

# Passive Co-presence

## Exploring How Peripheral Devices Connect People Over Distance

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### ABSTRACT

When families live in the same home, they feel a sense of connection through the subtle, passive aspects of family life. Over distance, these passive aspects are hard to experience as most communication technologies support sharing conversations or activities. Using a co-design study, Research-Through-Design (RtD) methods, and a field deployment, I aim to explore the design of smart home technologies for passive co-presence over distance. The co-design study uncovered differences in the connection needs of emerging adults and their parents, and provided a set of design considerations including designing for the need for control and privacy, sharing multi-sensory environmental ambience, and supporting nostalgia and comfort. These findings guided an RtD exploration resulting in the design of two artifacts – the There Chair and Fragrance Frame. To understand the impact of integrating passive co-presence designs into the home, I plan to conduct a field deployment, which I describe in this work.

### CCS CONCEPTS

• Human-centered computing; • Collaborative and social computing design and evaluation methods;

### KEYWORDS

Family Connection, Smart Home Technology, Remote Communication

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## 1 INTRODUCTION

In the communal spaces of a family home, togetherness is felt passively in the ambience of daily life. Noticing someone's presence in one's peripheral vision, sitting together without actively interacting, hearing their footsteps, or similarly subtle sensory experiences create feelings of co-presence in the home. When families are separated over distance, this experience changes drastically. Existing mainstream tools for connection support active togetherness,

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such as having conversations using video conferencing software [16, 19, 26], through instant messaging [23], or sharing virtual experiences such as online games [22, 38]. The subtle, passive aspects of family connection are not present over distance.

In my doctoral research I introduce the term “passive co-presence” which I define as a sense of togetherness that is felt through sensing each other's presence and without actively engaging with one another. Previous research has suggested that this form of togetherness can create a heightened sense of closeness [28]. Distance separated families sometimes attempt workarounds such as long-term video or audio calls left on in the background [16, 28]. However, these solutions create challenges with privacy, autonomy, and solitude [16]. Passive connections have the potential to preserve privacy, as they do not rely on the exchange of *information*; instead, these connections rely on *sensing* the presence of another person. In my research, I break experiences of co-presence down into the five senses (sound, sight, smell, taste, and touch).

I am undergoing an exploration of how computational objects within the home can be designed to support a sense of passive co-presence between distance-separated family members. First, I investigated the existing co-presence behaviours and needs of remote households, specifically focusing on emerging adults and their parents. *Emerging adults* are adults who are beginning to gain independence from their parents. I chose this demographic as I was especially interested in learning if there would be privacy concerns or conflicting needs around certain senses, as this demographic is known to have a strong need for privacy and independence [35]. Second, I explored the design of passive co-presence systems integrated in the home. Third, I will study how remote households experience passive co-presence with devices integrated into their homes. Through this research, I aim to answer the questions outlined below. The overarching research question I plan to address is the following: *how should we design a set of computational objects within the home that track and share ambient information, in order to create a meaningful experience of passive co-presence between remote household members?*

While previous research has addressed aspects of this such as home telepresence [14, 16, 18, 19], peripheral and ambient technology [12, 20, 28], and home-integrated technology [4, 21, 32], the combination of these remains unexplored. I break down the problem into multiple questions to rigorously investigate each aspect:

- **RQ1:** How is co-presence currently sensed by distance-separated emerging adults and their parents in remote households, and what are the needs of family members in relation to these senses?
- **RQ2:** In what ways can passive co-presence technological systems be designed to blend into the home?

- **RQ3:** How do family members in distance separated households experience passive co-presence with special-purpose devices integrated into their homes?

## 2 RELATED WORK

### 2.1 Technological Approaches to Family Connection

Remote family communication has been extensively studied by HCI researchers. Staying connected with family members can influence individual well-being and strengthen interpersonal bonds [11], but experiencing a sense of connection can be a challenge when separated by distance. There is a need to balance the desire for communication with the feelings of obligation, to support ease of use while being meaningful and personalized, as well as providing awareness while respecting privacy [36]. Video connections comprise a significant part of past research on family connection [13, 15, 16, 19], as they can support feelings of closeness and shared experience [2]. With always-on video, the constant availability of connection can increase feelings of connectedness and involvement in one another's lives, but also creates challenges around privacy and feelings of awkwardness [25]. The majority of remote family communication technology relies on actively sharing in activities, such as sharing meals over distance [5], sharing conversations [39], simulating hugs [37], or playing games [22, 38]. Studies of these systems have shown that the sense of connection is impacted by the social dynamics between the co-located and remote parties [5], as well as their relationships and personalities [39]. A challenge with technologies that focus on shared synchronous activities is assessing the availability of remote family members and coordinating. One approach to this challenge has included home devices that indicate the activities of a remote family member in a lightweight, ambient way, offering opportunities to connect [3, 9]. Another approach allows family members to "poke" one another to assess their in-the-moment availability for connection [31].

In my work, I draw inspiration from existing HCI literature about family communication over distance to inform the methodology, and I contribute to this body of knowledge by shedding light on connection needs and patterns specifically for passive, sensory connections between distance-separation households.

### 2.2 Ambient Connection Devices

Though passive co-presence is a novel area of HCI research, some technology designs have been proposed that support passive or near-passive connection over distance. An example is the MissU, which is a device designed to enable couples in long-distance relationships to share auditory ambience and music [20]. A study of this system showed that some partners actively shared sounds (e.g. selecting songs to share), while others passively observed and shared ambient sounds. Additionally, they found that partners often wanted to share the "empty" moments when nothing was happening, but they were thinking of their partners [20]. This offers an opportunity to design for connection passively through ambient audio. A visual system with mostly passive interaction is Painting Portals - this prototype included a pair of interconnected picture frames integrated into the decor of a home that display slow-changing digital paintings generated from a camera stream of

the remote home, providing peripheral awareness of the other space [30]. Another example is FamilyFlower. This system is a flowerpot display intended to provide subtle, peripheral awareness of human presence, movement, and sound levels in a remote household [12]. Degraen et al. found that an ongoing awareness of activities in the remote home created feelings of connection [12].

While each of these example systems provides some insight into the benefits and drawbacks of specific designs, the field of HCI currently lacks broader design guidelines for passive co-presence technology. Through my work, I begin this research about designing passive co-presence technology within the communal spaces of a home, taking into consideration the role of sensory experiences and temporality in connecting distance-separated families.

## 3 METHODOLOGICAL APPROACH

### 3.1 Objective 1 - Co-design Study

I first conducted a study of remote co-presence between emerging adults and their parents between July and December in 2021 [29]. Prior to this work, HCI research about the communication needs and patterns of emerging adults and their parents was limited. Research from the field of health science had shown that maintaining a positive connection between emerging adults and their parents has positive health impacts for the emerging adults, for example impacting dangerous drinking behaviours and physical activity [33, 34]. Some of the limited HCI research about this demographic only explored the perspective of the emerging adults and investigated how they choose between existing active communication tools [35], or explored how technology could enrich the emerging adult-parent relationships primarily through active interactions [24]. This study was intended to address **RQ1**. The co-design study had four parts: a pre-session interview on individuals' perspectives on togetherness, an in-home activity to collect personal reflections on connecting through the senses, group design sessions to generate speculative technology designs for connection, and a post-session interview with parent-emerging adult pairs to discuss and reflect on ideas generated in the design sessions.

After the initial interview, 22 participants completed an in-home activity over five days. These activities were guided by a set of questions delivered to participants through online surveys sent by email at the beginning of the five days that prompted the participants to reflect on how they experienced passive connections with one another through each of the five senses (1) when they lived together, (2) currently while living apart, and (3) in a hypothetical ideal scenario. By formulating the prompt questions as such, I elicited information about (1) passive connection behaviours in a co-located home, (2) workarounds or new ways to have these needs met when separated by distance, and (3) unmet needs and priorities for passive connection. Participants were encouraged to capture photos, videos, sketches, or audio clips for each of these cards, or they could choose to provide written answers.

Once I had compiled all the responses from the initial interviews and in-home activities, I summarized the findings based on the five senses, due to the sensory nature of passive co-presence. I used these findings to guide brainstorming in co-design sessions with the participants, focusing on challenges that arose in the responses. In total, there were 8 sessions. Each session was comprised only of

emerging adults or parents, so that the resulting designs would be representative of either the parent or child perspective on togetherness. Maintaining the separate groups for parents and emerging adults was important in understanding the unique needs of each group, as well as allowing open discussion without any discomfort caused by parent-child dynamics.

**3.1.1 Findings.** Learning from participant experiences and needs, several considerations arose for creating a sense of passive co-presence for emerging adult-parent pairs, which I discuss in the following sections.

**The Need For Control and Privacy** - The need for privacy has been examined and documented in great depth for connection over distance [1, 8, 25], however we highlighted it as a design consideration due to its specific importance within this demographic, and the conflict of needs between the emerging adults and their parents. Designers could ensure that their designs do not capture and display information that could be sensitive or private; for example, we found that some emerging adults wanted to maintain privacy about when they were at home or away, when their spaces were untidy, or when they had guests over. Sharing this information is especially likely through the senses of sight or sound. Designs with these senses could avoid capturing/displaying this information without sufficient abstraction, especially if they are designed to be always-on.

**Sharing Multi-sensory Environmental Ambience** - Sharing environmental ambience is an important way to share and display in-the-background information. Parents and emerging adults felt connected through shared sounds and smells, which created a backdrop of togetherness in a shared home. The desire to share the ambience of home is especially important for this relationship type, as emerging adults highlighted the desire to connect with comfort and home when connecting with their parents – for example, missing the smells of traditional food at home. We learned that home ambience was experienced through multiple senses simultaneously, with multiple ambient streams of information combining to create more complex experiences of passive co-presence. We speculate that future designers could replicate this by combining multiple sensory streams over distance.

**Supporting Nostalgia and Comfort** - The third design consideration is supporting nostalgia and comfort. Parents and emerging adults appreciated sensing familiar and routine actions taking place in the periphery of their attention – for example, noticing a cupboard door left ajar after a family member was in the kitchen. When distance-separated, the desire to share these passive streams of information arose mainly from the hope of reconnecting with the nostalgia and comfort of home, especially for the emerging adults. Future designers could use memories and reminders of togetherness to passively recreate feelings of connection and co-presence.

## 3.2 Objective 2 - Research Through Design

From January 2022 to July of 2023, I conducted research to address RQ2. I undertook a design process to create a dialogue about passive co-presence as a form of connection between distance-separated families, and to inform future design practice by discussing my design decisions. My approach followed a Research



**Figure 1: The There Chair.** Each chair is to be placed in one of the distance-separated homes.

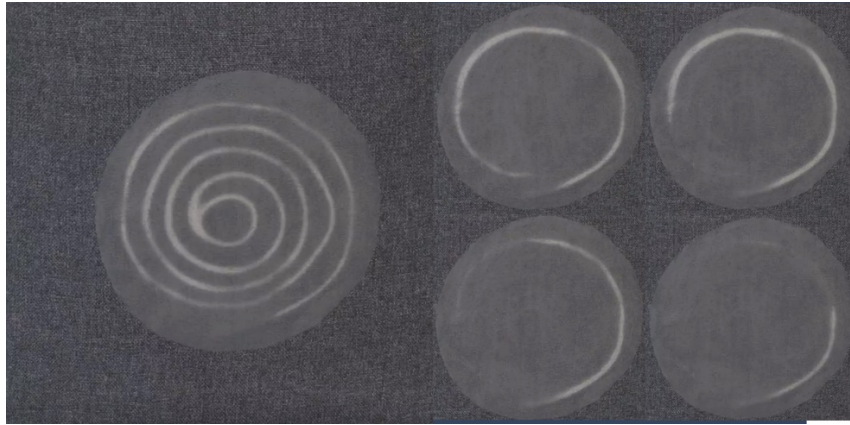
Through Design (RtD) methodology [6, 7]. In the RtD methodology, researchers ideate and iterate toward the design of an artifact, during which a “wicked” problem is continually reframed and examined from various perspectives [40]. This process has been established in HCI as a way to arrive at research findings [6, 7, 27] through an account of the insights during the process. I took a designer-researcher stance for this inquiry, which “involves a small but multi-disciplinary team that is reflexively focused on the experimental and novel outcomes of the design process that are critically and reflectively arrived at through design practice” [10]. This process led us to the following two design artifacts which we iteratively designed and developed.

## 3.3 Designs

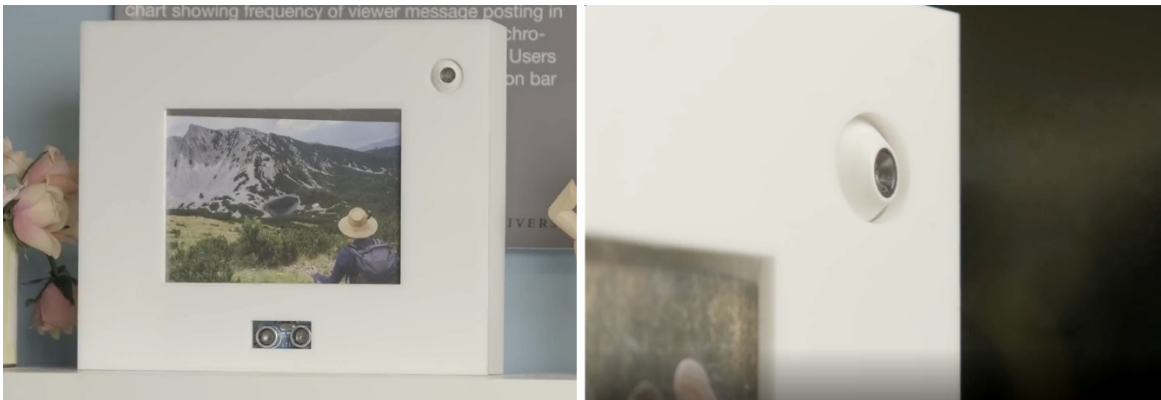
**There Chair** - The There Chair (Figure 1) uses a colour-changing fabric to show when a remote family member is sitting on their chair, and has integrated heating pads on the left edge and right edge of the seat to indicate to a seated family member whether someone in the remote home is sitting to the left or right of them on a spatially mapped remote table. Chairs placed around a dining table are assigned a relative position; for families that were previously co-located, this could be based on where the now-remote family member(s) used to sit at the table. If the remote person sits to the left or right of a seated family member, the seat will heat accordingly, simulating body heat and passive awareness of their presence. A colour changing feature shows temporality, indicating how recently a remote family member was occupying their chair. Once the remote family member leaves their chair, the outer circle of the spiral forms a visual “clock”, as seen in Figure 2.

Consider the following scenario demonstrating the There Chair in use:

*A distance-separated grandmother and grandson each have a There Chair in their homes. The grandmother generally sits on the chair three times a day – for breakfast, lunch, and dinner. The grandson is away most of the day, and usually gets home in the evening shortly*



**Figure 2: (Left):** The back of the There Chair when someone is sitting on the remote chair, showing a spiral pattern. **(Right):** The outer circle of the spiral shows how recently the remote person was sitting on their chair, from 0-15min (top left), 15-30min (top right), 30-45min (bottom left), 45-60min (bottom right).



**Figure 3: The Fragrance Frame, with each frame placed in one of the distance-separated homes.**

after the grandmother's dinner time. When he gets home he sees a half-circle on the back of the There Chair – she was sitting there roughly 30 minutes ago. He sits down for his dinner, and the grandmother, passing by in her home, sees the full spiral on the back of the chair, and knows that he is home.

**Fragrance Frame** - The Fragrance Frame (Figure 3) is a pair of picture frames that emit scent when the remote person passes by their connected frame. We envisioned the Fragrance Frame being placed in a location that may only be passed by quickly, such as a hallway. With a spray mechanism, the moment of remote passage is distinctly marked by scent, which naturally fades to create a temporal effect, indicating whether someone passed by recently. Consider the following usage scenario demonstrating the Fragrance Frame in use:

*A distance-separated brother and sister each have a Fragrance Frame in their homes. The brother has placed the frame in the hallway of his apartment, and the sister has placed hers by the staircase in her house. They have each chosen a scent for the frames that is connected with a memory of the other – the smell of coffee for the brother, and pine trees for the sister. When the brother gets a whiff of pine trees*

*as he moves through his apartment, he is reminded of his sister, and knows that she is home, and vice versa.*

### 3.4 Objective 3 - Field Deployment

The final study of my doctoral research plan, which is not yet complete, aims to address **RQ3**. I plan to conduct a field deployment of the technology emerging from the RtD process to elicit further findings that can inform the design of passive co-presence technology in the home. I am planning to conduct a field deployment study with 3-5 distance separated families (6-10 households), ideally across a range of demographics (e.g. homes with young children, homes with only adults, couples without children, divorced families, blended families, different cultures, etc) for a broader perspective on the range of experiences families may have with this technology. This deployment would take place over the course of six months (in order to get a sense of the experience once the novelty has worn off [17]), in which I will deploy the There Chair and Fragrance Frame into their homes and observe their use of these devices. The goal with this field deployment is not to evaluate the effectiveness of these specific designs. Instead, these designs are intended to act as

tools around which I can collect in-situ information centered on sensory experiences that can then inform the design of future passive co-presence systems. During the deployment, data collection will consist of weekly diary entries where participants reflect on their experiences with the devices, as well as sensor logging.

#### 4 DISSERTATION STATUS AND LONG-TERM GOALS

I am currently a fourth-year PhD candidate in the School of Interactive Arts and Technology at Simon Fraser University working with Dr. Carman Neustaedter. This is a four-year PhD program, and I am expecting to complete my dissertation within the next year. However, I started my PhD during the COVID-19 lockdowns, and since then I have struggled to connect with the HCI community; until this year I was attending virtual conferences. Thus, I have not had a chance to receive feedback on my work from the community or to connect with my peers, which is important for me to do before completing my degree. Following the completion of my PhD, I hope to pursue a career in academia. I have not previously attended a Doctoral Consortium, and am looking forward to gaining the valuable experience of discussing my research and networking with peers.

#### REFERENCES

- [1] Susan Abel, Tanya Machin, and Charlotte Brownlow. 2021. Social media, rituals, and long-distance family relationship maintenance: A mixed-methods systematic review. *New Media & Society* 23, 3: 632–654. <https://doi.org/10.1177/1461444820958717>
- [2] Almond Aguila. 2012. Time and space on Skype: Families experience togetherness while apart. *Explorations in Media Ecology* 10, 3–4: 303–312.
- [3] Aloha Hufana Ambe, Alessandro Soro, Daniel Johnson, and Margot Brereton. 2022. From Collaborative Habituation to Everyday Togetherness: A Long-Term Study of Use of the Messaging Kettle. *ACM Transactions on Computer-Human Interaction (TOCHI)* 29, 1: 1–47.
- [4] Patrick Bader, Alexandra Voit, Huy Viet Le, Paweł W. Woźniak, Niels Henze, and Albrecht Schmidt. 2019. WindowWall: Towards Adaptive Buildings with Interactive Windows as Ubiquitous Displays. *ACM Transactions on Computer-Human Interaction* 26, 2: 1–42. <https://doi.org/10.1145/3310275>
- [5] Pollie Barden, Rob Comber, David Green, Daniel Jackson, Cassim Ladha, Tom Bartindale, Nick Bryan-Kinns, Tony Stockman, and Patrick Olivier. 2012. Telematic dinner party: designing for togetherness through play and performance. In *Proceedings of the Designing Interactive Systems Conference*, 38–47.
- [6] Jeffrey Bardzell, Shaowen Bardzell, Peter Dalsgaard, Shad Gross, and Kim Halskov. 2016. Documenting the research through design process. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, 96–107.
- [7] Jeffrey Bardzell, Shaowen Bardzell, and Lone Koefoed Hansen. 2015. Immodest proposals: Research through design and knowledge. In *Proceedings of the 33rd annual ACM conference on human factors in computing systems*, 2093–2102.
- [8] Michael Boyle and Saul Greenberg. 2005. The Language of Privacy: Learning from Video Media Space Analysis and Design. *ACM Trans. Comput.-Hum. Interact.* 12, 2: 328–370. <https://doi.org/10.1145/1067860.1067868>
- [9] Margot Brereton, Alessandro Soro, Kate Vaisutis, and Paul Roe. 2015. The messaging kettle: Prototyping connection over a distance between adult children and older parents. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 713–716.
- [10] Amy Yo Sue Chen and William Odom. 2021. Crafting temporality in design: Introducing a designer-researcher approach through the creation of Chronoscope. In *The Routledge International Handbook of Practice-Based Research*. Routledge, 368–380.
- [11] Carla Crespo, Magdalena Kielpikowski, Jan Pryor, and Paul E. Jose. 2011. Family rituals in New Zealand families: Links to family cohesion and adolescents' well-being. *Journal of Family Psychology* 25, 2: 184.
- [12] Donald Degraen, Hannah Hock, Marc Schubhan, Maximilian Altmeyer, Felix Kosmalla, and Antonio Krüger. 2021. FamilyFlower: an Artificial Flower to Foster Distant Family Connections. In *20th International Conference on Mobile and Ubiquitous Multimedia*, 204–207.
- [13] Yumei Gan, Christian Greiffenhagen, and Stuart Reeves. 2020. Connecting distributed families: Camera work for three-party mobile video calls. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–12.
- [14] Yasamin Heshmat, Carman Neustaedter, and Brendan DeBrincat. 2017. The autobiographical design and long term usage of an always-on video recording system for the home. In *Proceedings of the 2017 Conference on Designing Interactive Systems*, 675–687.
- [15] Hilary Hutchinson, Wendy Mackay, Bo Westerlund, Benjamin B. Bederson, Alison Druin, Catherine Plaisant, Michel Beaudouin-Lafon, Stéphane Conversy, Helen Evans, Heiko Hansen, and others. 2003. Technology probes: inspiring design for and with families. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, 17–24.
- [16] Tejinder K. Judge and Carman Neustaedter. 2010. Sharing conversation and sharing life: video conferencing in the home. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 655–658.
- [17] Tejinder K. Judge and Carman Neustaedter. 2015. Studying and designing technology for domestic life: lessons from home. Elsevier/MK, Amsterdam; Boston.
- [18] Tejinder K. Judge, Carman Neustaedter, Steve Harrison, and Andrew Blose. 2011. Family portals: connecting families through a multifamily media space. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1205–1214.
- [19] David S. Kirk, Abigail Sellen, and Xiang Cao. 2010. Home video communication: mediating 'closeness'. In *Proceedings of the 2010 ACM conference on Computer supported cooperative work*, 135–144.
- [20] Danielle Lottridge, Nicolas Masson, and Wendy Mackay. 2009. Sharing empty moments: design for remote couples. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, 2329–2338.
- [21] Sarah Mennicken, A. J. Bernheim Brush, Asta Roseway, and James Scott. 2014. Exploring interactive furniture with EmotoCouch. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct Publication*, 307–310. <https://doi.org/10.1145/2638728.2638846>
- [22] Chelsea Mills, Carman Neustaedter, and William Odom. 2021. Distributed Letter Jam: Designing Distributed Board Game Play for Social Connection. In *Companion Publication of the 2021 Conference on Computer Supported Cooperative Work and Social Computing (CSCW '21)*, 135–139. <https://doi.org/10.1145/3462204.3481753>
- [23] Alireza Mogharrab and Carman Neustaedter. 2020. Family Group Chat: Family Needs to Manage Contact and Conflict. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–7.
- [24] Diego Muñoz, Bernd Ploderer, and Margot Brereton. 2019. Position Exchange Workshops: A Method to Design for Each Other in Families. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 1–14. <https://doi.org/10.1145/3290605.3300339>
- [25] Carman Neustaedter, T. Judge, A. Kurtz, and Elena Fedorovskaya. 2010. The Family Window: Connecting families over distance with a domestic media space. *Video Proc. CSCW* 2010.
- [26] Carman Neustaedter, Jason Procyk, Anezka Chua, Azadeh Forghani, and Carolyn Pang. 2020. Mobile video conferencing for sharing outdoor leisure activities over distance. *Human-Computer Interaction* 35, 2: 103–142.
- [27] William Odom, Ron Wakkary, Ishac Bertran, Matthew Harkness, Garnet Hertz, Jeroen Hol, Henry Lin, Bram Naus, Perry Tan, and Pepijn Verburg. 2018. Attending to slowness and temporality with olly and slow game: A design inquiry into supporting longer-term relations with everyday computational objects. In *Proceedings of the 2018 CHI conference on human factors in computing systems*, 1–13.
- [28] BER de Ruyter, CAGJ Huijnen, P. Markopoulos, and WA Ijsselstein. 2003. Creating social presence through peripheral awareness. In *10th International Conference on Human-Computer Interaction (HCI International 2003)*, 889–893.
- [29] Hanieh Shakeri, Denise Y. Geiskovitch, Radhika Garg, and Carman Neustaedter. 2023. Sensing Their Presence: How Emerging Adults And Their Parents Connect After Moving Apart. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. Retrieved from <https://doi.org/10.1145/3544548.3581102>
- [30] Hanieh Shakeri and Carman Neustaedter. 2021. Painting Portals: connecting homes through live paintings. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–6.
- [31] Xiaoyan Shen, Maggie George, Stephan Hernandez, Agatha Park, Yang Liu, and Hiroshi Ishii. 2019. Mole messenger: pushable interfaces for connecting family at a distance. In *Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction*, 269–274.
- [32] Samarth Singhal, Carman Neustaedter, William Odom, Lyn Bartram, and Yasamin Heshmat. 2018. Time-turner: designing for reflection and remembrance of moments in the home. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–14.
- [33] Meg L. Small, Nicole Morgan, Caitlin Abar, and Jennifer L. Maggs. 2011. Protective Effects of Parent-College Student Communication During the First Semester of College. *Journal of American College Health* 59, 6: 547–554. <https://doi.org/10.1080/07448481.2010.528099>
- [34] Meg L. Small, Nicole Morgan, Lisa Bailey-Davis, and Jennifer L. Maggs. 2013. The Protective Effects of Parent-College Student Communication on Dietary

- and Physical Activity Behaviors. *Journal of Adolescent Health* 53, 2: 300–302. <https://doi.org/10.1016/j.jadohealth.2013.03.010>
- [35] Madeline E. Smith, Duyen T. Nguyen, Charles Lai, Gilly Leshed, and Eric P.S. Baumer. 2012. Going to College and Staying Connected: Communication between College Freshmen and Their Parents. In *Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work (CSCW '12)*, 789–798. <https://doi.org/10.1145/2145204.2145322>
- [36] Kimberly Tee, AJ Bernheim Brush, and Kori M Inkpen. 2009. Exploring communication and sharing between extended families. *International Journal of Human-Computer Studies* 67, 2: 128–138.
- [37] Frank Vetere, Martin R Gibbs, Jesper Kjeldskov, Steve Howard, Florian Floyd Mueller, Sonja Pedell, Karen Mecoles, and Marcus Bunyan. 2005. Mediating intimacy: designing technologies to support strong-tie relationships. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, 471–480.
- [38] Andrew D Wilson and Daniel C Robbins. 2007. Playtogether: Playing games across multiple interactive tabletops. In *IUI Workshop on Tangible Play: Research and Design for Tangible and Tabletop Games*.
- [39] Qingxiao Zheng, Daniela M Markazi, Yiliu Tang, and Yun Huang. 2021. "PocketBot Is Like a Knock-On-the-Door!": Designing a Chatbot to Support Long-Distance Relationships. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW2: 1–28.
- [40] John Zimmerman, Jodi Forlizzi, and Shelley Evenson. 2007. Research through design as a method for interaction design research in HCI. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, 493–502.