the person using the telepresence robot by performing a single factor ANOVA on the given data. The results can be seen in Table 4.1.

No correlation between the subject group instructed by the person using the telepresence robot and the subjects' familiarity with robots was found for the amount of liquid drunk ($r = 0.07$, $p>0.05$) or the amount of liquid discarded ($r = 0.01$, $p>0.05$).

No correlation was found between the amount of time participants spent on each survey question and the method of instruction. Figure 4.1 shows the mean and standard deviation for the amount of time spent for each group on each question.

Dependant Variable	Human Group	Robot Group	ANOVA F-Value
Liquid Poured	M=3.15, SD=1.97	M=3.02, SD=1.12	.06
Liquid Thrown Away	M=19.87, SD=287.72	M=16.18, SD=190.36	.26

Table 4.1: Table of results showing the mean and standard deviation for both groups (human instruction and robot instruction) for both of the variables analyzed (liquid poured and liquid thrown away) as well as the ANOVA F-values. The amount of liquid poured is the amount that a participant took from the pitcher during the course of a trial, measured by height of the liquid in the pitcher. The amount of liquid thrown away is the amount the participant discarded and did not drink over the course of a trial, measured by weight in grams.

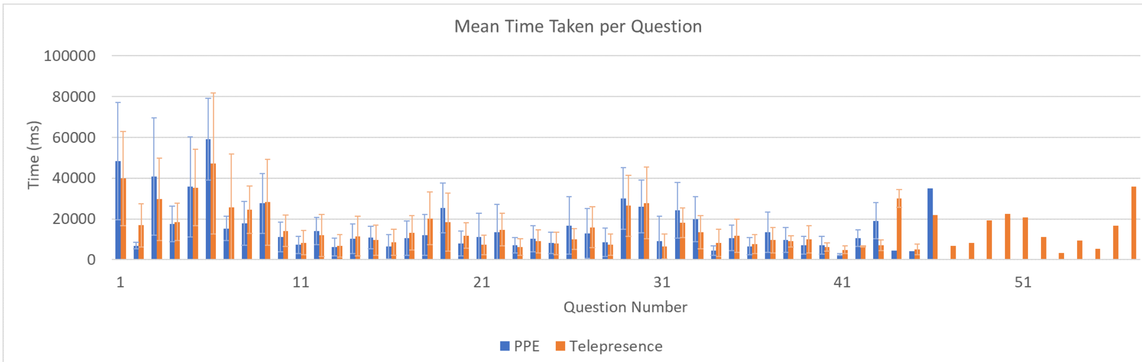

Figure 4.1: This graph shows the mean and standard deviation for the time spent answering each question. Not all participants had the opportunity to answer all questions before the task was completed.

No distinct difference can be discerned from these graphs between the two groups. A conclusion also cannot be made about whether participants spent less time per question in an effort to speed up the process and drink less liquid overall as not all the questions required the same length of answers and there was no distinct trend for either data set.

No conclusion can be made the weight measurement over the course of the experiment because the scale had an auto-shutoff that often turned if off, so most of these data sets were not complete.

Chapter 5: Discussion

This section discusses the broader implications of these results as they relate to the intended application.

5.1 Applicability

In order to determine compliance for these results, we observed how much of the unpleasant tasting liquid was drank and thrown away over the course of each study trial. A higher amount of liquid drank and lower amount thrown away indicated higher compliance with the original instructions given to the participant. These results indicate that under the given conditions subjects are similarly likely to be compliant with the instructions of a person using a telepresence robot as with the instructions of a person wearing Ebola-style PPE. This supports the initial hypothesis that participants would be at least as compliant with instruction via telepresence robot as they would be with instruction from the person wearing PPE. These findings suggest that it may be appropriate to use telepresence robots in infectious disease scenarios to avoid further spread of contagion and allow more time for caretaker-patient interactions.

Further work could look at using robots that were remotely operated but did not show the person who was speaking on a screen or could use a robotic voice to give instruction to determine if humans are as compliant when they do not feel as though there is another human on the other side of the interaction. A comparison could also be done to a human wearing everyday clothes giving in-person instructions to contrast with the previous results.

5.2 Generalizability of Results

All participants in this study were college students, most of whom interact regularly with technology, and none of whom were currently fighting for their life due to an infectious disease outbreak. The conditions this study was performed under were not the same as actually deploying to the location of an Ebola outbreak. Though some differences were addressed, it is not ethical to make participants fear for their lives. In an Ebola outbreak, the PPE is often viewed as terrifying because of its association with death. In the study setting, it was seen as almost comical.

Another key difference between this participant pool and a real deployment case is the cultural difference. Technology is less common in some of the regions in West Africa where these outbreaks occur. In some of these regions the people who are at risk for infection do not even believe there is an infection and instead believe that the health workers who are trying to help them are actually trying to kill or kidnap them. Adding robotic technology to this mix may not help the problem. On one hand, the use of telepresence robots may allow people to interact with friends or family who have been infected and are in treatment units to see that they are alive and being taken care of; however, this would likely be limited to a very small population and may not do much to quell fears and doubt about the strangers in the token yellow suits.

Further work could deploy robots in an outbreak. This may end up proving to be quite difficult because of the previously discussed issues with battery life, overheating, maneuverability, and cleaning. Another way to simulate a similar technological familiarity difference might be to use robots in medical settings in impoverished regions of cities as newer technology is often less prevalent due to its expense; however, there is also a possibility this will not adequately simulate the same associated fear of technology because technology may still be familiar to the people in these regions even if it is not the newest technology and may create more of a novelty effect.

This work does not explore any possible detrimental effects of using telepresence technology for patient instruction and interaction. There may be a lower perceived interaction quality or lower level of trust established with the caretaker which may cause patients to comply less in the long term even if compliance in the short term remains the same. This may or may not be a factor in infectious disease scenarios where most patients are already afraid for their lives, but may be relevant to lower stress medical settings where there is still a distinct negative effect from not complying with instructions but it is not immediately tangible.

Chapter 6: Conclusion

As part of this Masters thesis, a study was conducted to determine if there is a difference in compliance when an individual is directed by someone using a telepresence robot compared to when they are directed by someone wearing Ebola Virus Disease style PPE. This work is pertinent to patient compliance for those under the care of health workers in Ebola treatment units as well as in the treatment of other infectious diseases. Participants in the study were asked to drink an unpleasant mixture of cocoa powder and water while performing mundane tasks in order to simulate the boredom and displeasure Ebola patients experience without making the participants actually nauseous or ill. The participants were split into two groups: those who were instructed by the person using the telepresence robot and those instructed by the person wearing PPE. The amount of liquid that the participants drank and the amount that they threw away informed their overall compliance with the original instructions.

Based on performing ANOVAs on the resulting data, there was no statistically significant difference between the two groups. These results indicate that telepresence robots may be able to replace physically present healthcare workers for some tasks in the treatment of Ebola and other infectious diseases. Previously, the evidence that telepresence robots may be useful in these scenarios was purely anecdotal. Though these results may not be directly applicable due to the limitations of this study, this work provides a first step toward observing the positive impact telepresence robots may be able to have for the treatment of infectious diseases.

Bibliography

[1] Symposium on Advancement of Field-Robots for Ebola Response (SAFER). Nov 2014. This workshop was conducted under Chatham House Rules.

[2] Health Worker Ebola infections in Guinea, Liberia and Sierra Leone: A Preliminary Report. *World Health Organization*, May 2015.

[3] U.S. Homes Cleaning and Decontamination for Public Health Planners (Ebola Virus Disease). *Centers for Disease Control and Prevention*, Mar 2015.

[4] National Center for Health Statistics FastStats for Infectious Disease. *National Center for Health Statistics*, Jan 2017.

[5] Years of Ebola Virus Disease Outbreaks: 40 Years of Ebola Virus Disease around the World. *Centers for Disease Control and Prevention*, Apr 2019.

[6] S Asch. Studies in the Principles of Judgments and Attitudes: II. Determination of Judgments by Group and by Ego Standards. *Journal of Social Psychology; Political, Racial and Differential Psychology*, 12:433–433, 1940.

[7] S. E. Asch. The Doctrine of Suggestion, Prestige and Imitation in Social Psychology. *Psychological Review*, 55(5):250–276, 1948.

[8] Elhadj Ibrahima Bah, Marie-Claire Lamah, Tom Fletcher, Shevin T. Jacob, David M. Brett-Major, Amadou Alpha Sall, Nahoko Shindo, William A. Fischer, Francois Lamontagne, Sow Mamadou Saliou, Daniel G. Bausch, Barry Moumi, Tim Jagatic, Armand Sprecher, James V. Lawler, Thierry Mayet, Frederique A. Jacquerioz, Mara F. Mndez Baggi, Constanza Vallenas, Christophe Clement, Simon Mardel, Ousmane Faye, Oumar Faye, Bar Soropogui, Nfaly Magassouba, Lamine Koivogui, Ruxandra Pinto, and Robert A. Fowler. Clinical Presentation of Patients with Ebola Virus Disease in Conakry, Guinea. *New England Journal of Medicine*, 372(1):40–47, 2015. PMID: 25372658.

[9] Barry Blackwell. Patient Compliance. *New England Journal of Medicine*, 289(5):249–252, 1973.

[10] Robert B Cialdini and Noah J Goldstein. Social Influence: Compliance and Conformity. *Annual review of psychology*, 55, 2004.

[11] Joyce A. Cramer, Anuja Roy, Anita Burrell, Carol J. Fairchild, Mahesh J. Fuldeore, Daniel A. Ollendorf, and Peter K. Wong. Medication Compliance and Persistence: Terminology and Definitions. *Value in Health*, 11(1):44–47, 2008.

[12] Wael Dabbous. Ebola Outbreak. *Frontline*, 32(17), Sep 2014.

[13] M Desai, K M Tsui, H A Yanco, and C Uhlik. Essential Features of Telepresence Robots. In *2011 IEEE Conference on Technologies for Practical Robot Applications*, pages 15–20. IEEE, 2011.

[14] Leon Festinger and James M. Carlsmith. Cognitive Consequences of Forced Compliance. *The Journal of Abnormal and Social Psychology*, 58(2):203–210, 1959.

[15] J. Forlizzi, T. Saensuksopa, N. Salaets, M. Shomin, T. Mericli, and G. Hoffman. Let's be honest: A controlled field study of ethical behavior in the presence of a robot. In *2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, pages 769–774, Aug 2016.

[16] Guy Hoffman, Jodi Forlizzi, Shahar Ayal, Aaron Steinfeld, John Antanitis, Guy Hochman, Eric Hochendoner, and Justin Finkenaur. Robot Presence and Human Honesty: Experimental Evidence. In *Proceedings of the Tenth Annual ACM/IEEE International Conference on human-robot interaction*, volume 2015- of *HRI '15*, pages 181–188. ACM, 2015.

[17] Annica Kristoffersson, Silvia Coradeschi, and Amy Loutfi. A Review of Mobile Robotic Telepresence. *Advances in Human-Computer Interaction*, 2013, 2013.

[18] S Matht, D Schreij, and J Theeuwes. OpenSesame.

[19] Stanley Milgram. Behavioral Study of Obedience. *The Journal of Abnormal and Social Psychology*, 67(4):371378, 1963.

[20] Da Sclar, TA Tartaglione, and Mj Fine. Overview of Issues Related to Medical Compliance with Implications for the Outpatient Management of Infectious-Diseases. *Infectious Agents And Disease-Reviews Issues And Commentary*, 3(5):266–273, 1994.

[21] D Sirkin and W Ju. Consistency in Physical and On-Screen Action Improves Perceptions of Telepresence Robots. In *2012 7th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, pages 57–64. IEEE, 2012.

[22] James A. Trostle. Medical Compliance as an Ideology. *Social Science Medicine*, 27(12):1299–1308, 1988.

[23] K. M Tsui, M Desai, H. A Yanco, and C Uhlik. Exploring Use Cases for Telepresence Robots. In *2011 6th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, pages 11–18. IEEE, 2011.

APPENDICES

Appendix A: Question Bank

The questions will be drawn from the following list for the first video:

1. What was the name of the video?
2. Were the land masses in the opening sequence solid colored or textured?
3. What color was the United Kingdom displayed as?
4. The United Kingdom is described as...
5. The countries in the United Kingdom are...
6. What color was Scotland Displayed as?
7. What color was Wales Displayed as?
8. Which country is most often forgotten from the UK?
9. Who are regarded as "slave-masters" by the other countries in the UK?
10. What kind of passports are issued to all citizens of the UK?
11. Great Britain is a term that describes...
12. Ireland refers to...
13. The crown is said to be best thought of as...
14. What is the official state religion?
15. What are the former colonies that gained their independence through diplomacy known as?
16. Where is Gibraltar?
17. What is Gibraltar famous for?
18. Which different categories of countries and geographical locations fall under technical rule by the crown?
19. Who does the video gives special thanks to at the end?
20. Approximately how long was this video?
21. Describe the voice of the narrator.

22. Describe the art style of the video.
23. What, if any, of the information in this video did you already know?
24. Provide a summary of this video.
25. How can this video relate to you?
26. List all the colors used in this video.

The questions will be drawn from the following list for the second video:

1. What color were the other cars in the opening sequence?
2. What color was "your" car in the opening sequence?
3. The narrator says the problem is "______ not cars."
4. In general, more intersections = ______.
5. What colors are the stick figures coffee cup?
6. What crosses the road in the narrators example of how traffic can develop on highways?
7. A phantom intersection is...
8. What is a realistic way traffic can develop on highways?
9. How should we change the way we drive to avoid "traffic snakes"?
10. What is a terrible solution?
11. What does the driver propose as a solution that doesn't involve humans?
12. What is the stick figure with the coffee wearing?
13. What was the title of this video?
14. What company sponsored the video?
15. What book was discussed at the end of the video?
16. Who was the Author of the book discussed at the end of the video?
17. How many different types of cars (not colors) were depicted?
18. What color was the chicken?
19. What type of view angle were the depictions of intersections drawn from?
20. Approximately how long was this video?
21. Describe the voice of the narrator.

22. Describe the art style of the video.
23. What, if any, of the information in this video did you already know?
24. Provide a summary of this video.
25. How can this video relate to you?
26. List all the colors used in this video.

The questions will be drawn from the following list for the third video:

1. What color tie is the figure wearing in the opening sequence?
2. What is the judge holding?
3. What are the first two more well-known choices for this situation?
4. What is jury nullification?
5. Does any figure in this video have a happy expression? If so, who?
6. This video was meant for _______ purposes only.
7. Nullification exists because of...
8. Lawyer and judges talking about jury nullification is likened to...
9. Give a positive example where this can be used.
10. Give a negative example where this can be used.
11. When can jury nullification be overruled?
12. Lawyers existence is dependent on...
13. 95% of criminal charges in the US...
14. Telling jurors about nullification has the impact of...
15. What color is the judge's robe?
16. List all the colors used in this video.
17. What test appears in the speech bubbles during the jury nullification and quantum mechanics metaphor?
18. What emoji is used once in this video?
19. Who was responsible for the music in this video?
20. Approximately how long was this video?
21. Describe the voice of the narrator.

22. Describe the art style of the video.
23. What, if any, of the information in this video did you already know?
24. Provide a summary of this video.
25. How can this video relate to you?
26. List all the colors used in this video.

Appendix B: Survey Questions

Entrance Survey

Please answer the following questions.

Age:

Gender:

- Male
- Female
- Non-binary
- Other/Decline to answer

Ethnicity origin (or Race):

- White
- Hispanic or Latino
- Black or African American
- Native American or American Indian
- Asian / Pacific Islander
- Other

Highest Education Level:

- Some high school, did not graduate
- High school graduate
- Some college, no degree completed
- Bachelor's degree or other Undergraduate degree
- Graduate or Professional degree

What is your profession?

- Undergraduate Student

- Graduate Student
- Faculty
- University Staff
- Other:

Field of study, specialization, or profession:

What is your yearly income?

- Less than $20,000
- $20,000 - $29,999
- $30,000 - $39,999
- $40,000 - $49,999
- $50,000 - $59,999
- $60,000 - $69,999
- $70,000 - $79,999
- $80,000 - $89,999
- $90,000 - $99,999
- $100,000 - $149,999
- More than $150,000

I am aware this study involves consuming cocoa powder (as stated in the availability survey and consent form). Please indicate below that you do not have an allergy to cocoa. If you do have a cocoa allergy, please inform the staff member assisting you immediately.

- I do not have an allergy to cocoa.

Screen Transition (STOP)

You have finished the first part of the survey. You will take the rest of the survey after the study activities have been completed.

Let your study staff member know you are done by showing them this screen and they will instruct you in the next steps.

Intro to Exit Survey

Reflect on and respond to the following statements based on the tasks you have just completed.

There will be about 30 questions.

Questions About Task Section

What did you think the purpose of this study was?

How much do you think the study results are focused on each of the following:

	Not at all	A smaller amount	Somewhat	A larger amount	Entirely
Memory/knowledge retention	○	○	○	○	○
Performance	○	○	○	○	○
Compliance	○	○	○	○	○
General knowledge/learning	○	○	○	○	○

How much did you enjoy the liquid you were asked to drink?

Did you use the restroom before beginning the study?

Do you need to use the restroom after the study?

When did you start feeling full?

Had you previously seen any of the videos you viewed during your participation in this study?

NARS Introduction

In this section, we will now ask you questions to learn about your experience and thoughts about robots. There will be about 15 questions.

NARS QUESTION 1

I would feel uneasy if robots really had emotions.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 2

Something bad might happen if robots developed into living beings.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 3

I would feel relaxed talking with robots.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 4

I would feel uneasy if I was given a job where I had to use robots.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree

NARS QUESTION 5

If robots had emotions I would be able to make friends with them.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 6

I feel comforted being with robots that have emotions.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 7

The word "robot" means nothing to me.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 8

I would feel nervous operating a robot in front of other people.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 9

I would hate the idea that robots or artificial intelligences were making judgements about things.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 10

I would feel very nervous just standing in front of a robot.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 11

I feel that if I depend on robots too much, something bad might happen.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 12

I would feel paranoid talking with a robot.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 13

I am concerned that robots would be a bad influence on children.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

NARS QUESTION 14

I feel that in the future society will be dominated by robots.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
○	○	○	○	○	○	○

Experience with Robots Section

What is your experience working with robots?

- Never seen a robot before
- Seen a robot on TV or in the movies but not in person
- Seen a robot in person before
- Interacted with a robot before
- I own a robot or use one regularly
- I design and/or build robots

Share any of your robot experiences or general thoughts on robots.

Experience of Study Section

Please use this section to tell us about your experience with this study.

How did you feel about being asked to drink the liquid? What were some of your thoughts?

How did you feel about being asked to watch the videos? What were some of your thoughts?

How did you feel about being asked to answer the questions? What were some of your thoughts?

How did you feel about your level of distraction during the tasks? What were some of your thoughts?

You are done! Thank you for your time and valuable input. A study staff member will debrief you and answer any questions you have about your experience or the study.

Appendix C: Video Links

"The Difference between the United Kingdom, Great Britain and England Explained": https://www.youtube.com/watch?v=rNu8XDBSn10

"The Simple Solution to Traffic": https://www.youtube.com/watch?v=iHzzSao6ypE

"The Law You Wont Be Told": https://www.youtube.com/watch?v=uqH_Y1TupoQ