Humanoid Robots for Wellbeing Assessment in Children: How Does Anxiety towards the Robot Affect Perceptions of Robot Role, Behaviour and Capabilities?

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Abstract— **With the introduction of socially assistive robots in many avenues of children's lives, it is becoming increasingly vital to understand how children's perceptions of the robot affect their evaluation and interaction. The main objective of this work is to investigate how children's anxiety towards robots has influenced their perceptions of their interaction with a Nao robot. We collected data from 37 children (8 - 13 years old) who interacted, for about 30-45 minutes, with the robot which delivered initial pleasantries and four different tasks to help assess their mental wellbeing in a lab setting. We collected audio-visual recordings of the interaction. At the end of the session, we asked children to answer three self-report questionnaires to evaluate: the robot's role as a confidante, the anxiety towards the robot, and the children's perception of the robot's behaviour and capabilities. Based on their responses to the robot's anxiety questionnaire, children were divided into two categories: "low anxiety" (anxiety score $<=$ median anxiety score) and "high anxiety" (anxiety score$>$ median anxiety score). Our results show that i) most children (89.2%) irrespective of their wellbeing, experience some degree of anxiety towards the robot, ii) children's anxiety has influenced their willingness to participate in the initial pleasantries conducted by the robot, and iii) children's anxiety has also affected their evaluations of the robot as a confidante and their perceptions of the robot's behaviour and capabilities. Findings from this work have significant implications for designing effective and successful robot-led initiatives for assessing mental wellbeing in children, by taking into account their mindsets and dispositions.**

I. Introduction

Socially Assistive Robots (SARs) have penetrated many facets of human life. Robots are being used in several public applications like restaurants [1] and shopping malls [2] and even in personal spheres like being placed in people's homes [3]. In vulnerable populations like the elderly, robots are being used as social companions [4] and for providing therapy and care [5]. In children, robots are being used for the enhancement of learning [6], improvement of social skills [7], and assessment of mental wellbeing [8]. Due to the varied nature of these applications, it is essential to understand how children's perceptions affect their interaction experience, especially in population groups that do not have very advanced communication abilities, like children. This is vital to inform the design of future robot-driven initiatives to assess mental wellbeing, which should consider children's mindsets, outlooks and any existing hesitancies.

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There have been many works that have investigated anxiety caused by robot use in recent years [9], [10]. However, most of these studies have primarily investigated robot anxiety in adult participants [9], [10] with very few works [11]–[14] having children as their target population. Children differ significantly from adults in their cognitive abilities and perception of robots and technology [15]. In addition, some studies [13], [16] that do focus on children are more dependent on the stakeholders' (parents, teachers) perspectives as compared with that of the children themselves. Further, studies that do incorporate children's opinions [12], [14] have not investigated how robot anxiety has influenced their perception of the robot's role, capabilities and behaviour in the context of mental wellbeing assessments. This is critical in designing effective and successful robot-driven initiatives to aid the evaluation of mental wellbeing in children.

To this goal, we have undertaken an empirical study with 37 children (8-13 years old) who interacted with the Nao robot in a dyadic interaction setup, as introduced in [8]. The Nao robots delivered initial pleasantries (ice-breaking in [8]) and four tasks to aid the assessment of mental wellbeing in children. We collected audio-visual recordings and three self-report questionnaires, namely questionnaires inspired by the Robot Anxiety Scale (RAS) [17], Godspeed questionnaire [18], and children's evaluation of the interaction via a questionnaire inspired by [19]. First, we clustered children based on their anxiety scores into two categories "low anxiety" and "high anxiety". We then compared how the two categories (i.e., levels of children's anxiety towards the robot) have differed in their initial pleasantries with the robot, their perception, and their evaluation. We hope that the findings from this research work can direct the design of effective and successful robot-led interactions for assessing mental wellbeing in children, by considering children's mindsets and alleviating any stress attributed to the robot.

II. Related Works

A. *CRI for wellbeing*

Within the child-robot interaction (CRI) literature, there is a growing interest in exploring the use of robots for healthcare and wellbeing applications. Past studies have demonstrated that robots can be used as companions for children in various healthcare scenarios [8], [20]–[23]. For instance, Trost et al. [20] showed that empathetic social robots helped children to alleviate their fear and pain during painful medical procedures. Rossi et al. [21] showed that a social robot could act as an emotional and behavioural distraction for reducing children's anxiety during vaccination. Abbasi et al. [8] showed that social robots are promising tools to potentially evaluate mental wellbeing-related concerns in children. Other related works have shown that robots can make children at ease during assessment activities [24], [25]. For example, Godoi et al. [24] proposed a collaborative system that included a humanoid robot to keep children motivated and engaged in taking part in psychological evaluation. Also, Bethel et al. [26] showed the potential of using social robots for disclosing occurrences of bullying from children. None of these works has investigated how children's anxiety towards the robots influenced their perceptions.

B. Psychological measures in HRI

There are many psychological scales that have been developed that measure users' perceptions, rapport, expectations and attitudes in order to evaluate their HRI experience. For example, the Robot Anxiety Scale (RAS) [17], the Godspeed questionnaire [18], the Negative Attitude Towards Robots (NARS) [27] and the Robotic Social Attributes Scale (RoSAS) [28] have been developed to measure users' anxiety attributed to the robot, their assessment of the HRI experience, participants' attitude towards robots and users' evaluation of their interaction, respectively. Child-specific scales [14], [29] have also been developed to measure children's trust, closeness, social support and openness with respect to the robot in a CRI setting. In addition, previous works have also used adapted versions of standardised psychological instruments from HRI literature to enable compatibility with CRI studies [30]–[32].

C. Child anxiety towards robots

Many studies in HRI have investigated anxiety attributed to robots [9], [10]. However, most of these studies [9], [10] that have investigated anxiety towards social robots predominantly involved adults, with very few works [11]–[14] focusing on children. Children have significantly distinctive and developing cognitive systems as compared with adults, often attributing living characteristics to robots rather than viewing them as mechatronic tools [15]. In addition, studies that do focus on children's anxiety towards robots have mostly incorporated opinions from parents, teachers and other stakeholders that primarily drive the research findings [13], [16]. Very few studies focus on children's outlooks [12], [14], but these have not investigated how anxiety towards robots has affected their perception and evaluation of the robot's role, behaviour and capabilities. Thus, in order to develop robots that could be used as tools in mental wellbeing assessment, it is important to understand the effect that robots have on children's perception and evaluation of robots' roles, capabilities and behaviour. This is vital in designing effective and successful robot-driven technologies that account for the children's mindset and attitudes, especially for use in mental wellbeing assessment and other sensitive healthcare-related avenues.

III. Research Questions

Self-disclosure in children is known to be influenced by their attitude towards therapists [33], mental health applications [34], and even online support groups [35]. Thus, in the context of robot-assisted assessments of mental wellbeing, this work aims to understand whether and how children's anxiety towards the robot has affected their perception of the robot. Firstly, we investigated whether children feel anxiety towards the robot **(RQ1)**. Specifically, in the context of our study on wellbeing assessment, we wanted to investigate whether children's levels of mental wellbeing have any relation to the anxiety towards the robot **(RQ1.1)**. Previous works [27], [36] have also investigated how anxiety towards robots has affected users' willingness to take part and be involved in the interaction. Thus, in this work, we have investigated how children with varied levels of anxiety attributed to the robot have differed in their responses and the initial pleasantries (i.e., touching the robot, watching the robot perform certain actions and making small talk) conducted by the robot (**RQ2**). Though past studies [31], [32] have investigated children's perceptions of robots, to the best of our knowledge, no study has looked into how robot anxiety has affected the children's perceptions of the robot's behaviour and capabilities and the evaluation of the robot as a confidante (**RQ3**). Since the main objective of the study was to investigate robots as tools for wellbeing assessment, we have investigated how children belonging to varying levels of robot anxiety have differed in their evaluation of the robot as a confidante (**RQ3.1**). In addition, we have also explored how anxiety attributed to the robot has affected children's perceptions of the intelligence and the likability of the robot and its behaviour and capabilities (**RQ3.2**).

IV. Materials and Methods

A. Experiment protocol

Participants: We recruited 41 participants (21 females, 20 males) for the study. Four participants were excluded from this work as they did not complete the user perception and evaluation questionnaires conducted at the end of the interaction session. Thus, we collected data from about 37 children (19 females and 18 males) between the ages of 8-13 years old (M =9.59 years old, SD= 1.48 years old) who interacted with the Nao robot in an in-lab setting. The study was approved by the University of Cambridge Psychology Research Ethics committee and informed and written consent was shared with and signed by children's guardians prior to the study. The children were recruited via adverts circulated in the schools and snowball sampling using the contacts in the research team. Participants were excluded if they had any existing psychological conditions declared by their guardians.
Setup: We used the Nao humanoid robot[1] from Softbank Robotics for the study. The robot followed a pre-scripted interaction with relevant movements while conducting the sessions. The experiment setup consisted of a sound-proof

[1]https://www.aldebaran.com/en/nao

room where the robot sat on a table in a crouching position, about 1.5 m away from the children, and a screen which acted as a visual aid, placed behind the robot. The sessions were audio and video recorded using microphones and cameras placed in the interaction room. Details of the study design can be found in [8].

Experiment tasks: First, the child entered the room and was comfortably seated in the experiment room. Then, the experimenters explained the housekeeping rules (e.g., regular breaks, and stopping/skipping parts of the interaction) for the session but did not disclose the experimental task to avoid priming the participants. Then, the robot delivered an initial pleasantries activity, as described in [8]. This consisted of the robot introducing itself and asking for the child's name and describing the experiment session and asking whether the child would like to give it a fist bump and see the robot wipe its forehead. The child could respond by pressing the right toes of the robot for a "yes" and the left toes of the robot for a "no". In order to ensure a certain level of participation from every child, the robot also conducted activities for which the yes/no options were not provided. For example, the robot asked the children to press any of its toes to know its favourite colour and to touch its arms to tickle it. This phase concluded with the robot asking about the child's day ("Are you having a good day today? Can you please tell me about your day?"). The robot waited for about 2 seconds after which it prompted the child with an "uhuh" in order to stimulate a more naturalistic conversation flow. After that, the robot delivered four different tasks, described in detail in [8]. These tasks included (i) recalling a recent happy and sad memory, (ii) the Short Moods and Feelings Questionnaire (SMFQ) [37], (iii) a picture task inspired by the Child Apperception Test [38], (iv) certain subscales from the Revised Child Anxiety and Depression scale (RCADS) [39]. When children finalized their interaction with the robot, the experimenters entered the room to conduct three questionnaires that measured respectively i) children's evaluation of the robot as a confidante, ii) the anxiety attributed to the robot, and iii) the children's perception of the robot's behaviour and capabilities. For administrating the questionnaires, the experimenters read aloud the statements of the questionnaire, and children provided their responses by raising one of the printed papers (e.g., for the robot as confidante questionnaires we provided them with five papers with numbering from 1 to 5). Missed/incorrect responses were replaced with the mode value of the questionnaire under consideration ($\approx 0.003\%$ of responses).

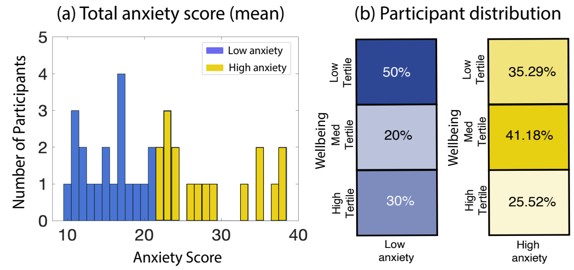

Fig. 1: (a) Participants were divided using their responses to the Anxiety measurement into two categories: "Low Anxiety" (Anxiety score <= Median Anxiety score) and "High Anxiety" (Anxiety score > Median Anxiety score). (b) Distribution of the population across the two anxiety clusters ("low anxiety" and "high anxiety") and the three wellbeing clusters ("low tertile", "med tertile" and "high tertile").

B. Measurements

In this study, we collected the following measurements:

(1) Initial pleasantries: A member of the research team looked over the video recording of the experimental session to determine the number of the children who had fist bumped the robot, said yes to watch it wipe its forehead, responded after the prompt from the robot and had provided details about their day. A member of the research team also transcribed the audio recordings using DeepSpeech software [2] in order to investigate the themes that the children delved into while describing their day. Errors in the transcription were tweaked manually by the experimenters.

(2) Robot as a confidante: We were inspired by the questionnaire in [19] to investigate the role of the robot as a "listener". We excluded statement 10, i.e., talking with the robot was similar to talking with a stranger, the frequency questions and the open-ended questions to enable better understanding by the children. The response ratings corresponded to the Likert ratings: (1) Strongly dislike, (2) Somewhat dislike, (3) Neither like nor dislike, (4) Somewhat like, and (5) Strongly like. The participants were instructed to raise the response rating that they thought was the closest to what they felt in response to the questionnaire items. These questionnaire items can be seen in Fig. 3.

(3) Children's anxiety towards the robot: We were inspired by the RAS [17] to measure the anxiety attributed to the robot. For the purpose of our experiments, we simplified the language of statement 3 from "the robot may be unable to understand complex stories" to "the robot may be unable to understand my stories". Statement 10 was also modified to enable better understanding from "Whether the robot understands the contents of my utterances to it" to "Whether the robot understands what I am saying". Finally, statement 11 was adapted from "I may be unable to understand the content of the robot's utterances to me" to "I may be unable to understand what the robot is saying". The response ratings corresponded to the following: (1) I do not feel anxiety at all, (2) I hardly feel any anxiety, (3) I don't feel much anxiety, (4) I feel a little anxiety, (5) I feel much anxiety, and (6) I feel anxiety very strongly.

(4) Children's perception of the interaction: We took inspiration from the Godspeed questionnaire [18] to understand the user perception of the robot's behaviour and capabilities. For this purpose, we measured user perception from the likability and the perceived intelligence subscales

[2] https://github.com/mozilla/DeepSpeech

of the Godspeed questionnaire as these sections were easier to understand for the children. The response ratings for this questionnaire ranged from one to five with one corresponding to the negative trait (for example "Awful") and five corresponding to the positive trait (for example "Nice").

We computed Cronbach's alpha in order to measure the internal consistencies of the children's responses (adequate reliability $\alpha > 0.6$ [40], [41]). This was done to ensure that the responses were not random and coherent with the items of the questionnaires.

C. Data analysis

Data clustering: We categorised the participants according to their responses to the robot anxiety measurement. Participants that scored lower than or equal to the median anxiety score were marked in the "low anxiety" category while participants that scored higher than the median anxiety score were marked in the "high anxiety" category. In addition, we also clustered the participants into three wellbeing categories (using tertile categorisation as defined in [8]) in accordance with their responses to the SMFQ. The SMFQ provides a clinical threshold of depression in children [37]. Thus, the children in the low and med tertile are highly unlikely to be suffering from depression while some children in the high tertile might have a diagnosis of depression.
Thematic analysis: We followed a data-driven thematic analysis approach for analysing the qualitative data obtained from the children's descriptions of their day. We employed the grounded theory approach [42] where the identified themes were not pre-defined but based on the data collected.
Statistical analysis: We used non-parametric statistics as our data did not follow a normal distribution (using the Kolmogorov–Smirnov test). We used a chi-square test of independence to investigate the relationship between the wellbeing of the participant (between low, medium and high tertile) and their anxiety ("low anxiety" and "high anxiety") attributed to the robot. We used Wilcoxon rank sum tests to conduct between-subject comparison among the two classes of anxiety (i.e., "low anxiety" and "high anxiety") for their responses to the evaluation of the robot as a confidante and their perception of the robot's capabilities and behaviour.

V. Results

A. Relationship between anxiety and wellbeing

We clustered participants into two categories based on their responses to the robot anxiety measurement (Cronbach's $\alpha = 0.86$, Fig. 1 (a)). Children belonging to the "low anxiety" category (20 children) had anxiety scores less than or equal to the median anxiety score (21) while children belonging to the "high anxiety category" (17 participants) had anxiety scores greater than the median anxiety score (21). The wellbeing-based tertile clustering (Cronbach's $\alpha = 0.84$) resulted in about 16 participants in the low tertile (SMFQ score <=2), 11 participants in the med tertile (2 < SMFQ score <= 4) and 10 participants in the high tertile category (SMFQ score >4). We also observed that most participants (about 89.2%), irrespective of their wellbeing

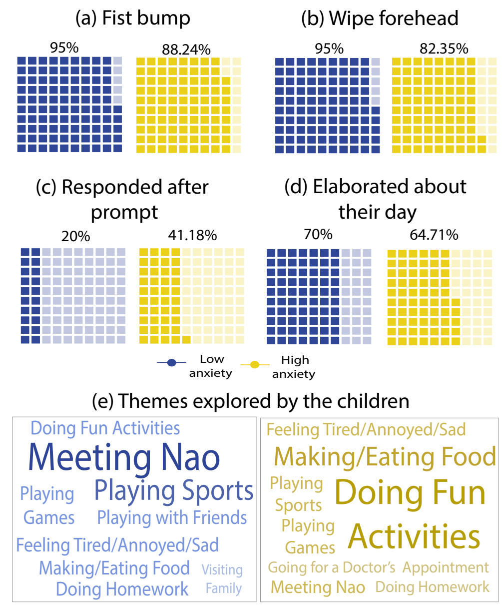

Fig. 2: Children's responses to the initial pleasantries by the robot ("low anxiety" vs "high anxiety" group).

had attributed some degree of anxiety towards the robot (total anxiety score $>$ 11 (lowest score)). The participants that did not experience any anxiety towards the robot (i.e., their anxiety measurement was the lowest possible response rating (11)) mostly belonged to the low tertile (3 participants). Only one participant who did not report any anxiety towards the robot belonged to the high tertile of mental wellbeing. We also observed (Fig. 1(b)) that about 50% of the participants in the "low anxiety" category were also a part of the low tertile group of wellbeing. This is not the case for the "high anxiety" category, as about 35.29% belong in the low tertile. The highest amount of participants from the high anxiety category (41.18%) was part of the med tertile category. However, the Chi-square test of independence showed that there was no statistically significant relationship between the wellbeing of the participants and the anxiety towards the robot ($\chi^2 = 1.99, p = 0.37$), i.e., wellbeing of the participant is independent of their anxiety towards the robot.

B. Effect of robot anxiety on initial pleasantries

Our results show that children in the "low anxiety" category were less hesitant in being involved in the initial pleasantries conducted by the robot (see Fig. 2). Specifically, more children (about 95%) in the "low anxiety" category gave a fist bump to the robot (Fig. 2 (a)) as compared with the "high anxiety" category (about 88.24%). They were also more interested (about 95%) in watching the robot wipe its forehead (Fig. 2 (b)) in comparison with the "high anxiety" category (about 82.35%). Only 20% of the children in the "low anxiety" category waited for the prompt to respond to the robot's question about their day (Fig. 2 (c)) as compared with the "high anxiety" category (41.18%). Finally, about 70% of the children from the "low anxiety" category provided details about their day in comparison with

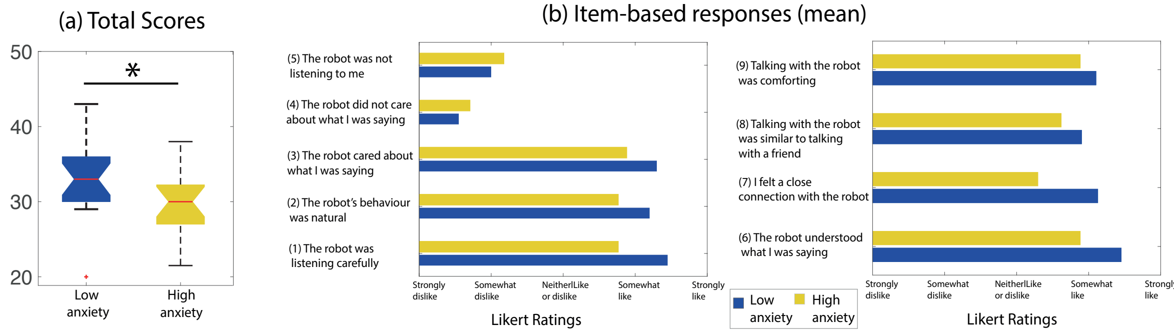

Fig. 3: Response ratings of the user's evaluation of the robot as a confidante have been shown for the "low anxiety" and the "high anxiety" categories. $*p < 0.05, **p < 0.01$

the "high anxiety" category (about 64.71%). The remaining children (30 % in the "low anxiety" category and 45.39 % in the "high anxiety" category) did not elaborate on their day (Fig. 2 (d)) and responded with statements like, "Yes, I am having a good day" or "This is a good day but I don't really know what to say more". Based on their descriptions, we identified about 10 themes that the children delved into while describing their day. In the case of the children belonging to the "low anxiety" category, children explored positive themes like (i) Playing sports (3 children, e.g., "I went swimming"), (ii) Playing games (2 children, e.g., "I have been playing crash of cars"), (iii) Doing fun activities (2 children, e.g., "I drew a little bit"), (iv) Making/Eating food (2 children, e.g., "I ate breakfast"), (v) Meeting Nao (4 children, e.g., "We came for the robot study and it is pretty cool"), (vi) Visiting Family (1 child, e.g., "I have been at my Grandpa's house"), and (vii) Playing with friends (2 children, e.g., "I went to school and I played with some friends"). They also delved into one neutral theme like- Doing Homework (2 children, e.g., "I did some homework") and one negative theme - Feeling tired/annoyed/sad (2 children, e.g., "I am really sad because my dad left to go to California for some work"). For the children belonging to the "high anxiety" category, children delved into positive themes like (i) Playing sports (2 children, e.g., "I was riding a bike"), (ii) Playing games (2 children, e.g., "I played some games"), (iii) Doing fun activities (5 children, e.g., "I went for choir this morning"), (iv) Making/Eating food (4 children, e.g., "I am having chicken fajitas for dinner"), and (v) Meeting Nao (2 children, e.g., "I am basically here and then I am going to go home"). They also delved into neutral themes like- (i) Doing Homework (1 child, e.g., "We had this homework where we are learning about World War II and about rationing"), and (ii) Going for a doctor's appointment (1 child, e.g., "I had a dentist appointment") and one negative theme - Feeling tired/annoyed/sad (2 children, e.g., "I am kind of tired").

C. Effect of robot anxiety on the perception of the robot's role, behaviour and capabilities

As seen from Fig. 3 (a), the Wilcoxon rank sum test indicated statistically significant differences ($W = 445.5, Z = 1.99, p = 0.047$) between the "low anxiety" ($Mdn = 33$) and the "high anxiety" ($Mdn = 30$) categories for total score computed from the questionnaire of the robot as a confidante (Cronbach's $\alpha = 0.67$). The item-based responses (Fig. 3 (b)) also show that children belonging to the "low anxiety" category have higher response ratings for all items (except for the inverse items) as compared with the children belonging to the "high anxiety" category. Regarding the Godspeed questionnaire, we computed corresponding sub-variables: likability (Cronbach's $\alpha = 0.82$) and perceived intelligence (Cronbach's $\alpha = 0.76$). Wilcoxon rank sum test indicated statistically significant differences ($W = 469, Z = 2.78, p = 0.006$) between the "low anxiety" ($Mdn = 25$) and the "high anxiety" ($Mdn = 23$) categories for overall likability of the robot (see Fig. 4). Further, a Wilcoxon rank sum test also indicated statistically significant differences ($W = 460.5, Z = 2.45, p = 0.01$) between the "low anxiety" ($Mdn = 23.5$) and the "high anxiety" ($Mdn = 20$) categories for overall perceived intelligence of the robot. We also observed from the item-based responses (Fig. 4 (b)) that the children belonging to the "low anxiety" category have consistently provided higher response ratings in relation to the likability and the perceived intelligence of the robot as compared with the children belonging to the "high anxiety".

In summary, we observed that most children, irrespective of their level of wellbeing, experience some degree of anxiety towards the robot and that the wellbeing of the child is independent of their anxiety attributed to the robot. Further, a higher number of children in the "high anxiety" category are hesitant to take part in the initial pleasantries with the robot than children from the "low anxiety" category. In terms of user evaluation of the robot as a confidante, we observed that children with perceived varying levels of robot anxiety differed in their evaluation of the robot as a confidante, with the "low anxiety" group providing consistently higher response rating (except for the inverse items) as compared with the children belonging to the "high anxiety" category. Finally, we have also observed that children in the "low anxiety" category have a more lenient outlook on the robot's likability and perceived intelligence. It is also important to note that the internal consistencies of all the responses (computed using Cronbach's alpha) discussed above were found in the acceptable range ($\alpha > 0.6$ [40], [41]), showing

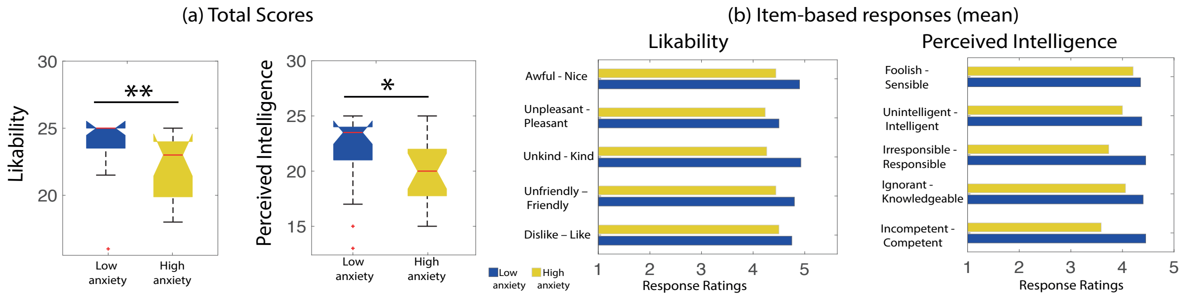

Fig. 4: Response ratings of the users' perception of robot's behaviour and capabilities have been shown for the "low anxiety" and the "high anxiety" categories. $*p < 0.05, **p < 0.01$

that the responses of the children were not random and consistent with the items of the questionnaires.

VI. Discussions

A. Do children feel anxiety towards robots during the robot-aided assessment of their mental wellbeing? (RQ1)

Our results have shown that most children (89.2%), irrespective of their wellbeing, feel some degree of anxiety towards robots (RQ1). This could be caused due to hesitation in participation, their mindset about robots or even their opinion on the interaction experience. Mehenni et al. [43] have shown that children are, at times, hesitant to participate in CRI sessions. However, regular exposure to robots can help overcome any hesitancy and even improve any of their predispositions [44]. We have also observed that the wellbeing of the participants is independent of their anxiety attributed to the robot (RQ1.1). Wellbeing of children is a very broad psychological construct and can be influenced by multiple factors ranging from social isolation from peers, familial issues, academic pressures, financial restrictions and even physical inabilities [45], [46]. In comparison, anxiety towards robots is a more specific concept and can be caused due to past experiences, less exposure or even having negative opinions of the robots [47], [48]. While wellbeing of children is a representation of their psychological health [45], [46], anxiety towards robots could be primarily derived from their outlook on technology [47], [48].

B. How does anxiety towards the robot affect the children's responses to the initial pleasantries with the robot? (RQ2)

Our results have shown that a higher number of children in the "high anxiety" category are more hesitant to speak, touch, and interact with the robot. We have also seen that a higher number of children belonging to the "low anxiety" category did not wait for prompts from the robot to carry out their conversation and willingly offered details about their day. Similar phenomena have also been observed in HRI literature with adult participants where negative attitudes and anxiety towards robots have affected the amount of time spent conversing with the robot [27], [36] and touching the robot [27]. Nomura et al. [49] have also shown that robot anxiety affected the social distance maintained between the robot and the participants. Kanero et al. [10] have also observed that anxiety towards robots has affected robot-driven learning in adults. Thus, from our study, we find that robot anxiety affects children's interaction with the robot in the context of physically touching the robot, watching the robot perform certain actions, needing to converse with the robot, requiring prompts and being more reluctant to have detailed conversations. We have also observed that for many children in the "low anxiety" category, the highlight of their day was "meeting Nao" which was not the case for the children in the "high anxiety" category. This could be due to the excitement elicited by this novel experience of getting acquainted with the robot for those children who did not hold many predispositions to robots. Studies have shown that children find robots very engaging and exciting [50] as compared to traditional screen-based tools [51]. Robots have also been successfully employed as social companions for children [52]. Studies have also shown that robots can be used as mood enhancers [53] and for alleviating stress in children confined in hospital rooms [54]. An interesting observation is that some children that did belong to the "high anxiety" group still tried to converse with the robot despite their disinclinations. This implies that for wellbeing-related assessments, robot-led technologies could be potentially used to promote increased participation from children, irrespective of their perspective on robots.

C. How does robot anxiety affect the children's perception of the robot's role, capabilities and behaviour? (RQ3)

As seen from Fig. 3 (RQ3.1), we have observed that robot anxiety affects children's evaluation of the robot as a confidante. We can also observe that children belonging to the "low anxiety" category have consistently had a higher opinion of the robot as compared to their counterparts in the "high anxiety" category. Kanero et al [10] have shown similar observations in a robot-driven learning paradigm where the general attitudes towards robots have affected learning outcomes in adult participants. This finding is instrumental in designing future robot technologies for mental wellbeing assessment of children as robot-led assessments might be impacted by how comfortable the children feel with the robot. Further, as seen in our work (RQ3.2, Fig. 4), we have observed that children belonging to the "high anxiety" category have a stricter judgement of the robot's behaviour and capabilities. These children have consistently provided lower ratings for all aspects of likability and perceived intelligence for the study questionnaire, with the least rating provided for the competency of the robot, followed by the sense of responsibility in the robot. This finding gives us a unique perspective on the children's mindset about robots performing mental wellbeing assessments and whether they consider them to be responsible and competent agents that they can rely on, disclose sensitive information to or in general trust them enough to divulge their feelings. However, we cannot conclude whether anxiety was the cause of this perception or vice versa because the questionnaire was administrated at the end of the interaction.

An important aspect to consider is why some children are more apprehensive of the robot's capabilities and behaviour as compared with others who are more comfortable and accepting. Studies have shown that the media coverage of robots does influence people's expectations of the robots. For instance, Sandoval et al [55] have shown that fictional representations of robots often drive people's expectations of robots, and a perceptible mismatch has been observed between what the robots today are capable of achieving in comparison with what the movies feature. In addition, Horstmann et al. [47] have shown that media portrayals of robots have heightened peoples' expectations of robot capabilities; negative portrayals have increased negative attitudes towards robots amongst the public. This could have contributed to the formation of existing outlooks in relation to robots, leading to some children being more apprehensive of the robot ("high anxiety" category) as compared with their "low anxiety" counterparts, who are more open and accepting of the robot. However, Conti et al. [44] have shown that exposure to robots has improved discomfort caused by the robot and sometimes even led to forming positive opinions about the robot in kindergarten children. Thus, longitudinal interactions with multiple robot sessions need to be conducted in order to understand whether and how children's perspectives towards robots vary in the context of wellbeing assessments.

VII. Conclusions & Future work

In this work, we have analysed the children's perception of a Nao robot during a robot-aided assessment of their mental wellbeing to understand how anxiety towards the robot affects initial pleasantries, evaluation of the robot's role as a confidante and the perception of the robot's capabilities and behaviour among children. We observed that most children, regardless of their wellbeing, experience some degree of anxiety towards the robot and that their wellbeing is not related to their anxiety towards the robot. We also found that a higher number of children that belonged to the "high anxiety" category were hesitant in touching the robot, watching the robot perform certain actions, requiring prompts and being less willing to elaborate on their day. Further, children in the "low anxiety" category have a higher opinion of the robot as their confidante and a more lenient judgement of the robot's likability and perceived intelligence. Our future work will investigate understanding not only self-reported verbal responses but also non-verbal behaviours to obtain a more holistic understanding of robot-aided assessments of children's mental wellbeing.

Acknowledgments: N. I. Abbasi is supported by the W.D. Armstrong Trust PhD Studentship and the Cambridge Trusts. M. Spitale and H. Gunes are supported by the EPSRC project ARoEQ under grant ref. EP/R030782/1. All research at the Department of Psychiatry in the University of Cambridge is supported by the NIHR Cambridge Biomedical Research Centre (BRC-1215-20014, particularly T. Ford) and NIHR Applied Research Centre (P. Jones, J. Anderson). J. Anderson, T. Ford and P. Jones acknowledge support from the NIHR ARC East of England and the Cambridge BRC. The equipment used in the study was supported by the University of Cambridge's Human Machine Collaboration (OHMC) Small Equipment Funding. The views expressed are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care.

Data Access: Overall statistical analysis of research data underpinning this publication is available in the text of this publication. Additional raw data related to this publication cannot be openly released; the raw data contains transcripts of interviews, but none of the interviewees consented to data sharing.

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