Opportunities and Challenges for Reflective Data-Objects in Long-Distance Relationships

Maria Karyda[1(✉)] and Andrés Lucero[2]

[1] University of Southern Denmark, Kolding, Denmark
mkaryda@sdu.dk
[2] Aalto University, Espoo, Finland

Abstract. Personal data representations have been used to support acts of self-reflection, a topic that has received little attention in the context of long-distance relationships (LDRs). To explore a design space for reflective data representations in the LDR context, first-person methods have been employed together with nine generative sessions with people who had been or were in LDRs. Unlike previous work, the generative sessions were part of an autoethnographic exploration. The participants interpreted the first author's visualizations, sketched their own visualizations, and imagined their data as data objects. The insights from those sense-making sessions were then analyzed in a card sorting activity between the first author and their partner where seven themes around communication of long-distance couples emerged. Furthermore, based on the data-object ideas and the various sense making sessions, design opportunities and challenges are drawn related to the transformative nature of relationships, negative reflection and aspects of privacy. In conclusion, personal data are seen as co-evolving with humans constantly transforming people's impression of their romantic relationships in mundane environments.

Keywords: Data-objects · Reflection · Long-distance relationships

1 Introduction

People have been experimenting with their personal data through different formats, e.g., by producing visualizations [23,27,37,47], or physicalizations [1,21,33]. Those explorations are outcomes of numerous data assemblages [29] a person produces throughout time. Research on digital data practices have explored the temporal and emotional qualities of personal data to understand how people make sense of their data assemblages, but also, how they feel about them. This sense making process that relates to feelings has been discussed by scholar within the HCI community [10,11,28], however, it remains an ongoing challenge. The work in this paper sets out to further explore affective qualities of digital data, and furthermore, to imagine data objects [50] that may exist in people's everyday environments in the context of communication in LDRs.

Published by Springer Nature Switzerland AG 2021
C. Ardito et al. (Eds.): INTERACT 2021, LNCS 12936, pp. 42–62, 2021.
https://doi.org/10.1007/978-3-030-85607-6_3

In this paper, the lens is set on communication data extending previous work by examining personal data as an inherently social phenomenon [9,29]. Furthermore, the LDR research context has been selected as romantic partners already experiment with their data-sets pointing to an area for further exploration. For instance, we can find examples of this type of experimentation in online forums, such as Reddit[1] where couples share visualizations of their messaging data. The act of synthesizing [2,41] personal data into alternative formats can help couples reflect on their shared past data-sets [10]. In those cases, data acquire characteristics of memorabilia. While acts of self-reflection have been broadly discussed in data representations, they have received little attention within the context of romantic relationships [15,44]. Exploring data representations in that context may open up a path towards more reflective technologies supporting romantic relationships over time. In this paper reflection [3] is understood as data experiences and stories put together in ways that couples can better understand or gain some kind of insight through their communication data about their LDRs.

To explore that area, I[2] have inquired into LDR couples as their communication routine usually entails constantly keeping in touch through digital means (e.g., texting) producing large amounts of information. In fact, Stafford [43], puts emphasis on the need of LDR couples for continuous close communication, *"relationships are considered to be long distance when communication opportunities are restricted because of geographic parameters and the individuals within the relationship have expectations of continued close communications."*

Thus, I tried to make sense of Facebook messaging data between my LDR partner and I through visualizations and cardboard prototypes. Then, I invited nine people who were themselves in LDRs – or they had been in one – to generative sessions combined with semi-structured interviews where the visualizations from the previous step were discussed and further reflected upon inspiring the participants to imagine data-objects – in that last part people stretched their understandings about their data by starting to think about them as design material [42]. Data-objects [50] are artifacts in the intersection of industrial design and data physicalization [21].The coupling of personal data and everyday objects can make objects more affective and able to provoke reflection in everyday life.Last, my LDR partner was involved in a one-to-one card sorting activity to make sense of the outcomes of the first and second step. Unlike previous work [7,18,46], the generative sessions were integral to the autoethnographic exploration. Furthermore, that lengthy and detailed sense making process contributes to the corpus or research [9,12,30] that aims at understanding how people make sense of their data using qualitative methods, but also, reflects a typical Research through Design process [24].

I pose the following research questions: *How can LDR partners make sense of their communication data? How can we invite LDR partners to imagine their communication data in physical forms? Do data-objects offer opportunities for design in the area of romantic relationships?* Through this research I gained

[1] https://www.reddit.com/r/dataisbeautiful.

[2] First-person singular narrative will be sustained throughout the paper as this research heavily draws from first-person methods.

an understanding of the types of data-objects that people imagined in their homes and, I illustrated opportunities for design which view data-objects as living things that co-evolve with humans and help them conceptualize themselves and their actions. That is in line with Lupton and Watson's [31] research on more-than-human perspective which "positions personal data as lively human–data assemblages that are constantly changing as humans move through their everyday worlds". The contributions of this work are first methodological, where I have approached the broader context of this research on LDRs and fit that into a unique, idiosyncratic and private setting (i.e., a single couple) leveraging an interplay between an autoethnographic and a participatory approach. Second, this work contributes to *personal visualizations research* [47] as visualizations were used in novel ways e.g., sketching, and last, I offer opportunities for design in the context of LDR couples.

2 Relationships of Data Representations and Reflection

2.1 Making Sense of Reflective Representations of Personal Data

As described by Baumer et al. [3], in personal informatics [26], reflection is an element that can lead to self-knowledge through numbers. Whilst it is yet unknown how people self-reflect when triggered by data representations, previous works have illustrated various ways through which people make sense of their data and how these sense making processes might relate to self-reflection. For instance, in personal data physicalization [21], self-reflection may be triggered through association between personal data and different material-structures. However, due to emotional and temporal qualities of personal data there is much more depth in those processes which I attempt to illustrate below.

Barrass [1] has created sonifications of his personal data, a singing bowl. The interaction with the sonification triggers novel associations between data and sound. Barrass went through several iterations of the sonification. From that, I can speculate that reflection may occur during an iterative design process, and through the interaction with final sonification. In another example, Huron et al.'s [19] constructive visualizations, build upon constructive theories of learning, arguing that physical data construction is connected with learning and reflection, since reflective thought is common in education and learning [40]. In Karyda et al.'s [22] work on narrative physicalizations, three tailor-made physicalizations allowed for bodily interactions with people's data demonstrating how by involving the body people may arrive in nuanced understandings about the self.

Involving the body in data physicalization has been a way through which people can synthesize past data to then reflect on them both individually [19,22] and collectively [33]. In Data-things [33] people explored their personal data through knitting. Each participant formed a visualization through sensors placed on their knitting needles. Later, the same people were involved in the digital fabrication of their visualizations during which, they reflected on their data not only through construction but also by comparing and discussing with the rest of the group. That project illustrated the role of the social in self-reflections.

While in these examples the acts of constructing and comparing data may provoke self-reflections, there are social aspects that are rarely discussed in current literature on data physicalization. For instance, Data-objects [42,50] are inherently social opening up opportunities to explore reflection through data in mundane environments as they can become part of people's routines. As Li et al. [25] argue *"In comparison to creating completely new devices, augmenting current technologies and integrating them into users' communication ecology could be more easy and beneficial than introducing totally new devices."* I argue that, while integrating any device to people's communication ecology might be destructive for the couple, data-objects could blend into the background providing feedback only when people want to interact with them, and therefore, are appropriate for the context of this research.

In the context of InfoViz, one of the goals of personal visualization is to enable multi-faceted insights with one of them being *reflective insights* [37]. In *Dear Data* projects by Lupi and Posavec's [27] that goal of personal visualizations is very distinguishable. That project employed a manual approach to gathering and analyzing data. For a year and every week, the two authors would exchange postcards. Every week both authors agreed on a topic and then focused on gathering data based on that. Some of their topics were clocks, number of thank yous, smiles and more. The postcards included in their front drawings of each topic and on the back, they contained the address and instructions on how the receiver should read the drawing. As the authors described, the process of gathering but also visualizing the data was labor intensive and very slow. However, that process helped the author to realize things they do they were not aware of such as, Posavec's who realised that she tells more often *thank you* to strangers compared to her family and friends.

2.2 Data Sharing and Reflection in Romantic Relationships

In the context of LDRs there are several examples of tangible user interfaces (TUIs) [8,34,39,49] that explore remote communication between couples in an attempt to bridge the physical distance yet none explicitly discuss aspects of reflection. As Jansen et al. [21] argue while there is an overlap between TUIs [20] and data physicalization, the former focuses on input and manipulation while the latter is meant to explore and gain insights so it is more focused on output and exploration tasks. The focus on insights is interlinked with reflection and therefore, data physicalization appears to be appropriate for exploring reflection in the context of LDRs. Below, I present examples which focus on data sharing between romantic partners. While in most examples it is not apparent how and if reflection has occurred, when possible, I attempt to speculate on how the designed artifacts in those works might have triggered people's reflective thinking.

Thudt et al.'s [45] work is at the intersection of data physicalization [21] and romantic relationships. Thudt created ceramic tableware on which she represented communication of data (e.g., Skype) between herself and her partner. The purpose of those objects was for data to become part of everyday life in

a meaningful way during mundane tasks for the purpose of self-reflection. As Heinicker [35] argues, *"being in a long distance relationship requires a thoughtful way of communication."* For that purpose he created an SMS necklace as a gift for his long-distance partner where he physicalized Goodnight SMSs that were exchanged between the two partners. Heinicker views text messages as manifestations of the self in his partner's life while in a long-distance situation.

Similarly, Helms [18] developed the leaky objects where implicit information is shared between couples through everyday objects. For instance, a lamp that is left switched on in someone's apartment shows presence of someone else, or a warm stove indicates that someone has used it recently. The leaky objects is an autobiographical design project where Helms builds upon the notion of implicit information shared between them and their partner enabling *"expressive communication and ambiguous speculation."* In that project reflection is not discussed, however, implicit information may have triggered reflections about the routine of the couple or even other unforeseen thoughts. Differently Branham et al.'s project, Diary Built For Two [4] focuses on reflection. In that project, the authors investigate reflection and restorying through exchange of selected diary entries between romantic partners. Similarly, Thieme et al. [44] developed the Lovers' box through which couples exchanged video messages. In that project the video messages became *"mirrors and sources of reflection"* about the couples' relationship and the videos became meaningful artifacts.

Away from the physical, Griggio et al. [15] study couples' communication through different streams of data. Those streams illustrate closeness to home, battery level, steps and more. One of the findings of that study was that there were no patterns on how couples used the app as couples appropriated the app and reflected on those data streams in their own idiosyncratic way. This finding supports the idea of how unique intimate relationships are for those experiencing them [13], a fact that provides researchers with a great opportunity to develop something for uniqueness within that research context. In fact, in research about intimate relationships there are several examples of autobiographical design exploration [7,18,46], yet none of those examples explore the prospect of reflective artifacts which is aimed through this paper.

3 Methodology

This research investigates how can we use communication data to inform the design of data objects in the context of LDRs. To conduct this research, I have used an RtD approach [24] which involved several interlinked sense making activities. Unlike previous work, I have combined first-person methods with co-design design activities. Traditionally an auto-ethnographic approach would focus on the individual. In my work, following an RtD approach where iterative thinking and doing is central, I contextualized nine one-to-one generative sessions as part of a broader (iterative) sense-making process (three levels of sense-making) which were all part of the autoethnographic exploration. In particular, this research started as an autoethnographic exploration where I used the messaging data of

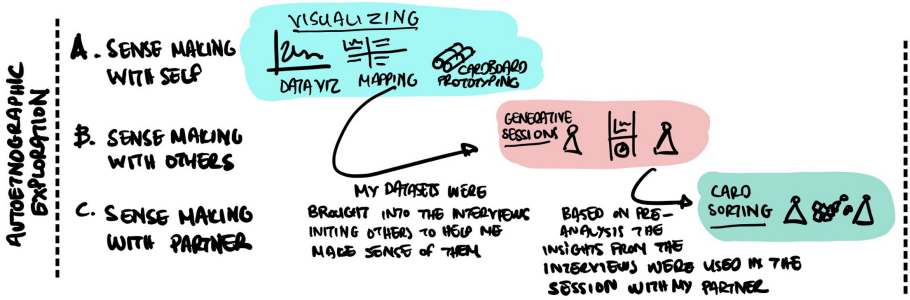

Fig. 1. Three levels of sense making took place throughout the stud. In level A, I explored the Facebook messaging data-sets by myself. In level B, I explored the data-sets with nine people who were themselves, or had been, in LDRs. In level C, I conducted an analysis with my LDR partner of steps A and B in a card sorting activity.

my long-distance partner and I in different sense making activities with the purpose to design data-objects. One of those sense making activities involved nine people to interpret and sketch visualization based on their own LDR communication data, which then helped them to imagine their data in material forms. *"Couples build their own idiosyncratic universe which is different from others"* [6]. Building upon this notion, I used interviews with people who had been or were in LDRs. The purpose of this mixed method approach Fig. 1 was to enrich the autoethnographic accounts by taking into consideration a broader perspective yet adjusted to the unique communication routines of a single couple. Prior to participation, my partner, as well as, all participants of the study read a detailed description of the project and signed consent forms.

3.1 Visualizing Messaging Data Between My LDR Partner and I

Thus, based on nine months of Facebook messaging data at the beginning of my LDR relationship, data visualizations were created in traditional graphs but also in exploratory ways (Fig. 2a, 1b). During those months I was in [European Country A] and my partner was living in [European Country B] therefore, we were in the same time zone.

To make sense of those data sets, I formed a mapping (Fig. 2c) where the traditional visualizations were juxtaposed with questions such as, *what are the main thoughts the graph brings to me?* Three main categories were generated based on the mapping. *Intensity, togetherness* and *flow-maintenance*. Following that activity, I did cardboard prototypes which reflected the categories of the mapping. After my initial explorations, I realised I needed input to better understand my research context, both from people who were themselves in a LDR, as well as from my partner. The reason was that I needed to better understand the data I had extracted from Facebook, as well as, the potential of designing for data representations in the context of LDRs.

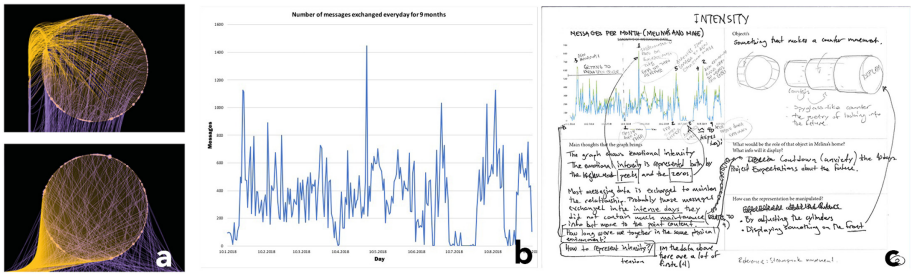

Fig. 2. (a) InfoViz of the messages using processing, (b) Traditional Visualization of the nine months LDR graph and (c) Data Visualization Mapping.

3.2 Generative Sessions with People in LDRs

For the second part of this research, I invited nine people (6 female, 3 male) who were in LDRs, to individual generative sessions that included semi-structured interviews. Since I was set to explore a sensitive topic such as, individuals' romantic relationship and also reveal information about my relationship to them, I intentionally reached to people with who I was acquainted with and I knew they were or had been in long-distance relationships. Sharing personal information mutually, created an environment of trust where the participants were comfortable to reveal personal information. Three of the participants were in a cross-continental relationships (P1, P2, P9), the other six were either in the same time zones (P3) or an hour apart (P4, P5, P6, P7, P8). All the participants apart from P6 and P7 (25–30) were in the 30–35 age group. All the participants were in heteronomrative relationships. In my view, it was irrelevant to aim for a more diverse sample as online communication data between couples should not be seen as something that is affected by sexual orientation. The main goal of the generative sessions were to help me better understand my data-sets as those people were or had been themselves in LDRs.

The generative sessions were split into three parts and seven out of nine were conducted through Skype. Throughout, I used slides as a visual aid. In the first part, I invited the participants to help me reflect on my nine-month messaging data visualizations. I showed three visualizations to them, all presented in Fig. 3. One that shows the amount and frequency of messages of each person (Fig. 3a), another that illustrates the overall amount and frequency of messages (Fig. 3b), and a last that showed the amount of messages sent over day and night (Fig. 3c). I asked the participants open questions such as, *what comes to mind when you see this graph?*, similar to the questions I asked myself while I was doing the mapping. In addition, questions that were related to the topics that emerged in my mapping (e.g. intensity) were added, *do you see intensity in the graph?* During the second part of the session, I asked the participants to pick one of the messaging visualizations that were discussed earlier and sketch out on paper a similar visualization to reflect on their own communication data (Fig. 4). The sketches were an interpretation of what the participants thought their communication

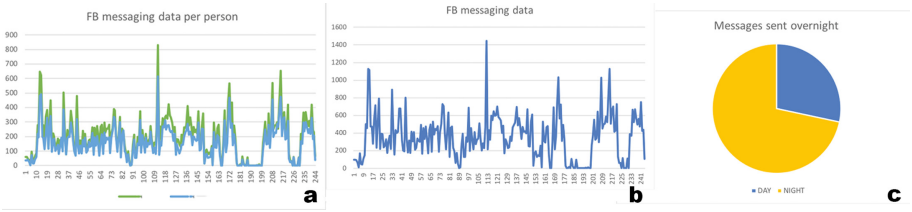

Fig. 3. From left to right the visualizations show: a) amount and frequency of messages of each person, b) overall amount and frequency of messages, c) the average of the amount of messages sent over day and night.

data might look like resulting into subjective visualizations [47]. After, the participants completed their sketches I asked them to present them. Next, I asked participants questions about the concepts that were discussed previously about my visualizations (e.g. intensity, maintenance). In the last part of the generative sessions, I challenged the participants' perception about their visualization by inviting them to think of the data as an artifact that has three dimensions and can be placed somewhere in the participants' personal environments. This last part of the generative sessions was also supported by visual inputs, which were gradually helping the participants to imagine *the kind of data-object they wanted, the texture it would have, the type of modality it would use to show the data, the interaction it would facilitate*, and *if or how the participants' partners would use that artifact.*

3.3 Card Sorting Activity with My LDR Partner

In the third part, a card sorting activity was conducted face-to-face between my partner and I where our messaging data visualizations, as well as, some of the concepts from the generative sessions were discussed and reflected upon. Concepts and quotes were selected from the interviews by conducting a pre-analysis [48]. To reflect, I used three sets of hexagonal cards. The first set included visualizations and raw data from the nine-month messaging data. The second set included concepts around messaging derived from the generative sessions in the form of provocative statements or direct quotes. The third set were blank cards used to write down our reflections from synthesizing the other two sets of cards. The data visualizations, the concepts and our reflections were discussed and organized in an open-ended way. Though this activity I wanted to combine a broader understanding about the communication of long-distance couples and see how those practices were reflected in my own relationship.

3.4 Analysis

All the qualitative data collected from the generative sessions and the card sorting activity was transcribed. I open coded the generative session data and

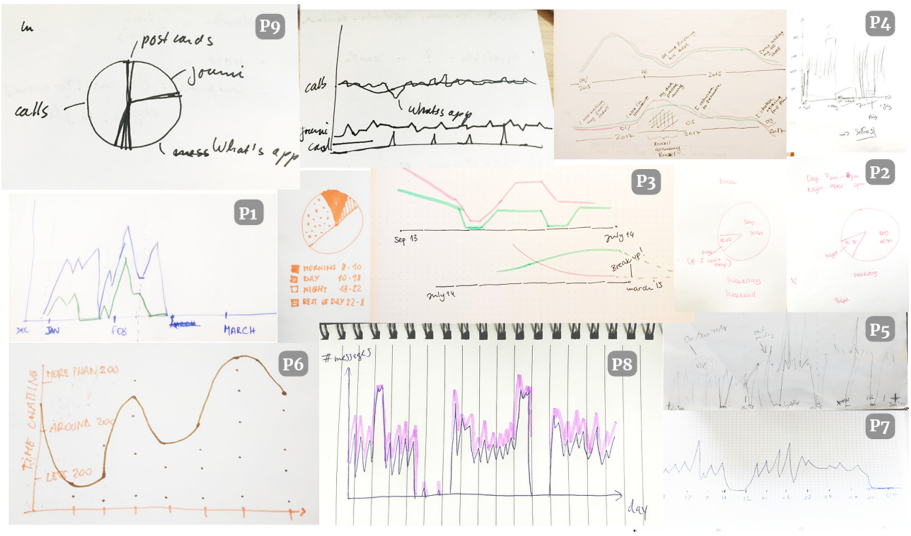

Fig. 4. In this collage I present the visualizations the participants produced during the generative sessions.

organised it in thematic categories following abductive reasoning [5]. Then, the categories were challenged by the second author to validate the results. Parts of the generative session data was also analysed, reflected upon, and categorised during the card sorting activity. The clusters formed in the latter provide a more in-depth analysis of the communication practices of the nine participants with their partners and are presented below.

4 Results

In this section, I present how the participants interpreted, sketched, presented and reflected on the visualizations. Then, I present the results from the card sorting activity that illustrates current communication practices of the participants with their partners' and what that meant from the point of view of my relationship. Last, I present what purpose the participants assigned to the data-objects and which aspects of communication appeared relevant to materialize.

Notably, six participants reflected on their current or former relationships already from the beginning of the generative sessions. For instance, P3 reflected on how she used to communicate 15 years ago with her long-distance partner. *"There wasn't even like MSN chat. We had to go into like chat rooms offered by specific portals and private mode to be able to talk over chat once a week."* P4 would link almost every question to the communication practices with her partner. P1 and P2 compared the second part of the session to therapy with P1 using the word "cathartic" to describe how she felt visualizing a former-relationship of hers. Overall, the participants were of the opinion that my graphs

were too open for interpretation since the peaks and lows opened up for multiple explanations. For instance, the peaks in the first visualization were translated as emotional support (P1, P9), doing an activity together (P8, P1), meaningful discussions/special days (P1, P2, P4, P5, P9) and arguments (P1, P6, P7, P9). The lows of the graph or the *"valleys"* (P3) were translated as busy days (P1, P9), silence due to arguments (P1, P7, P8, P9) and holidays together (P1, P3, P6, P7, P9). My graphs were described as having a certain *"balance"* (P1, P8). The communication is described as frequent, homogenic (P6), constant (P1, P3) and consistent (P9). My second graph showed separately my amount and frequency of messages and my partner's too. In that case a discussion was raised around the length of the messages, about who is *"feeding the chat"* (P6) meaning who initiates the discussions and about how the communication appears to be balanced between me and my partner since *"the two lines follow each other"* (P7) in a consistent way.

Overall, my Facebook data visualizations provided enough information for the participants to guess texting habits such as, to understand that one follows the other, that the communication is balanced, to understand when my partner and I were physically together and to guess important moments in the data-set while they knew nothing about the content of the messages.

In the second part of the generative sessions, when the participants were sketching their communication graphs, the sketches showed a person's own truth and a subjective image of their communication with current and former partners. P1 said *"It's funny to..to think of.. because I'm imagining, right? I'm telling the story I want to. Not necessarily what happened because we're not checking the data sets."* Not all of the graphs resonated with all the participants. Depending on the type and state of each relationship the participants selected different graphs to sketch. For instance, P1 created a communication visualization of her former relationship where the communication was one-sided, her writing to him a lot, and him not responding. That made her pick graph B because graph A in her case would not make sense. P2 who was in a cross-continent relationship selected graph C because through that she could show the different time zones for her and her partner. P9 was also in a cross-continent relationship however, in her relationship she uses different channels to communicate with her partner thus, she came up with her own visualization style.

Topics such as, the communication rituals of each couple, special days of texting, stand by messages and other practices related to digital data were also discussed. In relation to communication routines P4 who uses a lot of texting in her relationship said *"...and I have our little messenger open and we just write the whole day basically."* P6 in an almost ritualistic way waits for the weekend to talk to her partner. During the week her and him discuss casual topics and *"the weekend is the time for meaningful conversations."* (P6) Those meaningful conversations might have been initiated during the week with stand by messages. P4 also talks about messages that might be answered even two hours later but for her it is fine because this is how the couple communicates. P9 talks about messages that, due to the time difference, her partner will only

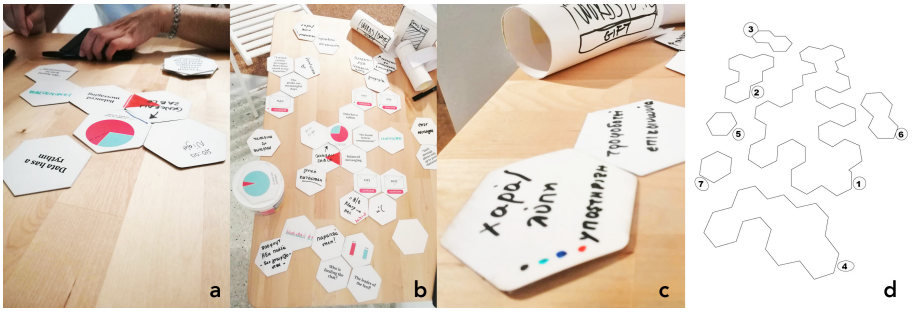

Fig. 5. This Figure shows, (a) the first cluster that was formed during the session, while in (b) we can see the entire mapping. (c) is an example of marking the cards to connect the with cards in other clusters (d) the order in which the clusters were formed.

see nine hours later: *"so you can send a text message but you won't receive a reaction. Only nine hours later."* In the case of P6, those stand by messages that are also important become long and concise and the communication begins to become slow since each partner takes time to reflect and then reply. Or for P2 whose partner lives in North America there are periods when she is worried and then their communication changes since she starts texting more: *"for instance September is the hurricane season in [...]. So, I guess in September we talk much more because then you to constantly check where the thunder and hurricanes are going."* Last the participants talked about other digital communication practices apart from texting they use in their daily life such as, the journi application[3] that P9 uses with her partner and both update every week with pictures from their days, which gives a glimpse into each other's life.

4.1 Card Sorting Activity

The card sorting activity was conducted between my partner and I, using graphs from our communication data, building upon the concepts and ideas that were discussed in the generative sessions. In this activity, a visualization would be picked and juxtaposed with another and with the concepts from the generative sessions. Visualizations, concepts and our reflections were all clustered. The outcome of that process was a physical mind map of seven clusters which are presented in Fig. 5b which we see as aspect of communication data that could be further extended to design for reflection. In Fig. 5d we illustrate the order in which the clusters were formed. We present them below accordingly.

Balanced Communication. The session started by discussing the day and night visualization (Fig. 3c). That graph made my partner think of three main qualities revolving around communication between couples. The graph presented the communication between the two of us involving a natural external condition such as, day and night. That led to a discussion of how external factors may

[3] https://www.journiapp.com.

influence the communication between a couple. Despite external factors, she and I learned how to communicate with each other and we co-constructed our normality through messaging. In that respect, the day and night graph illustrates a balance of communication between us. The graph illustrates a balance not in the sense of evenness but in terms of how a couple builds its own normality of communication. Our normality included a large amount of messages and a distinguishable difference between day and night. For other couples, this might appear extreme. However, the normality of the communication between partners perhaps can always be seen as a product that is co-constructed depending on external factors and the behavioral traits of the people involved.

Four more data sets were included under this cluster. Those were four of the days that my partner and I exchanged the most messages which would be about 1000 messages per day. Two of those data sets had exactly the same amount of messages which at first glance was an odd finding. However, when further discussed, we realised that indeed, in terms of balanced messaging *"if you speak around the same time, everyday, it's very likely for this to happen,"* to have the same amount of messages. Linking this back to the idea of balanced communication, there was a routine which was built over time. Thus, although that finding appeared to be odd in the beginning, in essence it was very likely that the numbers would repeat. While discussing the dates with the largest amount of messages, my partner and I were trying to remember what happened in those days. For most of the cases it was quite easy to recall the events. *"Do you remember? It was the day that I was sending you voice messages,"* my partner said. *"You were going somewhere, you were hitting the road I remember,"* I replied. Thus, together based on an event we remembered the reason behind the large amount of messages. At some point I asked her to compare how the messages sent on January were different from those sent in August. She said that the first were messages of getting to know each other, while the second were messages of being already in the relationship. *"You know what, everything connects with each other,"* my partner said while thinking about where to place the cards. That happened when we were half way through the first cluster.

Meaningful Messages. The main data set of the second cluster was the day my partner and I had exchanged 1445 messages. That date was a very emotional day for us as we were texting until the next morning. Hence, we connected it with a card that we then wrote on top *"the peaks are meaningful days."* That led to a discussion of how that data, the number 1445, while it is raw data it was not perceived as such anymore. It acquired a sentimental, meaningful value for us. At that point we also discussed how sometimes we save messages by taking a screenshot, in essence capturing a picture of the communication between us. My partner and I keep screenshots to remember an important moment to be able to revisit when wanted. However, meaningful days were also discussed in relation to the concept of normality of a relationship. *"For instance, if the peak of a relationship are two messages per day, it is still a meaningful day,"* my partner said. At this point the aspects of how a couple constructs their communication, quantity versus quality and aspect of meaningfulness come together.

Important Events Feeding the Communication. *"When there is something good happening or something bad you indeed need support, and often in those two cases you talk a lot (with your partner)."* This sentence refers to the dates when most messages were exchanged. While the card that says *joy, sadness and support* is connected with the card that says *feeding the chat*, forming a separate cluster both of them connect to all dates with most messages exchanged from different clusters. To indicate that, we marked the card with different color dots and connected it with other cards, drawing the same annotation on them as illustrated in Fig. 5. When I asked my partner if she can find the same emotions in the days we exchanged less messages, she said, *"yes, but, I believe that one of them (joy, sadness and support) may feed the chat."* That statement indicated that emotions can be the reason for exchanging more messages than usual. The main reason is support. You reach to the other person because you want to share how you feel and find support.

Deception. In this cluster we discussed how the amount of messages may be deceiving. The visualization of this cluster was line graph which illustrates how many messages each of us send over time, as well as the relationship of those messages. There was also a bar graph that shows the overall amount of messages exchanged throughout the nine-month period. The line graph clearly shows that the person behind the pink line was constantly sending more messages than the other person. In the generative sessions this person was named as the one who was *"feeding the chat"* (P6). My partner thought the card *"who is feeding the chat"* was rather confusing, because, while in the visualization the pink line appeared to be leading the conversation, in reality things were different. As she said *"often you are the one who is feeding the chat. While you send much less messages, you often say more substantial things."* The point she was making initiated a discussion around content versus quantity. In relation to the line graph my partner said *"I think that depending who sees the graph may understand different things."* Thus, the story told through the visualization may have different interpretations since the content seems essential in this case to understand what this graph means.

Quantity vs Quality. While quantity vs quality is a theme that came up towards the end of the session it has been discussed indirectly throughout. *Quantity vs Quality* was written on a card when discussing the amount of messages and what those numbers meant in the context of our and other relationships too. That she and I exchange several messages says little about the relationship. Other couples might exchange fewer messages while the content is more dense and or complemented by phone calls, which is also reflected in the generative sessions (P2, P5, P6, P9). Again the theme of normality comes up as we discussed that couples construct their own normality when it comes to the amount of messages, content and frequency. My partner argued that the *"quantity vs quality"* should be placed in the middle of the mapping since it connects with everything we had discussed. Then she placed the card at the edge of the table because *"this is where everything starts from."*

My partner thinks that the amount of messages *"is irrelevant information about the communication of a couple."* The quantity does not provide us with much information. However, as a matter of fact, while the quantity does not say much about the relationship the interaction between the two lines on a graph (each line represents each one of the partners) reveal a lot about the relationship itself. If there is a disconnect between the two lines probably communication is failing (lack of communication also seen in P1 and P3), or when the two lines follow each other, it seems that there is a balance in the interaction.

Error Messages. This cluster very well connects back to the amount of messages. My partner defines several of her messages as *"error messages."* The reason is that as she writes messages very quickly often it is even hard for her to make sense of them if she reads them after a while. This happens due to mixed words, auto-correct, as well as, texting sentences that are not well thought through and do not connect very well with each other.

Zero Messages. *"When all the rest were happening (pointing to the mapping on the table) this happened too (16 days of 0 messages)."* It was intriguing that there were so few days without exchanging messages–we were in the same location. Reflecting on our communication over time we realised that even when we are together sometimes we might exchange messages. This fact perhaps illustrates how instant messaging is a great part of our communication routine. This may connect again to the normality of a relationship. The fact that my partner and I constantly exchange messages illustrates how using instant messaging is not only necessary due to the distance, but instant messaging is also an inseparable part of how we chose to communicate with each other.

4.2 Imagining Data-Objects

The third part of the generative sessions, which involved imagining the couples' communication data in material forms, highlighted different aspects around the meaning, significance and functionality of data objects, as well as, aspects related to privacy. While the data-object ideas could be separated into *data-objects for reminiscence* and *reflective data-objects*, P5's and P7's ideas were not included as they were not related to data practices. For instance, P5 imagined an artifact that would enable memories through the body (touch) as he said, he would touch e.g., Christmas, on his end, an she would feel it on the inner part of the thighs. He then described a story where him and his partner went sleighing and she fell off the sleigh resulting in *"a horrible blue spot"* on her leg. As for P7, his objects would remind him of the summer when the couple spends time together.

Separating the data objects ideas into data-objects for reminiscence and reflective data objects Fig. 6 does not mean that objects in the second category can provoke reflection while objects in the first category cannot. Reflection and remembering are two concepts that are tied together in the field of personal representations of data [10,41], and thus, reflection is not exclusive to one. The first category relates to memory and the second sees data objects as artifacts that through ongoing synthesis of information can shape people's perspectives about their data.

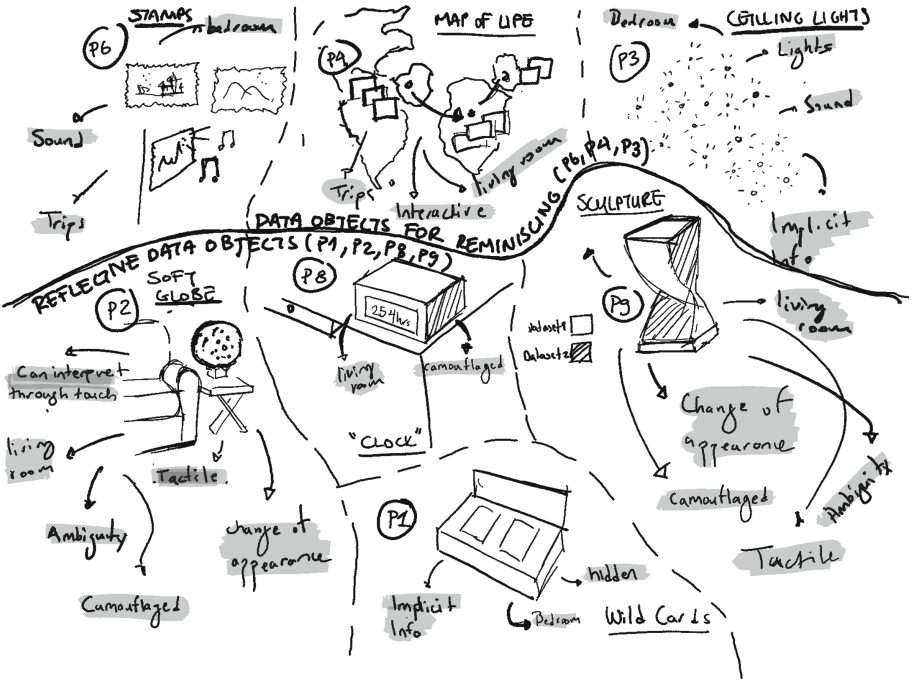

Fig. 6. An illustration of the two categories of data-objects.

Data-Objects for Reminiscence. P3, P4 and P6 thought of data-objects as reminders of their digital communication data. P3 imagined lights on her bedroom's ceiling representing humorous messages P3 exchanged with her partner in the beginning for their relationship. P3 acknowledges the design limitations such artifact might have, *"that period that I chose is the one that we have the most messages and the most exchange. If it would be light it would become very bright. – A lot means a lot and that wouldn't be pleasant."* While P4 imagined as she said, *"the map of our life"* (P4), which would show P4's and her partners story described through the different cities they have visited. Each city would be represented with a point on the map showing all the digital data (e.g. text, pictures, etc.) the couple produced to organize each trip. P6's data-object was a stamp that would symbolize the trips of the couple similar to the P4's data-object but it would also include sound. P6 referred to the limitation such artifact might have. As P6 said "I don't want to be reminded all the time that I'm missing him", which means that she would require control over the artifact.

Data-Objects to Reflect. Lupton's characterized personal data assemblages as companion species [28] suggesting recognizing the interdependency between humans and data. The type of objects that are presented in this category could be described as 'companion species' mainly because they allow transformation

from the side of data that is independent from what the person might want, and thus, demonstrates characteristics of a co-evolving relationship. In particular, P1, P2, P8 and P9 imagined data-objects that would help them synthesize their communication data in novel ways rather than just remember past digital data. The data-objects, as described by the participants, would synthesize the data and present it back to them in different ways. For instance, P1 imagined an artifact that would symbolically relate to the communication P1 had with her former partner. The artifact would have a "didactic" (P1) function which would show that the communication was one-sided through, among other ideas, bouncing dice. P2 imagined a soft globe which she could hold between her hands. That object would surface the aspect of care and show the transformative nature of a relationship since it would change overtime depending on the communication data of the couple. P8's artifact would present "the time of the time" (P8) of their communication. He imagined a clock which would show the total of their communication time. This number would change daily providing the average of each day. P9 imagined of a data sculpture which would represent two timelines of pictures, one for each partner. The data-object would present an abstract version of the pictures. The viewers could only see the interaction between the timelines rather than pictures in full resolution.

5 Discussion

This research involved several sense making activities in which personal digital data took various formats e.g., different types of visualization. In the second activity, the visualizations of communication data helped the participants interpret and reflect on their LDRs, while viewing data as design material helped them imagine data-objects. In terms of using data as design material, Sosa et al. [42] argue that as sketching, modeling and prototyping are all intended to help the designer make-sense of the materials they want to manipulate, the same rational could be applied to the processes required to shape data as a design material. The findings of this study illustrated how unique but also how multi-faceted couples' communication data can be. For instance, communication data cannot always be *pleasing* [47] (P1, P3) as it represents a social bond that transforms over time illustrating both positive but also negative aspects. Below I present design opportunities that emerged through the study related to *the transformative nature of relationships, negative reflection and aspects of privacy.* The design opportunities I present below draw from the data-objects the participants envisioned. I speculate that the design opportunities combined with the seven aspects around communication that were discussed previously could be used as departure points for designing for reflection in the context of long-distance relationships.

5.1 Long-Term Use of Data-Objects

Couples reveal themselves over time [38]. Some of the participants talked about former relationships (P1, P3), others were just living temporarily apart from

their partners (P9) and last, most of the participants were in LDRs for a long time (P4, P5, P6, P7, P8). Due to that diversity, the way the participants thought of the data-objects changed depending on the state of their relationship. This indicates a path for exploration on the long-term use of data-objects focusing on the transformative nature of relationships. Mazé and Redström explore what means to design a relationship with a computational thing that will last and develop over time [32]. In essence, they investigated objects whose forms are constituted by their temporal manifestations. While that demonstrates the natural cycle of a product in the case of data objects the transformation of the form over time may affect the relationship people will develop with those artifacts.

In particular, to support transformation, data-objects may grow or transform in ambiguous ways, depending on the communication of the couple. This would require the device to constantly keep track of the data, translate and represent it through the properties of the object. For instance, the example of the soft globe (P2) indicates transformations such as, change of size over-time. Based on Hassenzahl et al.'s joint action [17] a device that shows live time data, indeed implies that each partner's behavior has implications for the other and by extension for the data-set itself. Thus, the couple by exchanging messages sustain the lifespan of the device, as well as, affect its physical expression which may be perceived differently by the respective partners while the relationship evolves.

However, engineering such device may come with limitations. Intimate relationships, have a beginning and an end. Therefore, it is valuable to critically reflect on the possible impact of such objects when in use. A data-object that transforms with the relationship becomes a unique creation bounded between the respective partners. When a relationship ends, an object like that most likely will be discarded, as P3 indicated or as P1 suggested, it would be kept somewhere that P1 would only stumble upon it rarely. However, how people would treat those objects cannot be predicted, as what happens to the object after the relationship ends mostly depends on the intricacies of the relationship itself. Most certainly an object that represents live time data and connects to a 'living' relationships will pass through a lot of transformations. Grosse-Hering et al. [16] argue that many objects people acquire for their functional aesthetics are eventually discarded while still being fully functional. In that case, the data objects could be imagined as something similar which in the future might eventually be discarded, or alternatively kept. As Petrelli et al. argue in their research, 80% of people had at least one object related to sad events such as death or divorce but they never displayed those sad mementos in public rooms [36]. Most certainly an object that represents live time data and connects to a 'living' relationships will pass through a lot of transformations.

5.2 Camouflaged Data in the Home

In the data-object ideas of P9, P8, P2 and P1, the information represented through the object would be *"camouflaged"* by the form and format of the objects providing privacy of information for the couples. Notably, those participants who imagined *data-objects to reflect* decided that their object would be placed in their

living rooms - except for P1 who thought of an object representing a former relationship - which would allow others (e.g., visitors) to see them. Perhaps that their information would be camouflaged allowed the participant to imagine the data-objects in environments (e.g., living rooms) open to acquaintances, family and friends. On the other hand, P3, P4 and P6 imagined their data-objects placed in their bedrooms with P4 arguing that she would choose the place of the data-object depending on the level of privacy in the information.

In terms of privacy, through the generative sessions I found out that data-objects may offer another layer to the data, which is the aspect of privacy when the physicalization is placed in real-world settings. Thus, data physicalization may offer opportunities to revisit the data without *"seeing"* the data, benefiting from the ambiguity of the form. Gaver et al. [14] argue that ambiguity is a key aspect for letting people imagine and interpret things in an open-ended way. Similarly, Thieme et al. [44] address this ambiguity in their designs for romantic partners. Thieme et al. [44] argue that the open-ended digital artifact played a role in provoking reflection to the respective partners. When thinking of data-objects in LDRs perhaps, systems that allow for this kind of re-visiting may facilitate reflection on the LDR in a way that is detached (in terms of format) yet connected (in terms of data) to the actual data. For instance, the content of important days may become abstract in a way that only the couple recognizes, the days when zero messages were sent can be shown through long pauses.

6 Conclusion

Reflecting on the methodology, during the generative sessions the roles switched between participant and interviewee in several moments. The generative sessions were conducted in an equal ground as the participants were free to ask more information about the content of my graphs and the other way around. The sessions made me realize a lot about my own relationships too. P1 said, *"who is interviewing whom now?"* when one of her comments triggered a reflection about me asking for more attention from my partner, while she is the one who was always more active in the chat. The personal tone in the generative sessions was enhanced by the fact that I knew the participants. This fact made it easier to create an environment of trust. Besides, them feeling comfortable to share, it was also easier for me to talk about my personal information to non-strangers.

In this paper, I presented a project on designing for reflection in the context of LDR. I set up several sense making session. In the first, I tried to make sense of data-sets myself; then I invited others who had experience with LDRs to help me make sense of my messaging data visualization, sketch and reflect on their own visualization, and imagine data-objects; last, I made sense of data from the previous two steps in a session with my LDR partner. Overall, the different sense making sessions allowed me to work with personal data as my design material. To further explore data as such, I plan to develop data-objects for my LDR and observe my partner's and my response to them over time.

References

1. Barrass, S.: Acoustic sonification of blood pressure in the form of a singing bowl. In: Proceedings of the Conference on Sonification in Health and Environmental Data, vol. 12 (2014)
2. Baumer, E.P., Khovanskaya, V., Matthews, M., Reynolds, L., Schwanda Sosik, V., Gay, G.: Reviewing reflection: on the use of reflection in interactive system design. In: Proceedings of the 2014 Conference on Designing Interactive Systems, pp. 93–102 (2014)
3. Baumer, E.P., Khovanskaya, V., Matthews, M., Reynolds, L., Schwanda Sosik, V., Gay, G.: Reviewing reflection: on the use of reflection in interactive system design. In: Proceedings of the 2014 Conference on Designing Interactive Systems, DIS 2014, pp. 93–102. Association for Computing Machinery, New York (2014). https://doi.org/10.1145/2598510.2598598
4. Branham, S.M., Harrison, S.H., Hirsch, T.: Expanding the design space for intimacy: supporting mutual reflection for local partners. In: Proceedings of the Designing Interactive Systems Conference, pp. 220–223 (2012)
5. Brinkmann, S.: Doing without data. Qual. Inq. **20**(6), 720–725 (2014)
6. Cheal, D.: 'Showing them you love them': gift giving and the dialectic of intimacy. Sociol. Rev. **35**(1), 150–169 (1987)
7. Chien, W.C., Hassenzahl, M.: Technology-mediated relationship maintenance in romantic long-distance relationships: an autoethnographical research through design. Human-Comput. Interact. **35**, 1–48 (2017)
8. Chien, W.C., Hassenzahl, M., Welge, J.: Sharing a robotic pet as a maintenance strategy for romantic couples in long-distance relationships. An autobiographical design exploration. In: Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems, pp. 1375–1382 (2016)
9. Elsden, C., Durrant, A.C., Chatting, D., Green, D., Kirk, D.S.: Abacus datagraphy: a speculative enactment. In: 3rd Biennial Research Through Design Conference (2017)
10. Elsden, C., Kirk, D.S., Durrant, A.C.: A quantified past: toward design for remembering with personal informatics. Human-Comput. Interact. **31**(6), 518–557 (2016)
11. Fors, V., Pink, S., Berg, M., O'Dell, T.: Imagining Personal Data: Experiences of Self-tracking. Routledge, Milton Park (2020)
12. Friske, M., Wirfs-Brock, J., Devendorf, L.: Entangling the roles of maker and interpreter in interpersonal data narratives: explorations in yarn and sound. In: Proceedings of the 2020 ACM Designing Interactive Systems Conference, pp. 297–310 (2020)
13. G.), S.E.C.: Intimate Objects. Leonardo **13**(1), 47 (2006). https://doi.org/10.2307/1577924
14. Gaver, W.W., Beaver, J., Benford, S.: Ambiguity as a resource for design. In: Proceedings of the SIGCHI conference on Human factors in computing systems, pp. 233–240. ACM (2003)
15. Griggio, C.F., Nouwens, M., Mcgrenere, J., Mackay, W.E.: Augmenting couples' communication with lifelines: shared timelines of mixed contextual information. In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, p. 623. ACM (2019)
16. Grosse-Hering, B., Mason, J., Aliakseyeu, D., Bakker, C., Desmet, P.: Slow design for meaningful interactions. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 3431–3440 (2013)

17. Hassenzahl, M., Heidecker, S., Eckoldt, K., Diefenbach, S., Hillmann, U.: All you need is love: current strategies of mediating intimate relationships through technology. ACM Trans. Comput.-Human Interact. **19**(4), 1–19 (2012). https://doi.org/10.1145/2395131.2395137
18. Helms, K.: Leaky objects: implicit information, unintentional communication. In: Proceedings of the 2017 ACM Conference Companion Publication on Designing Interactive Systems, pp. 182–186 (2017)
19. Huron, S., Carpendale, S., Thudt, A., Tang, A., Mauerer, M.: Constructive visualization. In: Proceedings of the 2014 Conference on Designing Interactive Systems, pp. 433–442 (2014)
20. Ishii, H., Ullmer, B.: Tangible bits: towards seamless interfaces between people, bits and atoms. In: Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems, pp. 234–241 (1997)
21. Jansen, Y., et al.: Opportunities and challenges for data physicalization. In: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, pp. 3227–3236 (2015)
22. Karyda, M., Wilde, D., Kjærsgaard, M.: Narrative physicalization: supporting interactive engagement with personal data. IEEE Comput. Graph. Appl. **41**, 74–86 (2020)
23. Kim, N.W., Im, H., Henry Riche, N., Wang, A., Gajos, K., Pfister, H.: DataSelfie: empowering people to design personalized visuals to represent their data. In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems - CHI '19 (Chi), pp. 1–12 (2019). https://doi.org/10.1145/3290605.3300309. http://dl.acm.org/citation.cfm?doid=3290605.3300309
24. Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., Wensveen, S.: Design Research Through Practice: From the Lab, Field, and Showroom. Elsevier, Amsterdam (2011)
25. Li, H., Häkkilä, J., Väänänen, K.: Review of unconventional user interfaces for emotional communication between long-distance partners, pp. 1–10 (2018). https://doi.org/10.1145/3229434.3229467
26. Li, I., Dey, A.K., Forlizzi, J.: Understanding my data, myself: supporting self-reflection with ubicomp technologies. In: Proceedings of the 13th International Conference on Ubiquitous Computing, UbiComp 2011, pp. 405–414, ACM, New York (2011). https://doi.org/10.1145/2030112.2030166. http://doi.acm.org/10.1145/2030112.2030166
27. Lupi, G., Posavec, S.: Dear Data. Chronicle Books, San Francisco (2016)
28. Lupton, D.: Digital companion species and eating data: implications for theorising digital data-human assemblages. Big Data Soc. **3**(1), 2053951715619947 (2016)
29. Lupton, D.: Personal data practices in the age of lively data. Digit. Sociol. **2016**, 335–50 (2016)
30. Lupton, D.: Feeling your data: touch and making sense of personal digital data. New Media Soc. **19**(10), 1599–1614 (2017)
31. Lupton, D., Watson, A.: Towards more-than-human digital data studies: developing research-creation methods. Qual. Res. 1468794120939235 (2020)
32. Mazé, R., Redström, J.: Switch! energy ecologies in everyday life. Int. J. Des. **2**(3) (2008)
33. Nissen, B., Bowers, J.: Data-things: digital fabrication situated within participatory data translation activities. In: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, pp. 2467–2476. ACM (2015)

34. Pan, R., Neustaedter, C., Antle, A.N., Matkin, B.: Puzzle space: a distributed tangible puzzle for long distance couples. In: Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing, CSCW 2017 Companion, pp. 271–274. ACM, New York (2017). https://doi.org/10.1145/3022198.3026320. http://doi.acm.org/10.1145/3022198.3026320
35. Paul, H.: goof night sms (2015). http://paulheinicker.com/goodnightsms/
36. Petrelli, D., Whittaker, S., Brockmeier, J.: Autotopography: what can physical mementos tell us about digital memories? In: Proceedings of the SIGCHI conference on Human Factors in computing systems, pp. 53–62 (2008)
37. Pousman, Z., Stasko, J., Mateas, M.: Casual information visualization: depictions of data in everyday life. IEEE Trans. Vis. Comput. Graph. **13**(6), 1145–1152 (2007)
38. Reiss, I.L.: Toward a sociology of the heterosexual love relationship. Marriage Fam. Living **22**(2), 139–145 (1960)
39. Samani, H.A., Parsani, R., Rodriguez, L.T., Saadatian, E., Dissanayake, K.H., Cheok, A.D.: Kissenger: design of a kiss transmission device. In: Proceedings of the Designing Interactive Systems Conference, pp. 48–57. ACM (2012)
40. Schön, D.A.: Educating the reflective practitioner (1987)
41. Selby, M., Kirk, D.: Experiential manufacturing: the earthquake shelf. In: Proceedings of RTD 2015 Conference on Research Through Design (2015)
42. Sosa, R., Gerrard, V., Esparza, A., Torres, R., Napper, R.: Data objects: design principles for data physicalisation. In: Proceedings of International Design Conference, DESIGN, vol. 4, pp. 1685–1696 (2018). https://doi.org/10.21278/idc.2018.0125
43. Stafford, L.: Maintaining Long-distance and Cross-residential Relationships. Routledge, Milton Park (2004)
44. Thieme, A., Wallace, J., Thomas, J., Le Chen, K., Krämer, N., Olivier, P.: Lovers' box: designing for reflection within romantic relationships. Int. J. Hum Comput Stud. **69**(5), 283–297 (2011)
45. Thudt, A., Hinrichs, U., Carpendale, S.: Data craft: integrating data into daily practices and shared reflections (2017)
46. Thudt, A., Hinrichs, U., Huron, S., Carpendale, S.: Self-reflection and personal physicalization construction. In: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, p. 154. ACM (2018)
47. Thudt, A., Lee, B., Choe, E.K., Carpendale, S.: Expanding research methods for a realistic understanding of personal visualization. IEEE Comput. Graph. Appl. **37**(2), 12–18 (2017)
48. Visser, F.S., Stappers, P.J., Van der Lugt, R., Sanders, E.B.: Contextmapping: experiences from practice. CoDesign **1**(2), 119–149 (2005)
49. Werner, J., Wettach, R., Hornecker, E.: United-pulse: feeling your partner's pulse. In: Proceedings of the 10th International Conference on Human Computer Interaction with Mobile Devices and Services, MobileHCI '08, pp. 535–538. ACM (2008)
50. Zhu, C.L., Agrawal, H., Maes, P.: Data-objects: re-designing everyday objects as tactile affective interfaces. In: 2015 International Conference on Affective Computing and Intelligent Interaction, ACII 2015, pp. 322–326 (2015). https://doi.org/10.1109/ACII.2015.7344590