Investigating the Correlation Between Robot Informality and Ability to Affect Patient Anxiety

Investigating HRI in Child Care

Devan Neil
Computer Science
Colorado School of Mines
Golden, CO, USA
devanneil@mines.com

Matthew Nielsen
Computer Science
Colorado School of Mines
Golden, CO, USA
mjnielsen@mines.edu

Chloe Sem
Mechanical Engineering
Colorado School of Mines
Golden, CO, USA
chloesem@mines.edu

Introduction

What makes a good robot? We have decided to test out the waters by testing out the Nao robot's functionality and how we can direct it towards a purpose.

Children in hospitals suffer from lots of problems, such as loneliness, stress in an unknown environment, pain, and more. Our goal is to treat mental health problems for children patients in health care.

Often children's mental health is difficult to treat as children are individual and unique. We believe that by using social robotics, we can connect children to a robot with the ability to answer questions the child might have compassionately and to keep them connected to both their families and their doctors during their stay at the hospital.

Mental health is deeply tied to physical health and recovery during long stays in the hospital. This is why we believe it is crucial to have care directed at healthcare, to ensure patients are well taken care of.

We are investigating further the applications of robotics in pediatric care. This has led us to design Iris, a child-friendly robot to help with children's mental health during hospital stays.

Children have been observed to be much more receptive to robotics. This is likely due to media and cultural norms not yet being applied to children. This means children are great proving grounds for concepts in HRI.

In our case, we are experimenting with health care. Often during long stays in the hospital children are separated from their parents. This often leads to loneliness. Nurses are a great solution to this issue as they can be companions to children, and if a child is not in too critical of a state they can often socialize with other children staying in the same hospital. However, in high-demand environments, nurses are not always available, and it's not best to hope for children to be stuck in the hospital.

We believe Iris will be a solution to this problem. While robots can never completely replace human interaction, they can offer a stopgap solution. We believe Iris can be used to treat anxiety and to help children with basic nursing duties.

Figure 1: Iris' Fistbump Gesture

Above is a photo of our robot, Iris, performing a fist bump so the patient can feel connected with it. We wanted to not just have ChatGPT be the main way of our robot to express itself and to have other actions that can help express itself.

Background and Related Work

Robots are becoming increasingly common in the household and daily life. Children are especially receptive to this technology [1] and we believe that we can apply HRI to health care for long stays.

We believe that robotics can be applied to health care. Hospitals are showing a decline in care along with a decreasing number of nurses and staff. We believe social robotics can aid in this [2].

Robotics can be used to effectively handle basic nursing duties, things such as delivering blankets and warm meals. While we do not believe that robots can completely replace human nurses, we do believe that robots can be a supplementary tool.

Socially assistive robots are already being used because of their ability to move, listen, and play audio, being a great tool to interact with humans. These robots can provide assistance in terms of learning and even rehabilitation [3]. Moving away from the uncanny valley, robots will also appear less human-like and unsettling. Using this as a base, we can expand upon this knowledge and create a robot that can assist in a hospital setting with young children.

Biases towards robots tend to come from the media we are presented with. Different media tend to give people different views [4]. Children who haven't had a lot of exposure to media will likely make the best candidates for grounded theory research as they have not been exposed to societal biases towards robots.

In this paper, we are going to dig into the applications of robotics to mental health specifically in regards to children.

Interview

For our interview, we interviewed a healthcare nurse. He specialized in patient care during his nighttime shift. Our interviewee has experience as a paramedic and professor as well, so we believe he is a very reputable source. Our interviewee is a new nurse of 1 and ½ years, as he spent much of his previous career working in diverse settings within health care.

To interview this individual we set out with a list of questions to get answers to. We primarily asked about our interviewee's role at the facility and where he stands with robotic applications in healthcare.

Much of our interview was focused on the effects of mental health on physical recovery. The interviewee seemed convinced that when a patient loses mental health their physical health will decline with it. Our interviewee stressed his experience as a 'de-escalator' in his team. He has experience working with a whole variety of student situations as well as handling very tense interactions, and he has learned a lot.

The most impactful part of this interview was his description of his methods. He believes that if he spends time with a patient to listen to their situation and provide meaningful help he can make a situation better for everyone involved.

Our interviewee especially stressed the importance of spending time with cognitive patients, people who suffer from Alzheimer's and similar conditions. He believes that by spending time with these patients he can help them to not only recover from their condition that put them into the hospital, but that they can also find a little bit more memories.

Grounded Theory

After the interview, we decided to identify several different open coding concepts that we found represented our data together in some sort of theme. Some examples include nurse, educator, and experience because they come directly from the interviewee's point of view, as he has been in healthcare for over 20 years and is very knowledgeable in this field. Others include atmosphere, mental health, compartmentalization, and environment because it includes a different side of hospitals that most people tend to not think about but is just as important when it comes to keeping everything running smoothly. All of the concepts from the interview were considered for the robot's final design.

We decided to split up our axial coding process into 4 main categories. Learning, technology, job responsibilities, and care. We decided to deep dive into some of these categories more than others, by categorizing learning as learning - education and learning - experience. We also categorized technology into technology - modern technology and technology - robotic technology, and care into care - physical care and care - mental care. These main categories helped to describe what makes up our interview. We learned a lot about what a nursing job has to offer, from doing simple tasks for others to make their day better or needing therapy outside of work to care for yourself.

Analysis of Grounded Theory

The reason why we chose to make our axial codes the way we did was because it allowed us to categorize what we learned the most out of the interview into sections that then we could further develop into ideas for what to base our healthcare robot on.

After careful consideration, we decided that care is the most impactful area of healthcare, and to focus on the idea that caring for children to make their experiences in hospitals more hospitable. For a child's first time in the hospital, it is miserable, as they are in an unfamiliar environment, away from their friends, and stressed as their body is not what it used to be. We want to make their experience more comfortable and for them to not be freaking out.

One of the main axial codes that helped solidify this idea is, "So therapeutic animals are absolutely useful. Not only does it change the environment for the patient, it also changes the environment for the staff. You bring a puppy in, and everybody's excited to see a puppy". This quote shows the impact of mental health on patients, and it was a great starting point for where we wanted to take our robot - to be a presence in a room that people would be excited about or to be therapeutic to patients.

Another useful quote is, "I did mental health transports for several years, and you spend 8 hrs in the back of an ambulance taking a patient on a mental health transport. The biggest thing is just listening to the patient. They feel ignored, or if they feel like they're not being heard". This quote shows the significance of having a robot to talk to. Everyone is stressed in the room and a robot would be the perfect way to make the situation more relaxed and for people to enjoy the rougher times in their life.

Design Vision

In this project, our team wanted to create a robot to treat mental health problems for children-aged patients in healthcare. Mental health can be difficult to treat in young patients since children are individual and unique. With the use of robots as a different medium, doctors can achieve better communication through social robotics. The Nao robot can be used to interact with the patient in a unique way; it can have a conversation and answer any questions while also keeping them connected to their families and doctors.

Design Goals

We want our robot to be safe as children in hospitals are generally compromised in health. There also should not be any fast movements or anything that warrants pushing or pulling the user.

The robot should be friendly, engaging, and approachable as we believe it is important for our patients to interact with our robot of their own free will. It should not be intimidating as that is the opposite of what the purpose of the robot should be.

Our robot needs to be funny, comforting, and able to connect such that it can provide companionship and utility to the patient. We believe we can achieve this by designing interactions with the Nao robot such that it can provide the patient with laughter and keep the patient entertained during their stay. It also needs to be funny because laughing is a great way to relax patients and improve the atmosphere

We have had success doing prompt engineering, facial detection, light color changes, and designing gestures to convey emotions.

Design Process

To design a robot, we started by coming up with situations the robot may be used for. This allowed us to more fully understand what is expected of the robot. Our favorite interaction was having a robot enter a room that had a sad child in it and then proceeded to cheer him up by telling a couple of jokes. We have since used this scenario as a foundation for the rest of the project, making adjustments as needed.

Next, we all drew out design ideas for what features the robot should have. We realized that as a healthcare assistant, the robot needs to maintain a friendly appearance.

Since the robot was already prebuilt, there was not much we could do to change what it looked like, but we were able to change the color of the eyes and make them spin. We determined that a soft gold color would suffice because it was not too harsh and made it seem that the robot was actively listening.

We went through a lot of testing to include prompt engineering, and integrating ChatGPT into the robot. This was implemented directly into our code. By telling the artificial intelligence that the user is a young child who broke their leg, we achieved satisfactory results. This also

allowed us to easily control the level of informality so that we could run experiments to test our hypothesis.

A fistbump gesture was also added for the robot to appear even more friendly. Using a program called Choreographe, we were able to individually control the robot's joints to specific positions. The fist bump gesture can be seen in Figure 1.

Experimental Method

Our goal was to explore the interaction between formality and effectiveness on patient mental health. We believe that the formality of our robot can substantially impact the effectiveness of our robot application. Much of our interview was focused on patient care on a very personal level. We believe this is evidence to suggest that more personal care is better at treating patient's mental health.

We hypothesized that informal delivery of news would prove to be more effective in treating patient anxiety. Our grounded coding suggested that spending more time and care with patients would lead to more healthy results.

To test this theory we set up two different applications. The first was to deliver the news of a broken leg to a hypothetical patient using fairly formal terms, the kind you would expect a doctor to use. The second application was to deliver the same news using more informal terms as though it were speaking to a peer or friend. We recorded both of these applications.

The experiment itself involved participants giving us information about their mood and anxiety as well as information that could be relevant such as age, hours of sleep, and gender. Participants then would watch either the informal or formal application. They would then be asked to rate their anxiety again. We measured important metrics on a feeling face scale from one to ten where 10 is the worst and 1 is the most well.

For this study, our participants were a group of college-age students at the Colorado School of Mines, which we are a part of.

Experimental Results (Including Figures)

Bayesian Paired Samples T-Test

Measure 1		Measure 2	BF_{+0}	error %
Anxiety0	-	Anxiety1	0.476	~0.028
Anxiety0	-	Anxiety2	0.095	~0.002
Anxiety1	-	Anxiety2	0.067	$\sim 2.804\times10^{-4}$

Note. For all tests, the alternative hypothesis specifies that Measure 1 is greater than Measure 2. For example, Anxiety0 is greater than Anxiety1.

Figure 2: Bayesian Analysis of Anxiety. Anxiety 0 is measured before the experiment and Anxiety 1 and 2 are measured after the Formal and Informal videos respectively.

Our data is evidence to suggest that our hypothesis is incorrect. In the figure above we show the Bayesian analyses of the data. In the first row, we show evidence that formal delivery decreases anxiety more than what is shown in the second row which shows less evidence to the desired effect. In this data, the first row is data from our formal application while the second row is data from our informal application. We believe that this data is much more showing as it compares the change to the 'grounded' anxiety state. We have included the third row as well, which shows the relationship between the formal and informal applications.

All of this to say, it appears to be likely that a more formal delivery is more effective than an informal delivery in this case. We believe this to be because a robot can seem much more irreverent when delivering news. However, this study needs to be expanded upon to see if age has a significant correlation with the desired effect.

Descriptive Statistics ▼

	Anxiety0	Anxiety2
Valid	47	47
Missing	7	7
Mean	6.234	6.404
Std. Deviation	1.856	1.952
Minimum	2.000	2.000
Maximum	10.000	10.000

Figure 3: Descriptive statistics showing the feeling faces scale used to measure anxiety.

We also believe that it is important to look at all the collected data to see if there could be any other insights gleaned from our data. While we were not experimenting

on the effect delivery can have on mood, we did inadvertently collect the data. We believe that this is important for data verification, and we believe that if the same conclusion can be drawn from mood then our data is valid. Given in the figure below is the same Bayesian analysis but with mood instead of anxiety.

Bayesian Paired Samples T-Test

Measure 1		Measure 2	BF_{+0}	error %
Mood1	-	Mood2	0.051	~0.014

Note. For all tests, the alternative hypothesis specifies that Mood1 is greater than Mood2.

Figure 4: A Bayesian Analysis of our mood data. Note: we did not collect a pre-operative mood, and thus cannot compare the mood data to a grounded point.

In the above figure, we observe the same hypothesis, which validates our data. We did not take an initial mood measure, as it was not the primary goal, thus we cannot compare our data to any grounded state as we could with anxiety, however, we can note that the Bayes factor between Anxiety 1- Anxiety 2 and Mood 1 - Mood 2 is similar enough to argue our data is valid.

Each of the figures below are expressive of our conclusion.

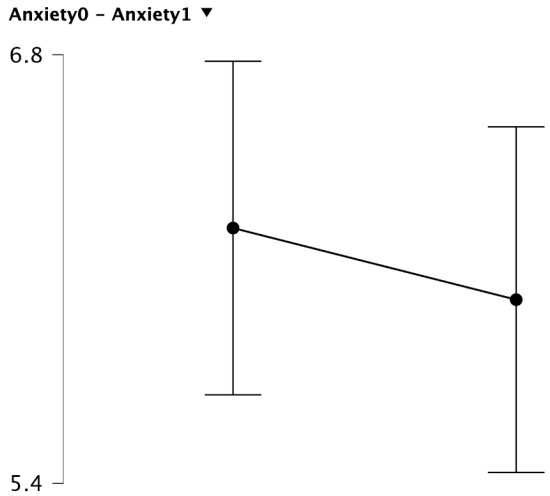

Figure 5: A graph showing the change between ground anxiety and anxiety after formal viewing. Note: Higher anxiety is an undesirable outcome.

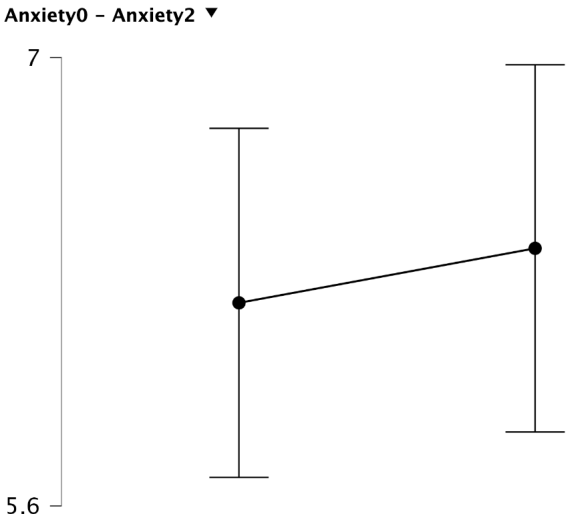

Figure 6: A graph showing the change between ground anxiety and anxiety after the informal viewing. Note: Higher anxiety is an undesirable outcome

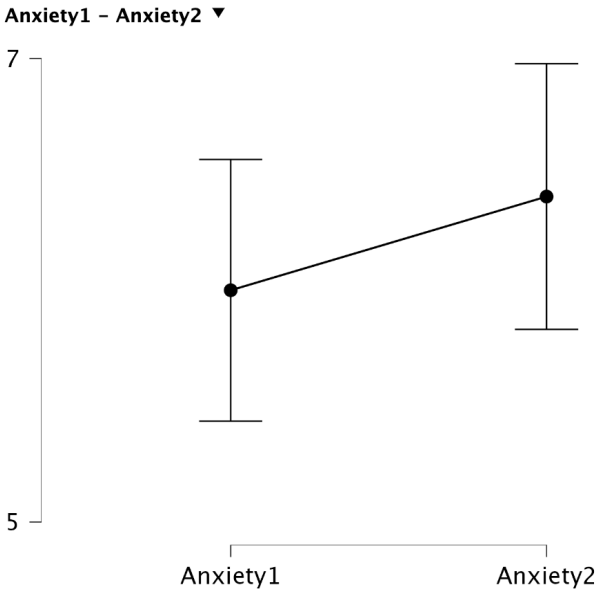

Figure 7: A graph showing the change between anxiety after the formal application and after the informal application. This graph shows clear evidence that anxiety worsens after the informal application.

Discussion

Discussion of Hypotheses

Our conclusion is evidence against our hypothesis that informal delivery can be more effective than formal delivery by a robotic companion. We believe that this can be explained by robots being generally perceived as less

humane, and thus including informal terms can make them seem irreverent. We believe that further research should be undertaken in specifics regarding age and reception, as we believe that many of the statements used in the informal case may be more effective on children as opposed to college-age adults.

We believe our hypothesis is limited by our small population size and that our population is all within certain demographics. Being college students, our surveyed population are all already anxious people, as we can observe in our data, and are all at a point in their lives where a broken leg would put them significantly behind on their work. While the participants were aware this was just a survey, there may be an effect of hearing bad news that is hard to negate with any suspension of belief.

Conclusion

Our study has shown light evidence that a robot treating patients with formal terms can be more effective at reducing anxiety than a robot using informal terms. We believe that this means that it is better to prioritize informal terms in an interaction before we have enough information on the patient to determine their preference. Similar behavior can be found in human-to-human interactions as often people will prefer to ‘open up’ after they have known someone for a length of time.

We also believe that this is evidence to suggest that robotics can be used to effectively treat patient anxiety. In our study, we did find a decrease in anxiety after the formal application. However, we believe that this could also be due to the size and demographics of our survey population.

Further study needs to be done on various age demographics and intensity of injury. In our study, we were only able to target college-age students who were not actually injured. We believe that children will be more receptive to robotic interactions and thus might feel better after interacting with a lightly informal robot. Intensity of injury could also be an important feature. To an extreme no one wants a robot to laugh at a terminal illness. However, a cut or bruise with no life-altering implications is often best treated with a light-hearted mood.

References

[1] Vallès-Peris, N.; Angulo, C.; Domènech, M. Children’s Imaginaries of Human-Robot Interaction in Healthcare. Int. J. Environ. Res. Public Health 2018, 15, 970. https://doi.org/10.3390/ijerph15050970

[2] González-González, C. S., Violant-Holz, V., & Gil-Iranzo, R. M. (2021). Social Robots in hospitals: A systematic review. Applied Sciences, 11(13), 5976. https://doi.org/10.3390/app11135976

[3] Scoglio, Arielle AJ, et al. "Use of social robots in mental health and well-being research: systematic review." Journal of medical Internet research 21.7 (2019): e13322. https://www.jmir.org/2019/7/e13322/

[4] A. Henschel, G. Laban, and E. S. Cross, “What makes a robot social? A review of social robots from science fiction to a home or hospital near you - current robotics reports,” SpringerLink, https://link.springer.com/article/10.1007/s43154-020-00035-0