Designing consensual mediated social touch interactions

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Abstract

Purpose – The purpose of this paper is to advocate the consideration of consent and non-intrusiveness when designing Social Touch Technology (STT) – technology that allows people to touch each other remotely. Although STT is already available on the market, there are no standards to ensure consent in such technologymediated social touch. The paper is intended primarily for researchers and designers working on STT, but also addresses a broader audience of potential users.

Design/methodology/approach – The authors' follow value-sensitive design approach. They conducted a conceptual investigation, followed by an empirical investigation, where they relied on ethnographic research and two focus groups to elicit information about potentially intrusive situations for STT users. They further engaged in technical investigation and developed three intrusiveness-mitigating protocols, implemented them in a pair of haptic sleeves and assessed their effectiveness in a user study.

Findings – The findings indicated varying levels of success among the tested protocols in reducing perceived intrusiveness. Users reported all of the protocols to be helpful to some degree and emphasized the need for customizable solutions instead of fixed protocols.

Originality/value – They propose a typology of situations where technology-mediated social touch can be intrusive and non-desirable. They further demonstrate that intrusiveness-mitigating protocols can be built into STT and that they are effective. They propose directions for further development of these protocols and non-intrusive STT design.

Keywords Value based design, Computer-mediated communication, Consent, Social touch technology

Paper type Research paper

Introduction

Social touch technology (STT) refers to technology that "allow one actor to touch another actor over a distance by means of tactile or kinesthetic feedback" (Haans and IJsselsteijn, 2006). This technology is increasingly finding its way into consumers' everyday lives (Jewitt *et al.*, 2021a;

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Jewitt and Price, 2024). Wearable STT, in particular, is gaining popularity. A key feature of wearable STT is its placement on the user's body, allowing touch to be passively received. STT can serve as an independent communication channel, enrich videoconferencing or enhance extended reality (XR) experiences (Huisman, 2017; Pacchierotti *et al.*, 2017). While the ability to touch each other remotely introduces more richness into remote communication, it also raises concerns about consent and the potential for intrusiveness of remote touch, similar to those associated with offline touch. Yet, unlike for offline touch, there are neither universal social norms, nor legal regulations in place, ensuring that such mediated social touch is consensual and non-intrusive (Ley and Rambukkana, 2021). This paper aims to raise awareness of the subject and makes the first steps toward designing non-intrusive wearable STT.

Designing non-intrusive technology-mediated social touch is more challenging because, unlike offline social touch, mediated social touch provides fewer opportunities to account for contextual factors. The nonverbal feedback typically available before, during and after social touch offline, in wearable STT is reduced to limited visual cues available in VR or video calls or can be even entirely absent in standalone STT. Also, the contextual cues that regulate the appropriateness of social touch in offline environments are yet undeveloped or in flux for mediated social touch (Jewitt *et al.*, 2020). For instance, in VR environment, the user's avatar does not have to be representative of their gender, social status, age, culture or religious views. Such lack of contextual cues should be compensated by some additional form of ensuring consent in STT interactions.

This paper introduces a framework for designing non-intrusive mediated social touch experiences. First, we define intrusiveness in the context of mediated social touch and present a taxonomy of situations in which mediated touch might be perceived as intrusive. Drawing on ethnographic research and focus groups, we propose guidelines for reducing the potential intrusiveness of mediated social touch. We then demonstrate the application of these guidelines by augmenting a haptic sleeve with non-intrusive modes and collecting user feedback through a case study. We aim to inspire further discussion and support the design of mediated social touch interactions that prioritize non-intrusiveness.

Theoretical background

Intrusiveness and consent in mediated social touch

Intrusiveness refers to behaviors or states that are unwanted by the recipient, causing disruption or annoyance (Fantasia *et al.*, 2019). A distinguishing feature of intrusiveness is the *recipient's* perception of the behavior as illegitimate or uninvited, differentiating it from mere unpleasantness (Gavazzi, Reese and Sabatelli, 1998). For example, such intense form of touching as massage may be painful yet desired by the recipient, and thus not intrusive. Conversely, a sudden grab may initially feel unpleasant, but if the recipient interprets it as necessary – such as to prevent an accident – it may not be perceived as intrusive. Similarly, a pleasant touch, such as a kiss, can become intrusive if the recipient deems it illegitimate, such as when it comes from someone without sufficient social closeness. In the context of mediated social touch, a touch is intrusive if it is uninvited and perceived as illegitimate by the recipient, highlighting the role of psychological consent.

Psychological consent refers to the recipient's subjective agreement to a touch, either in advance or retrospectively. This concept is distinct from legal consent. For instance, at airport security, individuals may legally consent to a search by answering "yes" to a request but may still experience the search as intrusive if they do not genuinely perceive it as welcome or legitimate (Bohns, 2022). Similarly, in mediated social touch, legal consent, such as informed consent obtained by researchers, does not guarantee psychological consent.

Ensuring the recipient's psychological consent is both an ethical obligation and a practical necessity to ensure desired user experience.

Meeting the requirement of psychological consent is particularly challenging in the context of wearable STT. To explore the challenge, we first summarize the general characteristics of wearable STT. STT interactions:

> […] include situations where human communication partners engage in social touch mediated through technology, as well as situations where humans interact with artificial social agents that have the capability of responding to, and/or applying social touches (Huisman, 2017, p. 391).

Wearable STT can be characterized by multiple parameters, such as the types of haptic stimulation used (pressure, vibration, temperature), the range of various physical parameters of the haptic stimulation (for instance, velocity range, force range, the duration of the haptic stimulation), location on the body (for instance, hand, arm, back, full body, genitalia, lips), the human-to-human physical interaction that the device is approximating, if any (for instance, handshake, tapping the back, stroking the arm, hugging, kissing; it can also be abstract). That is, wearable STT can take a variety of shapes.

Existing STT available on the market ranges from bracelets that allow sending gentle vibrations to the other person's wrist (for instance, Hey Bracelets [1]), to sex toys that can be controlled by a remote partner (for instance, Kiiroo [2]), to complex full-body suits that provide a variety of sensations throughout the entire body and can be used for a variety of applications (for instance, Teslasuit [3]). Besides the solutions available on the market, dozens of STT devices have been developed in the labs in the last decade (see Huisman, 2017 for an overview of the early designs; see Gallace and Girondini, 2022 for a recent overview of STT available for VR). In principle, other technology, such as smartwatches, can be used as wearable STT, if the users agree and set the parameters in a way that haptic stimulation from the watch always represents a connection signal, but since this interferes with other functionalities of smartwatches and is unlikely to be done by many users. All in all, the key characteristic of a mediated social touch interaction is that the user can be potentially touched in a variety of circumstances by partners who are not in immediate physical proximity, which has raised ethical concerns around consent in such touch interactions (Ley and Rambukkana, 2021; Liberati, 2017; Sparrow and Karas, 2020).

This limited access to social cues in a mediated touch interaction creates challenges around consent to such touch. Specifically, in offline settings, touch is often preceded by cues – such as approaching the recipient, establishing eye contact, or extending a hand – that provide implicit warnings and opportunities for the recipient to reject the touch by stepping away, breaking eye contact, or using verbal or physical gestures. Such consent-communicating mechanisms is not currently incorporated in STT interactions. Mediated social touch lacks equivalent cues and mechanisms, making it harder to establish psychological consent.

To address this, we argue that STT should be designed to enable users to communicate their psychological consent effectively. In this paper, we first examine the conditions under which mediated social touch may be perceived as intrusive. Then, we describe efforts to address these challenges and propose a taxonomy of situations where intrusiveness in mediated social touch arises. This groundwork informs the development of design guidelines aimed at minimizing intrusiveness in STT.

A taxonomy of situations where mediated social touch can Be intrusive

The taxonomy presented in this section was developed through a combination of previous research, ethnographic studies and focus group discussions. First, we analyzed existing studies that reported on the user experiences of mediated social touch using wearable STT devices (Askari *et al.*, 2020; van Hattum *et al.*, 2022). Additionally, two of the authors

conducted ethnographic research using the Hey bracelets – commercially available social touch devices resembling watches. These devices, worn by two individuals, allow users to send gentle squeezes to each other's wrists over a distance. The researchers and their partners wore the bracelets and documented their experiences as couples.

Further insights were gathered from two focus groups. Participants were asked about desirable and undesirable experiences with mediated social touch and were given hands-on experience with the Hey bracelets to provide informed feedback. As many participants had no prior exposure to mediated touch devices, the Hey bracelets were used during the sessions to familiarize them with the technology. Each participant was paired with a partner and equipped with a bracelet, allowing them to exchange mediated touches throughout the session.

Participants for the focus groups were recruited through social media, and ethical approval was obtained from the University of Twente's ethics committee. Since the participants lacked prior experience with mediated touch devices, they were given time to explore the devices with their partners at the start of the session.

The focus group protocol consisted of three modules, spanning approximately an hour. First, participants freely explored the bracelets, sending touches to their partners as they wished. They then shared their general impressions and opinions about the devices. Second, potential issues, particularly those related to intrusiveness, were discussed. Participants identified real-life scenarios where mediated touches could feel intrusive or unsafe, such as during driving, focusing on a critical task or engaging in intimate activities. In the final stage, participants were asked to think of solutions that could mitigate the discussed issues.

The findings highlighted that while STT offers a novel communication channel, touches could arrive at inconvenient times, disrupting participants' focus, such as during group conversations. Participants also identified contexts where mediated touch could feel intrusive, including incompatible relationship dynamics or specific physical sensations that were not perceived as desirable.

Three primary categories of intrusiveness emerged from the combined insights:

- *Unwelcome Sensation*: The recipient does not consent to the specific sensation delivered by the technology, even if the interaction itself is desirable. Poor design choices in STT can lead to sensations that feel inappropriate or unpleasant, violating expectations of legitimate touch. For example, an overly strong or fast touch or a touch on a sensitive body part could trigger perceptions of intrusiveness (Suvilehto *et al.*, 2015; Weda *et al.*, 2022).
- *Contextual Intrusiveness:* The recipient is in a situation where touch is unwelcome, such as during personal activities or high-focus tasks like driving, meditating or public speaking. This type of intrusiveness often stems from an asymmetry in communication, where the sender lacks information about the recipient's circumstances at the time the touch is sent. As one participant in the ethnographic study noted, "Whenever a mediated touch occurs, the Hey bracelet is immediately present in the center of attention of the receiver. However, this is not a choice of the person being touched; instead, the person who is sending a touch is making this decision".
- *Relationship Dynamics*: The recipient does not consent to touch from a specific sender at a given moment due to relational factors, such as conflict. Participants indicated that even in an intimate relationship, mediated touch could be inappropriate if the relationship dynamic at that moment rendered touch undesirable.

This taxonomy serves as a foundation for defining the design space and exploring potential solutions to minimize intrusiveness in mediated social touch interactions.

Communication protocol design solutions to mitigate intrusiveness in mediated social touch interactions

To address the potentially intrusive situations identified earlier, several communication protocol design solutions were proposed. These solutions were generated collaboratively by the authors, focus group participants and experts working with mediated social touch. To guide the selection process, the following criteria were established:

- The solution must directly address the issue of intrusiveness.
- It should be feasible for implementation in wearable STT devices.
- It should be simple for users to adopt and require minimal time investment.
- The solution must be dynamic and easily adjustable during use.
- The solution itself should not introduce new forms of intrusiveness (e.g. auditory alerts that could be disruptive).

Out of the 54 solutions initially proposed, three were selected as feasible for further development based on these criteria:

- *Touchmail*: Inspired by voicemail, this solution allows a touch to be sent to a "touchmail," a haptic repository where the recipient can access the touch at their convenience. This approach ensures asynchronous communication, giving the recipient control over when to engage.
- *Status Update*: Users can set their availability status to indicate whether they are open to receiving touches. This proactive measure informs the sender about the recipient's readiness and helps avoid interruptions.
- *Snooze*: This feature enables the recipient to delay an incoming touch. Instead of being delivered immediately, the touch is "snoozed" and repeated after a specified time interval.

These selected solutions align with the goal of minimizing intrusiveness while maintaining the core functionality of mediated STT. They also balance practicality, user adaptability and the need for non-disruptive design.

User study

Study design

The user study aimed to evaluate the effectiveness of proposed solutions in mitigating intrusiveness in mediated social touch interactions. Pairs of participants with close relationships, comfortable with casual touch, were recruited. The study used a within-subject design to test four conditions: Touchmail, Status Update, Snooze and a Control (representing the default market condition without any intrusiveness mitigation protocols). Participants reported their experiences daily using four items designed to measure intrusiveness and responded to open-ended questions:

- In the *Touchmail* condition, incoming touches were stored and indicated by an LED light, allowing the recipient to retrieve them at their convenience.
- In the *Status Update* condition, users could set their availability status, which was communicated to their partner via an LED light.
- In the *Snooze* condition, recipients received a notification via LED light and could delay the touch for 3 min by pressing a button.
- In the *Control* condition, touches were transmitted immediately without restrictions.

The study protocol was approved by the Ethics Committee of the EEMCS faculty at the University of Twente. Over four days, each pair experienced all four conditions, randomized to prevent order effects. Participants were informed of the mode being tested.

The social touch technology

Haptic sleeves for the lower arm were designed as STT for this study. Two identical sleeves were developed. We opted for the simplest haptic feedback technology that provided a physical sensation similar to that of Hey Bracelet – a brief light vibration, with no other additional types of stimulation. The choice was dictated by the practicality of the solution, it is the easiest to implement and to replicate; it is also representative of a large proportion of haptic technology available on the market, as vibration motors are cheap, small and can be actuated by fairly small batteries, which makes them the most affordable and practical solution for a wearable STT, given the current technology available to broad public. This sensation might not be the most representative of human social touch, but it is widely used.

Each sleeve included two capacitative sensors: one to send a touch, the other allowed, depending on the respective mode, to, e.g. change the touch acceptance, snooze a touch or receive a stored touch. The sleeves are presented in Plate 1.

Of the two RGB LEDs (neopixel), one was indicating the status of the wearable, like battery status, or connectivity of the wearable, the other LED was used to implement the condition functionality, e.g. the availability of the partner's device for a touch, or the announcement or presence of a touch. Two coin vibration motors were used to generate a touch sensation. As controller, a Feather ESP32 was used, connecting via WIFI to a MQTT broker and allowing to exchange messages between the sleeves. The system was powered with a 3.7V Lipo battery. The components were integrated in a textile sleeve, taking comfort, robustness and ease of use into account.

Measurement

Intrusiveness was measured with the following four statements, which were developed by the researchers, not meant to be used as a scale, but rather as an index capturing different aspects of intrusiveness:

(1) Sometimes I received a touch, but I would not have wanted to.

(2) I experienced one or more incoming touches as unwanted.

(3) I got disrupted during an important task because I received a touch from my partner.

(4) I would not use the sleeve in public because it made me feel uncomfortable.

In addition, comfort was assessed with the item "Using the sleeve with my partner made me uncomfortable".

The responses were measured on a five-point Likert scale ranging from "Strongly disagree" to "Strongly agree." Participants also answered open-ended questions about their likes, dislikes and perceived advantages or disadvantages of each mode.

Participants

The study involved five pairs of participants, including two romantic couples, one pair of siblings, a pair of friends and one father-son pair. Ages ranged from 24 to 68, and all participants resided in the Netherlands. The inclusion criterion required participants to have a relationship close enough to involve regular physical touch and to feel comfortable with the study setup.

Plate 1. Haptic sleeves developed for the user study
Note(s): ALT TEXT: A picture of two haptic sleeves that can be worn on the lower arm
Source: Authors' own creation

Procedure

Participants were provided the haptic sleeves and performed four 5 h sessions over separate days, each testing one of the modes. To simulate real-world scenarios, participants used the devices during daily activities, coordinating start and end times for each session.

Before the study began, participants received a brochure and instruction guide, including troubleshooting information. They were instructed to remain apart during the sessions to ensure natural usage. Sessions were initialized by the researcher after participants confirmed their devices were connected via a pink LED indicator. Participants were reminded 15 min before each session and sent an end-of-session message afterward, prompting them to complete an online questionnaire.

During the sessions participants were free to send touches whenever they wanted. They were given no specific instructions on how to use the device. At the end time of each session, they received a text message stating that the session has come to an end. Consequently, they were asked to fill in the questionnaire in Qualtrics and charge the device.

Results

The means of the four modes are presented in Figure 1: the Touchmail mode had the lowest intrusiveness scores (meaning most mitigation of intrusiveness), followed by the Status Update mode (less mitigation of intrusiveness) and the Snooze mode (least mitigation of intrusiveness, but still lower than the control condition). While the pattern is observed for the three items, the differences do not reach significance, probably due to the lack of statistical power. As for the fourth item, the modes did not seem to affect how comfortable people felt using the sleeve in public, which makes sense, as the proposed modes did not change much any circumstances for those witnessing the use of STT.

There were also no differences in the level of comfort. As initial illustration of construct divergent validity, it is interesting to note that the correlation between the comfort item and any of the three intrusiveness items is not different from zero (Pearson's correlations with

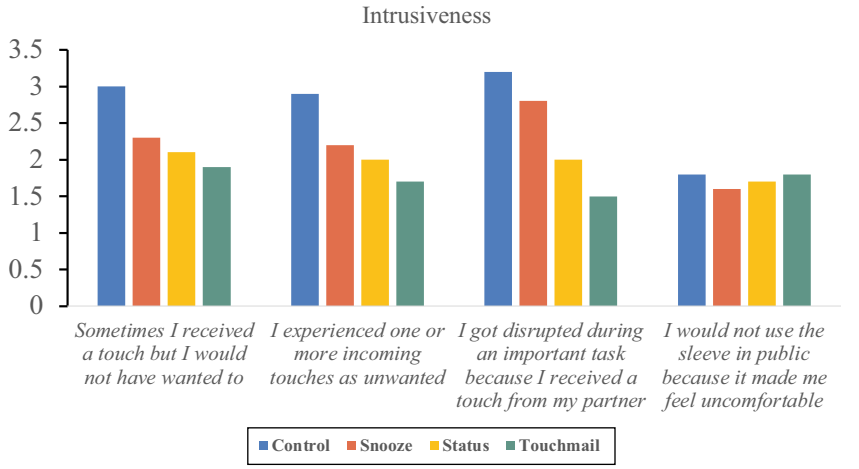

Figure 1. Mean values for the intrusiveness items for each of the four conditions of the user studies
Note(s): ALT TEXT: A bar chart of the means for the 4 items related to intrusiveness
Source: Authors' own creation

comfort were 0.18. 0.28 and 0.16 for items 1, 2 and 3 respectively, all coefficients are not significantly different from zero).

Qualitative user feedback

The open-ended responses from participants provided deeper insights into their experiences with the different modes and suggested several avenues for improvement. In the control mode, participants noted its simplicity, straightforwardness and natural feel, but they also highlighted its potential to lead to intrusive experiences. This underscores the inherent trade-off between spontaneity and intrusiveness in such systems. The Snooze mode, on the other hand, presented challenges for users, as they sometimes missed the opportunity to snooze due to noticing the notification too late. Moreover, the fixed three-minute snooze window was seen as a limitation. One participant remarked that it would be more convenient to have the option to set customized snooze times.

The Status Update mode received positive feedback for enabling participants to turn off touches when desired. One participant likened the experience to sending a message such as, "Hi, I'm driving right now so I can't text you back now, but I am not ignoring you on purpose!". However, this mode also served as a signal of touch acceptance from the other person, as one participant expressed feeling reassured that their touches would not distract or inconvenience their partner when the partner's status was set to "available." While this reassurance was appreciated, the "unavailable" status sometimes elicited unpleasant feelings, as participants were left speculating about their partner's activities. One individual suggested that this could be addressed by allowing users to choose whether or not their status is visible to others.

Participants generally valued the Touchmail mode for its ability to prevent disturbances by allowing touches to be stored until the recipient was ready to engage. However, this functionality came at the expense of the immediacy and excitement of live interactions. Interestingly, a surprising benefit of the Touchmail mode was the ability to experience multiple "accumulated" touches at once, which some participants described as enjoyable.

Several suggestions for improving the design of these modes were offered. For the Snooze mode, participants recommended introducing adjustable snooze durations and the option to either snooze or decline a touch altogether, allowing for greater flexibility when future interruptions would also be inconvenient. In the Status Update mode, participants proposed linking availability to an online calendar or incorporating intermediate levels of availability, such as an "orange" status to indicate "rather not." They also noted that while it was helpful to see a partner's availability, this could sometimes become a distraction, prompting unnecessary contemplation about the partner's "unavailable" status.

Finally, improvements to the Touchmail mode could include providing users with information about the number of stored touches and the times at which they were added. Overall, participants expressed a preference for a system that allowed them to combine these modes and tailor their functionality to individual preferences, suggesting that an ideal implementation would enable users to choose their own solutions for managing mediated social touch.

Discussion

Intrusiveness, i.e. the experience of unwelcomed interaction, in mediated social touch can arise from diverse and context-dependent situations. In this paper, we proposed a generic taxonomy of these situations for wearable STT based on ethnographic research and focus groups. This taxonomy aims to better equip designers and users of mediated social touch technologies with the tools to understand and address intrusiveness. Researchers and

designers should aim to develop customizable solutions, acknowledging that individual experiences of intrusiveness vary widely based on internal factors (e.g. personal preferences) and external factors (e.g. situational context). Users of STT should be aware of the potential intrusive experience and take responsibility for avoiding them via applying appropriate settings, or disabling STT when it can be disturbing.

Making the first steps toward a non-intrusive wearable STT design, we proposed and implemented three protocols in a pair of haptic sleeves: Touchmail (as voicemail, but for touch), Status Update (setting availability) and Snooze (delaying the touch receiving). Participants in a user study tested all three protocols and a control condition. While the sample size was too small to draw generalizable conclusions, the results suggest that the control condition – where touches were transmitted without restrictions – was perceived as the most intrusive. Among the proposed protocols, Touchmail emerged as the least intrusive solution, followed by Status Update and Snooze. Importantly, all protocols though, were reported to have pros and cons.

Our findings underscore the trade-offs inherent in designing mediated social touch systems. For instance, Touchmail protocol mitigated intrusiveness at the expense of immediacy. Our results point to the need for mediated touch devices to incorporate user-configurable communication rules and adjustable parameters. Ideally, devices should enable users to define their own communication protocols, tailoring the interaction experience to individual and situational needs. Alternatively, predefined rule sets could be provided, allowing users to activate and personalize them as necessary. A supporting interface, such as a smartphone application, could serve as a central platform for configuring these parameters, defining custom rules and activating protocols.

Our findings have implications for STT development. While it is fundamental that general considerations for social touch design are in place (Jewitt *et al.*, 2021b), the materials and touch parameters are inherently pleasant for most people (Weda *et al.*, 2022) and actuation location is suitable for the particular context, relationship and cultural context (Suvilehto *et al.*, 2015), personalization regarding consent to receive touch at a specific moment emerges as an additional critical requirement. Allowing users to communicate their changing preferences for receiving touch can greatly enhance the overall acceptability and effectiveness of STT.

Our findings contribute to the broader discussion of consent in mediated social touch. Scholars have highlighted various aspects of mediated social touch that complicate obtaining consent. One such factor, which we discussed, is the lack of communication opportunities. Other contributing factors include, but are not limited to, the reliability and safety of the technology itself (Jewitt *et al.*, 2020), the ambiguity surrounding the touch interaction parameters that require consent (Ley and Rambukkana, 2021), and the potential for deception regarding the identity and intentions of the touch sender (Sparrow and Karas, 2020). Thus, our study represents a small steps toward addressing one specific factor that complicates consent. However, this step is important as it underscores the complexity of designing consensual STT, even for a relatively simple and innocent form of touch, such as a brief touch on the forearm. These same factors apply to all mediated social touch interactions, though to varying degrees and in the context of teledildonics, they could lead to extreme forms of consent violation, including rape (Sparrow and Karas, 2020). Therefore, our study serves as a call for interdisciplinary research that examines how theoretical definitions of consent can be practically implemented in STT.

In conclusion, our study illustrates that designing for intrusiveness in mediated social touch requires balancing spontaneity, personalization and user control. Future work should explore how customization options and adaptive systems can further enhance the usability

and acceptance of mediated social touch devices, ensuring they meet the diverse needs of users while minimizing the potential for intrusiveness.

Notes

1. https://feelhey.com
2. www.kiiroo.com/
3. https://teslasuit.io

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