

Toward Personalized Pain Anxiety Reduction for Children

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Abstract

We are currently developing algorithms for personalized anxiety reduction feedback for use by a robot buddy interacting with a child about to receive intravenous therapy (an IV insertion). This three-phase study is currently being conducted; it consists of two data collections to determine domain-specific approaches, followed by the full study with personalized anxiety-reducing feedback. Participants receiving personalized feedback will be compared to participants with a non-personalized robot (to control for novelty) and a no robot condition (baseline control).

Motivation

IV insertion in pediatric hospitals is handled by both nurses and child life specialists, whose job it is to reduce young children's anxiety about medical procedures. The current method used by child life services is *distraction*, where a specialist distracts a child — asking questions, offering games and toys to play with or videos to watch — while the IV is inserted. The distraction method has been previously implemented on a Nao robot (Beran et al. 2013) in the context of flu shot administration, a much faster and less painful procedure. While effective, using a robot for distraction alone treats it more like a toy, and does not take advantage of its autonomous socially assistive capabilities.

This work is developing algorithms for a socially assistive robot to interact with a child as a buddy, alongside a child life specialist, and to use this unique relationship as a means of reducing anxiety. Such a robot buddy needs to display comforting words and gestures, related to displaying empathy. Robots that display empathy (Tapus and Mataric 2007) (Leite, Pereira, and Mascarenhas 2012) and emotional support have previously been studied — notably the Paro and Huggable robots have been used with pediatric patients (Okita 2013) (Jeong et al. 2015). We seek to develop methods for personalizing anxiety-reducing feedback that extends the potential calming effect of a robot buddy by taking into account the child's personality and changing emotional state.

Sensors and Measures

The study is using the Maki robot (Figure 1, left), which will be introduced alongside a child life specialist to provide

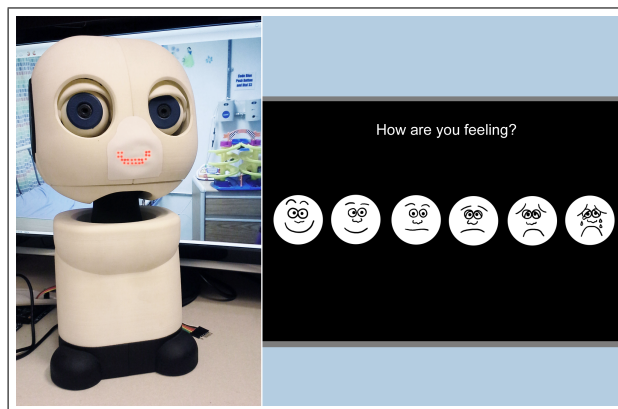


Figure 1: The Maki robot (left) will sit at the end of the child's hospital bed; the child will communicate with Maki through a touch screen (right).

anxiety-reducing emotional feedback while explaining the IV insertion process to the child. The Maki robot features custom LED mouth displays lip-synced to pre-recorded dialogue spoken in a child-like voice. While the interaction between the robot and the child will be as autonomous as possible, human-in-the-loop sensing will be incorporated to recognize spoken child responses and handle unexpected events.

To measure anxiety, we will be primarily utilizing child self-report and heart rate data. Participants will have a Masimo pulse oximeter recording their heart rate throughout the interaction. Periodically, the robot will perform an emotion probe by asking the child to report their current level of anxiety on a touch screen tablet (Figure 1, right) using the FACES pain scale (Bieri et al. 1990). The Child Pain Anxiety Symptom Scale (CPASS) (Pagé et al. 2011) and a child temperament questionnaire will be administered to participants and their parents prior to the session, to determine an anxiety baseline. An initial categorization of child anxiety (and subsequent selection of robot strategy) will be made from questionnaires and verified via self-report on the tablet.

Experimental Design

In order to develop and implement personalized, anxiety-reducing feedback for use in this domain, preliminary data collection is required. This study is divided into three

phases: first data collection, second data collection, and a full study with the three experimental conditions.

Phase 1: Anxiety Features Data Collection

We will begin by observing child life specialists at work without robot presence. We will work with child life specialists to integrate the emotion probe tablet into their existing strategies for interacting with children. Every sensor will be tested with real-world data — the Kinect 2, pulse oximeter, and the tablet interface.

Participants in Phase 1 will receive questionnaires (including background, CPASS and temperament) to provide information for classification in Phase 2. A formal interview with child life specialists suggests three categorizations for child pain anxiety in this context: *neutral*, *unsure*, and *very anxious*. The feature most commonly used to distinguish these classifications is prior experience receiving an IV. The formal interview and our Phase 1 observations will constitute the data from which the robot’s dialogue for the next phase will be derived. As of the submission of this paper, Phase 1 is currently underway.

Phase 2: Robot Data Collection

Data from Phase 1 will be utilized in Phase 2 to integrate the robot into the existing child life services infrastructure. Dialogue determined in Phase 1 will be implemented and tested alongside the emotion probe tablet interface in an initial data collection of 10 participants. Three types of dialogue will be tested in this phase:

- *Small Talk*: The robot will ask the child questions about school, family, and other topics, such as their favorite ice cream flavor. Early Phase 1 results suggest that small talk will be in relation to an activity or game the child is interacting with on the tablet.
- *IV Insertion Description*: The robot will describe the IV insertion process along with the child life specialist. The process involves the child’s arm being numbed and sanitized, and then the insertion.
- *Emotion Probe*: The robot will ask the child “how are you feeling?” (additionally, “how do you think this will feel?”) and record the FACES scale response. This dialogue will be personalized based on the anxiety classification of each child, from data collected in Phase 1.

These dialogue categories are not presented in sequential order, but rather mixed together throughout the interaction between a child life specialist and a child about to undergo an IV insertion. The emotion probe will be given at least three times during the interaction: after the robot introduces itself, before the IV insertion, and after the insertion is complete. The remaining time will be a mix of small talk and insertion description dialogue, the balancing of which is dependent on data from Phase 1.

Phase 3: Anxiety Reduction Study

The final phase will be to give personalized anxiety feedback based on *a priori* classification through questionnaires as well as observed child anxiety with any improvements

necessary from the Phase 2 data collection. As described in Phase 2, the interaction will consist of three emotion probes dispersed throughout small talk and IV insertion description dialogue from the robot. Three conditions will be compared, each with 30 participants:

- *No Robot*: Child life specialists will administer care in their usual manner, with no robot present, and no emotion probes from the robot or tablet.
- *Non-Personalized Robot*: The Maki robot will be a part of the interaction, give small talk and insertion description dialogue, but will not give emotion probes or provide emotional feedback to the child.
- *Personalized Robot*: Maki will respond to the child’s anxiety level, determined via parent questionnaire and self-report (using the FACES scale), with appropriate feedback. This emotion probe and feedback will be given three times throughout the interaction: in the beginning, before insertion, and after insertion.

In all conditions, questionnaires will be administered, and video, audio, and heart rate data will be collected to categorize participants across all sessions. Participants will be compared based on overall anxiety reduction as well as categorization of base anxiety level.

We expect the results to show child anxiety reduction in one or more of these scopes: over the entire interaction, between emotion probes, or immediately after emotional robot dialogue. We hypothesize that the personalized robot condition will show greater anxiety reduction (as measured by self-report, heart rate, and other sensor data) than the non-personalized robot, and both conditions will show greater anxiety reduction than the no robot condition. The presented study will show a real-world application of our personalization method, but since it is only a single interaction, there will be no adaptation over time involved. With the results of this study, we will expand this method into a model of adaptive feedback over time.

Future Work

Future work will be to adapt robot emotional feedback to a user’s anxiety level over multiple sessions, evaluated in a more controlled setting with a convenience population. Domain focus will expand to individuals with chronic conditions that require long-term monitoring and care, and our previous work with graded cueing feedback (Greczek et al. 2014) will also be integrated into this framework to create comprehensive personalized health care assistance. The overall effort is toward an adaptive method of personalized anxiety reduction over long-term human-robot interaction with real-world users.

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