A Robot Forensic Interviewer - The BAD, the GOOD, and the Undiscovered

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ABSTRACT

The goal of this paper is to begin a discussion of the benefits, challenges, and ethical concerns related to the use of robots as intermediaries for obtaining sensitive information from children within the human-robot interaction (HRI), criminology, sociology, legal, and psychological communities. This work examines how robots may impede disclosures from children, encourage inaccurate disclosures, facilitate unintended disclosures, provide a more reliable interviewer, decrease the likelihood of misleading children, and enhance forensic interviews through high fidelity data logging. Open research questions, proposed research studies, and pathways toward deployment of robots as forensic interviewers are provided. As HRI researchers working in an interdisciplinary team, with members trained by the National Child Advocacy Center in Child Forensic Interview Protocols, we believe sustaining a dialogue concerning the design and appropriate use of robots in this area is essential for continued progress.

CCS Concepts

•**Human-centered computing** → **Interaction design;**
•**Applied computing** → **Sociology;**

Keywords

Child-Robot Interaction; Forensic Interviews; Robot Intermediary; Deception

1. INTRODUCTION

A situation of growing concern in the United States is child maltreatment and the inability to gather information from children regarding what may have happened to them. This is a worldwide problem, but for the purposes of this paper, the focus will be on the U.S. population. In 2014, 6.6 million reports were filed with Child Protective Services related to claims of child maltreatment [26]. Of those reports, 3.6 million were referred to Child Protective Services for further investigation and in 2014 it was estimated that 1,580 children died because of some type of maltreatment (e.g., neglect, physical abuse, sexual abuse, etc.) [26]. A critical factor in child maltreatment cases is the ability to obtain veridical information from children regarding their situations and what occurred [3, 9, 16]. The primary concern regarding the gathering of this type of information from children is their suggestibility to interviewer bias during the investigative process [3, 10, 13, 15, 16, 21, 33, 71]. Therefore, it is important that methods for gathering this type of information are explored by the research community, and one possible approach is the use of robots acting as intermediaries by interacting with children during investigations of maltreatment and witnessed violence.

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2. MOTIVATION

One approach that has resulted in the ability to obtain better information is the use of forensic interview techniques [11,12,14,27,36,42,63,69]. This is a structured approach that allows for more open-ended responses from children instead of a traditional interview style of multiple choice, yes/no questions, and the wh- questions (e.g., where, when, who, why, etc.). Overall this approach has produced better information but it is not without its problems. Hence, it is important to explore methods for improving the interview process, keeping in mind the ethical implications associated with the investigative process. The primary research question is: *How can robot intermediaries be used to obtain more veridical and less false information from children while considering their rights?*

The goal of this paper is to explore the implications of using robots as intermediaries for gathering sensitive information from children. Is it possible to enhance existing forensic interview practices through the incorporation of robots acting as intermediaries for adult interviewers, not present in the interview room? The paper explores the challenges and possible benefits of this approach, what factors need to be considered, and provides a set of recommendations for future research directions.

3. RELATED WORK

Historically, there has been controversy in determining best practices for obtaining factual eyewitness accounts from children about what they have personally experienced or observed, such as maltreatment and violent crimes. This section explores the background and relevant research associated with forensic interviews of children, the use of deception

in HRI, and some common application areas associated with the use of robots with children.

3.1 Forensic Interviews for Children

Newlin et al. [42] provides the following definition: *"A forensic interview of a child is a developmentally sensitive and legally sound method of gathering factual information regarding allegations of abuse or exposure to violence. This interview is conducted by a competently trained, neutral professional utilizing research and practice-informed techniques as part of a larger investigative process."* The use of this approach has been effective in obtaining factual information, especially from children and was developed as a result of a multitude of problematic interview approaches historically used with children [15, 20, 21, 37, 43, 57, 60, 61, 69].

There are numerous benefits to the forensic interview approach and there are several approved approaches that have been used by professionals for obtaining information from children. Faller describes and evaluates the most common approaches used in forensic interviews in [15]. The primary structure used by most approaches typically includes the following phases: (1) initial rapport-building phase, (2) the substantive phase, and (3) the closure phase. Different approaches or protocols may include varying techniques within these phases. In the initial rapport-building phase, it is important for the interviewer to make introductions; discuss the importance of telling the truth and test whether children understand the difference between the truth and a lie; provide instructions related to the process; and practice having the child provide narratives and episodic memory training [42]. In the substantive phase, important information is requested from the children, in which the interviewer requests a description of the events, utilizes detail-seeking strategies to increase the information provided by the child, and tests for alternative hypotheses that might explain the experiences the child may have had. In the closure phase, the interviewer must transition the child away from the directed content gathering, and move toward everyday life occurrences, discuss safety, and provide education to the child such as reporting to others when they observe or experience something of concern. An important aspect of the forensic interview is for the interviewer to remain unbiased, neutral in his or her expressions and behaviors when interacting with the child to reduce the occurrence of suggestibility [27, 42, 55].

Although, the forensic interview approach has provided favorable results overall, it is not perfect primarily because humans are not perfect and have instinctive responses that without significant practice and evaluation may unconsciously bias or influence the information gathered from children, who are highly suggestible [10, 42]. Human interviewers can introduce biases by their demeanor, vocal prosody, nonverbal behaviors, and by the words they say, often because of prior knowledge of the events under investigation [2, 3, 16, 17, 39, 50, 68]. Another significant issue is the manner in which questions are expressed, such as with the narrative open-ended statements that allow for the child to present information as they recall it using phrases such as: *tell me more about that* or *then what happened?* [9, 20, 35, 44, 46, 55].

The quality of a forensic interview can impact the prosecution and the safety of the children involved. It is imperative to obtain the highest quality, detailed, and factual information that is not biased and considers all possible alternative hypotheses or reasons for what may have been experienced [42]. It is often best for the interviewer to go into the investigative session with no prior knowledge of the facts of the case [13, 33, 42, 55]. When accurate information has been obtained the outcome of the investigation is expected to be positive, with the children ending up safe though there may still be emotional challenges related to having a loved one possibly put into jail or having to change living situations. When inadequate information or inaccurate information is obtained, it could result in an innocent person being convicted of a crime they may not have committed or a child may be returned into a possibly harmful environment. It is critical to find methods to gather factual information regarding the incident under investigation.

3.2 Use of Deception in HRI

Introducing a robot interviewer requires consideration of how the robot will behave and interact with both the interviewee and human investigators. Research efforts in the field of HRI often use a Wizard-of-Oz approach [30], in which a remote human operator simulates the abilities of a robot that are not yet developed or reliable enough for autonomous use. In many cases participants are unaware of the hidden operator and are deceived into believing the robot is functioning autonomously [19, 52]. While use of this technique has raised ethical concerns within the HRI research community, the practice is often viewed as essential and limited to brief laboratory interactions where the participant's embarrassment is the largest possible risk [53]. Studies with children have led HRI researchers to raise questions specifically about children's expectations and comprehension of how data the robot collects will be used and shared [32, 72]. As robots have taken on roles in therapeutic and educational settings, where longer term interactions are typical, concerns about the ethical nature of robotic companions have also surfaced. Most notably, research has focused on the effects of social bonds and attachments (which may be sustained by deception) between the elderly or children and the robots they interact with [8, 63].

In the realm of robot forensic interviewers, children may be deceived in a manner similar to that of participants in a Wizard-of-Oz study, unaware that the information produced and consumed by the robot interviewer is conveyed to human investigators who are part of the investigative process but not present in the room with the child. This risk is different from both the risk of embarrassment that a study participant faces and the risk of social attachment a user of a companion robot may experience. It is also distinct from the risks associated with "smart" toys, like Mattel's *Hello Barbie*, which has been met with criticism for passing audio recordings of children playing to their parents and third parties without the child's knowledge [67]. While privacy violations from "smart" toys undoubtedly have the potential to harm children, thus far this has primarily impacted the parent-child relationship (though the future impacts of sharing data with third parties and data breaches should not be discounted). Though robot mediated interviews appear to be a benevolent use of deception [64], providing benefits to society when used appropriately, the risks posed to the children interacting with these systems are unique and deserve careful examination.

3.3 Use of Robots with Children

Robots have been used with children in a variety of domains with the most frequently examined areas being therapeutic applications, education or tutoring, entertainment, and information gathering. Therapeutic robots may serve as companions to children in hospital settings, at home, or in therapy sessions. Robots used in hospital settings may provide a distraction, entertainment, and/or coping mechanism [23, 56, 59], while those used at home or in therapy sessions may serve a motivational or skill development purpose [22, 54, 62]. In these settings a robot is often beneficial for its ability to engage regularly and repetitively with children. Robots in these domains may transmit information to a child or listen to information a child provides for the purpose of interacting again later with the child. Education and tutoring robots are designed to effectively convey information to children in a manner similar to a human teacher [31, 58]. These systems may track a child's progress and use this information to shape their interactions with the child [38].

Both therapeutic and educational robots make an effort to establish rapport with a child and build a relationship with the purpose of benefiting the child but typically do not intentionally relay sensitive information disclosed by the child to others. The primary use of information gathering robots is to collect and transmit information to other humans. For example, Wood et al. used a KASPAR robot with special needs children in the role of an interviewer and found that children interacted with the robot interviewer in a manner similar to that of a human interviewer [74, 75]. The use of robots as forensic interviewers places the robot in an information gathering role, which merits special attention as its full purpose may not be self-evident to children interacting with it. Bethel et al. [6] explored the use of robots for determining if preschool children, ages 4-6, would share a secret more easily with a robot or a human interviewer. They found that children were as likely to share the secret they were told with the robot interviewer as the adult interviewer with a similar amount of prompting effort. However, there were cases in which the the children shared the secret they were told with the human-like Zeno robot with less prompting than required by the human interviewer. The use of robots to obtain information about children's experiences with bullying has been investigated by Bethel et al. finding that children were more willing to share specific information (being teased about their looks) with the robot than the human interviewer [5].

4. NEGATIVE POTENTIAL OF ROBOT INTERVIEWERS

The use of robots as interviewers to obtain sensitive information from children has the potential to negatively impact the investigative process. This section examines three potentially problematic areas. First, perceptions of a robot interviewer's ability to provide support and empathy may be an impediment to disclosures by children. Second, the toy-like nature of robots may encourage creative thinking or play behavior and result in inaccuracies in the information provided by the children. Third, because it is not clear what responsibilities for reporting the robot may have, children may share information that they did not intend to convey to adults during the investigative process.

4.1 Impediment to Disclosures

Although robot-mediated forensic interviews provide a precise mechanism for controlling the vocal attributes and nonverbal behaviors of a robot interviewer, which may reduce unintentional misleading of the child interviewee, it is also possible that children may feel uncomfortable disclosing some types of sensitive information to a robot. The likelihood of a child disclosing information about abuse experiences or details of a violent crime (the most common types of information targeted by a forensic interview) to a social robot in comparison to a human interviewer has yet to be examined. Conducting experiments, which collect equally sensitive information from children with a robot poses an ethical challenge, meaning initial uses of robot forensic interviewers may need to occur with children already involved in an investigation. This presents a scenario which requires great attention to managing the amount of harm a robotic system in development may cause to the already established process as it is integrated and tested as part of the investigative process.

Though studies have demonstrated that adults are willing to engage with software-based therapeutic interventions for conditions like depression [70], these systems often fill the role of a support tool rather than a social actor [51]. Adults using technology as a tool for psychological well-being are typically well equipped to understand the capabilities and limitations of such systems. In addition, initial disclosures of traumatic experiences by children differ from the treatment of psychological problems of adults in that the level of emotional support required after disclosing a traumatic experience may be much higher for the children. If children feel that the robot interviewer will be unable to provide emotional or social support during particularly difficult portions of the disclosure they may avoid disclosing their experiences completely.

Human forensic interviewers engage in a rapport-building phase with the purpose of establishing a trusting relationship between the child and the interviewer [1, 49]. It may be more challenging for the children to develop the same level of rapport with the robot as they would a human interviewer. One challenging aspect of constructing appropriate rapport with a robot interviewer is allowing adequate time to overcome the novelty effect, which is the initial excitement about a new technology, such as a robot. This effect may cause people to have more favorable evaluations of the robot, but the effect may dissipate after spending time interacting with it [29]. In the case of using robots as forensic interviewers, a challenge may be fine tuning the level of rapport such that the child feels comfortable enough to share sensitive information, but is not overly enthusiastic or inclined to please the robot interviewer.

Literature examining the outcomes of forensic interviews with children has identified child characteristics that affect the likelihood of the child disclosing their experiences to human interviewers. Though each child and experience is unique, some general trends have been observed for the characteristics of children, who are willing to disclose [3]. Some of those characteristics that occur in the U.S. are that younger children are more likely to fully disclose to a human interviewer than older children; white children are more likely to disclose than black children; if the perpetrator is in the home, the children are less likely to disclose; and if the child has strong family support they are more likely to dis-

Figure 1: A forensic interview environment

close during the forensic interview process [3]. The combination of child and interviewer factors, like gender, can also affect disclosures. For example, a study involving 672 children between the ages of 4 and 14 found that girls provided more information to directive questions from female interviewers than from male interviewers while boys provided the same amount of information regardless of interviewer's gender [35]. These are trends that are common in human interviewer investigations; however, since they have been identified in human interviewer conditions it is not guaranteed that they will hold for a robot interviewer. Importantly, interviewer-interviewee interaction effects indicate that the interviewer's characteristics have an effect on disclosures, suggesting these interactions should be examined with robot interviewers as well.

4.2 Encouragement of Inaccurate Disclosures

Inaccurate disclosures by children during a forensic interview are a significant problem, which can have aversive consequences for all individuals involved in a particular case. Modern forensic interview protocols were largely motivated by inaccurate information obtained by investigators from children, many of whom were attempting to provide information they perceived investigators wanted to hear. As a result, forensic interview environments and protocols were developed to reduce the likelihood of a child constructing information which they did not actually recall. As children often enjoy playful suspensions of disbelief through make-believe and creating fictional stories, interviewing environments are constructed to be neutral, with no creative artwork or toys present in the environment (see Figure 1) [42]. If a child perceives the robot interviewer as a toy-like object, this could increase the child's propensity to construct fictional information and provide it to the interviewer.

As many social robots are aesthetically novel, often elicit a playful reaction, and depend upon a suspension of disbelief for interactions, it is reasonable to suspect they may encourage a constructive fantasy mindset that impacts the accuracy of disclosures [42]. Furthermore, as social robots are not yet a common element in most children's daily experience, the novelty of interacting with the robot may serve as reinforcement, causing children to generate interesting information that extends the length of the interaction (until the novelty effect dissipates) [29]. An alternative approach might involve the use of a traditional screen-based system, possibly with an avatar in order to reduce the novelty effect of an embodied collocated robot. While screen-based systems with an avatar have been found to increase the likelihood of adults in a healthcare context to disclose sensitive information [40], the increased rapport provided by the avatar is thought to be one of two critical reasons for increased disclosures (the other being perceived anonymity). Physically embodied interviewers that are collocated may provide a benefit in terms of a presence that helps to focus a child's attention and more easily establishes rapport in comparison to a virtual agent [48]. Furthermore, though virtual artificial interviewers merit investigation, the same novelty factors presented by robot interviewers may be encountered.

Another alternative approach would be computer-assisted self interviews [7, 18, 24, 34, 41, 45]. There have been studies conducted with children using computer-assisted self interviews that have demonstrated an increase in disclosure rates because of the level of anonymity and lack of judgment [7,18,24,34,41,45]; however it is very difficult without the use of an avatar or virtual human to establish rapport [40], which is a critical element in forensic interviews [42]. In order for a forensic interview to be successful in obtaining truthful and accurate information from children, the children must feel a sense of anonymity, a lack of judgement from the interviewer, and have the ability to develop rapport with the interviewer [40, 42].

The majority of our studies have been constrained to the domain of eyewitness memory. These experiments typically involve showing participants (children ages 8-12) a slideshow that depicts the events of a crime, optionally injecting false information about details of the events, and asking the participant to recall the details of the crime displayed in the slideshow. The same false information is inserted in both the human and the robot interviewer conditions. As a result, our studies have not provided participants with substantial opportunities to engage in more creative constructions of fictional memories. This is an area that is challenging to address as part of a larger experiment and merits further independent investigation.

4.3 Unintended Disclosures

Since robot interviewers are novel, children are unlikely to have expectations concerning the allegiances and authority of a robot interviewer. Specifically, children may not foresee the conveyance of disclosed information from a robot interviewer to human investigators, or may not grasp the impact of information provided to a robot interviewer that may be used in an investigation. This type of concern has also emerged with the development of "smart" toys, like Mattel's Hello Barbie, which passes recordings of a child's verbal responses to their parents and third parties without notification to the child [28]. While human forensic interviewers are likely to match a child's understanding of an adult authority figure, robot interviewers may not fit this template.

Since some responses to anthropomorphism are thought to be beyond direct conscious control [63], with even adults responding socially despite knowledge of a robot's true nature, informing the child of the robot's purpose may not sufficiently align the robot's identity with that of a human investigator. Children, lacking the experience and knowledge of adults, may also be more vulnerable to misunderstanding the robot's nature and intentions. Even if a child is informed the robot is being teleoperated by a human investigator, it

may be difficult for the child to remain cognizant of this throughout the interview.

If a child is unable to equate the consequences and importance of disclosures to a robot interviewer with those of disclosures to a human interviewer, the child may provide information they otherwise would not. This information could include non-factual statements or factual statements, which the child would not have otherwise supplied to adult authority figures. While the disclosure of additional factual information may serve to protect a child, obtaining such information through this type of deception raises ethical concerns and may threaten the rights afforded to children in some localities. Children supplying non-factual information as a result of the robot interviewer's unclear role may produce negative results for themselves or others involved in an investigation.

5. POSITIVE ASPECTS OF ROBOT INTERVIEWERS

There are several positive aspects to the use of robot interviewers in a forensic interview investigation. It is possible to have increased control over the speech, vocal prosody, facial expressions, and body movements of the robot. Prior and current research results indicate that a human interviewer is more likely to succeed at misleading a child interviewee than a robot interviewer. Additionally, robot interviewers can log a corpus of behavioral data and transcriptions which can be used for training and investigative purposes.

5.1 Increased Control of the Interviewer

Robot interviewers offer the ability to control the actions and reactions of the interviewer in a consistent and reliable manner. Though trained human forensic interviewers work to eliminate any reactive content (both verbal and non-verbal), it is often difficult for humans to maintain a completely neutral or tightly controlled response. Many standardization efforts for forensic interview protocols have focused on eliminating the biases of an interviewer by providing guidelines for the style of questioning, repeated training for controlling the overall demeanor and responses of the interviewer, and professional critiques of the interviewer's performance through post-interview video peer reviews [42]. Though trained human forensic interviewers are effective, many struggle to conduct a completely unbiased interview. Studies of forensic interviewers have emphasized that even investigators who complete training may engage in biasing practices and recommends the adoption of standardized protocols to combat this habit [14, 36].

While a teleoperated or semi-autonomous robot interviewer may directly transmit any biases introduced by its operator(s) in the form of the content of a question or direction of an engagement, a robot interviewer's non-verbal behaviors are more reliably controlled than those of a human interviewer. This may assist children by eliminating ambiguous or complex social signals that a human interviewer may emit consciously or unconsciously, reducing the opportunities for a child to misinterpret an interviewer's expectations. For example, a human interviewer may unintentionally alter the prosody of their voice in response to a child's statement resulting in the unintentional creation of reinforcement for the child's response [50]. Discontinuity may also be confusing to children, in that a human interviewer may express a negative vocal prosody with a positive spoken content, which results in a discontinuity of the messages being presented to the child [50]. Robot interviewers, unlike humans, will maintain the specified vocal prosody parameters (e.g., pitch, rate of speech, pauses, emphasis, etc.) regardless of the information disclosed by the child, helping to eliminate any unintended reinforcement.

Furthermore, a robot interviewer may reduce the overall amount of variation present in the forensic interview process. While human interviewers introduce variance in the process as a result of their own characteristics, personalities, moods, prior knowledge, and unrelated thoughts; robot interviewers perform in a repeatable manner, that allows for control over previously uncontrollable factors such as words spoken, affective expression, vocal prosody, and body movements.

Robot interviewers may also be manipulated in more precise ways to fit the needs of particular children. For example, the interaction of interviewer and child genders has been shown to impact the amount of information obtained during a forensic interview [35]. A robot interviewer has the benefit of adjustable factors, like gender (voice and/or appearance), which may be adapted to meet the needs of a specific case or local cultural norms.

5.2 Decreased Likelihood of Misleading

Prior research that investigated the differences between human interviewers versus robot interviewers with college-aged students indicated that human interviewers were more likely to successfully mislead the interviewee than a robot interviewer [4]. Our current research efforts have also resulted in this finding with research related to eyewitness memory accounts of an observed crime presented as a slideshow to children ages 8-12. Using a forensic interview approach, the preliminary results indicate that children are more likely to be misled by a human interviewer than a robot interviewer when the same misinformation is presented.

5.3 High Fidelity Logging and Data Corpus

The use of robotic systems for forensic interviews can produce a high fidelity log of both the interviewer's actions and the interviewee's responses, which is more easily audited than traditional audio and video recordings. Data collected by robot interviewers may also be used to further refine the system's responses and identify common trends across forensic interviews. Unlike human interviewers, robotic systems can provide explanations for each action performed by the robot.

The corpus of data collected from forensic interviews may also serve the purpose of training human interviewers both to use the robotic system (providing high level guidance) and to inform their own behaviors in the interviews they conduct. A standardized corpus of interview data would allow interviewers and those working in the area to identify common patterns and situations that arise during the forensic interview process. Currently this information is synthesized from a review of video recordings of forensic interviews and requires significant human processing to extract meaningful conclusions. While the data produced by a robot interviewer will require analysis and interpretation, it will be better standardized into a consumable format, requiring fewer subjective interpretative steps to arrive at meaningful insights.

Figure 2: Three robotic platforms used for interviewing children.

6. RECOMMENDATIONS AND FUTURE DIRECTIONS

This section details recommendations based on the literature reviewed and current research being explored by our research team. First, open questions in the areas of robot framing, robot type and disclosures, robot type and behaviors, and the legal/ethical impacts of integrating robot interviewers into the investigative process deserve further investigation are presented. Next, several HRI studies are proposed to investigate these open research questions. Lastly, we propose a pathway toward the deployment of robot forensic interviewers into the investigative process.

6.1 Open Research Questions

Before robot forensic interviewers can be used in field settings, a host of questions regarding their effect on children and the legal cases they are party to need to be further explored. Here we describe four fundamental areas that merit further exploration prior to attempts to deploy robot forensic interviewers into the investigative process.

- **Robot Framing:** Framing includes situational cues that allow people to better set expectations for their experiences and behaviors in social situations [65, 66]. Interactions with social robots are influenced by framing through the cues provided by the robot, its environment, or humans. The way a robot is framed affects human perceptions and feelings toward the robot. For example, Groom et al. found that framing a search and rescue robot's role increased ratings of trust in the robot [25], while Westlund et al. found that framing a robot as machine-like rather than a social agent produced subtle differences in children's gaze behavior while interacting with a social robot [73].

  The framing of a forensic robot interviewer's social alliances is expected to impact the interaction between the robot and child. For example, if the robot identifies itself as a member of an investigative team or converses directly with another investigator, the child's perception of the robot's abilities and allegiances may move towards treating the robot as a human interviewer would be treated. If the robot is not presented as having any connection to the investigation a child may respond differently, which may influence the overall disclosures the child provides.

  The way a robot is framed may also impact the level of deception the child experiences. A robot that is identified as a member of the investigative team and informs the children that it is controlled by and passes information to the investigators takes on a different role than a robot, which appears independent and omits the details of its information sharing. While choices in this area pose ethical concerns and may be governed by local laws, they also impact the likelihood and accuracy of disclosures made by a child.

- **Robot Type and Disclosures:** A robot interviewer's appearance and form may impact the frequency, accuracy, and types of disclosures a child provides. For example, a robot that exhibits human-like facial expressions, like the RoboKind R25, may produce different results than one which has limited facial features like a Nao robot (see Figure 2). These considerations extend into the robot's perceived gender, race, personality, and/or demeanor.

  During a forensic interview it is important that children feel comfortable sharing sensitive information, often related to traumatic experiences, with the interviewer. An important unexplored area is how the robot's appearance and characteristics influences the comfort a child feels in disclosing sensitive information. Further, some robot designs may cause a child to be more or less likely to provide fictional information. For example, a robot that has a novel appearance or method of actuation may cause the child to engage in more of a play session, provoking creative thoughts, and leading to inaccurate or fictional information disclosures.

- **Robot Behavior and Disclosures:** Robot forensic interviewers offer a level of response filtering that humans cannot achieve, but the correct balance of responsiveness and reserved behavior must be maintained to be of benefit to the forensic interview process. An interviewer that is too disengaged or non-responsive may become annoying or burdensome to a child. If the modality of conversing with the robot requires additional cognitive effort in comparison to a conversation with a human, the interview process will be negatively impacted. Conversely, it is possible that a robot, which is too responsive, eager, or excited will degrade a child's ability to concentrate on recalling case details and factual responses.

  The development of appropriate behaviors for robot interviewers is essential for their integration into actual cases. Further investigation into the correct behaviors and parameters for robot interviewers and their impact on children of different ages, gender, and race/ethnicity are required.

- **Legal and Ethical Impacts of Robot Interviewers:** Though not unique to robots used as forensic interviewers, ethical and legal concerns will arise as

machines begin to assist in this arena of human activity. This domain is likely to provoke high scrutiny as it involves ensuring the welfare of children and as such is expected to receive significant attention from law enforcement, attorneys, and judges.

HRI researchers with expertise in legal fields will be essential to the process of deploying and auditing the usage of robot forensic interviewers. While the utility and ethics of these systems will undoubtedly be called into question, we also believe the use of robotic systems in this domain provides ample opportunity to improve the reliability and transparency of investigations concerning the welfare of children. HRI researchers with experience in law, social work, and criminal justice are pivotal to the development of systems that will be compatible and useful in existing societal frameworks.

Throughout the development of the basic components of these systems, we recommend adherence to the principles enumerated in the HRI code of ethics [53]. Though each of these principles is important, we advise remaining particularly mindful of those related to human dignity, legal considerations, and social considerations. Although considerations of transparency and predictability are important, the implementation of a robot forensic interviewer in itself provides drastic improvements in comparison to human interviewers. For example, a robot's logs will reveal the exact reason a particular non-verbal behavior was triggered and a high fidelity snapshot of each variable in the interaction at any point in time. Current best practices are able to review video of an interview at best, which cannot capture an interviewer's intentions or internal reasoning. Litigators have recognized the growing role of sensor data from smart devices in legal cases [47] and have indicated that legal systems are beginning to establish precedents for the use of this type of data.

6.2 Studies and Approaches

This section details several lab-based experiments that would help to further inform the design of robots as forensic interviewers with children. These experiments will form the foundation for the future deployment of robots as forensic interview partners, which is expected to enhance the ability to obtain veridical information as part of the investigative process with children.

- **Effects of Framing:** While the effects of framing robots have been examined in prior studies, none have framed a robot to be a member of a group with a relationship similar to that of authority figures in forensic investigations. Additionally, most studies measure a participant's feelings about an interaction or their engagement in a non-intimidating behavior rather than their disclosure of sensitive information. Since forensic interviewers will have an opportunity to manipulate a robot's perceived group membership it will be important to better understand the baseline assumptions children have of a robot interviewer's group membership and the range of manipulation that is possible.

- **Sensors in the Forensic Interview Domain:** Robotic systems usually incorporate vision and sound localization subsystems for perceiving their environment. These sensors could provide insights into the behaviors of children throughout the forensic interview process that are not currently captured by traditional video recording systems. However, the design of forensic interview spaces and interactions with children present challenges to reliably acquiring meaningful data. Many forensic interview spaces are configured similar to the one shown in Figure 1 so that the child and interviewer interact while seated at a table with up to a 90 degree angle between the child and interviewer in order to have complementary versus confrontational interactions. While face tracking is achievable for a majority of the interaction, children occasionally engage in rapid shifts of posture or location, escaping the range of the sensing equipment. The seating configuration combined with unpredictable and sometimes odd postures of the child also poses a problem for tracking a child's body movements during an interaction.

  Though off-the-shelf sensors and processing libraries in their default modes are somewhat useful, further efforts to refine sensors and develop their data processing libraries for use in this domain would be helpful. Forensic interviews would benefit from the refinement of sensing technologies and the examination of the data produced during a forensic interview. A simple understanding of this data is necessary for basic robot functionality (e.g., face tracking, orientation toward sounds, etc.), but extended analysis of this data may enhance the forensic interview process by identifying associations between a child's behavior and their comfort level.

- **Robot Type:** Further examination of the influence of robot form and appearance on a child's comfort level toward the disclosure of sensitive information is also necessary for the development of effective robot interviewers. While previous studies have made use of widely available platforms like the Nao robot [4], a systematic comparison of robot forms and their relationship to a child's likelihood to disclose sensitive information would benefit the design of robot interviewers. It is also important to determine what types of robots may elicit more fictitional information from children and avoid the use of those types of robots in forensic interviews.

  Figure 2 shows three robot interviewers which are used in our ongoing research efforts, however these are limited to the domain of small humanoid robots. Further investigations into robots, which are larger in size (e.g., the Pepper robot) or of a completely different form (e.g., zoomorphic) are needed to fully understand the range of robot interviewers that are possible for forensic applications. An investigation based on the gender, form, and race/ethnicity of the robot interviewer would be valuable to this research process.

6.3 Path to Deployment

Though many currently open questions, like the effects of framing on disclosures, can be informed by laboratory experiments, others like the propensity of a child to disclose a traumatic experience to a robot are better informed through field studies. As a result we believe a graduated process of

integrating robot technologies into forensic interviews to be the most responsible and acceptable route forward.

We propose a first step of the deployment of sensing and processing technologies as part of the investigative process without incorporating the robot interviewer. This would provide investigators with an opportunity to adapt to and benefit from many core components of the system while simultaneously providing feedback and training data for the robotic system. Most importantly, this step could be conducted without influencing the outcomes of actual forensic interviews.

After successful field deployments of the sensing and processing components of the system, the robot interviewer could be deployed and used in tandem with human forensic interviewers. During initial trails of the robot interviewer, special permission from legal guardians and/or authorities involved in these cases may be necessary to mitigate any negative repercussions.

As usage of robot forensic interviewers increase, individual jurisdictions may decide to employ strategies that involve solely robot interviewers or a combination of human and robot interviewers. Once sufficient data is available, individual jurisdictions may elect to create laws or regulations that govern the range of operational parameters they deem acceptable for robot interviewers.

Throughout the development and deployment phases, we believe HRI research contributes best by working to provide all involved (e.g., investigators, children, legal teams, the public) with a clear understanding of how a robot interviewer influences the process of obtaining information from a child.

7. CONCLUSIONS

The use of robots as intermediaries in gathering sensitive information from children is a complex and important area of research that requires further exploration and discussion in the different research communities, such as human-robot interaction, criminal justice, legal and ethical standards, psychology, and sociology as well as others. This work has provided a snapshot of the current state of forensic interviewing protocols and described some of the positive and negative aspects associated with using robots as intermediaries when interviewing children. While robot interviewers offer consistency and fine-grained control of behavior, they also may impede disclosures, facilitate inaccurate disclosures, or encourage children through deception to disclose information they did not intend to share with adults. Further research in the areas of robot framing, robot appearance and behavior, sensor design and use, ethical design, and legal aspects of deployment is needed before robot interviewers are introduced into actual forensic interviews. Since laboratory experiments cannot capture the entire essence of this domain, we propose a graduated path to field deployment of robotic interviewers, which aims to limit harm and allow legal systems to better understand and shape their use in investigations. Robot interviewers have the potential to function as a tool that improves the outcomes of cases involving children in forensic interviews, but their development and deployment must be conducted as a careful collaborative process between researchers, professionals working in this area, and the public.

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9. REFERENCES

[1] A. Abbe and S. E. Brandon. The role of rapport in investigative interviewing: A review. *Journal of Investigative Psychology and Offender Profiling*, 10(3):237–249, 2013.

[2] J. Almerigogna, J. Ost, L. Akehurst, and M. Fluck. How interviewers' nonverbal behaviors can affect children's perceptions and suggestibility. *Journal of Experimental Child Psychology*, 100:17–39, 2008.

[3] G. Anderson. The continuum of disclosure: Exploring factors predicting tentative disclosure of child sexual abuse allegations. *Journal of Child Sexual Abuse*, 25(4):382–402, 2016.

[4] C. L. Bethel, D. Eakin, S. Anreddy, J. K. Stuart, and D. Carruth. Eyewitnesses are misled by human but not robot interviewers. In *2013 8th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, pages 25–32. IEEE, 2013.

[5] C. L. Bethel, Z. Henkel, K. Stives, D. C. May, D. K. Eakin, M. Pilkinton, A. Jones, and M. Stubbs-Richardson. Using robots to interview children about bullying: Lessons learned from an exploratory study. In *Robot and Human Interactive Communication (RO-MAN), 2016 25th IEEE International Symposium on*, pages 712–717. IEEE, 2016.

[6] C. L. Bethel, M. R. Stevenson, and B. Scassellati. Secret-sharing: Interactions between a child, robot, and adult. In *Systems, man, and cybernetics (SMC), 2011 IEEE International Conference on*, pages 2489–2494. IEEE, 2011.

[7] M. M. Black and A. Ponirakis. Computer-assisted interviews with children about maltreatment: Methodological, developmental, and ethical issues. *Journal of Interpersonal Violence*, 15(7):682–695, 2000.

[8] J. Borenstein and Y. Pearson. Companion robots and the emotional development of children. *Law, Innovation and Technology*, 5(2):172–189, 2013.

[9] D. A. Brown and M. E. Lamb. Can children be useful witnesses? it depends how they are questioned. *Child Development Perspectives*, 9(4):250–255, 2015.

[10] S. Ceci, A. Hritz, and C. Royer. *Understanding Suggestiblity*, book section 8, pages 141–153. Springer International Publishing, Switzerland, 2016.

[11] L. E. Cronch, J. L. Viljoen, and D. J. Hansen. Forensic interviewing in child sexual abuse cases: Current techniques and future directions. *Aggression and Violent Behavior*, 11:195–207, 2006.

[12] T. P. Cross, L. M. Jones, W. A. Walsh, M. Simone, and D. Kolko. Child forensic interviewing in children's

advocacy centers: Empirical data on a practice model. *Child Abuse & Neglect*, 31:1031–1052, 2007.

[13] K. Daly. *The Purpose of the Forensic Interview: A Lawyer's Perspective*, book section 2, pages 19–39. Springer International Publishing, Switzerland, 2016.

[14] B. Earhart, D. LaRooy, and M. E. Lamb. *Assessing the Quality of Forensic Interviews with Child Witnesses*, pages 317–335. Springer International Publishing, Switzerland, 2016.

[15] K. C. Faller. Forty years of forensic interviewing of children suspected of sexual abuse, 1974-2014: Historical benchmarks. *Social Sciences*, 4(1):34–65, 2015.

[16] K. C. Faller. *Disclosure Failures: Statistics, Characteristics, and Strategies to Address Them*, book section 7, pages 123–139. Springer International Publishing, Switzerland, 2016.

[17] M. Fanetti and R. Boles. *Chapter 12: Forensic Interviewing and Assessment Issues with Children*, book section 12. Elsevier Science & Technology, Inc. - Credo Reference, Oxford, 2003.

[18] K. Fängström, P. Bokström, A. Dahlberg, R. Calam, S. Lucas, and A. Sarkadi. In my shoes–validation of a computer assisted approach for interviewing children. *Child Abuse & Neglect*, 58:160–172, 2016.

[19] N. M. Fraser and G. N. Gilbert. Simulating speech systems. *Computer Speech & Language*, 5(1):81–99, 1991.

[20] V. H. Fritzley, R. C. L. Lindsay, and K. Lee. Young children's response tendencies toward yes-no questions concerning actions. *Child Development*, 84(2):711–725, 2013.

[21] S. Garven, J. M. Wood, R. S. Malpass, and J. S. Shaw, III. More than suggestion: The effect of interviewing techniques from the mcmartin preschool case. *Journal of Applied Psychology*, 83(3):347–359, 1998.

[22] N. Giullian, D. Ricks, A. Atherton, M. Colton, M. Goodrich, and B. Brinton. Detailed requirements for robots in autism therapy. In *Systems Man and Cybernetics (SMC), 2010 IEEE International Conference on*, pages 2595–2602. IEEE, 2010.

[23] K. Goris, J. Saldien, I. Vanderniepen, and D. Lefeber. The huggable robot probo, a multi-disciplinary research platform. In *International Conference on Research and Education in Robotics*, pages 29–41. Springer, 2008.

[24] J. N. Gribble, H. G. Miller, S. M. Rogers, and C. F. Turner. Interview mode and measurement of sexual behaviors: Methodological issues. *The Journal of Sex Research*, 36(1):16–24, 1999.

[25] V. Groom, V. Srinivasan, C. L. Bethel, R. Murphy, L. Dole, and C. Nass. Responses to robot social roles and social role framing. In *Collaboration Technologies and Systems (CTS), 2011 International Conference on*, pages 194–203. IEEE, 2011.

[26] K. Heisler. Child maltreatment 2014 - 25th year of reporting, 2014.

[27] J. L. Johnson, K. McWilliams, G. S. Goodman, A. E. Shelley, and B. Piper. *Basic Principles of Interviewing the Child Eyewitness*, book section 10, pages 179–195. Springer International Publishing, Switzerland, 2016.

[28] M. L. Jones and K. Meurer. Can (and should) hello barbie keep a secret? In *Ethics in Engineering, Science and Technology (ETHICS), 2016 IEEE International Symposium on*, pages 1–6. IEEE, 2016.

[29] T. Kanda and H. Ishiguro. *Human-Robot Interaction in Social Robotics*. CRC Press, 2012.

[30] J. F. Kelley. An iterative design methodology for user-friendly natural language office information applications. *ACM Transactions on Information Systems (TOIS)*, 2(1):26–41, 1984.

[31] T. Komatsubara, M. Shiomi, T. Kanda, H. Ishiguro, and N. Hagita. Can a social robot help children's understanding of science in classrooms? In *Proceedings of the second international conference on Human-agent interaction*, pages 83–90. ACM, 2014.

[32] J. Kory Westlund and C. Breazeal. Transparency, teleoperation, and children's understanding of social robots. In *The Eleventh ACM/IEEE International Conference on Human Robot Interation*, pages 625–626. IEEE Press, 2016.

[33] M. Krueger. *Forensic Interviewing and Charging: A Prosecutor's Perspective*, book section 4, pages 57–79. Springer International Publishing, Switzerland, 2016.

[34] M. Kyriakidou. Discussing robot crime interviewers for children's forensic testimonies: a relatively new field for investigation. *AI & SOCIETY*, 31(1):121–126, 2016.

[35] M. E. Lamb and M. E. Garretson. The effects of interviewer gender and child gender on the informativeness of alleged child sexual abuse victims in forensic interviews. *Law and Human Behavior*, 27(2):157, 2003.

[36] M. E. Lamb, Y. Orbach, I. Hershkowitz, P. W. Esplin, and D. Horowitz. A structured forensic interview protocol improves the quality and informativeness of investigative interviews with children: A review of research using the nichd investigative interview protocol. *Child Abuse & Neglect*, 31:1201–1231, 2007.

[37] C. Laney and E. F. Loftus. *History of Forensic Interviewing*, book section 1, pages 1–17. Springer International Publishing, Switzerland, 2016.

[38] D. Leyzberg, S. Spaulding, and B. Scassellati. Personalizing robot tutors to individuals' learning differences. In *Proceedings of the 2014 ACM/IEEE international conference on Human-robot interaction*, pages 423–430. ACM, 2014.

[39] S. O. Lilienfeld. *Forensic Interviewing for Child Sexual Abuse: Why Psychometrics Matters*, book section 9, pages 155–178. Springer International Publishing, Switzerland, 2016.

[40] G. M. Lucas, J. Gratch, A. King, and L.-P. Morency. It's only a computer: Virtual humans increase willingness to disclose. *Computers in Human Behavior*, 37:94–100, 2014.

[41] S. G. Millstein and C. E. Irwin. Acceptability of computer-acquired sexual histories in adolescent girls. *Journal of Paediatrics*, 103:815–819, 1983.

[42] C. Newlin, L. C. Steele, A. Chamberlin, J. Anderson, J. Kenniston, A. Russell, H. Stewart, and V. Vaughan-Eden. Child forensic interviewing: Best practices, 2015.

[43] B. S. Newman, P. L. Dannenfelser, and D. Pendleton.

Child abuse investigations: Reasons for using child advocacy centers and suggestions for improvement. *Child and Adolescent Social Work Journal*, 22(2):165–181, 2005.

[44] Y. Orbach, I. Hershkowitz, M. E. Lamb, K. J. Sternberg, P. W. Esplin, and D. Horowitz. Assessing the value of structured protocols for forensic interviews of alleged child abuse victims. *Child Abuse & Neglect*, 24(6):733–752, 2000.

[45] D. M. Paperny, J. Y. Aono, R. M. Lehman, S. L. Hammar, and J. Risser. Computer-assisted detection and intervention in adolescent high-risk health behaviors. *Journal of Paediatrics*, 116:456–462, 1990.

[46] C. Peterson, C. Dowden, and J. Tobin. Interviewing preschoolers: Comparisons of yes/no and wh-questions. *Law and Human Behavior*, 23(5):539–555, 1999.

[47] A. Peyton. A litigator's guide to the internet of things. *Richmond Journal of Law & Technology*, 22(3):9, 2016.

[48] A. Powers, S. Kiesler, S. Fussell, and C. Torrey. Comparing a computer agent with a humanoid robot. In *2nd ACM/IEEE International Conference on Human-Robot Interaction (HRI2007)*, pages 145–152. IEEE, 2007.

[49] E. A. Price, E. C. Ahern, and M. E. Lamb. Rapport-building in investigative interviews of alleged child sexual abuse victims. *Applied Cognitive Psychology*, 2016.

[50] K. M. Quinn, S. White, and G. Santilli. Influences of an interviewer's behaviors in child sexual abuse investigations. *Journal of the American Academy of Psychiatry and the Law Online*, 17(1):45–52, 1989.

[51] B. Reeves and C. Nass. *The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places*. Cambridge University Press, New York, NY, 1998.

[52] L. D. Riek. Wizard of oz studies in hri: a systematic review and new reporting guidelines. *Journal of Human-Robot Interaction*, 1(1), 2012.

[53] L. D. Riek and D. Howard. A code of ethics for the human-robot interaction profession. *Proceedings of We Robot*, 2014.

[54] B. Robins, K. Dautenhahn, R. Te Boekhorst, and A. Billard. Robotic assistants in therapy and education of children with autism: can a small humanoid robot help encourage social interaction skills? *Universal Access in the Information Society*, 4(2):105–120, 2005.

[55] M. Rohrabaugh, K. London, and A. K. Hall. *Planning the Forensic Interview*, book section 11, pages 197–218. Springer International Publishing, Switzerland, 2016.

[56] R. Ros, M. Nalin, R. Wood, P. Baxter, R. Looije, Y. Demiris, T. Belpaeme, A. Giusti, and C. Pozzi. Child-robot interaction in the wild: advice to the aspiring experimenter. In *Proceedings of the 13th international conference on multimodal interfaces*, pages 335–342. ACM, 2011.

[57] R. Rosenthal. State of new jersey v. margaret kelly michaels: An overview. *Psychology, Public Policy, and Law*, 1(2):246–271, 1995.

[58] M. Saerbeck, T. Schut, C. Bartneck, and M. D. Janse. Expressive robots in education: varying the degree of social supportive behavior of a robotic tutor. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 1613–1622. ACM, 2010.

[59] J. Saldien, K. Goris, S. Yilmazyildiz, W. Verhelst, and D. Lefeber. On the design of the huggable robot probo. *Journal of Physical Agents*, 2(2):3–12, 2008.

[60] K. Saywitz and L. Camparo. *Contemporary Child Forensic Interviewing: Evolving Consensus and Innovation Over 25 Years*, book section 6, pages 102–127. The Guilford Press, New York, NY, 2009.

[61] K. J. Saywitz, T. D. Lyon, and G. S. Goodman. *Interviewing Children*, pages 337–360. Sage Publications, Inc., Newbury Park, CA, 3rd edition, 2011.

[62] B. Scassellati, H. Admoni, and M. Mataric. Robots for use in autism research. *Annual review of biomedical engineering*, 14:275–294, 2012.

[63] A. Sharkey and N. Sharkey. Children, the elderly, and interactive robots. *IEEE Robotics & Automation Magazine*, 18(1):32–38, 2011.

[64] J. Shim and R. C. Arkin. A taxonomy of robot deception and its benefits in hri. In *2013 IEEE International Conference on Systems, Man, and Cybernetics*, pages 2328–2335. IEEE, 2013.

[65] D. Tannen. What's in a frame? surface evidence for underlying expectations. *Framing in discourse*, 14:56, 1993.

[66] D. Tannen and C. Wallat. Interactive frames and knowledge schemas in interaction: Examples from a medical examination/interview. *Social psychology quarterly*, pages 205–216, 1987.

[67] E. Taylor and K. Michael. Smart toys that are the stuff of nightmares [editorial]. *IEEE Technology and Society Magazine*, 35(1):8–10, 2016.

[68] Y. S. Teoh and M. E. Lamb. Interviewer demeanor in forensic interviews of children. *Psychology, Crime, & Law*, 19(2):145–159, 2013.

[69] P. Toth, J.D. Child forensic interviews: Differences, debates, and best practices, September 2011.

[70] A. van Straten, P. Cuijpers, and N. Smits. Effectiveness of a web-based self-help intervention for symptoms of depression, anxiety, and stress: randomized controlled trial. *Journal of medical Internet research*, 10(1):e7, 2008.

[71] N. E. Walker. Forensic interviews of children: The components of scientific validity and legal admissibility. *Law and Contemporary Problems*, 65(1):149–178, 2002.

[72] J. K. Westlund and C. Breazeal. Deception, secrets, children, and robots: What's acceptable? In *Workshop on The Emerging Policy and Ethics of Human-Robot Interaction, held in conjunction with the 10th ACM/IEEE International Conference on Human-Robot Interaction*, 2015.

[73] J. M. K. Westlund, M. Martinez, M. Archie, M. Das, and C. Breazeal. Effects of framing a robot as a social agent or as a machine on children's social behavior. In *Robot and Human Interactive Communication (RO-MAN), 2016 25th IEEE International Symposium on*, pages 688–693. IEEE, 2016.

[74] L. J. Wood, K. Dautenhahn, H. Lehmann, B. Robins, A. Rainer, and D. S. Syrdal. Robot-mediated interviews: Do robots possess advantages over human interviewers when talking to children with special needs?, October 27-29 2013.

[75] L. J. Wood, K. Dautenhahn, A. Rainer, B. Robins, H. Lehmann, and D. S. Syrdal. Humanoid robot as a tool for interviewing young children? *PLoS ONE*, 8(3):1–13, 2013.