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Mediated Social Touching: Haptic Feedback Affects Social Experience of Touch Initiators

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***Abstract*—Mediated social touch enables us to share hugs, handshakes, and caresses at a distance. Past work has focused on the experience of *being* touched by a remote person, but the touch *initiator*'s experience is underexplored. We ask whether a variation in haptic feedback can influence the touch initiator's social experience of the interaction. In a user study participants stroked a remote person's hand in virtual reality while feeling no haptic feedback, ultrasonic stimulation, or passive feedback from a silicone hand. In each condition, they rated the pleasantness of the interaction, the friendliness of the remote person, and their sense of co-presence. We also captured the velocity of their stroking and asked for reflections on the interaction and mediated social touch as a whole. The results show significant effects of haptic feedback on co-presence, pleasantness, and stroking velocity. The qualitative responses suggest that these results are due to the familiarity of the solid silicone hand, and the participants' assumption that when they felt feedback, the remote person felt similar feedback.**

***Index Terms*—haptics, virtual reality, human-computer interaction, mediated social touch, remote interaction, ultrasound mid-air haptics**

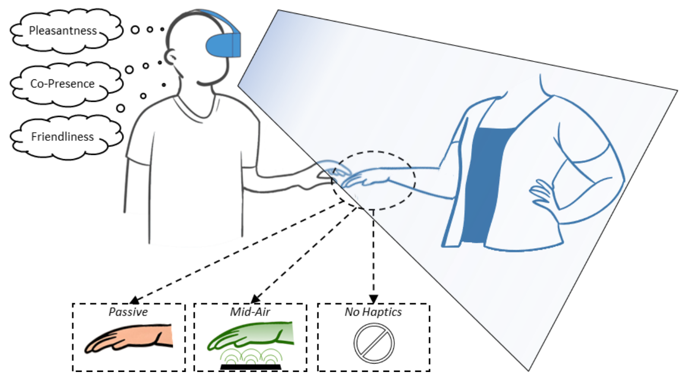


Fig. 1: A touch initiator (left) stroking the virtual hand of a remote avatar (right). The touch is mediated to a body-congruent point on the remote person's hand. The touch initiator can feel the virtual hand with one of three types of haptic feedback.

I. Introduction

Physical social touch is essential to human life. Social touch interactions can increase people's well-being and attachment, change their behavior, and communicate affect [1]. Touch can also positively impact people's feelings towards partners [2] and increase their pro-social actions [3]. But our remote communication lacks social touch.

Mediated social touch (MST) has explored means of touching others at any distance. A vast amount of prototypes have been developed where touch is transmitted through sleeves [4], scarfs [5], hands [6], gloves [7], phones [8]–[10], and in Virtual Reality (VR) [11]–[13].

While a lot is known about how *being touched* affects us, little work has examined how haptic feedback affects the social experience of the *touch initiator* [14]. Most of the literature focuses on either evaluating the user experience (UX) of an MST prototype, or the social experience of the person *being touched*. For example, these studies have shown that touch can increase well-being and bonding [5], [15]–[17]. However, the social experience of the *touch initiator* is also affected when touching others, as seen in research with co-located physical touching [18]–[21]. The observations about physical touches raise questions about how the touch initiator is affected when sending virtual touches with MST. For instance, we do not know what touching a remote person should feel like, and how the haptic sensation of touching affects one's perception of the remote person and the social interaction. When physically touching someone, the sensation on our skin impacts our experience of the interaction. This paper focuses on the impact of this sensation on the social experience including friendliness between actors and the feeling of co-presence. How does haptic feedback alone affect the social experience of the touch initiator?

To address this question, we conducted a study in a VR environment with three types of haptic feedback. Eighteen participants acted as touch initiators and stroked a remote person's avatar hand. We provided limited information about the remote person to the participants. We conceived the haptic feedback conditions to roughly vary along a continuum from nothing to life-like: no haptic feedback, ultrasonic mid-air feedback, and passive feedback from a silicone hand. The participants rated the pleasantness of stroking, the friendliness of the remote person, and their co-presence. We also asked what they thought the remote person was experiencing and asked for their reflections on the interaction.

II. Related Work

We review the literature on social touch and MST.

A. Social Touch

What makes a touch social? The answers range from skin-to-skin interaction between people to considering the psycho-social context. One perspective is that touch is social when occurring between two or more co-located individuals [1]. In another definition, social touch requires systematic changes in one's perceptions, thoughts, feelings, or behavior as a function of another person's touch in a given context [22]. In this definition, touch is only social if it results in a cognitive transformation for the actors. Elkiss and Jerome expressed this as: "To touch another is to be touched back. Touching, like dialogue, is bidirectional and reciprocal." [23]. This definition suggests that touch interaction also has an impact on the touch initiator.

Huisman discussed four areas where social touch has been shown to have a major impact on human life [1]. Physical touch is essential for *physical and emotional well-being* (especially in infants' development [24]). *Attachment and bonding* is impacted by caring touch throughout all stages of life. Touch can have a direct impact on *attitude and behavior change*, as in the phenomenon known as the Midas Touch [3], where a simple touch can lead to pro-social behavior like tipping a waiter more. Finally, similar to other forms of communication, touch can *communicate affect* or emotions [25].

The social experience of touch can also be linked to the receptors in our skin. Brushing on hairy skin at a velocity of 1-10 cm s^{-1} can signal social body contact by stimulation of c-tactile afferents [26]. Past studies have explored whether being stroked at this velocity affects social behavior [17], [27], [28], but the results are conflicting.

We acknowledge that social touch is more than merely a physical interaction, and we ask how the experience of social touch can be influenced by the design of haptic feedback to the touch initiator. Touch, and the social experience it can facilitate, is an interdisciplinary topic covering many factors including the relationship, norms, environment, context, and cognitive states of the individuals [29]. Social mid-air interactions add an additional layer to this, especially in terms of responsible research and innovation [30]. In our study, we attempt to control for these factors to the extent possible and focus on the haptic factor.

B. Mediated Social Touch

Social touch interactions and their effects are missing from our distanced communications. Jewitt et al. described "digital touch" as an emergent sociotechnical imaginary: "the immediacy and intimacy of touch make remote personal relationships a primary market for the promise of digital-touch" [31]. Many MST devices have been prototyped (see Huisman for a review [1]). MST devices can help promote well-being by reducing stress [5], [15], [16], increase attachment and bonding to others [17], and enhance the feeling of "togetherness" for parent-child dyads [32].

MST can provide both *direct* and *indirect* interactions. With physical touch, the point the touch initiator touches is the same point where it is felt on the person being touched. Some MST prototypes have adopted *direct* interactions [11], [33]. For example, Makino et al. created HaptoClone, where mid-air haptics were transferred directly from one part of the hand to another (e.g., fingertip to fingertip) [33]. However, most prototypes provide *indirect* interactions like buttons and knobs [7], teddy bears [34], and tactile displays [35]. *Direct* interactions enable more natural touches, as the input point is virtually congruent with the output point.

While the social effects of MST devices on the person being touched (the "receiver") are widely researched [12], [17], [35]–[39], the social effects on the touch initiator are not explored. Price et al. created a haptic glove, where interactions were given indirectly through buttons and knobs, but the impact of using buttons and knobs on the touch initiator was not evaluated [7]. Nakanishi et al. proposed direct interactions by shaking a robot hand to initiate remote handshaking, but the focus was on the positioning of the hand. Devices such as TaSST [4] allow touches to be recorded and reproduced on a receiver, but the focus is often on reproducing the touch, and not how the touch initiator socially connected with the person being touched.

C. Mid-air haptics

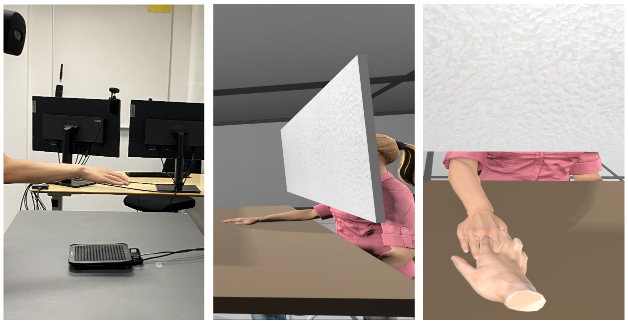
Ultrasonic mid-air haptic feedback can stimulate our skin receptors without physical contact with an object. The haptic feedback is induced by ultrasound waves colliding in one focal point to create vibrations on the skin [40]. Ultrasound haptics have been used for many mid-air interactions such as interacting with buttons [41], [42], rendering volumetric shapes [43], [44], mouth haptics [45], and more. In social contexts, specific emotions can be communicated through ultrasound mid-air haptic icons [46]. This work indicates that ultrasound haptics can go beyond discriminative touch and induce emotional experiences. Affective touch through the stimulation of c-tactile afferents has also been studied with ultrasound with varying results [38], [47].

III. Methods

To compare the impact of haptic feedback on the social experience of the touch initiator, we conducted a study with participants acting as touch initiators. They stroked a virtual hand while receiving variations of haptic feedback. They rated the *Pleasantness*, *Co-Presence*, and *Friendliness*, and we captured the stroking *Velocity*.

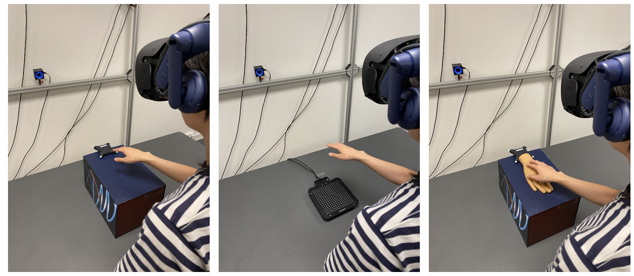
A. Design

The study used a within-subjects design where each participant conducted a stroking task three times, each with a distinct haptic feedback condition. The order of the haptic feedback conditions was counterbalanced. Each session ended with a short interview with the participant, and a reflective post-study interview was conducted at the end.



(a) Real-world view (b) VR side view (c) VR front view

Fig. 2: The setup seen from outside VR, inside VR, and the first-person perspective. Participants did not see the physical objects (e.g., ultrasound device) on the table.



(a) No Haptics (b) Mid-Air Haptics (c) Passive Haptics

Fig. 3: The three haptic conditions. The box on the *No Haptics* and *Passive* conditions were tracked by active markers, while the *Mid-Air* device was tracked by passive markers. The box was used to match the height for all conditions.

B. Apparatus

We used an HTC VIVE Pro head-mounted display (HMD) for VR, OptiTrack for tracking, and the Ultrahaptics STRATOS Explore ultrasound haptic device by Ultraleap Ltd. To render the ultrasound feedback, we adapted the PRO-STM algorithm by Barreiro et al. [48]. Instead of the pressure field in PRO-STM algorithm, we found the contact points between the participant's virtual hand and the avatar hand. The output intensity was consistent across the whole surface and the frequency was variable depending on the total distance between all contact points. We stimulated each point 0.3 mm apart. A pilot study helped verify the robustness of the hand tracking and that the ultrasonic haptic rendering followed the shape of the virtual hand. To mask the noise of the UltraHaptics, the participants listened to pink noise.

C. Participants

We recruited 18 participants (5 females, 13 males) 21-59 years old (M = 29.9) by advertising on the university mailing lists and social media channels. The study lasted 30 minutes and participants received a gift worth approximately 13 €.

D. Virtual Environment

The visual setting was inspired by a recent study by Seinfeld et al. [11]. The virtual room showed a virtual table and an avatar representing a remote person. The participant and avatar were seated at opposite sides of the table as seen in Figure 2. The participant could place their real hand over a physical table and saw a virtual representation of it in VR (Figure 2c). To avoid confounds based on the avatar's facial features, we placed a opaque glass screen in front of the avatar's face in the virtual room. We used an avatar from Microsoft Rocketbox Avatar Library [49].

E. Haptic Feedback

The haptic conditions were hidden from participants until all the responses had been collected.

The *No Haptics* condition (fig. 3a) was our control condition. The setup was a tracked box on the table. The box was placed on the table to elevate the interaction to the same height as the mid-air haptics stimulus (23 cm in height). The virtual table matched the height of the box.

The *Mid-Air* condition (fig. 3b) was induced by the ultrasound device placed on the physical table. The top of the virtual hand, and thus the maximum height of the ultrasound rendering was about 23 cm above the physical table.

The *Passive* condition (fig. 3c) using a silicone hand was selected to represent the shape and elasticity of a human hand. The silicone hand was selected over a human hand to avoid confounds from human movements and avoid the risk of linking the social experience to the experimenter. The hand rested firmly on the same box as the *No Haptics* condition and worked as a haptic proxy for the remote person's avatar hand. The top of the silicone hand approximately matched the *Mid-Air* condition (23 cm).

F. Mediation Deception

We informed participants that a *remote person* was receiving their touch. In reality, there was no actual human receiver of the mediated social touch. We provided participants minimal information to form a similar perception of the receiver with the following text at the start of the study: "The receiver is a 20-30-year old woman, located in London". Before starting each condition they were asked to wait with the in-VR message: "Please wait for the remote person to be ready...". Participants were informed that their hand-tracked stroking was mapped to the remote person's hand. In the post-study questions, we checked whether the deception was effective.

G. Procedure

The experimenter introduced the participants to the study procedure including the deception of the remote person. After collecting the consent form, the experimenter placed the tracking markers in ten locations on the participant's hand and calibrated the system. Participants chose their avatar's skin texture from six skin texture resources [50]. To limit the variation in stroking, the experimenter demonstrated the stroking on their own hand and directed participants to stroke as if they were stroking a real hand, and that the stroke should

TABLE I: The questions posed to participants. The first three were answered on a 7-point Likert-scale ratings ("not at all" to "very much so"), while the last four (Q1-Q4) were qualitative.

ID	Question
Pleasantness	Stroking the hand felt pleasant
Friendliness	I felt that the remote person was friendly
Co-Presence	I felt that the other person was together with me in that room
Q1	How does the interaction compare to stroking a real hand?
Q2	How do you think the stroking is felt by the remote person?
Q3	How do you think your stroking affected the remote person's perception of you?
Q4	After trying these examples, what do you think touching a virtual hand should feel like?

last three seconds from the wrist to the tip of the middle finger. With an 18 cm virtual hand, the instruction would result in a stroking speed of 6 cm s^{-1} within the affective touch range of 1-10 cm s^{-1} as reported in the literature [26].

The participants stroked with one haptic feedback condition at a time. In each condition, participants were asked to put on the VR HMD and headphones, and wait for the remote person to signal they were ready. They then stroked the virtual hand for 20 seconds two times. After the first 20 seconds, they rated their experience according to the *Pleasantness*, *Friendliness* and *Co-Presence* questions in Table I. The questions were inspired by co-presence questions from Slater et al. [51] and telepresence by Nakanishi et al. [6]. After the answers were confirmed, they stroked the hand for another 20 seconds. The setup was then hidden, and the HMD was removed as a palate cleanser to reduce carryover effects between conditions. They then answered the open-ended questions Q1 and Q2 in Table I. They repeated this for the two other conditions. The experimenter switched the haptic setup in between conditions without the participant seeing it.

After all conditions, the post-condition interview was conducted outside of VR. We asked the final two open-ended questions, Q3 and Q4 in Table I. Q3 was designed to both get their reflections, but also check whether they believed the deception. Finally, the experimenter debriefed the participants and explained that there was no remote person.

IV. Results

We report the ratings and measurements followed by the interview results.

A. Quantitative Ratings and Movement Velocity

The dependent variables consisted of the three subjective Likert-scale ratings, *Co-presence*, *Pleasantness*, and *Friendliness*, and one objective measurement, *Velocity* of stroking. Each dependent variable consisted of 18 measurements (one per participant) repeated three times (once per condition), resulting in 54 measurements for each variable. Figure 4 provides an overview of the results for the three Likert-scale ratings. According to the literature, a rating scale with more than five levels can be viewed as interval data [52]. Thus, we ran one-way repeated measures ANOVA on the three ratings and velocity.

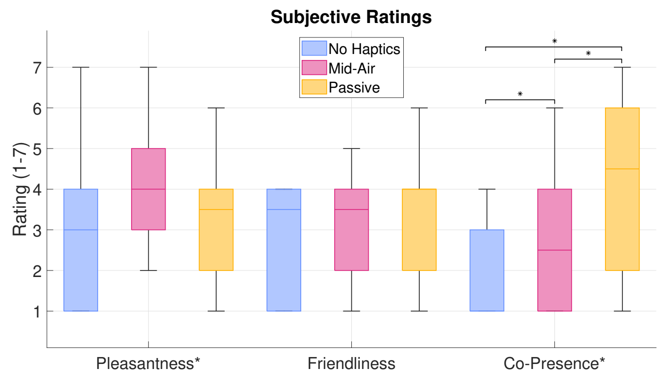


Fig. 4: The participant ratings for *Co-Presence*, *Pleasantness*, and *Friendliness*. Significant effects are indicated by *. Pairwise comparisons are adjusted with Bonferroni correction.

All p-values were adjusted using Bonferroni-correction for post hoc comparisons.

Pleasantness: The repeated measures ANOVA showed a significant effect of haptic condition on *Pleasantness* ($F(2, 34) = 3.30$, $p < 0.05$, $\eta_p^2 = 0.16$). The pairwise comparisons in Table II showed no significant results ($p > 0.05$). Thus, the feedback conditions have an effect on Pleasantness, but we cannot determine which conditions were significantly different. Except for one participant, the *No Haptics* condition was only rated four (neutral) or below. Thirteen participants rated the *Mid-Air* condition the highest or tied for highest. The *Passive* condition and *No Haptics* conditions were rated the highest or tied for highest by six and five participants respectively. No participant rated the *Pleasantness* uniformly across the three conditions, indicating the physical experience varied based on the haptic feedback for all participants.

Friendliness: The test showed no main effect on *Friendliness* ($F(2, 34) = 3.19$, $p = 0.08$, $\eta_p^2 = 0.16$). Seven participants rated the conditions uniformly, indicating that distinguishing friendliness from haptic feedback alone was difficult.

Co-presence: The one-way repeated measures ANOVA showed a significant effect of the haptic condition (F(2,34) = 13.17, $p < 0.01$, η_p^2 = 0.47). Post hoc analyses showed that *Co-Presence* ratings were significantly different among all conditions (Table II). Specifically, the ratings were significantly higher in the *Passive* condition ($M = 4.00$, $SD = 2.03$), followed by the *Mid-Air* condition ($M = 2.78$, $SD = 1.59$), and the *No Haptics* condition ($M = 1.89$, $SD = 1.18$). *Mid-Air* was rated significantly higher than *No Haptics*. All the ratings for the *No-Haptics* condition were four (neutral) or less, whereas the other two conditions had higher ratings. The participants had an enhanced feeling of being together with the remote person with *Mid-Air* compared to *No Haptics*. The feeling of being together was even stronger in the *Passive* condition. Sixteen participants rated the *Passive* condition the highest or tied for highest. The *Mid-Air* and *No Haptics* conditions were rated the highest or tied for highest by eight and five participants respectively. Three participants gave a uniform rating for *Co-Presence* across the three conditions.

TABLE II: Pairwise Comparisons for the four dependent variables. All the p-values (the two rightmost columns) are adjusted using the Bonferroni correction.

Variable	Condition	M	SD	No Haptics	Mid-Air
Pleasantness	No Haptics	2.89	1.68	–	
	Mid-Air	4.06	1.39	0.05	-
	Passive	3.44	1.34	0.66	0.66
Friendliness	No Haptics	2.72	1.45	–	
	Mid-Air	3.06	1.35	0.17	-
	Passive	3.39	1.54	0.19	0.69
Co-Presence	No Haptics	1.89	1.18	–	
	Mid-Air	2.78	1.59	**0.04***	-
	Passive	4.00	2.03	**<0.01***	**0.03***
Velocity	No Haptics	10.02	2.21	–	
	Mid-Air	10.67	2.93	0.62	-
	Passive	8.18	1.83	**<0.01***	**<0.01***

Velocity: The repeated-measures ANOVA showed a significant effect of haptic feedback on *Velocity* ($F(2, 34) = 11.43$, $p < 0.01$, $\eta_p^2 = 0.40$). The post hoc tests showed significant differences between the *Passive* condition and the other conditions. Stroking in the *Passive* condition ($M = 8.18$, $SD = 1.83$) was significantly slower than the *No Haptics* condition ($M = 10.02$, $SD = 2.21$), and the *Mid-Air* condition ($M = 10.68$, $SD = 2.93$). The velocities indicate participants stroked faster than they were instructed (approximately 6 cm s^{-1}).

B. Qualitative Responses

The participants answered four questions verbally. They answered the first two questions (Q1, Q2) after each condition and the last two questions (Q3, Q4) at the end of the experiment. We summarize their answers for each question below.

Q1. How does the interaction compare to stroking a real hand?

The perceived resistance and solidness of the hand was a major factor in the comparison to stroking a real hand. All the participants noted that the *No Haptics* condition was not comparable to real stroking since they could not feel anything: *"extremely different, because you only see the image of my hand, but you'll feel - I felt just air. No physical touch."* (Participant P7 in the *No Haptics* condition). Participants noted the same issue with mid-air haptics (7 out of 18 participants), while others thought the slight resistance from mid-air haptics was still useful (5/18): *"Like, just the fact that you feel some resistance as you touch. Or in this case, whatever it was... air or electric input does a lot."* (P1, *Mid-Air*). Feeling physical resistance and hand contours were the main reasons for the similarity of the silicone hand to touching a real hand (11/18).

The sensation of the stroking was another important factor to the participants. In the *Mid-Air* condition, several participants noted the sensation did not resemble real stroking. The ultrasound sensation felt like vibration (P3, P14), wind (P6, P12, P13), blurry (P5), or weird (P6, P11, P16, P18): *"I think it feel kind of weird because it feel like there's a wind coming from that hand."* (P6). Similarly, the participants noted that the texture and temperature of the silicone hand did not match a real hand. They noted that the hand felt sticky (4/18) or cold (4/18) or even "dead" (P2).

Q2. How do you think the stroking is felt by the remote person?

Several participants responded that they did not know what the other person felt (7/18 in all conditions). Some guessed that the feedback would be like what they felt (4/18 *No Haptics*, 7/18 *mid-air*, 13/18 *Passive*). *"I would say it's similar tingling, maybe it has some... pressure on where I go with my stroke."* (P7, *Mid-Air*).

Some participants thought that the remote person may get different feedback from their own. In the *No Haptics* condition, four participants described that the remote person may get an unnatural sensation such as tingling (P7), electrical impulses (P1), or a choppy sensation (P2). Similarly, in the *Mid-Air* condition they thought the sensation could be electric vibrations (P8), weird (P17), or not normal (P18). Interestingly, some participants (5/8 *No Haptics*, 4/18 *Mid-Air*) worried that their hand penetrating the avatar hand would lead to unnatural sensations for the remote person: *"I think again it would feel a bit clumsy or unnatural because... it was harder to keep, like, a natural rhythm..."* (P17, *No Haptics*).

Q3. How do you think your stroking affected the remote person's perception of you?

The point of this question was both to test whether participants believed there was a remote person (the deception) and to gauge what they imagined the other to take away from the social interaction. No responses indicated that they did not believe the deception. Most participants (10/18) noted that they had no idea about the remote person's impression, or described that the remote person's impression depended on their stroking, and how it was translated: *"I think that depends on how well I did it... It could either be a bit creepier perception or better perception."* (P17). Even though they had no idea, their responses indicated they believed the deception. Furthermore, no participant claimed they had seen through the deception after completion of the study. Six participants thought the interaction created a positive impression and a sense of social connection in the remote person: *"I would say it should make that person feeling more like in touch with me and like I'm a real person as well."* (P7). One participant thought they *"overstepped some boundaries"* (P10) by touching someone they did not know. As such, they were concerned that their touch may have created a negative impression in the remote person.

Q4. After trying these examples, what do you think touching a virtual hand should feel like?

Several participants thought the touching sensation should closely replicate the feel of a human hand (8/18) as it would help them stroke it naturally. Others wanted something in-between the silicone hand and the mid-air feedback (4/18). Four participants thought the warmth was especially important to replicate, and some aspects can be left to the user imagination: *"[I] really think that the warmth of the third one (Mid-Air) is very, very important... So in that I don't think you necessarily have to be like 100 percent accurate... Because then I think* *your brain does the rest of the work for you."* (P2). Finally, P10 and P17 mentioned that their touch should be reciprocated: *I would want [...] just to feel that there is some movement back, because when you touch a hand in real life [...] you can feel like in some way as that was a human being who can move and have feelings* (P10).

V. Discussion

We discuss the results and reflect on the implications for future work on the haptic design for remote touch interactions.

A. Materiality

The material feeling of the avatar's hand impacted the touching experience. *Co-Presence* was rated significantly higher in the *Passive* condition than in both the *Mid-Air* and *No Haptics* conditions. The interviews suggest that the higher rating was due to the solidness of the silicone hand. The solid hand allowed participants to control their stroking. The slight resistance from the ultrasound stimulation provided them with some cues, but it was not adequate for stopping their hand from penetrating the avatar hand. This is reflected in the stroking velocity, as participants stroked more in line with the instructions in the *Passive* condition. Only the stroking velocity in the *Passive* condition is within the 1-10 cm s^{-1} range associated with affective or social touch [26]. On the other hand, the material feeling also had negative consequences on user impressions. The participants could discern the absence of life in the silicone hand from its temperature and texture.

Designing material experiences for remote social touch is an interesting direction for future research in haptics. Recent advances in the design of synthetic materials for touch [53] as well as skin-like sensors [54] and soft actuators [55] can help create lifelike proxy hands. Alternatively, the feel of existing proxies such as the silicone hand may be augmented through ultrasound or other haptic technologies.

B. Reciprocity

Remote touch experiences should inform the users how their touch actions are felt by the remote person. In the study, many of the participants did not know what their touch felt like, they were unsure of how it was perceived by the remote person, and how to perform their stroking gently. This uncertainty was exacerbated when their hands penetrated the avatar's hand in the *No Haptics* and *Mid-Air* conditions. When physically stroking we can adjust based on the movements and expressions of the person being stroked. Without reciprocal feedback, there are no reactions or consequences to the stroking. A bidirectional scenario, where the remote person moves or even reciprocates touches, could likely affect the *Friendliness* of the remote person. Reciprocal touches could also help users understand what the other person feels.

C. Limitations

Since our focus was the effect of haptic stimulation, we designed the study to control for non-haptic factors as much as possible. For example, we deliberately placed a opaque screen in front of the VR avatars face (Figure 2b) to avoid the effect of facial reactions. In addition, we provided a short description of the remote person to the participants, and all participants interacted with a White female avatar. Nevertheless, a few participants noted that these parameters matter to their experience. Some claimed they could not estimate the *Friendliness* without any feedback in the form of facial expressions or reciprocating their touch actions. These factors could explain the lack of statistical difference in the *Friendliness* ratings across the three conditions.

The decision to use only one interaction, stroking, was due to technical and design limitations. The tracking with passive markers was more accurate when participants' hands were flat as in stroking compared to other motions (e.g., tapping), and we could provide consistent instructions for the stroking.

Feedback from a real hand was considered as one of the conditions, but discarded due to the complexities of the deception and whether the participant would link the experience to the researcher. Also, such a condition is not realistic for remote interactions.

We collected Likert-scale ratings, stroking velocity, and interview responses. Future studies can use behavioral measures or conduct in-depth interviews to replicate our results or provide further insights into the experience of touching remote people.

Finally, the ethics of remote social touch is an interesting avenue for future research [56]. One of the participants raised a point about consent and overstepping boundaries of the remote person by touching them. The contactless nature of ultrasound mid-air haptic technology raises questions about how to best design for consent in remote touch interactions.

VI. Conclusion

Our work suggests that the social experience of touch initiators can be affected by haptic feedback alone. As MST is still in its infancy, it is important to research the haptic factors that impacts not just the receiver of touches, but also the touch initiator. We conducted a user study in VR, where participants stroked a remote person's avatar hand while receiving haptic feedback. We varied the feeling of touching the remote person through different types of haptic feedback. Our results suggest the importance of haptic feedback on touch initiators' perception of co-presence, pleasantness, and the velocity of stroking. The participants' responses illustrate the need for surface familiarity, knowing how the touch is felt by the remote person, and the need for reciprocity. Our work provides insights into the user experience of touch initiators and provides avenues for research and development in haptic interaction design and social touch domains.

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