

# Qude: a Tool for Developing Tactile Code in Long-Distance Relationships

Marta Dziabiola

mdziabiola.hcie-m2020@fh-salzburg.ac.at

University of Salzburg and Salzburg University of Applied Sciences  
Salzburg, Austria

Robert Steiner

rsteiner.hcie-m2020@fh-salzburg.ac.at

University of Salzburg and Salzburg University of Applied Sciences  
Salzburg, Austria

Daniel Nørskov

dnorskov.hcie-m2020@fh-salzburg.ac.at

University of Salzburg and Salzburg University of Applied Sciences  
Salzburg, Austria

Ralf Vetter

rvetter.hcie-m2020@fh-salzburg.ac.at

University of Salzburg and Salzburg University of Applied Sciences  
Salzburg, Austria

## ABSTRACT

Technology-mediated long-distance relationships (LDRs) have long been of interest in HCI research, and several strategies, designs, and prototypes for mediating intimacy in LDRs have been proposed. This paper aims to explore and identify existing practices in experiencing intimate interactions in technology-mediated LDRs, to design an artefact that can alleviate some of the struggles people in this type of relationship are facing as well as to test the created prototypes with target users. First, a contextual analysis, consisting of seven in-depth semi-structured interviews combined with a creative task, was carried out. Based on the gained insights, we developed the concept of Qude which entails a physical and digital prototype: a vibrotactile wearable patch that enables a person to tap a rhythm and send it to their partner to experience via a corresponding wearable; and a supporting mobile app, through which users can assign meanings to the tapped rhythms, thus creating an exclusive, tactile code between the partners. The two prototypes were tested with four participants currently in an LDR. The paper concludes by relating and discussing the findings both from the prototype tests and the results from the contextual analysis to provide consideration for future works and designs.

## KEYWORDS

long distance relationships (LDR), computer-mediated communication (CMC), intimacy

## 1 INTRODUCTION

Over the last decades, globalization has imposed a shift towards higher job and educational mobility, resulting in more couples arranging their relationship as a long-distance relationship (LDR) [28, 37]. Under the COVID pandemic, travel restrictions and closed borders have made it even more difficult to visit loved ones. At

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

*HCI Students Conference '21, June 29, 2021, Salzburg, AT*

© 2021 for this paper by its authors. Use permitted under Creative Commons License Attribution 4.0 International (CC BY NC ND 4.0).

the same time, new technology increasingly provides new forms and modalities for mediating communication, opening up novel possibilities for people in LDRs to maintain their relationship [1, 37], even when apart.

The present paper aims to explore and identify the existing practices in experiencing intimate interactions in technology-mediated LDRs, to design an artefact that can alleviate some of the struggles people in this type of relationship are facing as well as to test the created prototypes with target users. To achieve these objectives, three research questions were formulated:

- 1) How are artefacts, tools, and technologies put to use for facilitating intimate interactions in LDRs?
- 2) What barriers and obstacles do couples face in the use of artefacts, tools, and technologies when experiencing intimacy?
- 3) How can a wearable artefact enable intimate interactions over distance for people in LDRs?

To answer these research questions, multiple methods for data collection (in-depth semi-structured interviews, elicitation by drawing) and analysis (affinity diagram, content analysis) have been applied, as well as for prototype design (experience prototyping, role and look-and-feel prototypes) and testing (think-aloud protocol, scenario-based tasks, semi-structured interviews).

This paper builds upon the rich body of research on LDRs and CMC in the field of Human-Computer Interaction. We further propose a prototypical design that supports intimacy over distance through the development of an exclusive, tactile code among partners. Drawing upon our learnings from this study, we outline design implications for further research and design work focused on mediating intimate interactions in LDRs. Therefore, we extend the state-of-the-art knowledge on intimate interactions in technology-mediated LDRs and exemplify a possibility to design for these.

The paper is divided into 10 sections as follows. The first section describes and defines the key concepts used in this paper. In "Related

Work" a detailed overview of papers on LDRs and prototypes connected to the proposed design is given. Following, in "Contextual Analysis: Methodology" the applied methods, participants, study procedure, and data analysis of the Contextual Analysis are elaborated upon. The "Contextual Analysis: Results" section is divided into four subsections according to the data gathering methods and a short summary. Next, "QUDE: Design" gives insight into the concept, process, and prototypes of the proposed design, followed by two sections on the Prototype Testing Methodology and Results. In the Discussion the combined results will be reflected upon and suggestions for future works be given, before a passage on Limitations leads to the Conclusions.

## 2 KEY CONCEPTS

Mediating intimacy in geographically-separated relationships through technology compromises several aspects. To set a starting point for this paper, three key concepts will be introduced.

### 2.1 Long-Distance Relationship (LDR)

Being in a long-distance relationship (LDR) is inherently different to being in a close-proximity relationship (CPR), which has made it a topic of interest for research. Geographical separation significantly reduces the number of encounters of physical intimacy as well as face-to-face communication and can, therefore, challenge the relationship quality [33]. At the same time, the experience of being in an LDR also brings with it positives such as developing independence and alternative forms of non-physical intimacy [23]. Thus, an LDR sits at a complicated intersection of motives, making it a challenging topic to design for.

Both distance between partners and travel time can be used as defining criteria for what is considered an LDR. However, in this paper we decided against giving a cut-off criterion and for leaving the definition of an LDR open to subjective classification.

### 2.2 Computer-Mediated Communication (CMC)

As physical face-to-face interactions in LDRs are reduced to a minimum, communication is often mediated by technology [1, 37]. Computer-mediated communication (CMC) can be defined as "[...] the interactive process of creating, exchanging and receiving information using computers." [39, p. 158] or as "[...] communication that takes place between human beings via the instrumentality of computers." [10, p. 1]. As noted by Carr in 2020, the variety of communication-mediating artefacts has increased since the first introduction of CMC, thus the term "computer" in CMC should be understood broader and at the same time be less emphasized. Instead, it is the mediation of human exchanges and the underlying human processes that are of interest, rather than the devices utilized [4]. We share this notion and understand CMC in this paper as described.

### 2.3 Intimacy

Intimacy is a central aspect of different types of interpersonal relationships, including romantic ones. For instance, Steinberg [38] defines it as one of three pillars of love. From his theoretical standpoint, intimacy subsumes feelings of closeness, connectedness, and

bondedness, which are experienced through shared happiness, reliability of the partner, mutual understanding, intimate communication, and an exchange of emotional support. In a literature review of 61 intimacy definitions, Moss and Schwebel [25] identified themes that make up intimacy, concluding that: "Intimacy in enduring romantic relationships is determined by the level of commitment and positive affective, cognitive, and physical closeness one experiences with a partner in a reciprocal (although not necessarily symmetrical) relationship." [25].

Other theoretical accounts focus on self- and partner-disclosure as key components of intimacy [31]. As noted by Laurenceau et al. [18], emotional self-disclosure is more important for the feeling of intimacy than informational self-disclosure. Thus, sharing ones feelings and opinions is more relevant for creating intimacy in a relationship than communicating autobiographical facts or pure information.

Lomanowska and Guitton [21] argue that the experience of digitally-mediated intimacy is influenced by three factors: social parameters of the context, communication modality, and prior familiarity. For LDRs, social parameters (one-on-one setting) and a pre-existing relationship are usually given. Thus, we argue the modality (unimodal, multimodal, immersive) is where digital intimacy in LDRs can be influenced the most.

For the purpose of this paper, we therefore define intimacy as an aspect of relationships premised on a reciprocal exchange of emotional states, thoughts, activities, and acts of physical affection, which aims at making partners feel close to and connected with each other. Consequently, intimate interactions facilitate those exchanges between partners that enable a feeling of intimacy under the given definition. Of special interest in technology-mediated intimacy are the particular artefacts along with the modalities of communication they afford.

## 3 RELATED WORK

Long-distance relationships in conjunction with CMC have been extensively researched within the HCI community. For example, Hassenzahl et al. [8] conducted a thorough literature analysis of 143 designs for mediating intimacy in LDRs, which revealed six common design strategies for creating such artefacts. These strategies were labeled as Awareness, Expressivity, Physicalness, Gift Giving, Joint Action, and Memories. For instance, artefacts designed for Expressivity allow for an interpretatively open expression of emotions, while those for Physicalness aim to simulate physiological and gestural aspects of touch [8]. Extending upon these six design strategies, Li et al. [19] carried out a systematic literature review of 47 papers containing 52 so-called 'unconventional' user interfaces for emotional communication. Their study showed that the dominating modalities in the designs were touch-based input and visual and/or haptic output. Further, manipulation, movement, and shape-changing of objects were less frequently used, and smell and taste as a modality were almost omitted. The communication style was mostly symmetric, i.e. via the same type of device, and the exchanged messages typically disappeared over time.

King and Forlizzi [16] explored the exchange of emotions instead of pure information for couples in long-distance relationships. Their findings showed that couples used a variety of means to maintain an emotional connection. Daily synchronous communication was important for relational stability, but less frequent acts that illustrate the time and effort spent were the most meaningful. Further, according to Li et al. [20] mainstream communication means, such as voice and video calling or texting, enable the exchange of information, but are incapable of mediating affection and emotions at its fullest. For this reason, adding wearable devices to the communication provides a great potential of lifting those limitations.

Individual adaption has been highlighted in the context of LDRs through the work of Kowalski et al. [17]. They found that participants made use of the ambiguity of the messaging forms to encode individualized, personal meanings into the messages, and that participants both adopted and extended the original concept of the prototype to fit their own wants and needs. In another study, Kaye et al. [15] explored communicating through only one bit at a time. Similarly to Kowalski and colleagues, they found that giving users an inherently simplistic and ambiguous communication modality affords active re-interpretation, which was considered a valuable and rich resource for communicating intimacy.

Personal meanings also surfaced in a study by Park et al. [29] exploring haptic interactions in the context of phone calls. Through manipulating an inflatable surface during their phone calls, the couples developed their own tactile vocabularies to enhance their communication with non-verbal, haptic expressions. Similarly, Mullenbach et al. [27] found that their participants were able to relate emotional expressions to varied haptic interactions throughout several contexts. Singhal et al. [36] also illustrated that vibrotactile sensations delivered through connected gloves can enhance intimacy in existing communication modes, such as video calling. Vibrations that represent heartbeats were also used by Werner et al. [40] to successfully create intimate moments for couples.

It has also been explored how prototypical wearable displays can be a lightway channel for intimate communication [14, 20]. From testing publicly viewable devices dedicated for communicating intimate messages with a partner, it was suggested that designers should carefully consider the visibility of the prototype in relation to the intimacy of the content to be transmitted. Thus, the authors propose that the messages conveyed through wearable ambient displays should be more implicit, subtle, and with a high level of personal meaning, and that the devices themselves should mimic ordinary everyday objects [14, 20]. Studies revolving around wearables have further suggested that positive emotions can be invoked via a ring-based touch stimuli [30], and that material choices for computational jewelry should be made to enable transferable modules for higher flexibility, customization, and adaption [34]. In summary, a rich body of research on CMC and LDRs and corresponding design strategies precede this study, among others showing that intimacy in LDRs can be facilitated through (wearable) artefacts, especially those stimulating bodily sensations and allowing to express individualized meanings. However as [8] have pointed out, so far utilized strategies might not be exhaustive, giving reason to further explore them through empirical research.

## 4 CONTEXTUAL ANALYSIS: METHODOLOGY

In order to get a first-hand account regarding experiences of being in a long-distance relationship as well as to identify the everyday practices and means of interaction between two partners when being apart, we have conducted in-depth semi-structured interviews. This method was chosen due to its ability to comprise both open-ended and theoretically driven questions and, therefore, deriving both the data grounded in personal experience of participant and the data guided by existing constructs [5].

The interviews were combined with a creative task, in which each participant was asked to sketch an idea of a product or a service he or she considers to be useful for people in a long-distance relationship and would like to use personally. As noted by Mitchell et al., imagery captures something that cannot be easily put into words, and therefore the use of drawings has the potential of transmitting the memories, thoughts, and feelings of a respondent that otherwise might not be expressed [24]. Since the nature of intimate relationships is rather sensitive and complex, the usage of drawings as a data collection method provided an opportunity for communicating additional dimensions of the experience. For instance, both the process of envisioning an idea via sketching and the follow-up reflection on it in the post-task interview allowed us to better understand the current pain points and needs of participants.

The in-depth semi-structured interviews were thematically analysed with an affinity diagram. As described by Holtzblatt et al. [11], this method allows for grouping data from individual interpretation sessions into key issues under labels that reveal the customer's needs and organizing them into a hierarchical diagram. Following the procedure proposed by the authors, the in-depth interviews and the post-task interviews were analysed separately.

To analyse the drawings, the method of qualitative content analysis was applied. Hsieh and Shannon [13] defined it as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" [13]. Even though content analysis was initially used to examine textual information, such as interview transcripts or articles, it can also be employed to make sense of visual data. For instance, McKay et al. [22] applied content and thematic analysis methods to examine collages, which were created by study participants, and elicited meaningful user experiences and impressions.

### 4.1 Participants

To be eligible for participation in the study, an individual must have met the following inclusion criteria: to currently be in an LDR (according to their own definition of LDRs) for at least two months; to be proficient at speaking in English; and to use digital technologies to communicate with their partner.

The seven participants of the interviews consist of three males and four females; with an age range from 23-44 years old. The time spent in an LDR ranges from 2.5 months to 2.5 years. Four participants report to have been in an LDR throughout the entire length of the relationship—with no period of being in a close-proximity relationship.

## 4.2 Study Procedure

In this paper, we report on the results of seven remote sessions which included seven in-depth semi-structured interviews and six creative task completions followed by a short post-task interview. The sessions were conducted via Google Meet and recorded on audio.

**Qualitative semi-structured interview:** In the first part of the session, each participant was asked questions covering different aspects of the experience of being in a long-distance relationship, including the rituals they share with their partner over distance, attitudes, fears, and motivations connected to that type of relationship, tools they use to communicate, and the ways in which they express their emotions.

**Creative task:** In the second part of the meeting, a participant was given the task to sketch an idea of a new product that he or she considers to be useful for people in an LDR and would like to use himself or herself. The participants were not limited in the form of the product: it could be something digital or physical or a combination of both. Additionally, we did not impose any restrictions on the form of drawings (e.g. digital or analogue) as well as the materials and tools used to produce them (e.g. pencils, pens, paper, etc.). The participants were free to add any notes or keywords they associate with the depicted product or service. Each person was given 15 minutes to complete the task. In case a participant had difficulties in coming up with an idea, we had prepared a slide with three already existing products to inspire him or her. This option was used by two of the participants. Once the task was completed, a participant was asked to either take a photo of the drawing or export it and send it to the researcher who conducted the interview for a follow-up discussion. Since one respondent refused to sketch her idea, six drawings and reflections on them were collected and analyzed in the second part of the session.

**Post-task interview:** During the post-task interview, each participant was asked to elaborate on his or her idea by explaining what that new product is, how he or she would personally use it, why he or she would need something like that in the first place, and what it gives him or her that is not possible with existing products.

## 4.3 Data Analysis

Following the procedure described by Holtzblatt et al. [11], an affinity map was created, consisting of 329 yellow notes, 112 blue notes, and 53 pink notes related to the first part of the session (the in-depth semi-structured interviews). From those, 17 main themes were identified and described.

To analyze the creative tasks, each of the six drawings were examined without analysing the post-task questions to identify codes and themes. Since drawings have a more intuitive nature than verbal expressions, the decision fell on first trying to interpret them independently from the answers given during the post-task interview. Codes included both the elements directly depicted in the drawings (household items, elements of devices, etc.) as well as the indirect, more interpretative codes (e.g. abstract feelings and impressions). Next, both types of codes were united into themes. After that, the descriptions of those themes were prepared.

At the next stage, the data collected during the post-task interview has been analyzed. This was done by creating another affinity

diagram for the purpose of identifying additional themes.

## 5 CONTEXTUAL ANALYSIS: RESULTS

In the following sections a general overview of the resulting themes and a detailed description of selected ones will be given.

### 5.1 Semi-structured Interviews

Analysing the semi-structured interviews with the affinity diagram resulted in 17 themes consisting of clustered issues, wishes, practices, and experiences verbalized by the participants in the interviews (see Table 1 for an overview). In this section, a selection of these themes are described briefly before continuing with the results of the creative task analysis.

Participants expressed many different aspects of being in contact with their partner, and also regular communication practices were mentioned, whether it happens daily or in longer intervals. Both frequency and type of content display a regular communication behavior, e.g. sharing mundane things of daily life or immediately sharing positive experiences. These findings make up the theme of "Regular communication practices".

It was also reported that the limitations of technologies often make communication complicated. For example, participants sometimes find the flow of online conversations to be less authentic than face-to-face conversations and noted that occurring technical problems, such as messages disappearing during the conversation or echoing when calling, often cause some disturbance to them. Moreover, participants pointed out that their focus on the conversation varies depending on the communication form, e.g. calling with video kept some of them less distracted than via audio. These notions were summarized in the "Limitations of technology" theme.

The themes "Physical presence" and "Sensory experiences" connect by the emphasis on physical experiences. The first one includes both the wish to feel the partner's presence over distance and the wish to reduce the physical distance to him/her. In the second theme, the participants expressed to miss sensory experiences of their partners like smell and the wish for shared sexual activities. Further, physical meetings are valued as a special and important event in this theme.

"Individual life" is a theme collecting some benefits of being in a long-distance relationship. Participants valued the ability to have time for their own activities and goals, and even use them as a distraction for missing their partner. While regularly connecting is seen in many other themes, the notion of not being in constant contact also plays a role in LDRs.

"Inadequacy of LDRs" refers to the thought that this type of relationship cannot fully substitute the close-proximity ones, especially when being in a conflict with a partner. Further, some participants expressed that they feel they cannot fully be there for their partner, and that it is not possible to completely recreate the intimacy that you have in close-proximity relationships.

The theme "Personal insecurities" refers to reflections of participants on how the lack of self-confidence tends to enhance over distance and, therefore, makes them doubt their relationships in

**Table 1: Resulted affinity diagram themes with descriptions**

Theme	Description
User requirements for technology	Having specific requirements for technology related to e.g. flexibility or physical layout
Limitations of technology	Finding certain limitations with CMC that complicates the exchanges
Conscious technology-use	Expressing a conscious choice and usage of technology
Supportive and caring exchange	Experiencing that exchanges are meaningful and supportive in the LDR
Individual life	Valuing ability to have time and space for personal activities and goals
Shared activities	Connecting over distance via shared activities and artefacts
Regular communication practices	Having regular practices for communicating with partner on daily/weekly basis
Physical presence	Feeling the need for partner’s physical presence in a variety of situations
Sensory experiences	Valuing sensory experiences with the partner—often touch, but also other senses
Difficult relationship maintenance	Putting effort into maintaining the LDR, even though it’s hard
Inadequacy of LDRs	Finding the LDR to be incapable of replacing an in-person relationship
Audio/-visual communication	Finding Audio/-visual communication to be more authentic than texting
Motivations to stay in LDR	Expressing motivations to put effort into staying in and maintaining the LDR
Personal insecurities	Reflecting on how personal insecurities challenge the confidence in the relationship
Distorted communication	Expressing that communication can get distorted when not being together
Awareness of emotions	Being aware of personal emotions when communicating
Conflict resolution	Having specific strategies or approaches for handling conflicts over distance

general. For example, some participants expressed that it can be difficult to feel trust and that they feel there are more risks of breaking up.

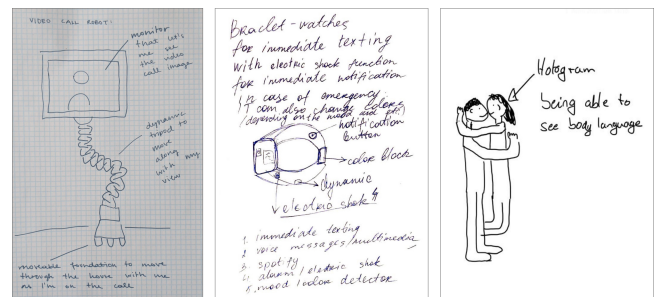
It was also described how it can be a challenge in LDRs to both encode and decode messages as well as understand the feelings of a partner when communicating via digital services. Participants further expressed that, sometimes, they feel that some things are left unsaid. These issues make up the theme of “Distorted communication”.

### 5.2 Creative Task

The following section presents the themes from analysing the six drawings. In the drawings, 24 content codes were identified, which then were grouped to form eight themes describing the product ideas. Additionally, elements such as arrows, product titles, and annotations were grouped into the theme “Elaborated product descriptions”.

Two themes relating to the geographical distance in LDRs are “Longing for physicality” and “Urge to break down the distance”. These themes are manifested in the participants’ drawings of being physically close with their partner by the means of their envisioned product.

The theme “Recreation of practices from in-person relationships” includes practices such as hugging, gifting, or saying ‘goodnight’ before falling asleep. Another interesting theme is “Transmitting subtle expressions and emotional states”, in which there is a focus on more discrete emotional states, or moods, and potential products through which one can express those.



**Figure 1: Collage of the participant’s ideas during the Creative Task**

The drawings also show products and contexts, where there is an “Appropriation of everyday objects and spaces”. This theme entails that everyday objects and spaces are altered, re-arranged, or re-purposed to accommodate for a wish or need in the LDR. Another theme is “Sharing moments”, which represents the act of sharing moments together, even when apart, for example lying in bed at night.

The theme “Mediation via digital objects” covers that all of the participants imagined how aspects of their relationship could be facilitated via digital objects. Lastly, the theme “Augmenting reality” covers that participants envisioned an augmentation of reality via the products that they drew.

### 5.3 Post-task interviews

The analysis of the post-task interviews revealed in-depth explanations of the imagined products, which resulted in five themes

**Table 2: Themes and related codes from the content analysis of the six drawings**

Theme	Codes
Longing for physicality	Wearables, Representation of the audio/-visual, People, Caring, intimacy
Urge to break down the distance	Closeness, Representation of partner
Recreation of practices from in-person relationships	Caring, Activities, Intimacy, Interpersonal communication
Transmitting subtle expressions and emotional states	Emotional expressions, Interpersonal communication, Connectedness
Appropriation of everyday objects and spaces	Household objects, Environments, Arrangement, Wearables
Sharing moments	Connectedness, Interpersonal communication, Emotional expressions, Intimacy, Closeness
Mediation via digital objects	Digital applications, Digital communication devices, Wearables, Interpersonal communication, Handles (of devices, objects)
Augmenting reality	Screens, Environments, Household objects, Emotional expressions
Elaborated product descriptions	Callouts and arrows, Product titles, Product names, Product features, Product functions, Written descriptions and captions

consisting of four specific themes as well as one theme of remaining outliers.

“Seamless and timely connection” refers to the requirement of having a stable technological implementation, where low effort has to be put into the system to access its benefits and functionalities. A further point of this theme is to have the possibility of reaching out to a partner in an immediate form.

The theme “Discrete Togetherness” covers respondents wishes for the product or service to not be disturbing or interrupting to neither their partner nor themselves, while simultaneously enabling a personal and mutual understanding, that is only known to the two users.

In “Reconnecting with the partner via sensory interactions”, a wish for feeling present and included in the partner’s life was expressed. Further, additions to current technological communication solutions is wished for, for example via simulation of touch or the possibility of reading body language. With these sensory interactions, the participants expressed that they could achieve a feeling of re-connection with their partner.

Lastly, “Tangible expression of care” is a theme in which gestures of care were in focus. These gestures have more emphasis on physical and tangible elements compared to the digital wishes presented in other themes. The gestures include sending gifts or physical products on special occasions.

## 5.4 Summary of results

The present section has reported on several aspects of mediating intimacy via technology in LDRs. A big focus was on physical and sensory experiences, where it was articulated how the participants value the activation of senses when interacting with the partner, how they long for more physicality and feeling present with their partner, and how they could imagine reconnecting with their partner over distance through sensory interactions.

Further it was reported that communication over distance can feel distorted, that LDRs in general seem inadequate in recreating

intimacy from in-person relationships, and that personal insecurities can cause a lack of feeling of confidence in the relationship. Lastly, the respondents imagined product ideas in which an everyday object or space has been adapted or appropriated to fit the wishes and needs when being in an LDR. This was further underlined in the participants’ wish for customizing the product and making it more personal. Here it was suggested to create a form of private code that is understandable only to the two persons in the relationship. These results along with the implications reported in the section Related Work make the foundation for our creation of a conceptual prototypical design for people in LDRs.

## 6 QUDE: DESIGN

### 6.1 Concept

As demonstrated by the findings from the semi-structured interviews and creative tasks, people in LDRs would like to make the experience of being in relationships more discrete and exclusive and feel the presence of their partner over distance. Since in-person meetings are reduced to the minimum, the participants above all valued sensory experience.

Qude is a patch, which can be placed on different body parts to support meaningful, unobtrusive tangible interactions for people in LDRs. Following the idea of a Morse code, the patch is going to allow one person to tap a message and another one to feel it on their skin via vibration patterns. Additionally, the combination of taps can be connotated to specific emotive images (emojis), which will further be displayed on a connected smartphone app. The goal of this representation would be to develop an exclusive physical vocabulary among partners. This vocabulary can be viewed and modified in the app. Additionally, the tapping-history will allow to replay recorded taps for oneself – similar to re-experiencing special moments and memories in a relationship. Since discreteness is a key factor, Qude should not be obtrusive to both partners nor reveal its purpose to people around. For this reason, on the outside it is going to look like a futuristic yet minimalist accessory.

## 6.2 Design process

Throughout the design process, experience prototypes [3] were created aiming to explore respondents' first impressions and understanding of Qude. In first iterations they focused on the role [12] they could have for a user, and in later iterations they aimed to explore the look-and-feel [12] of the prototype.

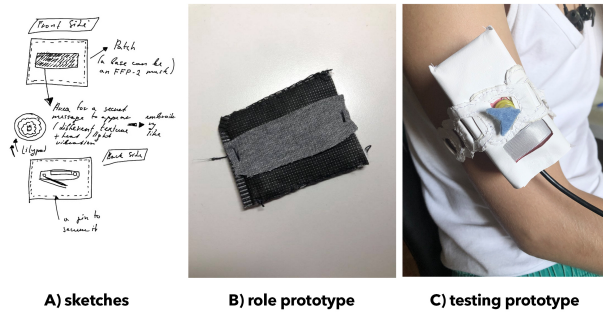


Figure 2: Design process with A) initial sketches, B) role prototype and C) testing of look-and-feel prototype.

*Prototype patch:* For an early exploration of the Qude concept, a physical role prototype was created. This led to the articulation of a set of opportunities and constraints, upon which further two look-and-feel prototypes were created to test the feasibility and usefulness and frame possible errors. A further prototype was developed to test the input and output modalities and proceed in a higher fidelity version. In this step an iterative process on the visual design was done as well, including casing, mounting, material selection, and ergonomics of the high-fidelity prototype. With the input from prototype testing, some minor adjustments were made, such as increasing the input frequency of tapping commands, which was initially set too low. The first hardware platform was created using LilyPad USB Plus. As the power requirements of the chosen input and output modalities were not met, the hardware platform was changed to the Adafruit ItsyBitsy 32u4. For the prototype testing, the functionality of the prototype was split up: three single case scenarios were tested in isolation - receiving a message, sending a message, and encoding in the app prototype.

*Prototype app:* To create the app prototype, initial hand drawn sketches were transformed to low-fidelity wireframes. Following a design review to pinpoint possibilities and limitations of the app concept, decisions were made about elements to remove, edit, add, and keep. For example, one concern came up that if only one person in the relationship sends Qude messages, the history section would maybe create a feeling that this person's effort of sending messages is not appreciated by the partner. For this reason, the time stamp and sender label were removed. Lastly, the wireframes were further developed into a higher-fidelity prototype with mapped screens. For the purpose of the prototype testing, only critical interactions were mapped - to a level that enables a test respondent to engage with, understand, and reflect on the prototype and concept in general.

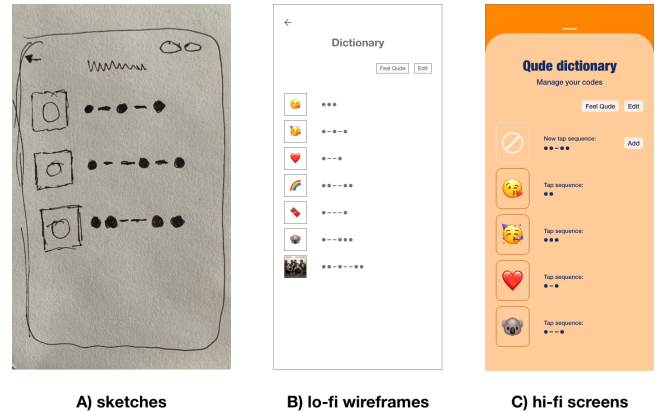


Figure 3: Design process with A) sketches, B) low- and C) high-fidelity screen designs. An important element of Qude is to enable the development of a private and exclusive code between couples. To do so, the app prototype includes the Qude dictionary and the flow of adding a new emoji to a tap rhythm.

## 6.3 Prototypes

The first prototype – Qude patch – integrates a vibration motor, a touch sensor and a button, all cased in a cardboard box and wrapped in pina-tex fabric. Additionally, a strap allows for dynamic positioning of the device. Every tap on the touch sensor translates into a subtle vibration, with the pattern being fully repeated after the button has been pressed and the message has been "sent". The length of the vibration changes depending on the length of tapping. A setup of two different programs allows the simulation of sending and receiving messages, and therefore covering the whole range of functionalities of the physical prototype.

The main feature of the Qude app prototype is the dictionary, in which users can define Qudes by assigning emojis to tap rhythms, and in this way encode their own personal meanings to the taps. The app also displays the latest three Qude messages sent by either users; the tap rhythm is visualized, and when applicable, the corresponding emoji is displayed.

## 7 PROTOTYPE TESTING: METHODOLOGY

Following the notion of experience prototyping [3], usability tests were conducted to learn about participants' experience with the prototypes and their first impressions of the concept, as well as to discover issues and positives connected to the prototypes. The usability tests combined think-aloud protocols, scenario-based tasks, and semi-structured interviews. For scenario-based tasks, participants were asked to imagine various situations of using the prototypes in contexts with and without their partner and then perform small tasks with both the patch and the app.

### 7.1 Participants

Four participants were recruited through the researchers' personal network. The inclusion criteria were the same as previously described in Contextual Analysis. Three of the participants identified

as female, with one identifying as male. Participant age ranged from 23 to 26 years-old.

## 7.2 Procedure

Adhering to COVID safety measurements, the participants were invited to one of the researchers' private premises for the usability testing. In a quiet and undisturbed environment, one researcher briefed the participants, conducted the semi-structured interview, and introduced the scenarios and tasks, while a second researcher supervised the prototypes, audio- and video recorded and observed the testing, and also asked follow-up questions. Following demographic and background questions, the first scenario-based task tested receiving a vibration-rhythm through the patch. The second scenario-based task asked for tapping and sending a rhythm, with the third testing the main functionalities of the app. The tasks were followed by questions to the understanding, likes, issues, and visions of the prototypes.

## 7.3 Data Analysis

To analyse and interpret the multiple types of data (transcripts, videos, photos) collected in the usability tests, a qualitative content analysis was chosen due to its flexibility. The following coding methods were applied: in-vivo codes for highlighting remarkable words and phrases used by participants, emotion codes for emotion states of the participants, action codes for observable actions of the participants, descriptive codes as summaries of a data passages [32], and analytic codes as interpretations of data passages [7]. At the next stage, duplicates were deleted, and remaining codes were grouped into categories. After that, the categories were critically analyzed to identify themes.

## 8 PROTOTYPE TESTING: RESULTS

A total number of 148 codes were identified, out of which 25 categories emerged. Furthermore, we have extracted 16 themes containing the key insights from testing. The full list of themes and descriptions is presented in Table 3.

“Interpreting design concept” subsumes categories and codes that relate to the participants' explanation and understanding of the Qude concept. When being asked to describe what Qude is, they were readily able to give their comprehension of it and articulate its value for them. This insight underlines the fit of the design concept to the intended user group and its context.

This was further supported by the theme “Fitting into the user's context and shared routine”, as the participants were interested to try the prototypes with their partner and could envision it as a pain reliever in times of no personal contact and as an intimate and exclusive form of communication. It was mentioned that the device should not be constantly on however.

The purpose of the Qude design concept is to enable the development of an exclusive tactile code among partners. During testing, the participants reported that the vibration rhythm enriches the traditional communication over distance by extending it to one more sensory experience. Furthermore, an opportunity for encoding less explicit meanings into discreet messages was seen as especially valuable.

One of the most interesting insights was that two participants reported the tactile interactions of tapping to be seen as a means of self-expression. Since articulation through verbal communication might be challenging for some individuals, the participants saw this touch-based communication system as an opportunity for them and their partner to open up, as well as to let the other person know they are thinking of them. The interaction of tapping a rhythm was observed and interpreted as intuitive, since all of the participants were able to tap a message and none of them felt the action to be disturbing in any way. Moreover, as noted by two participants, tapping is faster and easier than texting a message.

When describing the interactions and feelings evoked by the prototype, participants often referred to the examples from in-person experiences with their partner. Thus, the interactions created by the prototype could to some extent simulate physical in-person interactions, providing an alleviation in times of no contact.

The importance of face-to-face interactions was further emphasized in the “In-person first” theme. Here participants expressed that they would prefer the definition of codes to be done while being physically together. Through this, the definition of a rhythm would be linked to a special event or memory, giving it a personal value and revoking the emotions felt at these occasions. Additionally, participants pointed out that it would take time and effort for both partners to develop and use a personal dictionary.

Among the functionalities participants wanted to add to the present prototype was an opportunity to assign further forms such as text, music, or images to rhythms tapped. Furthermore, one participant mentioned that she would like to personalize Qude by changing elements in the app, not the patch itself. For instance, make it possible to change and sync the background color with the account of your partner.

A major concern that was raised by the participants was the possible intrusiveness of the prototype. This included the fear of overusing the tapping and therefore becoming obtrusive to their partners and not wanting to be in constant interaction with the device. As a potential remedy, the prototype should give the opportunity to be turned on and off.

## 9 DISCUSSION

In the following, the main results and implications of the Contextual Analysis, Design Process, and Prototype Testing will be outlined and discussed.

### 9.1 Intimacy and physicalness

The present paper aims to explore and identify the existing practices in experiencing intimate interactions in technology-mediated LDRs, to design an artefact that can alleviate some of the struggles people in this type of relationship are facing as well as to test the created prototypes with target users. Physicalness is one of the most prominent design strategies identified by Hassenzahl et al. [8], underlined by several further studies [27, 29, 36] which found it to be an unfulfilled need. This notion was supported by themes identified in the contextual analysis, e.g. in “Physical presence”, “Sensory experiences”, “Longing for physicality”, and “Reconnecting with the partner via sensory interactions”. In our design, touch wasn't the primary functionality of the device and didn't aim at simulating



**Table 3: Themes and descriptions from the analysis of the prototype testing**

Theme	Description
Referring to in-person intimate experience	Giving examples from interactions with a partner when describing the feeling evoked by a prototype or being asked to imagine using it
Understanding the usage (patch)	Finding the tapping area, tapping the message and sending it by pressing the button as well as being able to repeat the action without any assistance
Envisioning the ergonomics of future design (patch)	Mentioning the size and relative bulkiness of the current prototype as something they would like to change about it
Interpreting design concept	Explaining in their own words what Qude is as well as articulating how it can be valuable for them or their relationship
Self-expression through touch	Reporting tactile interactions to allow either them or their partners to open up and/or let them know that they are thinking about them
Developing exclusive tactile language	The vibration rhythm enriches traditional communication over distance An opportunity for encoding less explicit meanings into discreet
Haptic feedback impressions	The vibrations were described as rather pleasant and subtle, although three respondents reported that they would not like to feel them constantly during the day
Fitting into the user's context and shared routine	Expressing interest in trying Qude with a partner; envisioning how it can be a pain reliever when not being able to see one another in person for a long time as well as making communication more intimate and exclusive; pointing out that the device shouldn't be constantly on
In-person first	Expressing a wish to define the codes when being physically together to later on use it over distance or being able to link the rhythm to a special event or memory
Concerns regarding the intrusiveness	Fearing that they might overuse the tapping and become obtrusive to their partners; having an opportunity to turn the device on and off; not wanting to be in constant interaction with an additional device
Look and feel of the current prototype (patch)	Despite the relative bulkiness of the current prototype, no discomfort when having it on was reported; two participants have mentioned that they like it's aesthetics
Prototype limitations (app)	Participants identified the laginess of the Adobe Xd Mobile App (on which the app was displayed) as the bugs of the prototype itself; an additional issue was that many functions and screens are not mapped in the prototype at this point
Prototype limitations (patch)	Limited mobility and portability
Intuitiveness of tapping	All four participants managed to tap the message; none of the participants found this action disturbing; two reported tapping to be a faster and easier action than texting
Time to adjust	Pointing out that developing and using personal dictionary will require some time and thought from both partners
Further forms for encoding/decoding	Expressing a wish for assigning meanings to texts, songs, images, etc.

the in-person physicalness. However, during the prototype testing, the touch dimension was seen as a valuable extension to communication over distance. Therefore, we argue that a physical dimension of designs does not necessarily have to aim at replacing the realistic touch to support intimacy in LDRs, but be used as an additional layer of communication.

## 9.2 Code for two and self-expression

The nature of long-distance relationships implies a minimum amount of face-to-face interactions, which might limit the ability to articulate one's thoughts and feelings to their partner. For instance, the theme "Distorted communication" revealed that participants often feel disconnected when being away from their partners and find it difficult to understand what their significant other feels or tries to express, which might lead to the loss of connection. During the prototype testing, two participants stated that they could use Qude as a means of self-expression for both them and their partners and

suggested it to be beneficial for their relationships. By not limiting the users with pre-defined codes and allowing them to ascribe their own meanings to tactile rhythms, Qude enables self-disclosure, which is a key aspect of intimacy [18]. As the expression of negative emotions is largely neglected in research [2], future designs could investigate into this direction for example through novel ways (e.g. [17, 29]) of affording expressivity [8].

## 9.3 Appropriation and discreetness

Although there are many downsides to being geographically separated, there are also some benefits. In the contextual analysis, for instance, in the "Individual life" theme, the participants expressed that this form of relationship gives them time and space for their personal interests, work, study, friends and hobbies. This was also reflected in the results of prototype testing, as participants stated that they wouldn't like the device they use with their partner to be constantly on, since it might become intrusive. At the same time,

participants expressed a wish to reach out to their partner immediately in the "Seamless and timely connection" theme identified in the empirical part of the contextual analysis. This contradiction presents a challenge for both the artefact proposed in this paper as well as other existing and upcoming designs, and should be further explored.

Another interesting insight, related to the notion of providing a space for expressivity and encoding of personal meanings mentioned earlier, is the flexibility of services and tools used in LDRs as well as created and shared content, which was depicted in the theme "User requirements" from the contextual analysis. Additionally, this motive appeared in the analysis of the results of prototype testing ("Further forms for encoding/decoding"), as participants also would like to assign text, music, or images to the rhythms. Thus, an extension of forms that can be used in Qude could be beneficial. However, this comes with the risk of deviating from the initial design concepts, the core of which was the ambiguity of meanings.

In addition, prior research has suggested an ability to be personalised as one of the key qualities of designing for LDRs [17, 20, 29]. A wish for personalisation was mentioned by one of our respondents during testing. However, she didn't want to make the physical prototype customizable, but rather have an option to adjust some elements of the app instead. This remark is of particular interest for us as the simplicity of both interactions and look centered around the core of the patch's design.

In the creative task, one theme ("Discrete togetherness") expressed that participants would like their communication and overall experience of being in an LDR to be more exclusive, e.g. by having a form of code that is understandable just for the two of them. This is further exemplified in Li and colleagues' [20] exploration of wearable ambient displays, where they found that participants were concerned whether their personal and intimate messages on the wearable devices were visible or noticeable to the public. These insights were implemented in the development of the design concept. Thus, we have used the vibration as an output: it goes unnoticeable for everyone, except for the person wearing it. From testing it became clear that this solution indeed allows for creating an intimate and exclusive form of communication, thereby also supporting the findings of previous works [15, 17, 20].

## 10 LIMITATIONS

This study shows potential limitations as LDRs are a complex topic with many personal and intimate facets; therefore, talking about being in an LDR can be intimidating for some people, and doing an empirical study on this topic has the challenge of respondents not speaking openly and freely about their experiences [26]. Furthermore, the remote study setup of the contextual analysis interviews might have caused a feeling of alienation and distance among respondents, similar to how it is described in [9].

There is a risk that the explicit reflection in the interviews gave insight only to a restricted part of being in an LDR. Hindsight bias, loss of memories — especially of subtle moods and small details — or also withheld information make it possible that this method missed out on essential knowledge about LDRs. Adding a more private and immediate method of data gathering, such as diary

keeping [35], would complement the used methods and alleviate some of the mentioned limitations.

Regarding the creative task, limitations lie in participants' coding of ideas into drawings, as well as in our decoding of the drawings. In other words, the participants might have experienced difficulties in visualizing their concepts, and we might have faced challenges to accurately interpret those ideas [6].

For the physical prototype, the size and portability did not reflect the envisioned final product. Since the prototype had to constantly be connected to a laptop, users were restricted in their movements, which might have affected the experience of it. Furthermore, the size of the device challenges its discreetness and feel of it. As for the app prototype, only a selection of screens were mapped. These mappings directed the participants through the flow of the app, not allowing them to tap on everything they wanted nor redo an action. The limited mappings of the app might have made the test results blind towards key functionality flaws.

Furthermore, the prototypes were tested in a closed environment and not in the participant's contexts. Additionally, they were used for a short time and only by one partner alone. Respondents may have had different experiences and more elaborated reflections, if they had been using them over an extended period of time and together with their partner.

## 11 CONCLUSIONS

The purpose of this paper was to explore and identify the existing practices in experiencing intimate interactions in technology-mediated LDRs, to design an artefact that can alleviate some of the struggles people in this type of relationship are facing, as well as to test the created prototypes with target users. Based on the results of the contextual analysis, it can be concluded that physical and sensory experiences are particularly valuable for geographically separated couples. Furthermore, enhancing the feeling of exclusivity of relationships gains additional importance for them. Long-distance relationships are experienced as inadequate in comparison to close-proximity ones. This feeling is to a large extent fueled by distorted communication and the physical absence of a partner. For this reason, to support intimacy, the interactions embedded into an artefact should both contribute to the creation of meaningful exchanges and contain an aspect of physicality. The proposed design of Qude — a patch, which allows one person to tap a message another one to feel it on their skin via vibration patterns — is a response to problems and insights mentioned above. Instead of trying to replicate the in-person interactions, we focused on the development of exclusive tactile code among two partners with an added aspect of physicality. The participants of prototype testing saw a value in that decision: the intuitiveness and simplicity of the action of tapping and the freedom of assigning personal meanings to it makes this form of communication authentic in itself. We therefore believe that future works should consider a similar approach when designing for people in LDRs. Another prominent conclusion is that when designing for this user group, we should consider the usage of artefacts both when partners are geographically separated and during those shorter periods of time, when they are together.

## REFERENCES

- [1] A. Aguilá. 2011. Living Long-Distance Relationships Through Computer-Mediated Communication. *Social Science Diliman* 5 (2011), 83–106.
- [2] Janne Mascha Beuthel, Philippe Bentegeac, Verena Fuchsberger, Bernhard Maurer, and Manfred Tscheligi. 2021. Experiencing Distance: Wearable Engagements with Remote Relationships. In *Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction* (Salzburg, Austria) (TEI '21). Association for Computing Machinery, New York, NY, USA, Article 95, 13 pages. <https://doi.org/10.1145/3430524.3446071>
- [3] Marion Buchenau and Jane Fulton Suri. 2000. Experience Prototyping. In *Proceedings of the 3rd Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques* (New York City, New York, USA) (DIS '00). Association for Computing Machinery, New York, NY, USA, 424–433. <https://doi.org/10.1145/347642.347802>
- [4] Caleb T Carr. 2020. CMC is dead, long live CMC!: Situating computer-mediated communication scholarship beyond the digital age. *Journal of Computer-Mediated Communication* 25, 1 (2020), 9–22.
- [5] Anne Galletta. 2013. *Mastering the semi-structured interview and beyond: from research design to analysis and publication*. New York University Press.
- [6] J. Gasiorek. 2018. *Message Processing: The Science of Creating Understanding*. University of Hawaii Manoa. <https://books.google.at/books?id=sAp7zQEACAAJ>
- [7] Graham Gibbs. 2007. Analyzing Qualitative Data. *SAGE Research Methods* (2007). <https://doi.org/10.4135/9781849208574>
- [8] Marc Hassenzahl, Stephanie Heidecker, Kai Eckoldt, Sarah Diefenbach, and Uwe Hillmann. 2012. All You Need is Love: Current Strategies of Mediating Intimate Relationships through Technology. *ACM Trans. Comput.-Hum. Interact.* 19, 4, Article 30 (Dec. 2012), 19 pages. <https://doi.org/10.1145/2395131.2395137>
- [9] B Hensen, C R S Mackworth-Young, M Simwinga, N Abdelmagid, J Banda, C Mavodza, A M Doyle, C Bonell, and H A Weiss. 2021. Remote data collection for public health research in a COVID-19 era: ethical implications, challenges and opportunities. *Health Policy and Planning* 36, 3 (02 2021), 360–368. <https://doi.org/10.1093/heapol/czaa158> arXiv:<https://academic.oup.com/heapol/article-pdf/36/3/360/37225083/czaa158.pdf>
- [10] Susan C Herring. 1996. *Computer-mediated communication: Linguistic, social, and cross-cultural perspectives*. Vol. 39. John Benjamins Publishing.
- [11] Karen Holtzblatt, Jessamyn Burns, Wendell, and Shelley Wood. 2009. *Rapid contextual design: a how-to guide to key techniques for user-centered design*. Elsevier, Morgan Kaufmann.
- [12] Stephanie Houde and Charles Hill. 1997. Chapter 16 - What do Prototypes Prototype? In *Handbook of Human-Computer Interaction (Second Edition)* (second edition ed.), Marting G. Helander, Thomas K. Landauer, and Prasad V. Prabhu (Eds.). North-Holland, Amsterdam, 367–381. <https://doi.org/10.1016/B978-044481862-1.50082-0>
- [13] Hsiu-Fang Hsieh and Sarah E. Shannon. 2005. Three Approaches to Qualitative Content Analysis. *Qualitative Health Research* 15, 9 (2005), 1277–1288. <https://doi.org/10.1177/1049732305276687> arXiv:<https://doi.org/10.1177/1049732305276687> PMID: 16204405.
- [14] Pradthana Jarusriboonchai, Hong Li, Emmi Harjuniemi, Heiko Müller, and Jonna Häkklä. 2020. Always with Me: Exploring Wearable Displays as a Lightweight Intimate Communication Channel. In *Proceedings of the Fourteenth International Conference on Tangible, Embedded, and Embodied Interaction* (Sydney NSW, Australia) (TEI '20). Association for Computing Machinery, New York, NY, USA, 771–783. <https://doi.org/10.1145/3374920.3375011>
- [15] Joseph 'Jofish' Kaye, Mariah K. Levitt, Jeffrey Nevins, Jessica Golden, and Vanessa Schmidt. 2005. Communicating Intimacy One Bit at a Time. In *CHI '05 Extended Abstracts on Human Factors in Computing Systems* (Portland, OR, USA) (CHI EA '05). Association for Computing Machinery, New York, NY, USA, 1529–1532. <https://doi.org/10.1145/1056808.1056958>
- [16] Simon King and Jodi Forlizzi. 2007. Slow Messaging: Intimate Communication for Couples Living at a Distance. In *Proceedings of the 2007 Conference on Designing Pleasurable Products and Interfaces* (Helsinki, Finland) (DPPI '07). Association for Computing Machinery, New York, NY, USA, 451–454. <https://doi.org/10.1145/1314161.1314204>
- [17] Robert Kowalski, Sebastian Loehmann, and Doris Hausen. 2013. Cubble: A Multi-Device Hybrid Approach Supporting Communication in Long-Distance Relationships. In *Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction* (Barcelona, Spain) (TEI '13). Association for Computing Machinery, New York, NY, USA, 201–204. <https://doi.org/10.1145/2460625.2460656>
- [18] Jean-Philippe Laurenceau, Lisa Feldman Barrett, and Paula R Pietromonaco. 1998. Intimacy as an interpersonal process: The importance of self-disclosure, partner disclosure, and perceived partner responsiveness in interpersonal exchanges. *Journal of personality and social psychology* 74, 5 (1998), 1238.
- [19] Hong Li, Jonna Häkklä, and Kaisa Väänänen. 2018. Review of Unconventional User Interfaces for Emotional Communication between Long-Distance Partners. In *Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services* (Barcelona, Spain) (MobileHCI '18). Association for Computing Machinery, New York, NY, USA, Article 18, 10 pages. <https://doi.org/10.1145/3229434.3229467>
- [20] Hong Li, Pradthana Jarusriboonchai, Heiko Müller, Emmi Harjuniemi, and Jonna Häkklä. 2020. Emotional Communication between Remote Couples: Exploring the Design of Wearable Ambient Displays. In *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society* (Tallinn, Estonia) (NordCHI '20). Association for Computing Machinery, New York, NY, USA, Article 34, 5 pages. <https://doi.org/10.1145/3419249.3420139>
- [21] Anna M. Lomanowska and Matthieu J. Guittou. 2016. Online intimacy and well-being in the digital age. *Internet Interventions* 4 (2016), 138–144. <https://doi.org/10.1016/j.invent.2016.06.005>
- [22] Dana McKay, Sally Jo Cunningham, and Kirsten Thomson. 2006. Exploring the User Experience through Collage. In *Proceedings of the 7th ACM SIGCHI New Zealand Chapter's International Conference on Computer-Human Interaction: Design Centered HCI* (Christchurch, New Zealand) (CHINZ '06). Association for Computing Machinery, New York, NY, USA, 109–115. <https://doi.org/10.1145/1152760.1152774>
- [23] Sara Mietzner and Lin Li-Wen. 2005. WOULD YOU DO IT AGAIN?. *College Student Journal* 39, 1 (2005), 192 – 200. <http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=16663194&site=ehost-live>
- [24] Claudia Mitchell, Linda Theron, Jean Stuart, Ann Smith, and Zachariah Campbell. 2011. *Drawings as Research Methods*. Sense Publishers, 19–36.
- [25] Barry F. Moss and Andrew I. Schwebel. 1993. Defining Intimacy in Romantic Relationships. *Family Relations* 42, 1 (1993), 31–37. <http://www.jstor.org/stable/584918>
- [26] Jessica Mozersky, Meredith Parsons, Heidi Walsh, Kari Baldwin, Tristan McIntosh, and James M. DuBois. 2020. Research Participant Views regarding Qualitative Data Sharing. *Ethics & Human Research* 42, 2 (2020), 13–27. <https://doi.org/10.1002/eahr.500044> arXiv:<https://onlinelibrary.wiley.com/doi/pdf/10.1002/eahr.500044>
- [27] Joe Mullenbach, Craig Shultz, J. Edward Colgate, and Anne Marie Piper. 2014. Exploring Affective Communication through Variable-Friction Surface Haptics. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Toronto, Ontario, Canada) (CHI '14). Association for Computing Machinery, New York, NY, USA, 3963–3972. <https://doi.org/10.1145/2556288.2557343>
- [28] Carman Neustaedter and Saul Greenberg. 2012. Intimacy in Long-Distance Relationships over Video Chat. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Austin, Texas, USA) (CHI '12). Association for Computing Machinery, New York, NY, USA, 753–762. <https://doi.org/10.1145/2207676.2207785>
- [29] Young-Woo Park, Kyoung-Min Baek, and Tek-Jin Nam. 2013. The Roles of Touch during Phone Conversations: Long-Distance Couples' Use of POKE in Their Homes. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Paris, France) (CHI '13). Association for Computing Machinery, New York, NY, USA, 1679–1688. <https://doi.org/10.1145/2470654.2466222>
- [30] Gilang Andi Pradana, Adrian David Cheok, Masahiko Inami, Jordan Tewell, and Yongsoon Choi. 2014. Emotional Priming of Mobile Text Messages with Ring-Shaped Wearable Device Using Color Lighting and Tactile Expressions. In *Proceedings of the 5th Augmented Human International Conference* (Kobe, Japan) (AH '14). Association for Computing Machinery, New York, NY, USA, Article 14, 8 pages. <https://doi.org/10.1145/2582051.2582065>
- [31] Harry T Reis, Phillip Shaver, et al. 1988. Intimacy as an interpersonal process. *Handbook of personal relationships* 24, 3 (1988), 367–389.
- [32] Johnny Saldaña and Matt Omasta. 2016. *Qualitative research: Analyzing life*. Sage Publications.
- [33] Andrew I Schwebel et al. 1992. Factors Associated with Relationship Stability in Geographically Separated Couples. *Journal of College Student Development* 33, 3 (1992), 222–30.
- [34] Yulia Silina and Hamed Haddadi. 2015. New Directions in Jewelry: A Close Look at Emerging Trends & Developments in Jewelry-like Wearable Devices. In *Proceedings of the 2015 ACM International Symposium on Wearable Computers* (Osaka, Japan) (ISWC '15). Association for Computing Machinery, New York, NY, USA, 49–56. <https://doi.org/10.1145/2802083.2808410>
- [35] Anjali Singh and Sareeka Malhotra. 2013. A Researcher's Guide to Running Diary Studies. In *Proceedings of the 11th Asia Pacific Conference on Computer Human Interaction* (Bangalore, India) (APCHI '13). Association for Computing Machinery, New York, NY, USA, 296–300. <https://doi.org/10.1145/2525194.2525261>
- [36] Samarth Singhal, Carman Neustaedter, Alissa N. Antle, and Brendan Matkin. 2017. Flex-N-Feel: Emotive Gloves for Physical Touch Over Distance. In *Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing* (Portland, Oregon, USA) (CSCW '17 Companion). Association for Computing Machinery, New York, NY, USA, 37–40. <https://doi.org/10.1145/3022198.3023273>
- [37] Laura Stafford. 2004. Maintaining Long-Distance and Cross-Residential Relationships. *Maintaining Long-Distance and Cross-Residential Relationships* (12 2004), 1–150. <https://doi.org/10.4324/9781410611512>
- [38] Robert J Sternberg. 1986. A triangular theory of love. *Psychological review* 93, 2 (1986), 119.

- [39] Sonja Utz. 2013. Sabine Trepte / Leonard Reinecke (2013): Medienpsychologie. Stuttgart: Kohlhammer. *Medien & Kommunikationswissenschaft : M & K* 61, 3 (2013), 440–441.
- [40] Julia Werner, Reto Wettach, and Eva Hornecker. 2008. United-Pulse: Feeling Your Partner's Pulse. In *Proceedings of the 10th International Conference on Human*

*Computer Interaction with Mobile Devices and Services* (Amsterdam, The Netherlands) (*MobileHCI '08*). Association for Computing Machinery, New York, NY, USA, 535–538. <https://doi.org/10.1145/1409240.1409338>