A Social Robot to Mitigate Stress, Anxiety, and Pain in Hospital Pediatric Care

Sooyeon Jeong[1], Deirdre Logan[3,4,5], Matthew Goodwin[6], Suzanne Graca[2], Brianna O'Connell[2], Honey Goodenough[3], Laurel Anderson[2], Nicole Stenquist[3], Katie Fitzpatrick[3], Miriam Zisook[6], Luke Plummer[1], Cynthia Breazeal[1], Peter Weinstock[3,4,5]

[1]MIT Media Lab, Cambridge, USA
[2]Boston Children's Hospital Child Life Services Department, Boston, USA
[3]Boston Children's Hospital Simulator Program (SIMPeds), Boston, USA
[4]Department of Anesthesia, Perioperative and Pain Medicine, Div of Critical Care Medicine, Boston Children's Hospital, Boston USA
[5]Harvard Medical School, Boston USA
[6]Northeastern University, Boston, USA

ABSTRACT

Children and their parents may undergo challenging experiences when admitted for inpatient care at pediatric hospitals. While most hospitals make efforts to provide socio-emotional support for patients and their families during care, gaps still exist between human resource supply and demand. The Huggable project aims to close this gap by creating a social robot able to mitigate stress, anxiety, and pain in pediatric patients by engaging them in playful interactive activities. In this paper, we introduce a larger experimental design to compare the effects of the Huggable robot to a virtual character on a screen and a plush teddy bear, and provide initial qualitative analyses of patients' and parents' behaviors during intervention sessions collected thus far. We demonstrate preliminarily that children are more eager to emotionally connect with and be physically activated by a robot than a virtual character, illustrating the potential of social robots to provide socio-emotional support during inpatient pediatric care.

1. INTRODUCTION

For many children, hospitals are not a fun place to be. During hospital stays, children may experience painful, invasive procedures; are attached to intrusive medical devices; and, most of all, do not have much control over their circumstances. Parents may also become anxious and nervous about their child's status and care while in the hospital. In order to minimize stress and anxiety in children and parents, certified child life specialists (CLS) engage and support patients and their families in an effort to create a less intimidating and more comfortable healthcare experience [7]. CLS use developmental interventions and therapeutic play to reduce anxiety in children and to psychologically prepare patients and their families for upcoming procedures and clinical care.

Unfortunately, many pediatric hospitals are not able to provide children and parents with adequate socio-emotional support provided by the CLS due to a lack of available human resources. In order to fill the gap between this supply and demand, the Huggable project aims to develop a social robot that can extend human staff support by playfully interacting with children. Similar work has been done by Beran et al., in which their MEDi robot provided information and distraction for children during flu vaccinations [2]. However, their work focused on relieving short-term pain and anxiety for relatively healthy children. Our work focuses on mitigating stress and anxiety in patients who suffer from chronic and severe pain admitted to inpatient care for long periods.

HRI'15 Extended Abstracts, Mar 02-05 2015, Portland, OR, USA
ACM 978-1-4503-3318-4/15/03.
http://dx.doi.org/10.1145/2701973.2702028.

2. EXPERIMENTAL METHOD

Our experimental design aims to compare and contrast three different intervention conditions: a plush teddy bear (standard of care for comfort); a virtual character on a screen device; and a social robot (Figure 1).

We are recruiting native English-speaking children from ages 3 to 10 years old who are admitted for more than 48 hours for inpatient care at the Medical Surgical ICU and Oncology unit in Boston Children's Hospital. During study observation, each participant wears an Affectiva Q™ sensor (http://qsensor-support.affectiva.com/) to measure electrodermal activity (EDA), a peripheral index of sympathetic nervous system arousal associated with affect, stress, and pain [3]. We also video record study participants for up to eight hours over two consecutive days in order to code facial affect. All study procedures (both recording and intervention phases) are undertaken in participants' bed spaces.

During the 4-hour recording phase on the second day of the study, each child is given one of the three interventions and asked to freely interact and play with it as long as s/he would like. Both the robotic and the virtual Huggable look like a teddy bear and are capable of expressing verbal and non-verbal behaviors through Wizard-of-Oz teleoperation from a remote laptop device.

Figure 1. Three interventions used in the study. A plush teddy bear (left), the virtual (middle), and robotic Huggable.

The virtual and robotic Huggable engages participants by conversing about their likes/dislikes, singing nursery rhymes, and playing an "I Spy" game. These are typical games that CLS may play with patients at bedside. In this study, a CLS played the role of teleoperator for each intervention modality – picking up on patient cues, triggering animations, viewing and listening to the child and his/her surroundings, and talking through a microphone in a pitch shifted voice. In all three intervention conditions, an additional CLS who did not operate the Huggable sat inside the child's bed space to guide safe and proper usage of the intervention and assist interaction in case of any difficulties.

Before and after the intervention, participants and their parents were asked to complete a set of affect, anxiety, and pain rating scales [1, 4–6]. Eight hours of video of participants' facial expressions and time-synchronized EDA data were collected during intervention phases.[1]

3. RESULTS

In this section, we provide qualitative analysis of behavior in four participants (2 male and 2 female, age 5-10) recruited from the Oncology unit based on recorded video data during the study.

The two children who participated in the Huggable condition interacted with the robot for 16 and 27 minutes respectively, with each session ending when the child became tired or sleepy. Both children made frequent physical contact with the robot and seemed to treat it as a peer/pet that needed to be cared for. They were observed hugging, tickling, giving high-fives/fist-bumps, and petting the robot. The children also appeared to seek physical proximity with the robot, leaning toward it, reaching for objects to show the robot, etc., which continued even as they appeared to grow more tired.

These two participants also spent more time making conversations with the robot than playing I Spy with it; they spent 11 and 19 minutes, respectively, on conversations, and 5 and 7 minutes, respectively, on the game. Topics of conversations were about the toys and items participants had in their bed space, their favorite animals, movies, songs, etc. The children also seemed to consider and care about the robot's feelings and emotions. One child consoled the robotic Huggable by saying "it is okay not to have a heart in the belly" when it was admiring a big red heart on the patient's stuffed teddy bear, scratched its itchy nose, and offered a book to lean against when the robot said it was getting sleepy. The other child used expressions such as "no, thank you" to decline an offer or "one second" when she had to clear her throat and could not respond to the robot right away. Furthermore, these two children showed much emotional responses when the robot was departing. One child seemed rather disappointed to hear that the robot had to "sleep in his own bed" and could not stay in her room, and then asked if someone could be sent to play with it instead putting it to bed. The other child gave a hug and scratched the robot's head and ears while saying good-bye.

In comparison, the two children who were given a virtual character each interacted with the intervention for 20 and 30 minutes, respectively. These two participants were less fatigued than the other two participants in the robot condition. Compared to the children in the robot condition, they spent less time conversing with the intervention and more time playing the I Spy game: 12 and 8 minutes on conversations, respectively, and 8 and 22 minutes, respectively, on the game. Of the two, one child stayed under a blanket for the entire interaction and the other child sat up the whole time without any significant change in posture throughout the interaction period. Both children treated the virtual character in a social manner, but spent much less time talking about themselves than children in the Huggable condition. One child asked the virtual character a few questions in the beginning, such as about the number of its siblings, its height, etc., but later mostly provided short answers to the character's questions. The other participant spent the majority of time playing video games and I Spy with his father and CLS instead of asking the virtual any questions. Furthermore, both children showed limited emotional responses when the virtual said it was "getting tired and would need to take a nap" to end the interaction.

[1] Only qualitative observations of behavior are reported in this paper. Future papers will report on quantitative data sources collected in the study.

4. CONCLUSION AND FUTURE WORKS

In this paper, we present an experimental study design that compares and contrasts three different types of interventions and their ability to mitigate stress, anxiety, and pain in pediatric inpatients. We present some very early qualitative observations of the robot and virtual character conditions. While both intervention modalities succeeded in entertaining participants, children who interacted with the robot appeared to be more physically and mentally motivated to engage with it and conveyed more behavioral evidence that they perceived the intervention as a peer they could socially and emotionally connect with. This result preliminarily suggests a preference for the Huggable robot, but clearly more data and analyses are needed to confirm. For the time being, we are encouraged with our results and the following quote from one parent whose child played with the Huggable robot; "it was not a good day for her [the patient], but the teddy bear [robot] made it easier."

In future work, we plan to continue participant recruitment and to gather and present quantitative measures relating to patient stress, anxiety, and pain across the three intervention conditions. Furthermore, we seek to build a computation model to automatically detect a variety of emotional states we observe in hospitalized children using video coded facial affect and EDA..

5. REFERENCES

[1] Von Baeyer, C.L. 2009. Numerical rating scale for self-report of pain intensity in children and adolescents: recent progress and further questions. *European journal of pain (London, England)*. 13, 10 (Nov. 2009), 1005–7.

[2] Beran, T.N. et al. 2013. Reducing children's pain and distress towards flu vaccinations : A novel and effective application of humanoid robotics. *Vaccine*. 31, 25 (2013), 2772–2777.

[3] Dawson, M. et al. 2007. The Electrodermal System. *The Handbook of Psychophisiology*. (2007), 200–223.

[4] Hicks, C.L. et al. 2001. The Faces Pain Scale-Revised: toward a common metric in pediatric pain measurement. *Pain*. 93, 2 (2001), 173–183.

[5] Laurent, J. and Catanzaro, S. 1999. A measure of positive and negative affect for children: scale development and preliminary validation. *Psychological Assessment*. 11, 3 (1999), 326.

[6] Spielberger, C. and Edwards, C. 1973. State-trait Anxiety Inventory for Children: STAIC: How I Feel Questionnaire: Professional Manual. Mind Garden. (1973), 2014.

[7] Wilson, J.M. 2006. Child life services. *Pediatrics*. 118, 4 (Oct. 2006), 1757–63.