Transparency, Teleoperation, and Children's Understanding of Social Robots

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***Abstract*—Teleoperation or Wizard-of-Oz control of social robots is commonly used in human-robot interaction (HRI) research. This is especially true for child-robot interactions, where technologies like speech recognition (which can help create autonomous interactions for adults) work less well. We propose to study young children's understanding teleoperation, how they conceptualize social robots in a learning context, and how this affects their interactions. Children will be told about the teleoperator's presence either *before* or *after* an interaction with a social robot. We will assess children's behavior, learning, and emotions before, during, and after the interaction. Our goal is to learn whether children's knowledge about the teleoperator matters (e.g., for their trust and for learning outcomes), and if so, how and when it matters most (e.g. at what age).**

***Index Terms*—Child-robot interaction, deception, transparency, teleoperation, social robotics**

I. Introduction

Teleoperation or Wizard-of-Oz (WoZ) control of social robots is a pervasive method used in empirical studies of human-robot interaction (HRI) [1]. Using WoZ control is usually framed as a way to study human behavior with a robotic system that behaves in certain ways *before* it is potentially possible to build the system in actuality (usually due to technological challenges that have yet to be surmounted). We use WoZ to study future human behavior and to gain key insights about how we might interact with robotic systems, which will inform how we design and build the actual robotic systems in the future.

WoZ is especially prevalent in child-robot interaction research, where technologies that help create autonomous interactions with robots for adults (such as speech recognition) work less well. However, despite the prevalence of WoZ paradigms, relatively few studies have explored how children conceptualize robots in these studies, such as whether they are aware of the teleoperator, whether their knowledge (or lack of knowledge) of a teleoperator changes their behavior with the robot, and how they construe robots as social others [2], [3]. Since we using WoZ primarily to garner insights about children's interactions with future robotic systems, it behooves us to try to understand how children actually think about these systems and how the experimental paradigms we use affect our studies. For example, we need to understand whether children's behavior and feelings will transfer from one robot to another, and whether a teleoperated system will have the same effects and be understood the same way as an autonomous system.

II. Related Work

Some prior work in this area exists, but it is limited. In one study, children ages 5–13 played with the robots Cog and Kismet [3]. Then, the workings of the robot were demystified as children spent 20–30 minutes learning about how the robots operated. Finally, children once again interacted with the robot. Their interaction did not visibly change after learning about the robot. To quote, "it was received as interesting, some children even found it compelling. But it did not interfere with the sense of relationship" [3].

A similar encounter was described as a case study in [4]: a five-year-old boy played with a DragonBot robot, was shown how it had been teleoperated and was even given the opportunity to teleoperate it himself, but subsequently treated the robot and the teleoperator as separate beings—the robot was still its own self, despite human control. Finally, in [2], ten children ages 12–13 interacted briefly with a teleoperated robot. Then the children were told about the teleoperation, asked whether they had realized the robot was teleoperated, and whether they thought it made a difference that the teleoperator was seen or not. Most of the children were unaware of the teleoperator, and the study did not report any negative (or positive) consequences.

III. Research Questions

We address two main questions in this work. The first question is *how do children conceptualize social robots, particularly in teleoperation studies?* Who do they think they are interacting with—the robot? The wizard? As humans, we begin to categorize objects we encounter in the world into two general categories soon after birth [5]: (1) alive, animate beings, such as plants and animals, and (2) inanimate objects, such as tables, rocks, and computers. Prior work suggests that robots are not so simply categorized by children. Children may think of robots as in-between living and non-living [6], [7], attributing psychological and perceptual abilities but not biological properties to them [8]. The understanding children may have of robots as "sort of this and sort of that"—with some combination properties held by pets, puppets, computers, and people—may make sense to them in a way that may not make sense to adults who follow a stricter categorization scheme.

It may be difficult to tease out whether children believe a robot *is* a social agent on its own or whether they are merely acting *as if* it is—engaging in pretense play or willing suspension of disbelief—but the distinction is crucial to explore [7]. Thus, do children think of the interaction as pretense play? Do children truly believe that the robot is its own fully autonomous self? Perhaps children continuously and fluidly adjust their mental models of robots while interacting, such that they conceive of the robot as many things at once—alive, machine, teleoperated, etc. This question may have different answers in different contexts—short-term versus long-term encounters, pediatrics versus education versus therapy, in one culture versus another. We may see differences based on the child's age and their prior experience with technology.

Second, we want to understand what benefits or harms may come from using a WoZ paradigm. Specifically, *does it matter whether children know up front that a robot is being teleoperated?* Given that

children may think of robots differently than adults, what effects (or lack of effects) might knowing about a teleoperator have on children's interactions with a social robot? For example, is their trust in the robot or in the experimenter affected?

We could imagine that for older children and adults, knowledge of a teleoperator may change their behavior. We may think of teleoperation as deception and as an ethical concern—i.e., that by *not telling* a person up front that a robot is teleoperated, they are being deceived into acting a particular way and treating the robot a particular way [1], [9]. However, throughout scientific research, we deceive participants in research studies. We do not tell participants up front what a study is about because we do not want to bias their behavior. The potential benefits of what we may learn outweigh the risk, and further, the risk can be minimal. While there is still debate about the acceptability of placebos and deception in social psychological research [9], it is generally accepted that some amount of deception is necessary for this basic research to occur.

From this, then, we may also ask whether young children see teleoperation as deceptive. And if so—given that the word "deception" carries the negative connotation of lying—do children think they are being lied to? How similar do they see teleoperation to other activities, such as pretend play, playing with pets, playing video games, or talking to the puppets used by therapists? Children may think of interaction with a social robot—teleoperated or not—as a kind of technology-enabled pretend play. The primary question here is whether it matters that children know up front that a robot is being teleoperated, and what effects this may have.

IV. Proposed Study

A. Methodology

The study will follow a 2×4 between-subjects design: age of children (3yrs, 5yrs, 7yrs, 9yrs) × when they are told about the teleoperator (*Before* vs. *After*). Thirty children of each age group will be recruited. Children's parents will sign a consent form and children will be asked to verbally assent to participate.

Children will first be asked questions by an experimenter about their expectations and prior conceptions of robots, such as a robot's emotional, physical, and mental capabilities and their past experience with technology. Then, the children in the *Before* condition will be told that they will play with a robot that is being controlled by a person, like a puppet. All children will then play a cooperative learning game with a social robot for 10–20 minutes, which will allow the robot to be seen as a companion and teammate, and for a stronger relationship to develop. Following this, the experimenter will reveal to the children in the *After* condition that the robot had been controlled by a person. All children will be asked follow-up questions to determine whether their thoughts and feelings about the robot had changed, and what they have learned. Video and audio of the interaction, along with all questionnaire responses, will be recorded and coded for relevant nonverbal behavior.

B. Hypotheses

We expect a significant interaction between knowledge of the teleoperator and children's age. Younger children will care less about the teleoperator and treat the robot as a social other in both conditions [6], [7]. Older children may feel more awkward and less engagement in the *Before* condition, and thus perform fewer "social" behaviors (e.g., laughter, asking questions, leaning toward the robot vs. away) and learn less in the learning task due to lack of trust [10]. Younger children will perform these behaviors and learn in both conditions, perhaps more so in the *Before* condition since they know the robot is really a human whom they trust. Older children in the *After* condition may feel more negatively (e.g., about deception).

C. Robot and Teleoperator

We will use a Tega robot, an Android phone-based robot that is covered in fur and designed to be appealing to young children. The teleoperator will be trained by an expert on puppeteering the robot as a believable character. The teleoperator will follow a script for triggering emotional body actions and facial expressions (so these are only triggered at determined times) and speech playback (recorded audio pitch-shifted to sound more child-like). The teleoperator will attend to children's speech cues and their progress in the learning game to determine which phrases to play next.

V. Future Work

The proposed study is part of a series of studies investigating young children's conceptualization of social robots. What factors, such as the robot's autonomy (or lack thereof), affect how they perceive and respond to social robots? Children's sense-making of robots may be a dynamic, sophisticated process. In this work, we use teleoperation as lens through which to begin understanding how children conceptualize and understand social robots, but this just the first step, and only address some of the relvant variables.

Follow-up work could examine many different variables, including when the teleoperation is disclosed (i.e., before the interaction, after one interaction, after several interactions), the age of children and developmental differences, the embodiment and morphology of the robot, who discloses the teleoperation (e.g., the teleoperator, the robot, an experimenter, the child's parent), whether the reveal is intentional (children are explicitly told) versus accidental (children accidentally discover teleoperator), as well as the type of interaction that child have with the robot (e.g., more personal and social versus a more generic conversation, tour, or game).

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