Come Closer: A Social Bench to Measure Children's Interaction with Robots

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Abstract. As social robots enter educational and public settings, understanding how children perceive and engage with them becomes crucial. This study introduces the Social Bench Tool, an interdisciplinary measure adapted from social psychology to assess children's implicit attitudes toward robots. In the task, children choose where to sit on a bench next to a humanoid robot, revealing interpersonal orientation toward it. We tested a digital version in a pilot study with adolescents and implemented a physical version during a public event with children. Preliminary results from the digital study suggest participants sat closer to the robot after interacting with it. Observations from the physical setup support the tool's potential as a behavioral measure in more naturalistic contexts. The Social Bench Tool offers a simple, intuitive way to complement self-reports in Child-Robot Interaction research.

Keywords: Children-Robot Interaction · Measure · Humanoid Robot

1 Introduction

Research on Child-Robot Interaction (CRI) is gaining traction within the broader field of social robotics, especially considering its applications in the educational field [2]. Consequently, the development of appropriate tools to interpret children's perceptions and behaviors toward robots is increasingly necessary. Conventional self-report measures, while informative, often rely on verbal and metacognitive abilities that vary widely across developmental stages. Younger participants may struggle to articulate their attitudes explicitly, which can limit data interpretability and comparability [3]. To address this issue, researchers have advocated for more accessible and developmentally appropriate techniques, such as graphic or spatial representations of constructs [12].
In this context, we propose an innovative measure: the **Social Bench Tool (SBT)**, specifically designed for CRI. This tool draws inspiration from the Social Exclusion Bench Tool [8], a social psychology self-report method, where

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participants indicate where they would sit on a bench already partially occupied by a member of a stigmatized group (e.g., an immigrant). This allows researchers to assess implicit prejudice through physical distance. Inspired by this, the SBT presents a bench with the humanoid robot iCub [9] seated on one side, allowing us to gather indirect indications of children's attitudes toward the robot. Participants are asked to choose where they would sit, providing a non-verbal indication of attitudes toward the robot. To validate the SBT, we ran one pilot studies during school's Open Day at the Italian Institute of Technology, in which adolescents completed the digital SBT before and after interacting with iCub. Moreover, at another Open Day, elementary kids met iCub and chose seats on a real bench, letting us observe their natural seating behavior.

2 Background

Research has consistently shown that social interactions are crucial for supporting human learning, enhancing both cognitive and emotional outcomes [7]. Recently, evidence has emerged suggesting that some of these benefits can extend to interactions between children and social robots [6]. This is largely attributed to the physical embodiment of robots [15], which sets them apart from traditional learning technologies like tablets or computers [2]. Compared to virtual agents, physically embodied robots have been found to foster greater engagement and creativity [1], potentially leading to improved learning outcomes [7]. Despite this potential, the precise impact of robot behaviors on children remains unclear [13]. Some studies indicate that social behaviors in robots support learning [10], while others suggest they may distract young users [14].

To design effective educational applications, it is crucial to consider children's expectations and how their perceptions of robots change through interaction. In a previous study [5], we showed that children's acceptance of the robot NAO before interaction predicted how pleasing they found the experience. This highlights the value of self-reports in understanding CRI in educational settings. Furthermore, Sciutti et al. [11] found that younger children initially focus on a robot's appearance, but interacting with iCub shifts their attention to its functions, while older children already prioritize functionality. This demonstrates that direct experience can reshape children's perception of robots. The field of CRI, however, still lacks standardized tools to measure how children implicitly evaluate robots, especially in naturalistic and long-term settings [4]. Most studies use self-reports or behavioral observations, which may miss children's spontaneous attitudes—especially when verbal skills are limited. To overcome this, researchers advocate for intuitive, engaging methods to assess children's perceptions and social preferences.

3 Social Bench Tool implementation

To address the limitations outlined above, we conducted a pilot study during the School Open Days at the Italian Institute of Technology to test the digital version of the SBT. We then implemented the physical version in a similar setting. In the following sections, we first describe the testing of the digital version, followed by the implementation of the physical one.

3.1 Experimental Study: Digital Bench Tool

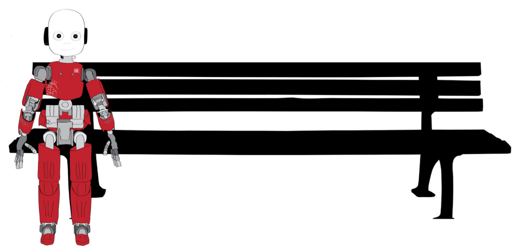

Fig. 1. Digital version of the Social Bench Tool

The study was approved by the Liguria Regional Ethics Committee. Parents or legal guardians gave informed consent. Forty-five Italian teenagers (Age: μ = 17.3, σ = 1.14; gender: M = 33, F = 12) were invited to visit the experimental lab hosting the humanoid robot iCub. Before the interaction with the robot, they were asked to sit in front of a laptop displaying the SBT, with the robot iCub seated, as shown in Fig. 1. The program was implemented in HTML and displayed a static image (size: 1280×635 pixels), replicating the format and dimensions used in the original version of the tool. Participants were asked to respond to the following prompt: "*Imagine you are in a park. The robot iCub is seated on this bench. Please indicate where you would like to sit in the scene by clicking with the mouse.*". Afterward, they attend a 5 minute self-introduction by the robot iCub, which in the Lab explained briefly its functional capabilities and how it can interact socially with the environment. Finally, they completed the bench again.

Similarly as what was done in the previous version of the tool [8] we identified iCub's centroid $(x_{\text{icub}}, y_{\text{icub}})$ as a reference point to measure the distance from participants' positions $(x_{\text{part}}, y_{\text{part}})$. Distances were calculated using the Euclidean distance formula (Eq. 1):

$$d = \sqrt{(x_{\text{icub}} - x_{\text{part}})^2 + (y_{\text{icub}} - y_{\text{part}})^2} \quad (1)$$

By calculating the distance between each participant's chosen position and the robot's position, we obtained a measure of physical proximity in pixels. We conducted a series of Wilcoxon Paired Sample tests over this data to test a difference between the pre- and post-interaction positions. Analyses were conducted on the open source software Jamovi [5].

[5] https://www.jamovi.org/

Results demonstrated a significant shift in participants' behavior following the interaction with the robot (Wilcoxon Signed-Rank test, $p = .0003$), with an average reduction in distance of approximately 9.08%. Participants' attitudes were categorized into five classes based on their horizontal distance from the robot, using an ordinal classification inspired by a Likert-scale structure. The observed distance ranged from 166 to 1117 pixels and was divided into five equal intervals. The distance-based categories were thus defined as follows: Distant (1): 1117–927 pixels; Far (2): 926–736 pixels; Intermediate (3): 735–545 pixels; Near (4): 544–354 pixels; Close (5): 353–166 pixels. The mean of class distribution was 4.29 ± 0.86 before the interaction and 4.42 ± 0.90 after the interaction. On average, participants tended to be positioned in the near-to-close range, with a slight shift toward closer proximity after the interaction.

3.2 Physical Implementation: the Real Bench Tool

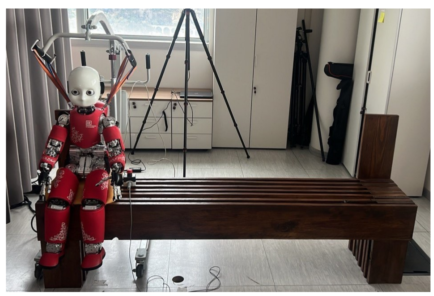

Fig. 2. Wooden version of the Social Bench Tool implemented in the lab

A physical version of the bench was built using wood, measuring 2 meters in length, 90 cm in height, and 38 cm in depth, replicating the appearance and proportions of the digital version used in the SBT. The humanoid robot iCub was positioned on the bench using a lifting device, as shown in Figure 2.

This physical setup was placed in our laboratory and made available during a public and Open Day event, which included a visit from local elementary schools (authorized by parents or legal guardians). Due to the nature of the event, no formal data collection was conducted, and we were not able to record detailed demographic information. However, we estimate that approximately $N = 140$ children aged between 7 and 10 visited the lab in small groups of about 15, each accompanied by teachers.

Although this initial implementation did not follow a structured observational protocol, the first author made informal observations during the school visit to explore how children spontaneously engaged with the physical bench and robot. The aim was to assess the ecological validity and potential of the tool for future studies in CRI. The following patterns were noted:

– Children generally responded with enthusiasm toward the robot: some chose to sit very close to it, while others preferred to keep a greater distance or sat on alternative chairs available in the room.
– Teachers occasionally expressed concern about the robot being touched or damaged and instructed children to avoid close proximity. This suggests that adult presence and norms may influence children's choices and should be carefully considered in future implementations.
– Differently from the digital version, children entered the room in groups, and not all could sit on the bench at once. This introduced group dynamics and spatial constraints, which may have affected behavior and should be accounted for in future designs.

While preliminary and anecdotal, these observations indicate that the physical version of the bench is a promising tool to evoke meaningful approach behaviors toward social robots. Based on this experience, we plan to design and conduct structured studies using the real bench, with appropriate methodological controls and ethical approval.

3.3 Conclusions

We presented a preliminary study showcasing the potential of a new research method. The SBT offers a simple and adaptable way to explore young users' perceptions of social robots. With both digital and physical versions, it can be used in various settings and is compatible with any robot that can (physically or *graphically*) sit on the bench. We used the digital SBT in two different contexts: a pilot study with teenagers and an exploratory implementation with younger children. These age groups were based on participants who spontaneously took part during Open Day events, where we had limited control over recruitment. In future studies, the SBT will be implemented with a more homogeneous age sample. We plan to validate the digital version by examining its correlation with established self-report measures in CRI, to strengthen its reliability. Future work will also explore different types of interactions with the robot, both in controlled laboratory settings and in more ecologically valid contexts such as schools, using video-based stimuli. Additionally, we will develop an experimental protocol for the physical bench, including systematic coding of children's behavior and measurement of their physical proximity to the robot. Overall, the SBT shows promise as a scalable and easily deployable method for assessing social distance and affinity toward robots, contributing to both research and design in CRI.

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