Don’t Touch Me There! Comfortability with Robot Touch Across Different Roles and Settings

Grace Pan
Department of Robotics
University of Michigan
Ann Arbor, Michigan
gracepan@umich.edu

Gurnoor Kaur
Department of Robotics
University of Michigan
Ann Arbor, Michigan
gurnoork@umich.edu

Patricia Alves-Oliveira
Department of Robotics
University of Michigan
Ann Arbor, Michigan
robopati@umich.edu

***Abstract*—Physical human-robot interaction is an evolving field that explores the role of robotic touch and its effects on human perception, trust, and comfort. Our study investigates how comfortability with robot touch varies across five roles (future of work, domestic life, romantic partnership, medical care, and education/culture) and five robot embodiments (mechanical, humanoid, animal-inspired, android, and functional). By using storytelling vignettes and body-mapping tasks, we found differences in touch comfortability, with medical and romantic partner robots eliciting the highest comfort levels. We also discovered gender differences, with males reporting greater comfort in receiving robot touch across all robot roles. Notably, participants preferred the animal-inspired embodiment and consistently indicated higher comfortability with imagined human touch compared to robot touch. These findings highlight the importance of evaluating robot touch within diverse social contexts and embodiments, offering insights for designing socially acceptable touch interactions that generalize to real-world HRI applications.**

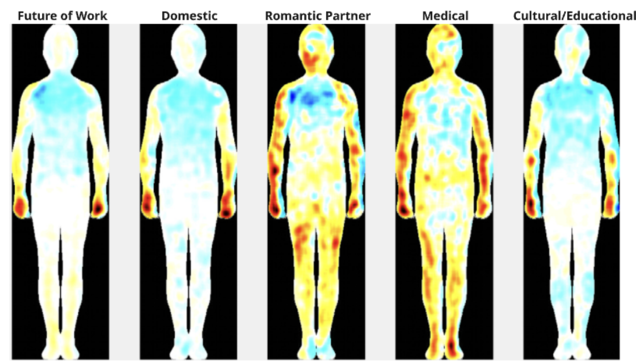

Fig. 1. Heatmaps illustrating comfortability with robot touch for each of the storytelling portions. The cool tones on the heatmaps correspond to the back of the body outline, whereas the warm tones correspond to the front. The darker the color, the more comfortability with robot touch in that region. The white areas indicate no comfortability.

I. Introduction

Physical touch is valuable due to its profound role in human development and social bonding. Human touch promotes well-being, reduces stress, and fosters trust and cooperation [19, 21, 17, 11, 14], and emerging evidence suggests that robotic touch can similarly encourage prosocial behavior and trust [9, 25, 26, 27, 20, 15]. Thus, it becomes important to study physical human-robot interaction (pHRI) to improve touch interactions between humans and robots. Past literature has shown that even the nature of touch —affective versus instrumental— and the perceived intent behind it may shape human responses [18, 5, 6]. In recent years, researchers have investigated not only touch allowance but comfortability with physical robot touch. Redondo et al. [23] defined “comfortability” to mean “(disapproving of or approving of) the situation that arises as a result of a social interaction which influences one’s own desire of maintaining or withdrawing from it. However, discovering if comfortability with robot touch varies across regions of a person’s body, the robot’s societal role, and the physical embodiment remains underexplored, particularly across diverse real-world contexts.

Prior research establishes that the nature of interpersonal relationships influences social touch acceptance, with stronger emotional bonds correlating with greater touch allowance [29]. An exception to this may lie within medical touch as it is often perceived as a “ritual,” generally accepted due to its clinical necessity, and is reported to elicit higher touch allowance [7]. More research needs to be conducted to investigate if social bonds and the impact they have in touch within human-human relationships may also be translated to human-robot relationships. Additionally, robot embodiment has been shown to affect user perceptions of competence and trust [12, 4], while robot roles modulate expectations of behavior [24, 16]. Touch acceptance is influenced by these factors combined with perceived intent and context of the robot [5, 18]. However, additional research is needed to study these factors and their joint effect on comfort in pHRI across varying social domains.

Our study investigates comfortability with robot touch through five storytelling vignettes representing distinct robot roles: future of work, medical care, education and culture, domestic life, and romantic partnerships. A vignette is “a

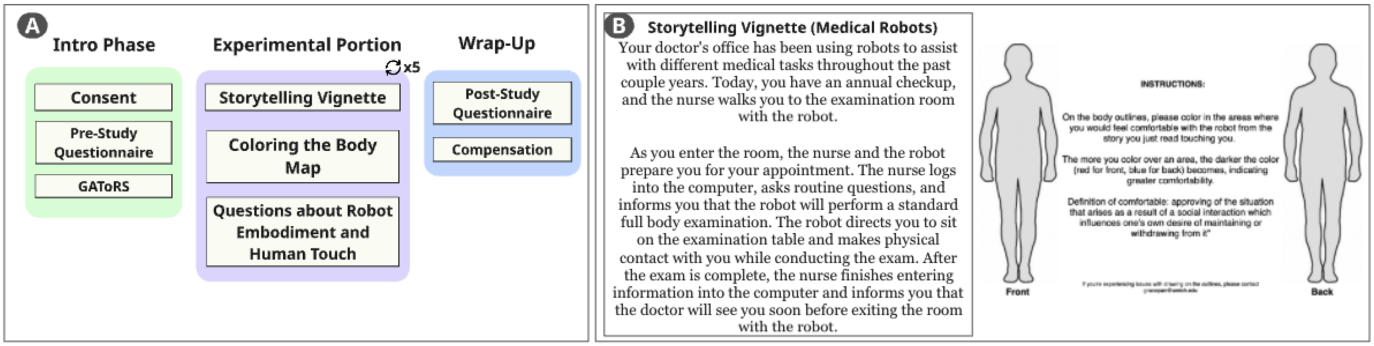

Fig. 2. A) Overview of our study procedure. B) Example of a storytelling vignette that participants saw during the study, and the body outlines they colored in after imagining the touch scenario described.

short, descriptive passage that captures a moment in time" which can describe a setting and enhance mood [1]. We used an online crowdsource study method where participants did not physically interact with a robot, but read the storytelling vignettes and imagined the robot touch in that scenario. Our method aligns with past literature that revealed that imagined or simulated scenarios can elicit emotional and cognitive responses that closely mirror those experienced in real-world interactions [22, 8, 10]. This work addresses a gap in the literature by integrating role, embodiment, and touch comfortability within an ecologically valid experimental paradigm. As the use cases of robots increase and spread to various academic, medical, and professional settings, the establishment of touch parameters has the potential to support HRI researchers to design safer, more comfortable, and intuitive physical interactions.

II. Methodology

A. Sample

Our study was approved by the University of Michigan International review Board (IRB) #HUM00266958. Our sample consisted of 333 participants recruited through Prolific, an incentivized online study platform, and they were compensated five dollars for completing our twenty-minute study. All participants were over the age of 18, currently residing in the United States, and spoke English to ensure they understood the storytelling vignettes.

B. Procedure

A layout of our procedure is provided in Figure 2. Each participant read five storytelling vignettes portraying robots in distinct social roles using the major fields of robotics identified by the Stanford Robotics Center as a guide [2]. After each story, participants colored the front and back of a human body outline to indicate comfort with robot touch in that scenario. In our study, we adopted the definition of comfort provided by Redondo et al. [23] and included it in the instructions given to participants as they engaged with the body coloring tool.

Robot embodiments were introduced after each storytelling scenario: Franka Arm (mechanical), Nao (humanoid), Care-O-Bot (functional), Aibo (animal-inspired), and Erica (android), and were selected from established social robot classifications [3]. Participants reported changes in their comfortability with robot touch when imagining these forms and if the touch came from a human rather than a robot.

Pre- and post-study questionnaires collected demographics, prior experience with robots, attitudes towards robots (via the General Attitudes Towards Robots Scale) [13], baseline comfortability with physical touch, and words participants associated with touch and robot touch. These word associations may serve in developing a new evaluation tool for assessing comfortability with robot touch across different robotic systems.

III. Results

Most of the data collected from the study was analyzed through one-way ANOVA and post hoc tests, t-tests, and heatmap visualizations of body comfort zones.

The average pixels colored in on the body outlines for each storytelling portion was as follows: Story 1 (Future of Work Robots) = 766.59, Story 2 (Domestic Robots) = 766.41, Story 3 (Romantic Partner Robots) = 1124.1, Story 4 (Medical Robots) = 1443.5, Story 5 (Education and Culture Robots) = 683.51. The pixels correspond with the participant's comfortability with touch, i.e., the more pixels colored in, the more overall comfortability with touch. Heatmaps illustrating the differences in comfortability with robot touch across the storytelling portions are shown in Figure 1.

We found that comfortability with robot touch varied significantly for a majority of the storytelling scenarios. We obtained these results by running a one-way ANOVA followed by Tukey's HSD to get pairwise differences between stories, $p < 0.05$. Particularly, we found that Medical and Romantic Partner Robots elicited the highest comfortability ratings, while Future of Work, Domestic, and Education/Culture Robots had lower comfortability ratings. Gender differences in comfortability with robot touch were also prominent: males reported greater comfort with robot touch across all scenarios, with the largest difference in Medical Robots, $p < 0.05$.

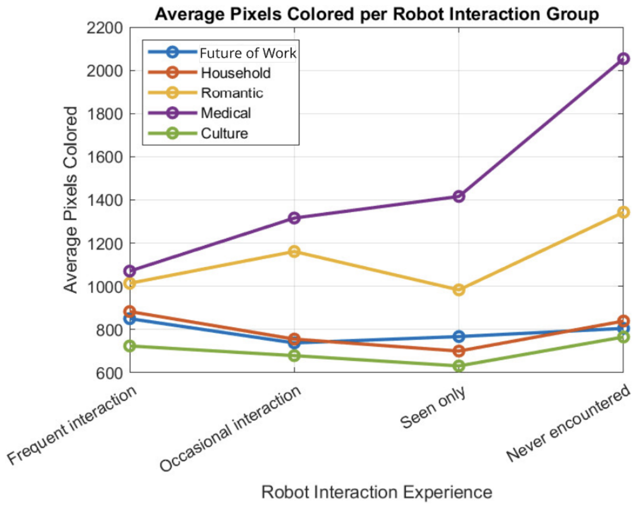

Fig. 3. Participants' prior experience with robots and their responses to comfortability with robot touch. In the Medical Robots condition, there was a statistically significant difference if participants had little to no previous experience with robots.

No significant differences in comfort emerged across participant ages. However, all except participants who were in the oldest age group (ages 51-80), indicated higher comfort in Romantic Partner and Medical Robots scenarios compared to others. In the Medical Robots scenario, participants who had no prior robot experience reported a statistically significantly higher comfortability by coloring more pixels on the body outlines. The correlation between prior experience and comfortability is shown in Figure 3.

Additionally, comfortability with robot touch was correlated positively with baseline attitudes towards physical touch, and the self-reported higher scores on the GATOR questions also tended to report higher comfortability with robot touch across all stories. Embodiment preferences showed a consistent inclination towards the animal-inspired embodiment (Aibo) in all storytelling portions. However, in all the storytelling vignettes, participants generally reported being more comfortable with a human than a robot.

We generated word clouds from the word associations to touch and robot touch. These results are shown in Figure 4. Larger words represent more frequent participant responses. This large data set of word associations may contribute to creating a new questionnaire measuring comfortability with robot touch in the future.

IV. Conclusion

Our methodology was largely informed by a study conducted by Suvilehto et al., which examined social human touch and produced heatmaps indicating acceptable touch areas based on relational closeness [29]. Their results showed that participants were more comfortable being touched by strangers and acquaintances on the hands, arms, and upper back, while other areas were generally considered off-limits. These findings align with our results now applied to the study of pHRI, where participants reported the hands, larger areas of the arms, and upper back as acceptable regions for robot touch, while most other body parts were generally uncomfortable. However, the heatmaps generated from imagined human-human touch in the study by Suvilehto et al. showed a broader and greater range of acceptable touch compared to those in our human-robot touch data, suggesting that touch from robots may be subject to more restrictive boundaries — potentially influenced by factors such as limited social signaling and uncertainty in robot systems.

By employing storytelling combined with body-mapping, this study offers a novel approach to understanding touch comfortability in pHRI. To develop assistive robots that physically interact with people, it is necessary to explore and establish boundaries of comfortability and uncomfortability with robot touch. Alongside collecting data to develop a measurement tool investigating comfortability across robot systems, our study generated body heatmaps of touch comfort across different robot types and contexts, identifying how embodiment and role influence comfortability in pHRI.

A. *Limitations & Future Work*

There were several limitations to our study, such as cultural bias in touch. While we only recruited participants residing in the United States, the United States contains a diverse population of people with varying cultural norms and expectations regarding touch. Touch behaviors can vary significantly across cultures [28], which may influence participant responses in reported comfort to the touch scenarios provided.

We also only generated one storytelling vignette for each robot role due to the constraints of time and participant fatigue in user studies. Future studies could expand our approach by incorporating a more diverse set of scenarios for each robot role. For instance, the vignette portraying medical robots could be revised to depict a touch interaction during a medical emergency. This would shed light on whether participants'

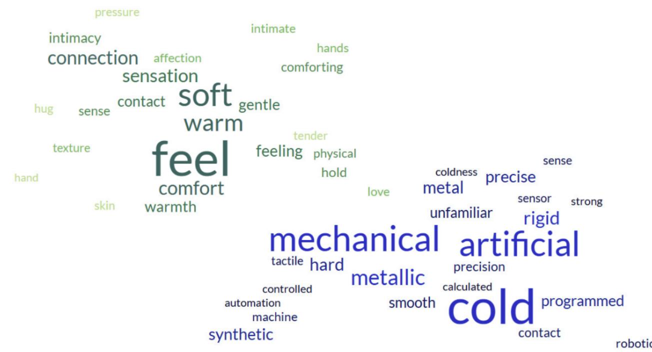

Fig. 4. Word clouds formed from participants' word associations to touch and robot touch. The green-toned word cloud corresponds to words associated with "touch", and the blue-toned word cloud corresponds to "robot touch".

comfort with robot touch would change depending on the intensity of context-specific situations.

Additionally, given that the current study was conducted online, we plan to invite participants to the lab for in-person interactions involving pHRI in improvisational scenarios. These scenarios will be based on the five roles utilized in our present study and will employ robots of the same embodiment types. Participant responses to the in-person pHRI experience will then be collected using the body coloring tool and compared to the heatmaps generated in our current study to identify any differences.

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