Touch Boundaries During Physical Human-Robot Interaction

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***Abstract*— Physical Human-Robot Interaction is an evolving field that explores the role of robotic touch. Prior work focused on perceptions of touch acceptance broadly, yet these perceptions are highly dependent on body region, social context, and embodiment – factors not systematically studied in human-robot interaction, nor captured by existing evaluation methods. We address this gap with two contributions: (I) adapting and assessing the usability of a body-mapping coloring tool, PHRI-BOUNDARIES, to measure comfort with robot touch, and (II) a crowd-sourced online study (N=350) using PHRI-BOUNDARIES to evaluate touch comfort across robot roles (future of work, domestic, romantic partner, medical, and education/culture). Results reveal that medical and romantic partner robots elicit the highest comfort in touch perception, with males reporting greater comfort than females, overall preference for animal-inspired embodiments, and human touch consistently rated as more comfortable than robot touch. These findings highlight the need to evaluate robot touch across diverse contexts and embodiments, supporting the development of tools like PHRI-BOUNDARIES to evaluate comfort with robot touch.**

I. INTRODUCTION

Physical touch is one of the first senses to develop and plays a profound role in human development and social bonding [1], [2]. Past research uncovered how human touch can promote well-being, reduce stress, and foster trust and cooperation in human-human interactions [3]–[7]. In parallel, Human-Robot Interaction (HRI) research has begun to explore whether robotic touch may elicit similar effects. Emerging evidence suggests that robotic touch can encourage prosocial behavior (i.e., behaviors and actions that benefit others) and promote trust in interactions [8]–[13]. As robots are deployed in sensitive domains such as healthcare [14], education [15], and caring for vulnerable populations like the elderly [16] and people with disabilities [17], these findings become particularly relevant since physical contact may provide comfort, reassurance, and support. However, unlike other modes of communication, touch is inherently more intrusive, and its interpretation may vary based on cultural, personal, and situational factors [18], [19].

To address the complexities involved in robot touch, researchers have begun investigating not only whether people will permit touch, but also how comfortable they are with it. Redondo et al. (2020) [20] wrote that *"comfortability" is the extent to which a person approves or disapproves of a social interaction, which in turn shapes their desire to maintain or withdraw from it.* Thus, comfortability provides a critical lens for evaluating Physical Human-Robot Interaction (pHRI) to capture the subjective experience of touch interactions with robotic systems. However, methods of evaluating comfort with robot touch and discovering if comfort varies across a person's body, the robot's societal role, and the physical embodiment remain underexplored.

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II. OUR RESEARCH QUESTIONS

Our work stems from two research questions:

- **RQ 1:** *Can a body-mapping coloring tool be an effective evaluation method to measure comfortability with robot touch in pHRI?* (Section IV).
  To answer this research question, we adapted a body-coloring tool originally developed in neuroscience for the HRI domain. PHRI-BOUNDARIES is designed to assess perceived comfort boundaries during interactions with robotic systems, and we analyzed its usability and accessibility in a large user study. While additional validation is needed, this work represents the first application of the tool in HRI.
- **RQ 2:** *Does the role of the robot influence comfort and willingness to accept robot touch?* (Section V).
  To answer this research question, we performed an online crowdsourcing user study using PHRI-BOUNDARIES to study the subjective perceptions of robot touch across different robot roles.

These contributions support HRI researchers in designing more safe, comfortable, and intuitive physical interactions.

III. RELATED WORK

In this section, we review prior work on evaluation methods in HRI and contributions on touch in HRI.

A. Evaluation Methods in HRI

With emerging evidence of the benefits of robot touch, there is a need for adequate evaluation methods to assess those touch interactions. Many commonly used evaluation methods in HRI are composed of questionnaires, with several dedicated to measuring people's perception of robots. For instance, the Godspeed Questionnaire Series - a highly cited and applied questionnaire in HRI - uses a Likert scale to rate the categories of anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety in robots [21]. The Robotic Social Attributes Scale (RoSAS) measures people's judgments of the social attributes of robots [22], the General Attitudes Towards Robots Scale (GAToRS) measures various dimensions of attitudes towards robots [23], and the Negative Attitude Towards Robots Scale (NARS) measures emotions when interacting with robotic systems [24]. While these robot-specific questionnaires provide valuable insight into people's general perceptions and emotions to robots, they are not focused on physical touch contexts and do not address the gap of evaluating robot-initiated touch in HRI.

Other existing evaluation methods in HRI literature regarding robot touch include questionnaires and surveys for individual studies, examining performance in games, and physiological measures such as heart rate, Skin Conductance Response (SCR), and electroencephalogram (EEG) [25]–[28]. While these measures can capture some perceptions of robot touch, their sensitivity is limited and may overlook subtle differences in user responses [29]. Therefore, to the best of the authors' knowledge, there does not exist a measurement method specifically examining touch in HRI.

Drawing from neuroscience and behavioral science, body-mapping tools have been used to demonstrate how emotions are experienced as bodily sensations [30] and to map acceptable touching zones on the body based on social and emotional bonds [31]. Extending this methodological approach to pHRI research provides more robust data compared to traditional survey techniques, as participants can delineate exact locations of touch comfortability on their body following interactions with robot systems. The resulting topographical heatmaps provide an intuitive and aggregated visualization comfort boundaries across participants.

To address the current gap in measurement tools for evaluating human perception of robot touch, we adapted the body-mapping tool emBODY, originally developed by the Nummenmaa Lab [30]. We introduce this instrument as pHRI-BOUNDARIES, a tool designed to evaluate perceived touch comfort boundaries in pHRI research. Additionally, we assessed its performance, examining usability and accessibility for deployment in empirical pHRI studies.

B. Touch and Comfortability in HRI

Touch plays a pivotal role in human development and social relationships, and robotics researchers have investigated whether robot touch can elicit similar positive benefits in human-robot interactions. Handshaking, for instance, is a simple gesture yet conveys implicit messages such as a greeting, a farewell, or an agreement [32]. Roboticists have examined robot handshake behaviors and how factors like gaze and facial expressions may shape perceptions to improve these interactive behaviors in future HRI [33].

HRI researchers have also uncovered the "Midas touch" effect – a phenomena where a brief touch, such as on the arm or shoulder, can evoke feelings of trust, compliance, and prosocial behavior in human-human interactions [34] – and how robot touch may encourage similar behaviors in human-robot interactions [8]–[13], [27]. As robot touch may offer positive impacts, research continues into how to improve and accurately measure these physical interactions [35].

Prior research establishes that many factors influence touch acceptance. For instance, interpersonal relationships influence social touch acceptance, with stronger emotional bonds correlating with greater allowance of touch [31]. An exception to this may occur in medical touch as it is generally accepted and elicits higher touch allowance due to its clinical necessity [36]. Even the nature of touch – *affective*, the subjective and emotional experience of touch, versus *instrumental*, the procedural and task-oriented aspect of touch – may shape human responses to touch [37]–[39]. Additionally, robot embodiment has been shown to influence user perceptions of competence and trust [40], [41], while robot roles modulate expectations of behavior [42], [43]. Perceived intent and context of the robot also contribute to touch acceptance [37], [38]. In our study, we considered these factors (i.e., robot role, embodiment, and context of touch) and their joint effect on comfort in pHRI across varying social domains. Furthermore, we investigated if touch patterns within human-human relationships may also be translated to human-robot relationships.

In recent years, research examining touch allowance in HRI has included comfortability with robot touch. Researchers have measured human comfort in collaborative relationships between humans and robots [44] and how to mitigate discomfort with robot touch [45]. Human comfort should be a key consideration to HRI designers; however, comfortability can be a complex internal state, with individual changes that are challenging to capture [46]. Our study aims to discover the boundaries of physical touch between humans and robots and to provide insights into human comfort in pHRI settings.

As mentioned, Redondo and colleagues (2020) [20] investigated people's comfortability levels with robots and have 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," and we adopt their definition of comfortability in our study. While physical touch may be administered by the robot, individuals and caretakers of those receiving robotic assistance may not necessarily enjoy or approve of that interaction [47]. Therefore, just as there are social parameters and acceptability for human touch, the same must be determined for robots.

IV. pHRI-BOUNDARIES EXPERIMENTAL TOOL

pHRI-BOUNDARIES builds upon the emBODY tool, originally developed by the Nummenmaa Lab in 2014 [30]. Although body coloring tools have been adopted in neuroscience to capture fine-grained bodily representations, this approach has not yet been applied to HRI. Adapting this method to HRI allows for continuous mapping of comfort boundaries on the body in response to robot touch, providing more precise and nuanced measurements than traditional questionnaires or region-based self-report methods.

pHRI-BOUNDARIES can facilitate end-to-end experiment deployment, creating a more coherent workflow for both participants and researchers. It also supports integrating self-report methods like questionnaires in addition to the body coloring tool, and can be adapted for both large-scale online studies and in-person experiments.

pHRI-BOUNDARIES is **personalizable**, and researchers can modify vignettes, prompts, and questionnaires to fit their specific study needs (the materials used in our study are available at [48]). It is **accessible**, with the codebase

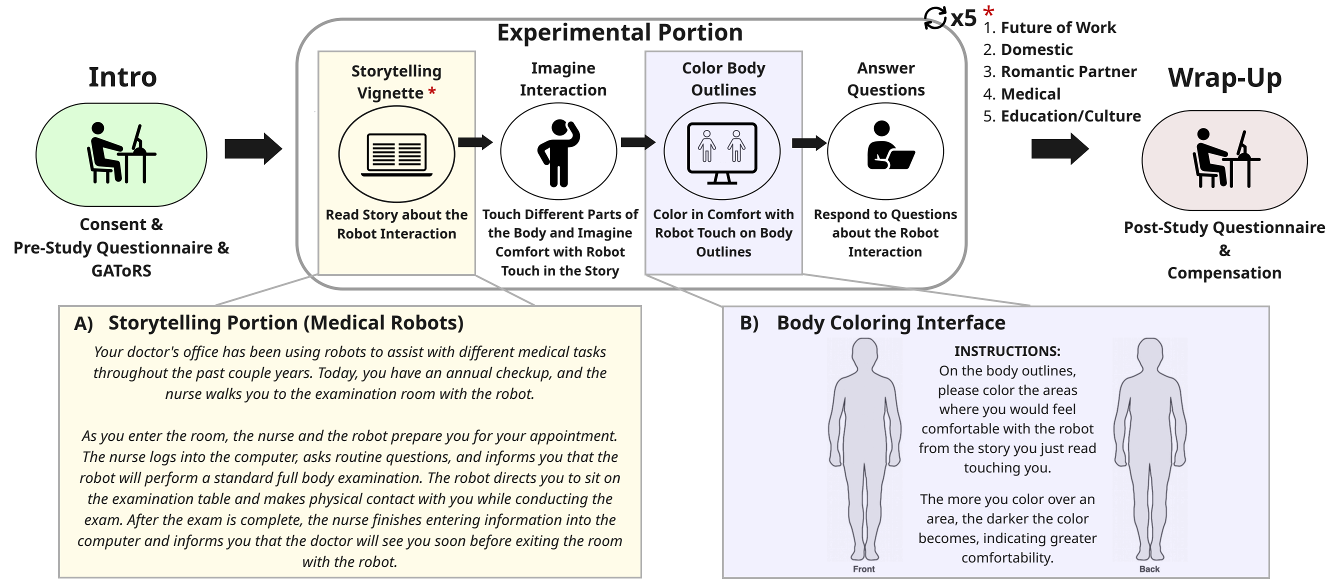

Fig. 1: Layout[1] of the online crowdsourcing study procedure, further detailed in Section V. The experimental portion was repeated five times, each with a different storytelling vignette. A) An example vignette participants saw during the study, and B) the body outlines and coloring tool for participants to report their touch comfortability after each described scenario.

publicly available on our GitHub: https://github.com/studiorobot/RobotTouch. Detailed deployment instructions and tutorials are also provided. Notably, pHRI-BOUNDARIES can be launched on standard cloud infrastructure, leading to scalable and low-cost data collection (we launched the tool using Amazon Web Services (AWS) and collected data from 350 participants at no cost). Finally, the tool is **extensible**, allowing for additional questionnaires, vignettes, and experimental materials while preserving the interactive body-mapping and survey functionalities.

V. CROWDSOURCING STUDY ON ROBOT TOUCH

We conducted an online crowdsourcing user study to investigate if touch comfortability would change across **robot role** (robot as: co-worker, domestic helper, romantic partner, medical assistant, educational/cultural instructor), **robot embodiment** (robot as: mechanical, humanoid, functional, animal-inspired, and android), or **agent type** (robot or human). This study was approved by the University of Michigan Institutional Review Board (IRB) #HUM00266958.

A. Participants

A total of 350 participants were recruited from Prolific [49], an incentivized study platform. Participants were above the age of 18 and resided in the United States. Participants with physical touch trauma who might experience distress during the study were excluded. Participants could stop their participation at any point. To prevent bots and unwanted agents, we used Prolific's built-in recruitment and screening procedures in addition to our "checker" questions that are easy for humans to answer but difficult for bots. Participants were compensated $5 at the end of the study.

B. Procedure

An overview of our study procedure is shown in Figure 1. Before beginning, all questionnaires and vignettes were loaded into pHRI-BOUNDARIES. We then collected participants' demographic information, prior experience with robots, attitudes towards robots (via GAToRS) [50], baseline comfort with touch, and words they associated with human and robot touch.

During the experimental portion, participants read five storytelling vignettes, shown sequentially, portraying robots in distinct social roles, guided by the major fields of robotics identified by the Stanford Robotics Center [51]: Future of Work, Domestic, Romantic Partner, Medical, Education and Culture Robots). After each story, participants imagined the robot touch interaction and colored the front and back of human body outlines to indicate their comfort with touch in that scenario. Comfortability was defined following Redondo et al. (2020) (see Section I). Participants then indicated how their comfort would change with different robot embodiments or if the agent were human instead of a robot.

Participants completed the study after responding to all stories and could offer comments before exiting.

C. Materials

The storytelling vignettes underwent multiple pilot rounds to verify that the robot's role and narrative context were clear to the reader. In later revisions, we used Large Language Models (LLMs), such as GPT-4o, to remove unintended valence that could bias participant responses. We revised the narratives according to pilot feedback to ensure that

[1] Icons: "Person working on computer" by Royyan Wijaya, "human body" by rekanice, "workspace" by Universal Icons, "thinking man pictogram" by Vectors Point, "screen reading" by undelivered, and "computer screen" by Jaya99. All icons used are from thenounproject.com CC BY 3.0.

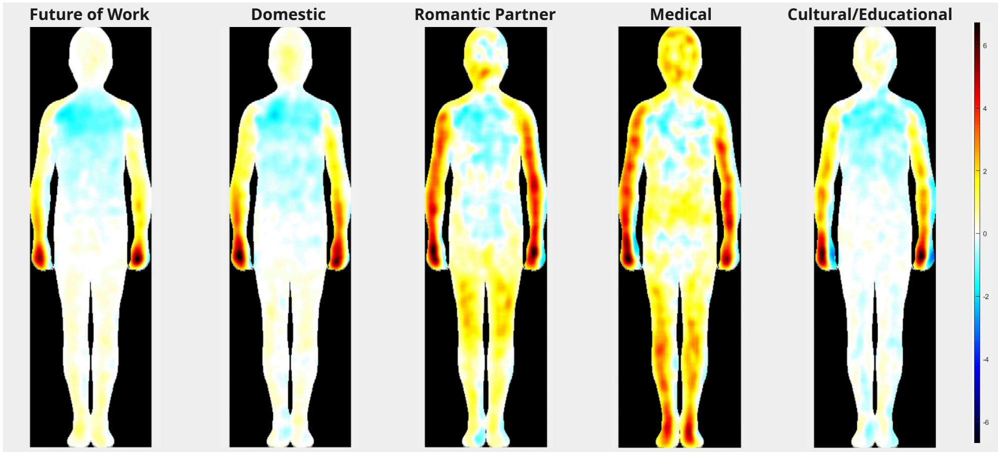

Fig. 2: Touch comfortability heatmap aggregated across participants for the storytelling vignettes. Warm colors represent the front of the body, while cool colors represent the back. Greater color intensity indicates higher comfortability, while white indicates no reported comfort.

participants' understanding matched the intended story. Each story passage was written to illustrate a human robot touch interaction, deliberately avoiding detailing specific body parts to allow participants to generalize the interaction across their body. Our story narratives are available at [48]. We used storytelling vignettes to enable large-scale data collection (N= 350), which would not be feasible in an embodied user study, while leveraging prior work showing that imagined scenarios can evoke meaningful cognitive and emotional responses [52]–[55].

The robot embodiments were largely chosen from the classifications presented by Baraka et al. (2020) [56]. We aimed to include a representative robot for each classification and a mechanical form often found in manufacturing and medical settings. The embodiments selected were the Franka Arm (mechanical), Nao (humanoid), Care-O-Bot (functional), Aibo (animal-inspired), and Erica (android).

D. Data Collection and Analysis

Data Storage and Privacy: We launched our platform using AWS [57], and the data was stored on Amazon's secure cloud services before being downloaded onto a hard drive in our lab. The data was password-protected and only the researchers had access. To protect participants' privacy, we separated the IP addresses from the remaining data so that no personal identifiers were linked to participant responses.

Body Heatmap Generation: Heatmaps were generated following the Nummenmaa Lab's procedures and visually represent comfort levels with robot touch. Coloring actions were recorded as a click and mapped to grid locations on the body outline. The data was processed in MATLAB, where a pre-defined body mask removed strokes outside the outline. The cleaned data compiled into a matrix where each cell in the matrix corresponded to a location on the body map, and its value reflected the frequency of coloring at that spot. Repeated coloring at the same location increased the pixel intensity and produced darker regions in the heatmaps.

Comfortability Analysis: To quantitatively analyze comfortability, we used the number of unique pixels colored as the primary metric. Pixel intensity (i.e., repeated coloring of the same area) was excluded as the subjective perception of color darkness may vary across users. Instead, the total number of pixels shaded was treated as an objective measure of participants' comfort with robot touch.

VI. Results

Section VI-A presents results for RQ1 on the performance of pHRI-Boundaries in studying human–robot touch comfortability. For RQ2, we report findings on comfort across robot roles (Section VI-B), gender (Section VI-C), questionnaire measures (Section VI-D), and robot embodiments (Section VI-E). A summary of our additional significant statistical analysis can be found at [48].

A. Deployment Performace of pHRI-Boundaries

To assess the accessibility and usability of pHRI-Boundaries for HRI research, we analyzed its deployment in our large-scale user study. Rather than a controlled environment, these results reflect a large, real-world deployment of the tool in an unsupervised setting, providing insight into the tool's practical performance, reliability, and ease of use.

1) Usability and Data Accuracy: To examine if participants could effectively utilize the tool, we analyzed the precision of user input during the body-coloring task. Across all storytelling vignettes, an average of 94.6% of colored pixels were within the outlines. The high level of spatial accuracy suggests that pHRI-Boundaries was used as intended, with minimal evidence of random or non-deliberate responses. These findings indicate that pHRI-Boundaries supports intuitive interaction without prior training.

2) Deployment Feasibility: A total of 348 participants (99.2%) successfully completed the study using pHRI-Boundaries, indicating minimal technical issues. All participants used desktop devices, ensuring consistency in the interaction with the tool. No errors or crashes were reported

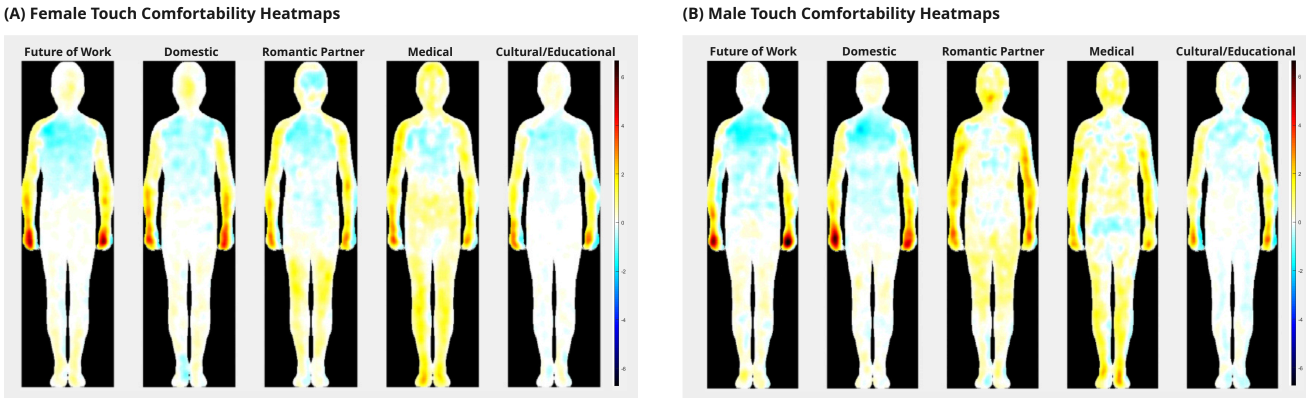

Fig. 3: Touch comfortability heatmaps of self-identified female and male participants across storytelling vignettes. (A) Responses from female participants. (B) Responses from male participants. Warm colors represent the front of the body, while cool colors represent the back. Greater color intensity indicates higher comfortability with robot touch.

during deployment. Participants were also able to contact the research team, though no issues were reported.

The projected study duration time based on our pilot study was $20 - 25$ minutes, and the observed median time was 23 minutes. This close alignment suggests that PHRI-BOUNDARIES can be deployed without extending the study time or adding procedural burden.

B. Touch Comfortability and Robot Roles

To ensure quality data, we included 333 participants in our final analysis after verifying that the checker questions were answered correctly. These participant responses were combined into body heatmaps, indicating comfort levels across the body, and are displayed in Figure 2. The average pixels colored in on the body outlines for each storytelling portion were as follows: S1 (Future of Work) = 766.59, S2 (Domestic) = 766.41, S3 (Romantic Partner) = 1124.1, S4 (Medical) = 1443.5, S5 (Education/Culture) = 683.51. The pixels indicate participants' comfort with touch - the more pixels colored in, the more comfortability with touch.

A repeated measures one-way ANOVA with Bonferroni-corrected paired t-tests assessed pairwise differences in comfort ratings across storytelling scenarios. Several significant differences were observed (see Table I), with the largest effects emerging between S4 (Medical) and S5 (Education and Culture), $d = 0.505$, [95% CI: $0.391, 0.619$]. Overall, the Medical and Romantic Partner scenarios consistently elicited higher comfortability ratings compared to the other vignettes.

C. Comfortability across Gender and Age

The data was divided into female (169) and male (154) participant responses. Composite comfortability heatmaps with robot touch are shown in Figure 3.

Independent samples t-tests compared comfortability (measured via pixel clicks) between male and female participants for each storytelling scenario. All five stories showed significant differences ($p < 0.05$), with males reporting higher comfort with robot touch across all scenarios. Small effects were observed in S1 and S2 ($p = 0.0497$; $d = 0.189$; $p = 0.0358$; $d = 0.212$). The effect sizes became stronger in S3 ($p = 0.00670$; $d = 0.303$) and S4, which showed the largest difference ($p = 0.00120$; $d = 0.362$), where males averaged 1851 pixels and females averaged 1152 pixels. S5 also demonstrated a significant difference ($p = 0.0139$; $d = 0.275$). However, high standard deviations across all groups indicated a large variability in responses.

TABLE I: Significant pairwise comparisons between story conditions: S1 (Future of Work), S2 (Domestic), S3 (Romantic Partner), S4 (Medical), S5 (Education and Culture).

Comparison	p-value	Cohen's d	95% CI
S1 vs. S3	<0.001	-0.299	[-0.409, -0.190]
S1 vs. S4	<0.001	-0.410	[-0.522, -0.299]
S2 vs. S3	<0.001	-0.346	[-0.457, -0.236]
S2 vs. S4	<0.001	-0.449	[-0.561, -0.336]
S3 vs. S4	<0.001	-0.241	[-0.349, -0.132]
S3 vs. S5	<0.001	0.427	[0.315, 0.539]
S4 vs. S5	<0.001	0.505	[0.391, 0.619]

Analysis by age group did not reveal any significant differences in comfortability ($p > 0.05$).

D. Comfort with Physical Touch and Prior Experience/Attitudes towards Robots

We divided the participant data by self-reported prior experience with robots and conducted a one-way ANOVA to examine differences between groups. The average pixels colored in per experience group are shown in Figure 4. Post hoc Tukey's HSD tests revealed significant differences in the Medical robots vignette. Specifically, participants with frequent prior interactions with robots colored fewer pixels than those with no prior interaction ($p = 0.00840$, $d = -0.527$, [95% CI: -0.934, -0.120]). Similarly, those with occasional prior interactions also colored fewer pixels than those with no prior interaction ($p = 0.0137$, $d = -0.434$, [95% CI: -0.736, -0.132]). No significant differences were observed in the other vignettes.

Comparisons with baseline comfortability from the pre-study questionnaire showed a marginal positive correlation

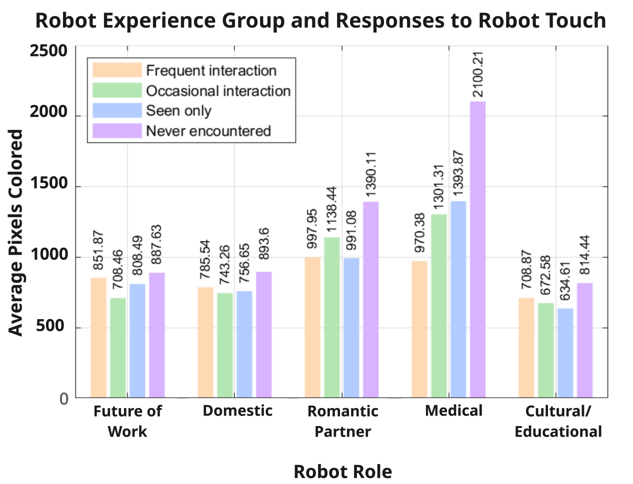

Fig. 4: Prior robot experience groups and the average pixels colored in the storytelling narratives.

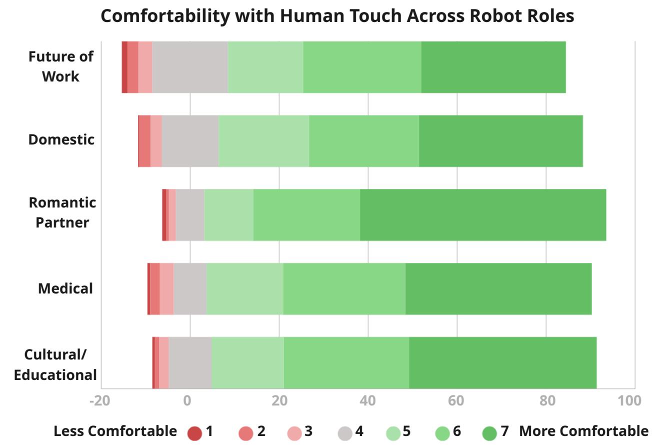

Fig. 5: Participant responses indicating whether they would be more or less comfortable with human touch instead of robot touch, shown as percentages for each story.

with pixels colored in each story. Similarly, participants who scored higher on GAToRS, a questionnaire measuring attitudes towards robots, tended to report higher comfort with robot touch across the stories. There was a positive trend for those who had more positive attitudes of robots and the number of pixels they colored on the body outlines.

E. Robot Embodiment and Human Touch

Participant preferences for robot embodiments are summarized in Table II, showing the mean and standard deviation of the ratings (likert scale of 1-7, "1" being "less comfortable" and "7" being "more comfortable") for each storytelling narrative. See [48] for a summary of the significant statistical results, including p-values, Cohen's d, and 95% CI.

Generally, Aibo, Care-O-bot, and Nao received higher comfort ratings across the stories, though some role-specific preferences emerged. In S1 (Future of Work), Franka Arm was rated significantly less than Nao, Care-O-bot, and Aibo ($p < 0.05$). It was also rated lower than Nao and Aibo in S2 (Domestic) and S5 (Education/Culture) ($p < 0.05$). In S3 (Romantic Partner), Aibo was preferred over all other embodiments ($p < 0.05$), and over Franka Arm, Erica, and Care-O-bot in S4 (Medical) ($p < 0.05$).

When asked about human touch, participants consistently reported higher comfort with human touch than with robot touch across all all storytelling vignettes and embodiments ($p < 0.001$). The distribution of participant preferences to human touch are shown in Figure 5.

VII. Discussion

The pHRI-Boundaries tool was successfully deployed without technical issues, demonstrating its usability for pHRI studies. It may be especially useful for HRI researchers investigating responses to robot touch, such as in medical care or therapeutic applications. The body coloring interface produced interpretable aggregate heatmaps denoting comfort with robot touch, consistent with its original applications in neuroscience research [30]. These results suggest the tool can provide a more nuanced evaluation of comfort with robot touch. However, formal validation is still needed to confirm reproducibility across participant populations, robustness in diverse experimental contexts, and content and construct validity in HRI applications.

The hands and the arms were the most comfortable areas across all vignettes, consistent with norms of acceptable touch in human-human relationships. Participants reported higher comfort with robot touch (more pixels colored) in the Medical and Romantic Partner scenarios which was also reflected in the heatmaps as more "sensitive" body regions were colored, such as the head, thighs, and abdomen. These regions were more intensely colored unlike in the Future of Work, Domestic, and Cultural/Educational vignettes. These results suggest that the robot's role influences touch comfort and acceptable touch areas on the body, indicating that touch allowance and emotional bonds in human-human relationships may also be translated to human-robot relationships.

Additionally, our results revealed significant gender differences in comfort with touch, with male participants consistently reporting higher comfort across all storytelling vignettes. One of the most pronounced gender disparities emerged in the Romantic Partner robot scenario, where males were comfortable with touch in the genital region, whereas females were not. Previous literature has found that women may find more comfort in affective touch than men [58], [59], but the discrepancy in gender responses may be attributed to existing societal stigmas associated with romantic or sexual robots, as women may be more likely to experience negative emotions towards romantic robots [60], [61]. However, the greatest disparity emerged in the Medical scenario, with females reporting lower comfort than males, highlighting the importance of considering gender differences in future human robot touch interactions.

Participants generally preferred animal-inspired, humanoid, and functional robot embodiments across the storytelling vignettes. Notably, Aibo received more positive

TABLE II: Preference of Robot Embodiment

Story	 Franka	 Nao	 Erica	 Care-O-bot	 Aibo
S1	4.59 ± 1.53	5.04 ± 1.32	4.70 ± 1.50	5.00 ± 1.52	4.99 ± 1.80
S2	4.48 ± 1.61	4.95 ± 1.43	4.69 ± 1.55	4.79 ± 1.57	4.93 ± 1.87
S3	3.21 ± 1.84	3.88 ± 1.94	3.39 ± 1.77	3.61 ± 2.03	5.32 ± 1.79
S4	4.28 ± 1.71	4.66 ± 1.61	4.35 ± 1.62	3.79 ± 1.91	5.05 ± 1.85
S5	4.41 ± 1.69	4.92 ± 1.41	4.55 ± 1.65	4.17 ± 1.81	5.24 ± 1.72

responses, particularly in the Romantic Partner scenario. This outcome was unexpected given the context and nature of that narrative, and Aibo being a pet-like robot. Prior research suggests interactions with dogs can trigger oxytocin – a hormone linked to social bonding and emotional connection [62], which may explain these results. Despite the general comfort reported with robot touch, participants consistently showed a stronger preference for human touch across all scenarios. This finding supports that while there may be acceptance of robot touch, human touch continues to be perceived as more socially acceptable and emotionally meaningful. Robot touch may require even more conservative boundaries due to perceived agency, uncertainty, and limited social signaling. More research is needed to uncover the factors related to positive touch interactions in HRI.

There were several limitations to our study, one being cultural bias in touch. We only recruited participants residing in the United States where diverse cultures exist, and touch behaviors can vary significantly across cultures [19], which may have influenced participant responses in reported comfort to the touch scenarios provided.

As our study relied on imagined rather than direct physical interaction with robots, there may be some concerns with ecological validity, as participants' comfort with touch may differ when confronted with a tangible robot in a real-world setting. However, prior literature both in psychology and HRI have shown that imagined or simulated scenarios can elicit meaningful emotional and cognitive responses that resemble those experienced in real-world interactions [52]–[55]. Imagined vignettes complement in-person studies [53]–[55], [63], allowing for rapid collection of responses from larger, more diverse populations in less time. We were able to identify patterns in comfort boundaries, preferences, and perceptions, which can guide subsequent physical studies.

VIII. Conclusion

Through pHRI-Boundaries, we combined storytelling with body-mapping tasks as a nuanced evaluation method to understand touch comfortability in pHRI. Our findings indicate that the societal role of robots influences human comfort with robot touch. The heightened comfort in medical and romantic contexts aligns with established human-human touch dynamics, emphasizing the importance of perceived relational context and intent. Gender differences further point to potential design considerations for future interactions. Together, these results highlight the value of pHRI-Boundaries in assessing touch comfort in pHRI and provide actionable insights in designing robots.

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