

# Strategies for Fostering a Genuine Feeling of Connection in Technologically Mediated Systems

Ekaterina R. Stepanova  
Simon Fraser University  
Vancouver, Canada  
katerina\_stepanova@sfu.ca

Kristina Höök  
KTH Royal Institute of Technology  
Stockholm, Sweden  
khook@kth.se

John Desnoyers-Stewart  
Simon Fraser University  
Vancouver, Canada  
john\_desnoyers-stewart@sfu.ca

Bernhard E. Riecke  
Simon Fraser University  
Vancouver, Canada  
ber1@sfu.ca

## ABSTRACT

Human connection is essential for our personal well-being and a building block for a well-functioning society. There is a prominent interest in the potential of technology for mediating social connection, with a wealth of systems designed to foster the feeling of connection between strangers, friends, and family. By surveying this design landscape we present a transitional definition of *mediated genuine connection* and nine design strategies embodied within 50 design artifacts: *affective self-disclosure, reflection on unity, shared embodied experience, transcendent emotions, metaphors, interpersonal distance, touch, provocation, and play*. In addition to drawing on design practice-based knowledge we also identify underlying psychological theories that can inform these strategies. We discuss design considerations pertaining to sensory modalities, vulnerability–comfort trade-offs, consent, situatedness in context, supporting diverse relationships, reciprocity, attention directedness, pursuing generalized knowledge, and questions of ethics. We hope to inspire and enrich designers’ understanding of the possibilities of technology to better support a mediated genuine feeling of connection.

## CCS CONCEPTS

• **Human-centered computing** → **Interaction design theory, concepts and paradigms; Collaborative and social computing design and evaluation methods; HCI design and evaluation methods.**

## KEYWORDS

social connection, genuine connection, design strategies, review, design considerations, intimacy, belonging

## ACM Reference Format:

Ekaterina R. Stepanova, John Desnoyers-Stewart, Kristina Höök, and Bernhard E. Riecke. 2022. Strategies for Fostering a Genuine Feeling of Connection in Technologically Mediated Systems. In *CHI Conference on Human Factors in Computing Systems (CHI '22)*, April 29–May 5, 2022, New Orleans, LA, USA. ACM, New York, NY, USA, 27 pages. <https://doi.org/10.1145/3491102.3517580>

## 1 INTRODUCTION

We all seek to belong [11, 98, 147]. Across every culture, we yearn to bond with one another, to form and maintain meaningful relationships, and to relate with and be accepted into social groups. Simple social encounters in our daily life and intimate relationships are the strongest predictors of happiness among regular activities and life satisfaction factors [39, 82]. Social connection is essential for our health and longevity [67, 101], mental well-being [147], and cognitive functioning [23]. Yet, technology designed to optimize efficiency has led to fewer meaningful social interactions and often seeks to eliminate even simple encounters with strangers in our lives. Pervasive automation designed to make life “easier” continues to remove human interactions from our daily routines: depositing cheques, shopping, booking holidays, and ordering a taxi—all point to a future where we will hardly ever need to talk to a stranger other than an AI assistant [22].

The social interactions we do have are already typically technologically mediated. Modern technology such as social media has a complex effect on our sense of connection [129] and has offered novel opportunities to connect across vast distances and form far-reaching social networks. It allows us to stay connected with our loved ones if we move away, or to discover unique communities of people that we may have otherwise never met. While providing new opportunities to connect, much of the technology we rely on today has also exacerbated our tendency to become polarized into groups of “us” vs. “them”, creating information bubbles and feeding into our confirmation bias [164]. Smartphones trap our attention with attention-grabbing notifications, infinite scrolling and constant access to an endless source of novelty for a quick boost of dopamine at the tip of our fingers, inhibiting our ability to enjoy our co-present social interactions [42, 92].

In recent years, the response to the COVID-19 pandemic brought technology’s pervasive role in our social interactions into the spotlight. It has emphasized the ever-present benefits and limitations of

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from [permissions@acm.org](mailto:permissions@acm.org).  
CHI '22, April 29–May 5, 2022, New Orleans, LA, USA

© 2022 Copyright held by the owner/author(s). Publication rights licensed to ACM.  
ACM ISBN 978-1-4503-9157-3/22/04...\$15.00  
<https://doi.org/10.1145/3491102.3517580>

using such technology for supporting meaningful connection. For instance, videoconferencing platforms such as Zoom have replaced many face-to-face interactions with face-to-screen interactions, allowing us to continue our work and social activities, albeit in a limited capacity. It sometimes afforded a fairly intimate interaction as we suddenly gained a window into a colleague's home, as if we were invited to their house for a casual cup of coffee rather than a professional meeting (for a similar argument see [25]). It revealed the complex lives of those we work with, as we heard children playing in the background and met beloved pets via the screen. Despite this potential for intimacy, more often than not Zoom leads to Zoom fatigue [182], a sense of depersonalization [28], and effortful struggles to connect rather than supporting seamless interaction, ultimately depriving us of the *genuine feeling of social connection* that we seek. While we can feel deeply connected when interacting over Zoom, we often end up feeling detached and easily distracted, suggesting that something is missing in what this technology affords.

Communication platforms such as Zoom commonly used to mediate our social interactions are typically designed to support our communication by maximizing the quantity of information exchanged. Guided by mathematical theories of communication, such as Shannon's information model, we have progressively increased the bandwidth available to produce the clearest possible picture or sound. However, this high bandwidth does not guarantee an improvement in the quality of the human interaction, nor in an understanding of the message contained therein, and perception of affective qualities that may not even be captured at the source. Instead, setting intentional constraints around interaction can in fact help guide users' attention to specific aspects of their social interaction with another person, which could better invite the genuine feeling of emotional connection (e.g. [83]). However, this **mediated genuine feeling of connection**, while intuitively familiar to all of us in our everyday lives, is a tacit experience that is difficult to describe in a rigid clear-cut definition. There is no suitable definition in the literature that captures this concept in a technologically-mediated context while remaining sufficiently open to stimulate design explorations. Thus, we need to articulate our intuitive understanding of it, albeit tentatively, based on design work, in order to formulate guidelines and considerations to guide further design explorations. Here we bootstrapped our understanding of what a genuine connection might entail by first starting with our *hunch* about the scope of the mediated experiences that could invite a genuine feeling of connection. This hunch was not drawn from thin air but is the culmination of our extensive backgrounds as designers creating systems with this specific aim [citations removed for blind review] as well as our human experiences of connecting with others. Based on our understanding, we then selected 50 artifacts and artworks that exemplify diverse techniques for mediating genuine connection, allowing us to unpack what it is and how it is supported. By analyzing these artifacts and the design intent behind them, we can better understand mediated genuine connection, and how it may be supported through specific designs, ultimately refining our original intuitive definition towards a practical one through the practice-based knowledge embedded in the design artifacts. But beyond design intent, we also looked to understand, from a theoretical perspective, why and how these designs might

work. All in all, this lead to a grounded understanding of some of the factors and design possibilities involved.

This design-based understanding of the phenomenon of genuine connection in a technology-mediated context is needed because technology already pervasively mediates many of our social interactions. As Donna Haraway famously declared in her *Cyborg manifesto*: each one of us is a cyborg, "*a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction.*" [64, p.117] As such, the technology that is ingrained in many of our activities defines our experiences and who we are. For example, as Zoom interactions have recently become the norm for many who work an office job, it shifts what connecting with others means. New terms, such as "zoom-fatigue" and feeling "zoomed-out" have entered our vocabulary because of the common familiarity of this ubiquitous new phenomenon. As cyborgs, we create technology, which in turn shapes ourselves and our society, defining what it means to connect with others. We should therefore strive to understand how technology shapes our experiences, and how we can design systems that elicit the qualities of our experience that we value and want to define our experiences through.

To transform our technology's dominance over our relationships and identify future opportunities, we need to reflect on which design elements of mediated systems best support the favourable qualities of experience that can foster a genuine connection. To understand how a genuine feeling of connection can be supported we conducted a bottom-up analysis of 50 existing mediated systems and artistic installations designed to support or stimulate the feeling of connection or an aspect of it. We selected these 50 systems based on their described motivation to support an experience of connection. We also looked for systems that offer unique and inspirational design elements that are not already part of the mainstream tools that we use daily. In this light, we leave such popular communication tools such as Zoom, emails, etc. out of our analysis as they present a status quo that we feel fails to sufficiently support mediated genuine connection. Instead, we focus on those systems which explicitly propose alternatives that prioritize affective inter-human experiences over technical communication. Of course, any telecommunication tool can support affective experiences, but it is not its main design focus. Through our analysis of these systems, we extracted nine strategies that designers can employ to better support a genuine feeling of connection. Together these frame a design space that informs the design of technology that can mediate our social interactions eliciting qualities of intimacy, connection, and closeness.

Through this process, we aim to explore the following **Research Questions**:

- What are the common strategies identified in designs of systems designed to support a genuine feeling of connection?
- What are the key experiential qualities that are elicited by the design elements of such systems? And how do they form a definition of a mediated genuine connection?
- Which psychological theories can inform the understanding of the mechanisms underlying these strategies?

## 1.1 Searching for the Definition of Mediated Genuine Connection Through a Hermeneutic Circle

In order to present an analysis of existing systems that elicit such an experience, we first must define the scope of what constitutes an experience of a **mediated genuine feeling of connection**. In a search for this definition, we could take one of the following three approaches: (1) a prescriptive intensional definition based on existing literature in social sciences, (2) an intuitive definition from our everyday understanding of the concept, or (3) a descriptive extensional definition based on an accumulation of representative examples with some family resemblance [187].

The first intensional approach is to provide a definition via a thorough and reductive structure of all the types and parameters constituting the variations of a given construct (e.g. Lombard and Jones' definition of "presence" [109]). We could look to how social connection is defined in the fundamental studies in psychology, often rooted in motivation theories (e.g. [4, 11, 17, 98, 99, 151]). Despite this being perhaps the most widely used approach in academic writing, it comes with a limitation of the definition being structured around operationalizing a linguistic term within a specific research context. The need for operationalization restricts the definition to a measurable slice of an often much larger and more complex phenomenon. This way, many definitions of social connection in social science literature focus on quantities and specific short-listed qualities of social interactions, chosen for their measurability in psychometric questionnaires. These definitions are often most applicable to one's overall sense of connection, or sense of connection to a particular individual, rather than the qualities of specific mediated interactions, which is of particular interest in design. For mediated interactions, while there is considerable research on the construct of social presence [15, 131], there is not a widely accepted definition for a mediated *genuine feeling of connection* that might be facilitated by such social presence. Thus, we did not find that the social science literature was able to offer a useful definition for the phenomenon we are interested in exploring in a design context. For our goal of unpacking the diverse design opportunities to mediate the feeling of genuine connection among our cyborg-selves, we require a more open and transitional definition, which can evolve as new technology and experiences enter our lives.

We then took the intuitive approach, defining the experience itself in terms of its everyday form and use of the term "connection", and how we typically understand it in our own daily experiences (e.g. how Taylor [174] defines "[machine] intelligence"). This provides us with the initial *hunch* of what constitutes the phenomenon we are after. Using this interim intuitive understanding of genuine social connection, we then identified the corpus of systems that have a variant potential of inviting such experiences. This corpus provides the basis for an extensional definition from the accumulation of the (proto)typical and atypical design exemplars (e.g. how Redström [145] discusses how all the chairs together define what a "chair" and "sitting" are). Opting for these two approaches allows us to arrive at a malleable and **transitional** definition, that can evolve with our cyborg experiences as new forms of designs begin to mediate our interaction giving rise to new forms of mediated genuine connection. We believe that such a transitional definition

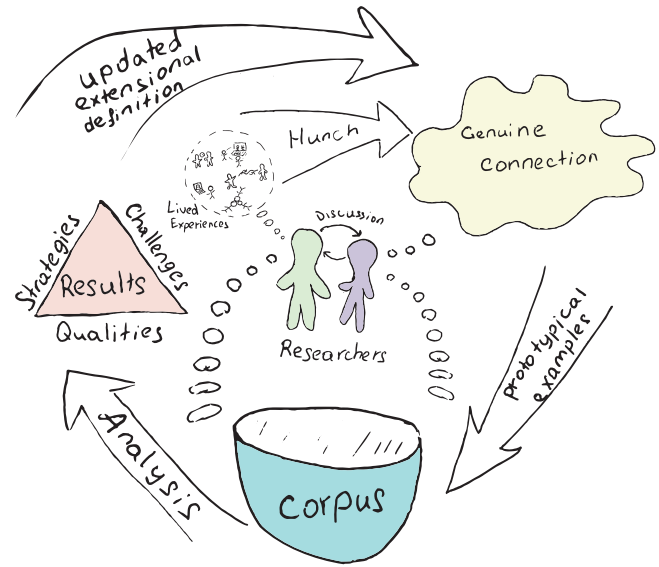


Figure 1: Searching for an extensional definition of mediated genuine connection through a Hermeneutic Circle.

is of most use for designers, as it avoids establishing rigid borders of what may constitute mediated genuine connection, allowing to extend the definition as new technology and designs come into use.

By its transitional nature, this presents a circular definition that evolves over time through our lived experiences. This approach is akin to how children learn to recognize categories of objects (e.g. what a dog is), not through a textbook definition of rigid criteria, but through experiences of coming across dogs and non-dogs and updating their definition of the category with each new instance that enriches their understanding. Similarly, here we start with our initial *hunch* of what constitutes a feeling of mediated genuine connection that originated in our prior lived experiences. Then we use this intuitive definition to select a corpus of design artifacts that can be, in Redström's terms, *prototypical* of mediated genuine connection. Through analyzing, these prototypical examples, we can update our definition to one that more precisely reflects the current design space but is nonetheless open to its future evolution (see an illustration of our process in Figure 1).

**1.1.1 The initial hunch.** We begin with our hunch that genuine human connection is a beautiful and inherently positive experience at the core of our existence and fundamental to our needs. Everyone intuitively understands what it means to feel a genuine connection with another person, yet, pinning down a specific definition of the term proves elusive. Perhaps not only because it is a tacit, felt experience, but also because elements of this genuine connection indeed vary between individuals and contexts. The genuine feeling of connection can consist of a mixture of experiential qualities that make us feel that we are not alone, that we are together, or close to someone, or that we are one with others or everything, that we care for and understand the other in a reciprocal relationship. However, the feeling of a **genuine connection** can be experienced very differently depending on the context, much like a feeling of

happiness can be experienced and expressed differently depending on whether we have received a picture of a newborn nephew, read a thankful email from a grateful student, or won an Olympics' medal in wrestling. Yet, despite the drastic differences in the context and expression, ranging from a quiet warmth and fuzziness to overwhelming excitement, we can recognize in all of these experiences what a genuine feeling of happiness is (for a discussion of the diversity of expressions and constructionist theory of emotion see [7–9]). Likewise, the experience of connection can take many shapes and forms and combine different experiential qualities, yet, among these experiences, we all intuitively know what *it feels like* to experience genuine connection.

For the purpose of our analysis, we consider experiences of connection as *mediated* through technology. To articulate our initial hunch of the scope of the experiences that we are interested in, we have reflected on our experiences and what we mean when we feel mediated genuine connection. Here, we see connection as a *felt* experience emerging in interaction, rather than an objective quality of information exchange between users, or a number of 'friends' on social media. As such, genuine connection has an *affective* dimension, which is experienced within our *bodies*. It is also meaningful, involving some personally relevant, often shared, meaning, beyond detached superficial and inconsequential technical connections.

**1.1.2 The dimensions of connection.** When defining genuine connection, we need to consider the **context** (where and towards whom it is experienced), and the **experiential qualities** of such experience that could be supported through design. For the purpose of our analysis, we will focus on three types of connection: connection to a person, connection with a community, or connection with humanity at large. Connection with another person may have a quality of *intimacy* and *closeness*, while connecting with a community may feel like *belonging*, *camaraderie*, *togetherness*, feeling of self as a *part of a larger group*. Connection with humanity may be experienced as *global interconnectedness* when the notion of *self dissolves* and is replaced by a feeling of *oneness*. Supporting connection with another person may involve connection with someone the user already has a relationship with, with a stranger, or with an abstracted specific other, such as a protagonist of a story. The interaction could be unidirectional, or bi-directional, and either synchronous or asynchronous. Naturally, these different types of connection imply different contexts of use that require different approaches to interaction design, however they are also all interrelated.

Connection could also refer to a singular experience or to an overall relationship which is tightly coupled as the sense of connection in a relationship emerges from the accumulation of experiences of connection and in return also produces such experiences of connection. Because of the temporary nature of their use, mediated systems typically aim to directly support momentary experiences of connection. They often do this, however, with an overarching goal of either supporting existing relationships or fostering opportunities for forming new ones.

Another frequently discussed phenomenon that designers may aim to support in their systems is *empathy* and *compassion*. Empathy is a relevant concept to connection as it emerges only towards people we feel connected to [153], and it equally facilitates affiliation, social cohesion, and communication and predicts prosocial

behaviour [34]. While empathy, compassion and connection are all complex and multifaceted concepts, for the purpose of this manuscript we will treat empathy and compassion as one of the many forms of connection, as it is applicable to designed systems, and is frequently proposed as the design goal [137].

**1.1.3 Hermeneutic circle.** As stated above, the definition of the feeling of what can evoke a *genuine connection* cannot be derived solely from top-down abstract reasoning and the social and motivational psychology literature that has explored this phenomenon for decades. It also requires investigating the designs and artworks that were created to elicit, foster, stimulate or support the feeling of connection from the bottom up. As discussed by Redström [145], the knowledge that emerges in design practice is contained in the design artifacts themselves and their use in our life. These artifacts then become the exemplars of the theory that they comprise, and together form the definition of a construct. As such, reviewing the domain of systems that were purposefully designed to elicit connection allows us to arrive at and update the definition of the mediated genuine feeling of connection, as it is embodied in these systems. This process forms a hermeneutic circle where the individual parts, i.e. prototypical examples, are in a continuous interaction with the meaning of the larger whole, i.e. the definition of a mediated genuine connection, in an ongoing process of reinterpretation.

## 2 RELATED WORK

In the Human-Computer Interaction (HCI) research and design community there are a plethora of systems designed to support social interaction and connection. Several reviews [48, 66, 104, 112, 132] have identified such systems and analyzed the common strategies employed in their design. The largest areas of HCI exploring approaches for supporting connection are: technology for long distance relationships (romantic and familial), and technology for cooperative work.

Olsson et al. [132] presents a review of 92 systems designed to facilitate collocated social interactions. The goals of the systems covered are to incentivize initial interactions or to improve existing interactions, usually in the context of a workplace. The main focus of the systems discussed is the quantity and quality of interaction rather than the feeling of connection emerging from it. Several systems aim to support the sense of community by facilitating the co-awareness of coworkers or other groups. The design approaches are categorized as: *shared digital workspace*, *disclosing information about others*, *introducing constraints*, *matchmaking*, *open space for shared activity*, *self-expression*, and *topic suggestions*. The evaluation of the reviewed systems predominately included assessment of usability and task completion, making it hard to assess if the systems supported the experience of connection. While several of the identified strategies are of relevance to our discussion, Olsson et al. are focused on designs aiming to augment workspace interaction, and as such the quality of intimacy and closeness is often not supported or analyzed in the reviewed systems, thus only covering some aspects of genuine connection.

Another review is presented by Lux et al. [112] who analyzed 76 bio-feedback systems including 20 multi-user systems. They found that multi-user biofeedback systems were typically designed to support social interaction by providing information about the internal



state of the other user to amplify social cues and support understanding and connection. Lux et al.'s analysis focused on providing an integrative framework identifying components of a design using a system-based approach, and thus did not provide an evaluation of strategies for supporting connection or discussion of qualities of supported experience. However, their identified implications for design are relevant to our discussion including the challenge of interpretation of biodata by users and the consideration for privacy.

Further exploring biofeedback, a recent review presents a landscape of biofeedback sharing systems augmenting interpersonal communication [48]. Feijt et al. [48] present a systematic review of 57 prototypes identified in the literature, analyzing them through the lens of communication and media theory. However, even though Feijt et al. followed a systematic review procedure, they did not include several of the systems discussed in Lux et al. [112] and Prpa et al. [140] reviews that also include multi-user biofeedback sharing systems, and thus should have fallen within the scope of Feijt's et al. analysis. This suggests that there is a lack of consistent terminology in the field, making comprehensive systematic reviews challenging. Nonetheless, Feijt et al. provide a thorough and valuable discussion identifying communication characteristics and typical user experiences with the systems that share biodata between users. They identify its value for supporting connection, as well as challenges with the user's sense of privacy and ambiguity of data. Feijt et al. analyze the system set-ups based on communication dimensions (e.g. synchronicity, co-presence, reciprocity, autonomy, etc.), and present design recommendations based on these parameters, but do not discuss design strategies. In our analysis, we are taking a broader look at the many diverse approaches for supporting connection while focusing on experiential qualities and the design decisions that elicit them. Yet, analysis of communication dimensions could also be applied to the systems discussed in the current paper in future work.

Hassenzahl et al. [66] and Li et al. [104] performed a review of systems for supporting connection in long-distance relationships, analyzing 143 and 52 systems respectively. The strategies identified include *awareness*, *expressivity*, *physicalness*, *gift-giving*, *joint action*, and *sharing memories*. Li et al. added strategies of *unobtrusiveness*, *playfulness*, and *joyfulness*, *personalization*, *coincidence*, *reassurance*, *effortlessness*, and *effortful investment*. These reviews focus on a very specific type of connection with non-located partners in a very close relationship. Thus, some of the identified strategies likely will not transfer to other types of connection or may have a different effect in a different context. Nonetheless, there is an overlap between strategies identified by Hassenzahl et al. and Li et al. and in our analysis.

Among the above review papers, only Hassenzahl et al. (2012) [66] and Feijt et al. [48] to some degree engaged with psychological theory to inform the discussion of the strategies identified, as they take a system focused approach. According to Redström (2017), a stronger use of theory could allow us to engage with the poetics and the politics of the theoretical foundations of design practice, and to enable the research-through-design to inform theory. Design as a practice itself, and the artifacts that emerge from it may provide invaluable practice-based insights which could help to evolve psychological theory. As the use of designed systems defines our

cyborg selves, understanding these systems is an important contribution necessary to understanding how we connect with others.

## 3 METHOD

### 3.1 Researcher Reflexivity

Researcher reflexivity or positionality is a key tenet of qualitative research [30, 78], as our background, identity and beliefs inevitably shape how we conduct research, formulate research questions, and interpret our data. To support the transparency of our research process and the biases and perspectives that come from our background, we present our positionality here to help the reader understand how our corpus and analysis were informed by our prior work and expertise.

- The first author, Ekaterina R. Stepanova, is an HCI researcher with a background in cognitive science and psychology. Her research focus spans Virtual Reality, breath-responsive systems, somaesthetics, and transformative experience design. She grounds her work in embodied cognition and phenomenology to design interactive systems that foster a feeling of genuine connection.
- The second author, John Desnoyers-Stewart, is a media artist, designer, and researcher, with a background in engineering, product design, and interactive art. His artistic and research practices focus on critically exploring emergent technology to stimulate creative expression, facilitate embodied interaction, and encourage social exchange.
- The third author, Kristina Höök, is a designer and a researcher in the field of affective interaction, somaesthetic design, internet of things, ethics of design and feminist theory. Her work focuses on soma-design and qualitative methods.
- The fourth author, Bernhard E. Riecke, is a VR researcher, psycho-physicist, and educator using transformative experience design frameworks, immersive technology and bio-responsive systems to create and investigate experiences that support well-being, connection, and sense of responsibility for nature.

Collectively, the authors have worked on several projects and art installations that aim to foster the feeling of genuine connection between users through breathing synchronization [166, 190], transcending social norms and encouraging interpersonal touch [36, 38], and simulating awe-inspiring phenomena [143, 167]. As such, when we began this review, we were already familiar with over 25 relevant design artifacts and artworks that we have accumulated through years of familiarity with this research topic. We then expanded the corpus by performing a literature search as outlined below. The corpus was primarily composed by the first author, with the second author augmenting the corpus with additional relevant examples.

### 3.2 Corpus

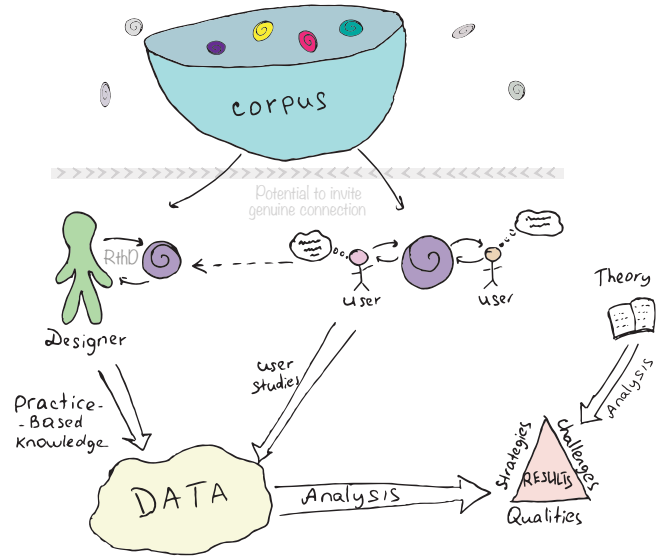
We started by identifying 50 systems designed to foster a genuine feeling of connection in various ways across diverse contexts. We are interested in systems, prototypes, and artworks that mediate our interaction through a purposefully designed technology, both

digital and material. We compiled the corpus of papers describing the design artifacts through a snowballing approach [188] by searching ACM Database and Google Scholar using keywords related to the experience of connection, such as *connection*, *belonging*, *interconnectedness*, *closeness*, and *intimacy*. The keyword terms were expanded based on the papers we found. For example, when *touch* was identified as a prominent strategy, we searched the databases for systems designed for touch, and included the ones that aimed to support social connection. We also searched for other related papers by looking at the cited work within the paper and using the “Related articles” function on Google Scholar, and in the ACM database. Finally, we added systems that we were aware of, but which did not come up in the search, for example, because they were artistic works. All paper were in English language, with 22 works from North America, 22 from Europe, 4 from Australia, 2 from Asia. The corpus reflects the tacit criteria based on our intuitive grasp of the phenomena of genuine connection as a felt, tacit and affective experience situated in our bodies.

Our search was not exhaustive, as we aimed to capture a breadth of strategies that could inspire other designers, rather than to provide a comprehensive overview of a narrowly defined field. As such, a systematic review would fail to capture the required breadth and would likely have missed artworks and other pieces that may not show up in academic search engines. Furthermore, the elusiveness of the construct of genuine connection that we aimed to capture in the prototypical examples in our corpus, did not offer us a set of well-defined, yet reductive, keyword terms that could return a coherent comprehensive corpus of all systems designed to support genuine connection. Instead of a systematic review, we used a qualitative approach continuing the search until we reached **saturation** in our analysis of strategies. Aligned with the criterion of saturation, we did not include some examples if they did not add any new information for analysis. As we did not set out to perform a systematic review, the important criterion for the corpus is not its completeness, but its cohesiveness and ability to extend our understanding of the phenomenon of interest. Consequently, the presented strategies do not claim to capture all the possible approaches used in the design and HCI community to elicit the feeling of connection, and other researchers can build on this work by identifying other systems and deriving new strategies. This corpus of systems is intended as a growing resource for the design community, and it is published online, where we will be updating it as new designs emerge. Indeed, we invite other designers to also contribute to the compiled corpus by proposing systems to be added through an online form on our website<sup>1</sup>. We also invite researchers to refer to our growing corpus to select works for their own analysis.

### 3.3 Analysis

Here we analyze the 50 systems that have been added to the corpus to date. After collecting the corpus, we read through and coded the papers aiming to understand the *design elements*, the *context* of use, the *experiential qualities* it aims to support, and its *motivation*. We have recorded these data in a concept matrix<sup>1</sup>, presenting an overview of all systems. When available, we reviewed video documentation of the designed systems to better understand the



**Figure 2: Conceptual illustration of the corpus and analysis process. Analysis is based on two sources of knowledge: practice-based research through design (RthD) and user studies.**

design. Then we engaged in iterative sketching of concept maps [33] and affinity diagrams [160] to group design elements, elicited experiential qualities, and the type of connection supported. Design elements were grouped into *implementation mechanisms* used to support connection or specific experiential qualities. From these groupings we inferred the nine overarching *design strategies*. Finally, we analyzed these strategies to identify the *psychological and cognitive science theories* that can inform the psychological mechanisms underlying these strategies. The analysis of theory was primarily based on the actual design of the artifacts rather than motivation discussed in publications describing the artifact.

### 3.4 Limitations of the Lack of Formal Evaluations

It is critical to note that our analysis is limited by the lack of validated cases of participants’ experience of genuine connection. Despite the prolific interactive systems which aim to foster the feeling of connection in HCI and artistic domains, formal evaluations of such systems are sparse and usually take a form of a user study (also identified in [104] and [62]), allowing for limited generalizations of the results. Generalization is a challenge as each design, participants, context of use and evaluation methods are different, making a fair comparison across multiple studies elusive and speculative. Controlled studies that isolate a specific parameter, e.g. the modality of the biofeedback output [80] or the social context [81], can provide a more rigorous comparison but are restricted by the needs of experimental control. Consequently, systems studied experimentally often fail to capture the complexity of the natural context of use and because of the need to isolate a singular parameter may use overly simplified designs distilled down to most basic outputs. However, despite the lack of experimentally validated cases, there

<sup>1</sup>See project page: <http://ispace.iaf.sfu.ca/project/design-for-genuine-connection/>

is rich knowledge available in this field coming from designers' experience and reflection (e.g. [70, 130, 157]) supported by some qualitative user studies (see Figure 2).

The challenge in conducting formal studies evaluating systems designed to support connection comes not only from the complexity of each context of use for a given system and the differences among them, complicating generalizations across systems, but also because of the complexities of the phenomenon of connection with a diverse set of approaches used to measure different facets of it applicable for different contexts (for a review of methods for evaluation of connection, see our forthcoming manuscript [37]).

The limited evaluation of designed systems presents a limitation for our current review, as our discussion of the strategies is largely based on our own understanding of the designs and their intent based on their description. Thus, we cannot know for certain if the experience of genuine connection with its associated qualities was actually elicited. What we can know is what the designed systems are and what they do as described by their creators. As such, these design artifacts, and papers describing them embody the tacit and articulated knowledge of designers which emerged through their practice, exploration and experimentation. Their own research and design process that led up to the described design artifacts offers invaluable practice-based knowledge that we aim to describe and synthesize in our analysis. Additionally, papers that report in detail participants' experiences (e.g. [56, 73, 116, 123, 162]) were very valuable in aiding our understanding of the nuances of participants' experiences that were most informative for identifying challenges emerging in designing for connection.

Additionally, a limitation of our analysis is that we have not been able to personally use many of the examples presented here. In many cases, the artifacts are presented in a very limited context such as in a singular demonstration or exhibition if at all, making personally sampling all of them infeasible. Given the tacit nature of genuine connection, this limits our ability to analyze the designs only based on their written description, images, and video. Nonetheless, we have experienced several of the analyzed systems at events and conferences and feel that we are able to provide useful analyses based on the descriptions available to us. The in-depth understanding that comes from such first-hand experiences could further enrich our understanding of designing systems for mediated genuine connection and may be a worthwhile pursuit for future work.

In the following sections, we first present the nine strategies identified in the systems, and then the general discussion of the overarching design considerations that are applicable across the strategies.

## 4 STRATEGIES FOR FOSTERING CONNECTION

In our analysis, we identified nine strategies, through which a genuine feeling of connection can be stimulated, elicited, or supported by:

- Sharing How We Feel: [*affective self-disclosure*]
- Seeing That We Are All Alike: [*reflection on unity*]
- Mirroring the Other: [*shared embodied experience*]
- Dissolving the Self: [*transcendent and social emotions*]

- Being Tricked by Body and Language [*embodied metaphors*]
- Moving Closer Together: [*interpersonal distance*]
- Feeling the Other: [*touch*]
- Challenging Social Discomfort: [*(dis)comfort and provocation*]
- Creating and Playing Together: [*play*]

These strategies can be employed alone, as is often the case for affective self-disclosure, but most often they naturally overlap and support each other. For instance, the strategy of *touch* often involves the reduction of *interpersonal distance*, as one needs to approach the other in order to touch them. The strategy of *provocation* often overlaps with *play*, as a playful interaction affords actions that can push participants outside of their comfort zone, such as *touching* a stranger. These interactions between the strategies are important to consider as strangers need to overcome the distance they naturally put between each other in order to touch, and play may alter the tone of a provocation which was perhaps meant to be sombre.

We structure the discussion of each strategy into three subsections: Theory, Design, and Challenges. In the **Design** subsection, we present some selected illustrative examples of designs that employ a given strategy. In the **Theory** subsection, we present theories that were developed in the fields of psychology, cognitive science, anthropology, and linguistics, which are relevant to understanding such designs and how they may support the desired experiences. Finally, in the **Challenges** subsection, we discuss some caveats or considerations that may emerge when designing with a given strategy. Our analysis was performed bottom-up starting with reviewing the designed systems, grouping them into strategies, and then looking into the psychological theories that might inform these strategies. However, here we reverse this order and start by presenting the theory. This allows us to first provide the general conceptual context and then continue to the particular examples, letting to refer back to the theoretical context. A summary of the strategies, relevant theories, design implementation mechanisms, and qualities and types of connection supported by each strategy are provided in Table 1. The table is not intended to present an exhaustive list of qualities and types of connection supported by these strategies, but rather the most typical ones.

### 4.1 Affective Self-Disclosure: Connecting Through Sharing How We Feel

**Theory.** Self-disclosure is a well-studied approach for supporting the feeling of intimacy and forming strong relationships [146, 178]. Emotional sharing, rather than factual, is an especially important part of intimacy-supporting self-disclosure [97], which is also effective when realized through technology, e.g. via emoticons [80]. There are two components through which self-disclosure supports bonding: (1) exposing trust and vulnerability by sharing something personal and feeling heard, and (2) learning something personal about the other person, allowing us to understand them more intimately, and develop empathy. One-sided self-disclosure can be useful, as demonstrated through self-disclosure with chatbots [69]. However, a reciprocal process when both parties self-disclose

Strategy	Supporting Theory	Implementation Mechanism	Experiential Qualities	Type of Connection	Examples
<i>Affective Self-Disclosure</i>	Self-Disclosure	Biofeedback sharing, Expressive messaging	Vulnerability, Reciprocity, Interactivity, Self-expression	Intimate. Long-distance relationships	[50, 55, 106, 107, 116, 142, 170]
<i>Reflection on Unity</i>	Self-Other Overlap	Abstraction, Obscuring and narrowing in on minimal signals	Anonymity, Reflection	Unity, Connection with humanity	[38, 56, 73, 110, 136, 155]
<i>Shared Embodied Experience</i>	Embodied Social Cognition, Self-Other Overlap, Emotional Cohesion, Synchrony	Encouraging Synchrony, Supporting Somatic Experience	Empathy, Interactivity, Oneness, Intimacy	Any, including fictional characters	[14, 40, 90, 123, 130, 152, 156, 166, 183, 190]
<i>Transcendent Emotions</i>	Self-transcendence	Nature and other, vastness scenes, meditations, psychedelic experiences	Reduced self-salience, need for accommodation	Interconnectedness, Connection with the world	[38, 56, 122, 143, 152]
<i>Embodied Metaphors</i>	Conceptual Metaphor Theory	Using Physical Metaphors (e.g. heat, softness), Visual Connection	Warmth, Coziness, Connectedness, etc. Reflection	Any	[20, 38, 57, 155, 159]
<i>Interpersonal Distance</i>	Proxemics	Nudging reduced distance through spatial design	Closeness	Distant relationships, (e.g. colleagues)	[70, 121, 126, 133, 185]
<i>Touch</i>	Proxemics, Self-Other Boundary Blurring	Detecting touch as interaction mechanism, Sending touch through tangibles	Intimacy, Care, Warmth, Playfulness	Mediated touch for close relationships, Touch as an interaction for distant relationships or strangers	[57, 70, 115, 121, 125, 155, 185]
<i>Provocation</i>	Arousal misattribution, Sharing in an experience	Challenging social norms	Vulnerability, Trust, Arousal	New encounters with strangers	[38, 70, 121, 126, 158, 185]
<i>Play</i>	Social play, Modulation of social norms, Flow	Creative exploration, Cooperation games	Belonging, Creativity, Playfulness, Shared intentionality	Encounters with strangers, distant relationships	[70, 77, 115, 126, 150, 166, 190]

**Table 1: Overview of design strategies supporting genuine connection with some examples**

can better support intimacy by engaging both components of self-disclosure (exposure and learning something personal about another) [97, 100] and by providing genuine responses that produce a positive feedback loop.

**Design.** Most biofeedback sharing systems can be considered self-disclosure systems that provide others with insight into one's intimate internal physiological data. That data is often interpreted as information about one's affective state. Hearing others' heartbeat increases users' ability to recognize the emotion shown in a picture of a face and supports self-reported emotional convergence with that emotion [186]. Sharing of breathing data in *Breeze* allows participants to make judgments about the other's emotional state, often through attempting to mimic their breathing [50]. Other systems facilitate this interpretive process by presenting emotional states derived from the biodata and the alignment of the states between the group members in an abstract display [142]. A tangible figure in *Tobe* allows users to customize how their state is being displayed by creating their own visualizations [55]. With the prominence of smartwatches, there is a growing interest in designing biofeedback sharing apps for on the wrist affective messages such as *Animo* [106] and *Significant Otter* [107]. See some examples in Figure 3.

**Challenges.** The majority of studies with biofeedback communication report skepticism of the users about the accuracy of the biodata [107, 119]. The modality through which the signal is communicated may have an important effect on how the signal is perceived, where a visual numeric output [162] may result in reflective processing in attempts to interpret the signal, while a tactile output, such as a breeze felt on the skin [156] may support pre-reflexive embodied perception. Additionally, how the signal is transmitted—as a raw signal vs. inferred affective state—will lead to different

meaning-making processes and capacities for emotional contagion. While biosignals are used to communicate emotions, emotions are much more contextual and complex than the numbers that biosensors acquire [71], and thus the use of de-contextualized heuristic interpretations can be misleading. The raw signal provides an opportunity for richer interpretation by the user and allows for the emergence of spontaneous synchronization of the biosignals even without direct intention or facilitation of it, e.g. in Sun et al. [170].

The type of relationship which participants have also affects the interpretation of the signal. Those in close relationships may not see any need to augment their interaction if they are already in the same space [162], as they can already feel the state of the other without the need for technological mediation. Meanwhile, when interacting with a stranger or an unknown other, the interpretation becomes more ambiguous, and the users have to rely on their own experience to make the interpretation, by either mimicking the physiological state [50], or by observing their own response to it [170].

## 4.2 Reflection on Unity: Connecting Through Seeing That We Are All Alike

**Theory.** Self-other overlap and self-expansion theory is one of the theories proposed to conceptualize the mechanism and motivation for connection [5]. According to this theory, connection is realized by incorporating others into the notion of self, and by extension expanding the boundary of the in-group. Here, affiliation emerges from seeing that the other is like us, and thus is part of our in-group. This judgment of a self-other dichotomy can be based on a variety of often superficial factors that present the quality of similarity. They can range from skin colour and personal beliefs [18], to the

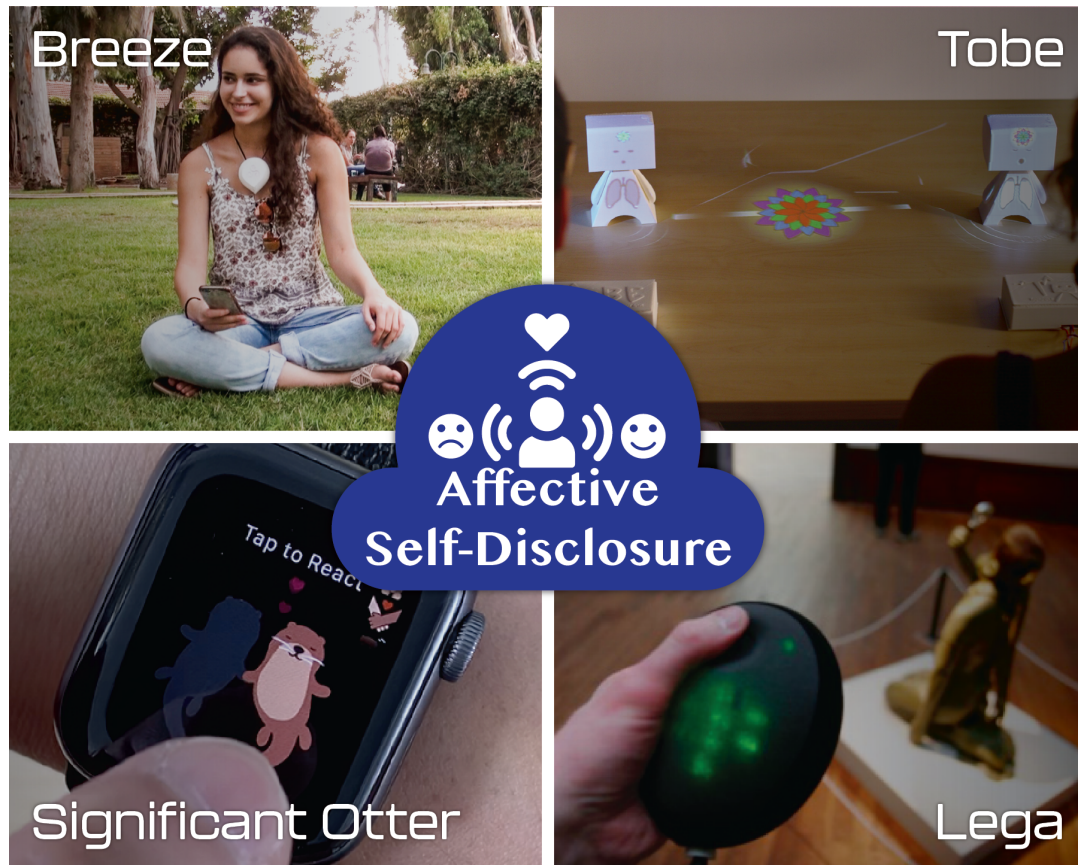


Figure 3: Examples of systems illustrating the strategy of affective self-disclosure.

TOP-LEFT: *Breeze* uses a pendulum to detect breathing and shares it with others through an app ©2018 Frey et al. [50].

TOP-RIGHT: *Tobe* incorporates customizable toys that project visualizations of physiological signals ©2016 Gervais et al. [55].

BOTTOM-LEFT: *Significant Otter* captures emotions as animations of otters that can be sent to a partner ©2021 Liu et al. [107].

BOTTOM-RIGHT: In *Lega* messages expressed through movement are played back to another user through vibration ©2014 Mentis et al. [116].

colour of a t-shirt and preference for crackers over green beans in infants [113], to even experimentally-induced false belief of group-division based on impressionist art preference [171]. Notably, these boundaries are flexible, as priming football fans to think about their shared love for football instead of competition shifts the perception of rival fans of an opposing team into the in-group of beloved football enthusiasts, leading to increased helping behaviour [103]. This presents a potent strategy for interactive systems to alter the self-other dichotomy by making the similarity between participants salient, reminding them of their shared unity as human beings and de-emphasizing superficial differences of race, gender, age, etc.

**Design.** This strategy relies on users reflecting on what unites them with the other user or humanity at large. The experience of the other in these systems often has a quality of anonymity, as they are perceived as representatives of humanity at large rather than individual people. This is achieved by obscuring the details of one's representation, leaving distilled elements that can signify our

unity. For example, this is achieved with capturing and replaying biosignals, as in *The Heart Sounds Bench* [73] that plays an analog recording of the heart beat of earlier passers-by who stopped at the bench. This simple signal reminded participants of all the other creatures on Earth with a beating heart and how we are all united by the experience of being alive. In a similar vein, two VR systems *Body Remixer* [38] and *Isness* [56] use an abstract representation of participants' bodies that become anonymous. This reminds participants of their unity as humans despite apparent superficial differences. See some examples in Figure 4.

**Challenges.** This strategy relies on de-emphasizing individual differences, and thus the identity of participants, making the interaction more anonymous and de-personalized. This goes against the prominent recommendation for reducing prejudice through individualizing others by considering them as individuals rather than a member of the other group [153, 181]. By connecting with





Figure 4: Examples of systems illustrating the strategy of reflection on unity.

TOP-LEFT: *We Are All Made of Light* captures participants movement as shadows of light that linger in the display ©2019 Maja Petric [136].

TOP-RIGHT: In *Having a Heart Time* heartrate-derived emotional states visualized as abstract images. Individual representations attract based on emotional cohesion ©2020 Qin et al. [142].

BOTTOM-LEFT: *Heart Sounds Bench* lets people feel each other's heartbeat and records and replays heartbeats of past visitors. [73]. ©2019 Kimiko Ryokai

BOTTOM-RIGHT: *imPulse* represents pulse as vibration between users ©200 Lotan & Croft [110]

an abstract other, we might be failing to connect to a particular individual that is taking the place of the neutral other. Designers should consider the possibility of including a process of individualization following or preceding the abstraction to support the development of a direct connection while overcoming superficial differences. For example, designers could create a space at the end of the experience, where participants can meet in person and debrief about their experience together.

### 4.3 Shared Embodied Experience: Connecting Through Mirroring the Other

**Theory.** Having a shared experience with another person is a powerful way to feel more connected to them. The embodied cognition perspective on social cognition suggests that connection, intersubjectivity, and interaffectivity are achieved through an alignment of bodily states [172]. Sharing an embodied experience with another

person can provide two pathways towards connection: through *self-other overlap* and through *emotional cohesion and empathy*. When our bodily states become observably aligned, the distinction between self and other becomes more blurred, as we seemingly see our own movement or feeling in the others [96]. This can be accomplished through synchronizing our movement [173] or seeing a tactile stimulation applied simultaneously to oneself and other [135]. A rich body of literature on interpersonal synchronization shows its benefits for supporting connection and other prosocial outcomes (for reviews see [35, 114, 148]). Another aspect of a shared embodied experience that can foster connection is emotional cohesion. There is a tight coupling between our emotional states and bodily states [32], and thus by aligning our bodily states we align our emotional states that emerge from them, resulting in emotional cohesion.

**Design.** Movement synchronization is a natural part of many cultural activities involving rhythm, such as dancing [173] and



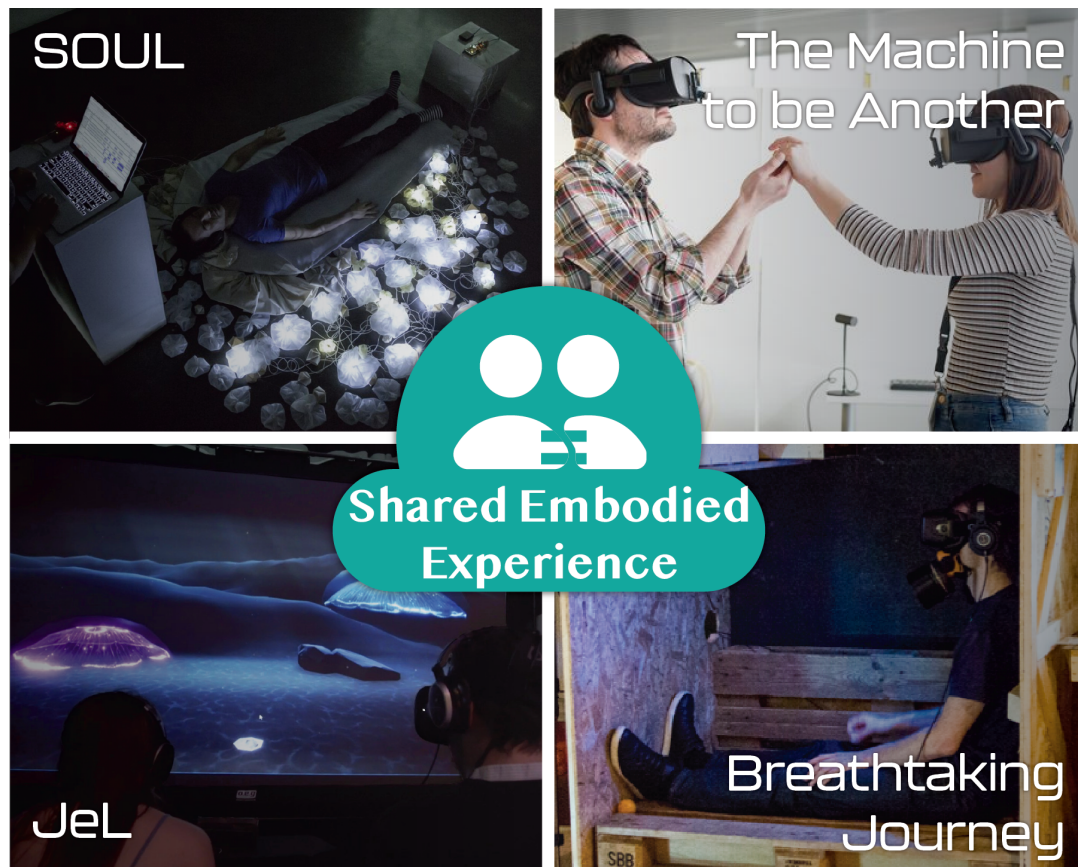


Figure 5: Examples of systems illustrating the strategy of shared embodied experience.

TOP-LEFT: *SOUL* is an experience of a moment of bliss during a Japanese drum concert supported through vibration and lights around the participant laying on the floor. ©2020 Art installation by Claudia Núñez Pacheco. Photograph by Baki Kocaballi. [130].

TOP-RIGHT: In *The Machine to be Another* two people wearing a VR headset with a camera swap their bodily perspectives. By synchronizing their movement they feel as if they are in the body of the other person, MachineToBeAnother CC-NC-SA [12].

BOTTOM-LEFT: *JeL* is an immersive installation where participants grow a coral by synchronizing their breathing ©2020 Stepanova & Desnoyers-Stewart [166].

BOTTOM-RIGHT: *Breathtaking Journey* is An immersive multisensory experience that takes a participant on the journey of a child refugee by recreating their embodied experience ©2016 Kors et al. [90].

collaborative sports, e.g. rowing [29], and as such, it is naturally integrated in many mediated interactions that involve music or coordination between participants. Some systems, however, design interactions that are explicitly focused on synchronization, such as *Yamove!*, a dancing game that requires players to engage in an improvised synchronized dance performance competing with other teams for the highest synchronization and amplitude of their shared movements [77]. *The Machine to Be Another* [12] is designed explicitly to provide participants with the bodily perspective of another person, by swapping their first-person perspective with the use of head-mounted cameras and VR headsets. Here, by synchronizing their movement, participants develop an illusion of being in another's body, fostering empathy and compassion [14].

Physiological synchronization can support connection through a much more intimate interaction than movement synchrony as it also engages the strategy of biofeedback sharing. The *exhale* installation [156] is a beautiful example where spontaneous breathing synchronization enabled a sense of intimacy. Here participants can share their breathing with each other initiated through touch and felt as a movement of air on the skin of their legs. Another example of spontaneously emerging synchrony was observed by Sun and Tomimatsu [170] who designed couches with pillows that inflate with the breathing of the other person. Less intimate examples include *In the Same Boat* [150] and *emRoll* [190] which use breathing synchrony as a game mechanic for progressing through the game requiring cooperation. A much simpler mechanic for directly visualizing synchronization in terms of scores was implemented

in *SynKin* [183] that included multiple physiological signals and emotions inferred from facial expressions. An interesting example of design for synchrony is neurosynchrony (synchronization of EEG brainwaves), as implemented in several installations by Dikker et al. [40]. While neurosynchrony is correlated with connection, it doesn't seem to support the intimate quality of interaction, unless supported through a different strategy (e.g. eye gaze in *Magic of Mutual Gaze*). While a direct comparison of outcomes across systems is not feasible, the challenge-based mechanic of gamified synchronization and reliance on visual feedback instead of tactile likely led to a less intimate sense of connection in these systems than in *exhale* [156] and Sun and Tomimatsu's couches [170].

Besides synchronization, a shared embodied experience can be elicited by recreating a similar physical space for users and applying tactile sensory stimuli to encourage a similar affective state. This approach is exemplified in narrated immersive multisensory story-telling pieces: *Breathtaking Journey* and *SOUL*. *Breathtaking Journey* [90] is a VR experience telling a story of a refugee child hiding in a cargo truck. To embody the experience of the protagonist the designers used several strategies: participants sit in a box, forcing them into the same physical position as the protagonist; when oranges fall out of a box in the story an orange fragrance is emitted; and finally, having to hold their breath to avoid being noticed like the protagonist did. Here, participants' somatic experience and breathing are being aligned with the protagonist supporting empathy for the character. A less literal approach of recreating the space for an embodied experience was realized in *SOUL* [130]—an installation telling a story of a profound moment of bliss experienced by a protagonist when attending a Japanese Kodo drum performance. The installation utilized vibrators placed under the participant and lights to mimic the concert hall with felt vibrations from hearing the drumming. See some examples in Figure 5.

**Challenges.** Emotions are much more complex than individual mediated bodily signals (e.g. breathing or heart rate) used in most physiological synchronization systems. Thus, while aligning bodily states through synchronization in mediated systems could support emotional cohesion, it is by no means guaranteed. An identical heart rate can be experienced as very different emotional states in different people, not only because of individual differences in physiology but also because of other contextual factors [9]. People have different ranges of comfortable breathing rates and while a slow breathing rate of 6 breaths per minute could support relaxation in some participants, it could be unattainably slow for others, causing anxiety. In explicit synchronization systems, when two people are trying to synchronize it can create a chasing pattern that is counter-productive to synchronization [166]. Having an explicit leader could support easier synchronization and guide the user to a desired state, as was implemented for yogic practice in *ExoPranayama* [123] and proposed for meditation in *BioFlockVR* [163].

#### 4.4 Transcendent and Social Emotions: Connecting Through Dissolving the Self

**Theory.** Awe-inspiring, psychedelic, and meditation experiences can lead to self-transcendent emotions associated with ego-dissolution

and a feeling of global interconnectedness [87, 189]. These experiences commonly occur when we are in the presence of something greater than ourselves resulting in an experience of vastness and need for accommodation [85]. For example, when witnessing the grandeur of nature, during a religious experience, or a mystical experience, etc. [102]. While there is a great variety of contexts in which transcendent emotion may occur, they are unified by the diminishment of self-saliency as observed both experientially and in reduced activity of the brain region responsible for self-concept [44, 118]. In return, this deactivation leads to social connection [74]. Such experiences are associated with pro-social outcomes [60, 105]. Social transcendent emotions such as compassion, gratitude and love can also lead to experiences of connection and facilitate social functions [84].

**Design.** Since nature in general, especially vast scenery, can elicit awe, mediated systems can use virtual nature to promote connection mediated by awe. Experiencing nature digitally on a screen has been demonstrated to increase the feeling of connection to a larger community [179]. VR experiences designed to elicit a sense of vastness through mountain views and spaceflight promoted connectedness [27, 52, 167]. Mediated systems can aim to elicit transcendent emotions on their own or as a part of a social experience, as was done in psychedelics-inspired experience *Issness* [56]. In this experience, participants are guided through an overarching journey aimed to support a psychedelic-like self-transcendent experience. In VR, participants are represented by a light that they can emit from their fingers and connect with the light emitted from other participants, representing their interconnectedness in an abstract but compelling way. See some examples in Figure 6.

There are many systems designed to support meditation [175], which may foster an experience of connection in a single user. A small number of systems offer a social experience of meditation directly facilitating connection among users. For instance, the *Dišmo* meditation tower [122], when activated by a user, invites other remote users to join in a collective breathing meditation. A VR experience *DYNECOM* [152] offers a compassion meditation experience for a pair of users who try to synchronize their breathing and brainwaves while directing compassionate thoughts towards the other. Salminen et al. [152] observed increased brainwave synchronization in their participants, as well as a self-reported empathy when synchronization was displayed to participants.

**Challenges.** While awe and other self-transcendent emotions are typically positive, they can also have a dark side, eliciting potentially overwhelming fear and distress, especially if a person is unable to accommodate the witnessed vastness [58]. Ego-dissolution, while giving the sense of interconnectedness, could also feel terrifying as an ego-death experience threatening an individual's sense of integrity [54]. While this is unlikely to be a concern with mild experiences of awe, such as experiencing nature, in case of more profound awe-inspiring scenarios the designers should take great care for considering how to avoid the risk of eliciting fear. Experiences of awe are characterized by the need for accommodation and, particularly in the case of psychedelics, a high sensitivity to set and setting. Thus, there is an especially heightened need for consideration of the full experience, beginning with relevant priming and providing space for reflection and accommodation at the end.



Figure 6: Examples of systems illustrating the strategy of self-transcendent emotions.

TOP-LEFT: *Isness* is a psychedelics-inspired VR journey where participants are represented by light, Glowacki et al. [56], Creative Commons BY-SA 4.0 .

TOP-RIGHT: In *Dišimo* users can touch a tangible tower to invite others to practice breathing meditation guided through the lights inside the towers ©2018 Mladenovic et al. [122].

BOTTOM-LEFT: *Body RemiXer [online]* is a telepresent experience that invites distant strangers to connect their virtual auras together and move in synchrony with one another ©2020 John Desnoyers-Stewart [47].

BOTTOM-RIGHT: *AWE* is a virtual journey inspired by the Overview effect, an awe-inspiring self-transcendent experience ©2018 Quesnel et al. [143].

#### 4.5 Embodied Metaphors: Connecting Through Being Tricked by Body and Language

**Theory.** Our brain shares the networks involved in embodied and social processing and language [24, 53], which may explain the prominence of bodily metaphors for describing social relations across many languages [91]. Indeed, our somatosensory cortex activates when processing statements containing embodied metaphors [93]. In cognitive linguistics, Conceptual Metaphor Theory proposed by Lakoff and Johnson [94] describes the intermodal embodied origin of metaphors allowing the processing of abstract concepts in concrete bodily relevant terms. This interconnectedness of conceptual domains creates a bidirectional relationship between our bodily experiences and language. We describe our intentions as warm, feelings as fuzzy, and perception of others as soft and caring. These linguistic metaphors can have powerful measurable effects,

such that our embodied experience affects our social perceptions. We perceive others to have a warmer personality, be more trustworthy and have a higher sense of closeness when we meet them in a warmer room or holding a cup of a warm beverage [184]. In a study relating to such embodied metaphors, participants took candidates to be more serious when their resume was attached to a heavier clipboard, and predicted others to be flaky in a cooperation game if they were sitting in a soft chair when making this judgment. Meanwhile, sitting in a stiffer chair correlated with others being perceived as more stable and unemotional [1]. This connection between bodily sensations and social perception applies to interoception as well: patients with chronic pain perceive themselves as being a pain for people they interact with [95]. These embodied metaphors are important for our judgment and behaviour. Damasio [32] introduced the somatic marker hypothesis explaining how our reasoning is guided by affective states experienced in our body

without our conscious awareness of the source of these somatic markers, thus presenting a wealth of opportunities for misattribution of these signals that could be leveraged in design. Engaging bodily experiences that are linked in our mind with close and intimate relationships, such as warmth and soft coziness, can affect how we perceive others and our relationship with them.

**Design.** The use of metaphors can recruit embodied pre-reflexive or reflexive mechanisms. Our bodily experiences affect our perception below the conscious level, and thus we can misattribute the source of our experience of physical warmth to social warmth, or experience of arousal (e.g. raised heart rate) to excitement and liking of the other. Other metaphors may rely on reflection on the meaning of a metaphor which then affects the embodied experience, e.g. the connection between people as in “tying the knot”. Many artists and designers intuitively use metaphors when designing systems for connection. Warmth is possibly one of the most salient metaphorical signals, and has been explored in HCI for affective technology design, e.g. mediating the perception of the valence of a message [43] and supporting the feeling of connection [76]. *Empathy Amulet* [20] transmits a message of warmth to a random person in the network that they receive as gentle warming of the amulet on their neck. The pillows in *move.me* [159] are designed to provide the metaphor of softness, caring, cushiness and intimacy. While participants don’t directly use the pillows to send intimate messages to each other, the overall space of the installation presents an ambient message of comfort and intimacy. The visual metaphors of connection showing visually how participants are connected are also used in *Body RemiXer* [38] and *We Are All Made of Light* by Maja Petric. While in *Body RemiXer* participants connect directly with other immersants present in the immediate interaction, Petric’s installation allows participants to see and reflect on the global interconnectedness of humans across the time span as visitors are observing overlaying moving shadows of previous visitors who have left traces in the gallery. See some examples in Figure 7.

**Challenges.** While there is considerable overlap in metaphors, e.g. warmth of a relationship, across cultures, interpretations of metaphors are inevitably culture and background specific. For example, people with spiritual practices may be more likely to see a visual connection of light emitting between participants as a representation of the exchange of energy binding two souls together than non-spiritual participants. Indeed, the impressively successful results in *Isness* reported by Glowaski et al. [56] were likely enhanced by participants being recruited from a psychedelics conference. Tactile metaphors are also contextual, as heat applied to palms or the chest can feel like holding hands or hugging, while on the back of the neck it may feel threatening as a breath of someone who has snuck up on you [20].

#### 4.6 Interpersonal Distance: Connecting Through Moving Closer Together

**Theory.** Proxemics is the study of the relationship between physical interpersonal distance and corresponding level of social closeness identifying four zones: intimate, personal, social, and public [63]. Accordingly, physical distance is correlated with social closeness and thus moving into a personal or intimate zone implies a proportional level of closeness. Hall observed how the physical radius

of these zones is culture-specific and context-dependent, opening an opportunity for manipulation of these boundaries. Allowing someone into a personal or intimate space signals inclusion and closeness, thus potentially facilitating interpersonal warmth and positive attitudes [2]. However, forcing two people closer together than they are comfortable with can cause them to compensate by making themselves more distant in other ways to restore equilibrium in their perceived level of intimacy [3].

**Design.** While proxemics is widely applied in HCI research, it is predominately used to analyze the interaction between users and devices or the design of co-located collaborative technology [61], and less attention have been given to its potential to increase social connection. One example is Mueller et al.’s [126] discussion of proxemics applied to create playful, provocative interactions. They discuss the *Musical Embrace* game that requires players to squeeze the corners of a pillow between themselves hugging over it to move through a game with the aim of collecting tokens. This creates an awkward and abnormally intimate physical closeness that is enabled by a playful setting of a game. A more gentle example is *Lokahi* [133]—a heartbeat sharing pillow that requires two people to slip their hands into the pockets of a single pillow inviting, but not requiring them to simultaneously embrace each other. Artist Jeppe Hein sought to bring people closer together by creating a U-shaped *Modified Social Bench 3* sitting on which people would literally gravitate towards each other [121]. As proxemics have been shown to equally apply in VR [108], this opens some potential for VR mediated interactions to manipulate the distances between users to bring them virtually closer together. See some examples in Figure 8.

**Challenges.** This strategy is closely related to strategies for physical interpersonal touch and therefore must address the same challenge of supporting the appropriate level of trust and intimacy discussed below. As described in proxemics, the distance between pairs is culture-specific and relationship-dependent, thus designing with a preset distance in mind likely won’t generalize across participants. Ideally, a system should have the potential to adapt to each pair of participants, beginning by assessing their baseline comfortable distance and gently nudging them closer together.

#### 4.7 Touch: Connecting Through Feeling the Other

**Theory.** Social touch can support the development and strengthening of social bonds [49]. Interpersonal touch is highly expressive and varies widely in its meaning depending on the quality of touch, location, social relationship, and context [2]. Affective touch is a powerful tool for creating interpersonal warmth and intimacy. Its effect is related to proxemics, as touching requires entering each other’s intimate personal space [2]. Touch also heightens the metaphor of warmth, as when touched, we experience both physical and psychological warmth simultaneously. Also, when touching another person, we can feel them in a direct literal and figurative way, providing us with a tacit way of knowing their state and their character. The feeling of a handshake of a new acquaintance can provide us with an intuitive sense of who they are as a person—whether they are firm, confident, tense, reliable, or gentle and caring. When



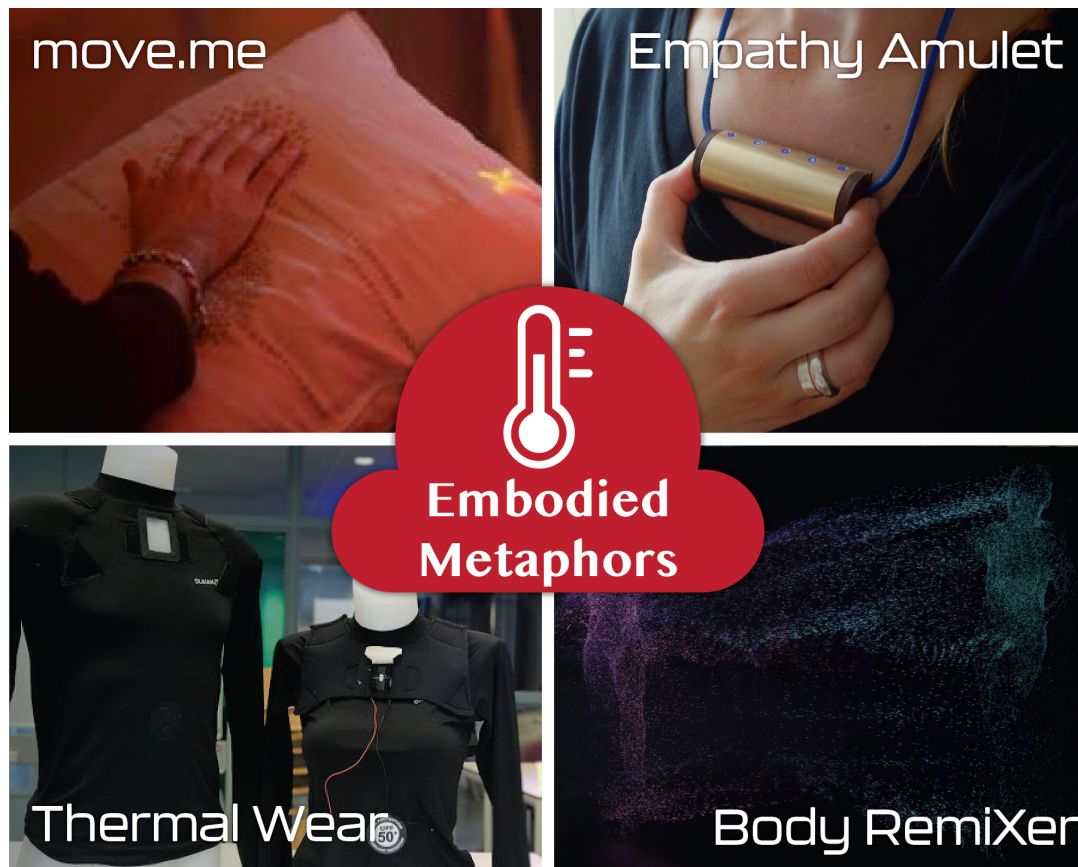


Figure 7: Examples of systems illustrating the strategy of embodied metaphors.

TOP-LEFT: *move.me* uses interactive pillows to sense and respond to the quality of touch creating the atmosphere of an intimate cozy space, such as when having a “pillow talk” ©2007 Schiphorst et al. [159].

TOP-RIGHT: When touched on both ends, the *Empathy Amulet* both ends sends a gentle signal of warmth to another user in the network that they feel on their chest ©2018 Sophia Brueckner [20].

BOTTOM-LEFT: *Thermal Wear* uses a chest-worn thermal display to convey emotion in communication ©2020 El Ali et al. [43].

BOTTOM-RIGHT: *Body RemiXer* is an immersive installation that invites participants to connect their virtual auras by physically joining their hands together ©2019 John Desnoyers-Stewart [38].

our bodies are joined in interpersonal touch, the boundary between self and other becomes blurred [144].

**Design.** Given the prolific role of touch in affective communication and intimacy, unsurprisingly HCI community has been fascinated by the potential to mediate social touch and create systems that allow users to hug and hold hands over distance. Haans & IJsselsteijn [62] reviewed several mediated systems designed for touch over distance developed prior to 2006 and identified the need for the development of a common symbolic meaning of such haptic symbols. Such systems typically translate touch at a distance through a tangible device for the receiving user to feel touched through either vibration as in *Flex-N-Feel* [161], squeezing pressure as in *YourGlove* [57] or *Hug Over Distance* [127], or heat as in *HotMits* [57]. Haans and IJsselsteijn [62] stressed that because the sensation of mediated touch is so substantially different from real

interpersonal touch, it is critical not to assume social touch solely from a mediated physical interaction.

Instead of transmitting touch, some other systems create space where physical interpersonal touch is invited. *Touchomatic* [115] is a cooperative arcade game where two participants control an aircraft by modulating the strength of touch between them. A beautiful example that centers around touch is *Mediated Body* [70], where touch between strangers is augmented with a sound produced through skin-to-skin contact like a human theremin. Unlike mediated touch over-distance, *Mediated Body* normalizes and enhances an intimate interpersonal tactile exploration. The system was worn by a performer at the Burning Man festival, making such tactile exploration more socially accessible resulting in playfully intimate encounters between strangers. It was also performed on the Berlin subway, demonstrating that such strange connections could even be facilitated in more formally distant settings. Draw



Figure 8: Examples of systems illustrating the strategy of interpersonal distance.

TOP-LEFT: *Modified Social Bench #03* by Jeppe Hein is a bench is shaped in a such a way that people sitting on it slide or “gravitate” towards each other. Courtesy KÖNIG GALERIE, Berlin, 303 GALLERY, New York, and Galleri Nicolai Wallner, Copenhagen Photo by T. Kaare Smith [68].

TOP-RIGHT: *Recoil* is a garment that contains strong magnets that pull the wearer towards metal objects that other people may carry with them ©2002 Katherine Moriwaki (<http://www.kakirine.com>) [124].

BOTTOM-LEFT: *Lokhani* uses a heartbeat measuring pillow shaped to invite user to hug or move closer to slide each of their hands into pockets containing a heartbeat sensor ©2020 Özcan & Sperati [133].

BOTTOM-RIGHT: In *whispers* participants wear garments through which they can “snap” together to start sharing and projecting their biodata ©2004 Schiphorst & Andersen [158].

*Me Closer* is a VR performance that also employs personal touch, with an actress performing as a mother to the immersant in a VR drama. She hugs and tucks the immersant in as she tells them of her terminal-cancer diagnosis. *Whisper* combines several strategies including interpersonal touch by inviting participants to snap their garments together to share biodata, requiring participants to get intimately close with each other in a playful movement based interaction [158]. See some examples in Figure 9.

**Challenges.** As discussed, touch is a very nuanced mode of expression, suggesting a rich design space of mediated touch, however the capacity of current systems to communicate this richness and nuance is limited. Most systems only afford the recognition of a single binary input and output limiting expression (e.g. *Hug Over Distance*). Schiphorst et al. [159] applied Laban Movement classification to develop soft pillows in *move.me* inviting tactile

and kinesthetic interaction which recognizes a substantial vocabulary of touch qualities. However, we identified few remote systems [138] that supported or explored a richness of tactile expression comparable to actual touch. Telepresent touch is limited by a small number of actuator parameters (e.g. frequency, amplitude and duration of a vibration) and rarely comes anywhere near reproducing the complexity of actual interpersonal touch. Examples from soma design focused on fostering attention to one’s somaesthetic experience such as the *Soma Mat* [169] can serve as an inspiration for tactile channels which can better support the development of richer interpersonal touch systems.

Interpersonal touch also elicits the quality of vulnerability, as when making ourselves available for other’s touch we are exposing ourselves for the potential intrusion and harm. As de la Bellacasa [141] explains “trust might be the unavoidable condition that allows





Figure 9: Examples of systems illustrating the strategy of touch.

TOP-LEFT: In *[i miss your touch]* participants are randomly paired in a video chat where they can virtually “touch” each other as their images are overlaid as if being in one room [155]. ©2020 Image by PluginHUMAN ([www.pluginhuman.com](http://www.pluginhuman.com)), with support from the Exertion Games Lab (<https://exertiongameslab.org>).

TOP-RIGHT: *Flex-n-feel* uses a pair of gloves to communicate touch. One glove detects the flex of the fingers and sends this signal as vibration onto the other ©2017 Singhal et al. [161].

BOTTOM-LEFT: *Huggy Pajama* is a pneumatic vest that communicates touch recorded as pressure on a doll to connect family members ©2009 Adrian David Cheok, iUniversity, Tokyo, Japan [26].

BOTTOM-RIGHT: *Touchomatic* is an arcade game requiring players to maintain skin-to-skin contact adjusting their strength to control an aircraft in the game ©2017 Marshall et al. [115]. .

*this openness to relation and corporeal immanent risk*” (p.100). Trust is both a prerequisite for the use of touch in mediated systems, and a potential outcome. The design of the system must cultivate a respectful environment facilitating trust and aiming to strike the balance where the trust is possible, yet still requires a leap (or rather a step) of faith from the user.

#### 4.8 Provocation: Connecting Through Challenging Social Discomfort

**Theory.** Interacting with a stranger can be uncomfortable and people ordinarily avoid initiating spontaneous new encounters, despite research showing that these encounters typically increase happiness [45]. Extraordinary experiences shared with a new person shift attention away from the discomfort of the new interaction

and support higher closeness of the relationship developed [120]. The famous Capilano Suspension Bridge experiment observed that anxiety-inducing experiences are associated with increased attractiveness towards a person encountered in such a context [41], which could be explained by a misattribution of the cause of the physiological arousal that occurs both in anxiety-inducing experience and when feeling excited about a new encounter. Uncomfortable and thrilling interactions shared with another person can strengthen social bonds [13]. Simply sharing any experience, even a negative one, provides an opportunity for bonding [11].

**Design.** Some interactive systems for connection, especially in the arts, attempt to provoke users to step out of their comfort zone to form a new connection, typically with a stranger. This can be done forcefully, as for example in *Recoil*, a garment containing powerful magnets that pull you towards a stranger on the street

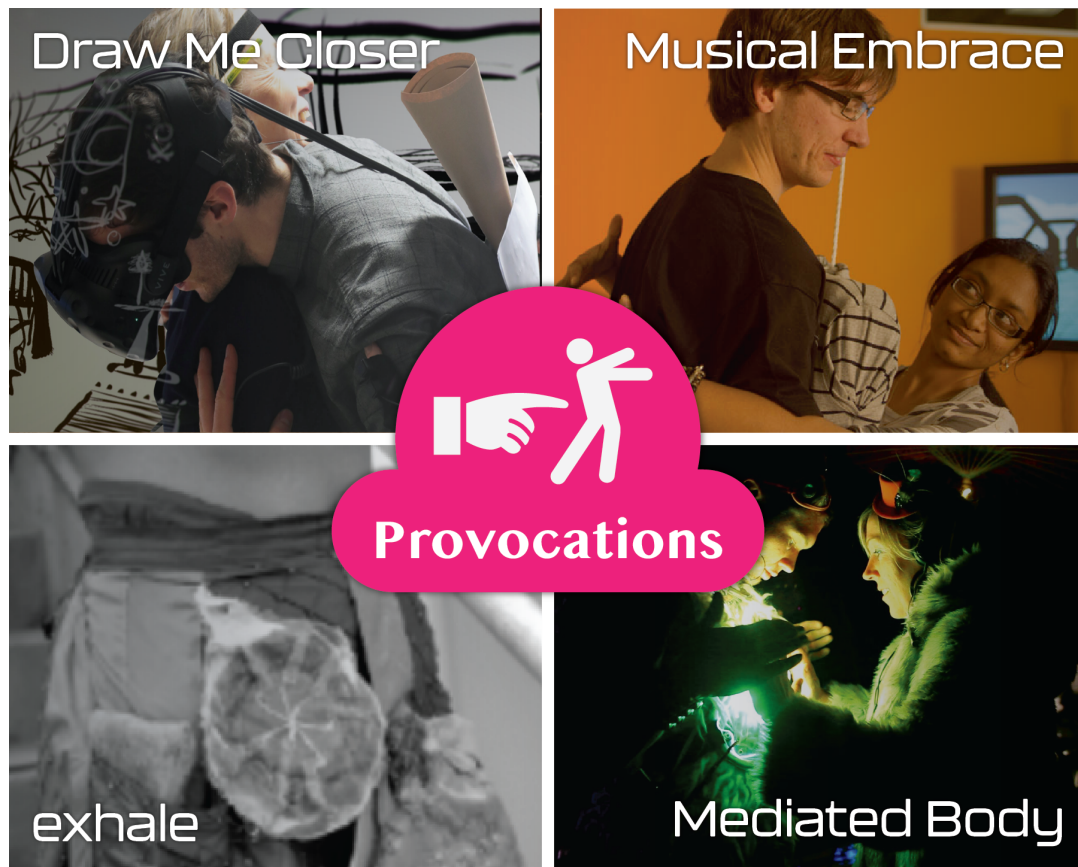


Figure 10: Examples of systems illustrating the strategy of provocation and (dis)comfort.

TOP-LEFT: *Draw Me Closer* is an immersive story where a participant is welcomed by an actress playing his mother, hugging him and tucking into bed [176] ©2019 Jordan Tannahill, National Theatre and NFB, <https://www.jordantannahill.com>.

TOP-RIGHT: *Musical Embrace* is a game played by coworkers requiring them to hug over a pillow to control virtual character leading to awkward interactions [126]. ©2014 Exertion Games Lab, [exertiongameslab.org](http://exertiongameslab.org)

BOTTOM-LEFT: *exhale* is an installation where participants put on a skirt that measures their breathing. By touching another's skirt they can send their breath as an airflow from a small fan under the other person's skirt blowing onto their legs ©2006 Thecla Shiphorst [157].

BOTTOM-RIGHT: *Mediated Body* is a participatory art performance where the performer becomes a human theremin inviting participants to explore creating sounds by touching his skin. Still from a video by Mads Hoby ©2011 [70].

[121]. However, other systems present an opportunity to normalize an ordinarily uncomfortable intimate interaction with a stranger as an invitation, as in the *Mediated Body* [70]. Here, participants have agency over whether and how they interact and what kind of touch they engage in. They are guided by the design of the sound of the system encouraging a soft and intimate interaction. A sense of privacy is supported by the headphones used to hear the soundscape which creates a bubble of intimacy shared between the participant and the performer. See some examples in Figure 10.

Provocative interactions can push participants towards exploring something new, forming a connection they would not have formed if not for the context of an art installation. However, managing an appropriate level of comfort is critical to ensure that participants feel safe enough to engage in and accommodate an intimate and

profound encounter. Wilson [185] discusses his experience with the VR installation *Draw Me Closer* where he had an intimate encounter with a character playing his mother sharing heart-breaking news. Wilson reflects how wearing the VR headset that obscured eye-contact and his awareness of the artificiality of the experience allowed him to accommodate this profound and intimate encounter, which may have otherwise overwhelmed him.

**Challenges.** Each individual's comfort level is different and can be hard to judge in advance. Using provocative approaches that force intimacy can result in compensations for this increased intimacy through different means [3], as seen by increased interpersonal distance when intimate heartbeat data is shared [79]. Giving consideration to participant consent is key [13] providing them with an opportunity to decide when to enter or leave the experience,

adjusting the level of their engagement to their own comfort level. This can be achieved by allowing participants to transition from onlookers to active participants, as exemplified in *Body Remixer* [38] and *exhale* [156] installations. Yet, the system should nudge and encourage the participant to take a “leap of faith” and partake in a potentially uncomfortable experience, with the trust that they can leave it if they so desire.

#### 4.9 Play: Connecting Through Creating and Playing Together

**Theory.** Play is a fun and creative process of exploration, testing, pushing boundaries and discovery. As children we are pre-occupied with this open form of encountering the world which is essential to discovering and learning the constraints and opportunities of our bodies and environment, and developing social, mental, and physical skills [21]. Likewise, playfulness in adults is associated with increased well-being [139]. Playfulness is described as the center of human sociability, which explains its positive effects on wellbeing via the social connectedness it fosters [177]. Even solo play engages sociability [165]. Play also often invokes the transcendent emotion of flow [31] thus having the potential to elicit a feeling of interconnectedness [189]. However, another key value of play comes from its power to transform social norms, enabling social connection that transcends pre-existing boundaries among strangers [134]. Finally, social play often involves cooperation. Cooperation by itself also supports social connection through shared intentionality and coordination [114].

**Design.** Several of the systems reviewed here aim to support a playful quality of interaction that aims to facilitate exploratory and creative informal interactions to enable more intimate connections than social norms would allow otherwise, as seen in *Mediated Body*, *whispers*, and *TOUCH\*Play*. These systems encourage participants to explore different ways of touching each other’s skin or physically connecting body parts to manipulate the output of the system serving as a reward for creative play. Other systems may not seek to employ play by supporting the playful quality of **creative exploration**, but rather engage play in a form of challenge-based game invoking **cooperation** (e.g. [77, 115, 190]). See some examples in Figure 11.

**Challenges.** While cooperation can support social bonds and feeling of belonging (as in belonging to a team), challenge-based interaction could result in goal-orientedness that can counter-act the potential for intimacy and even result in more competitive quality, especially if groups of participants compete with other groups (e.g. in *Yamove!* [77] or *SynKin* [183]). Such intentionality could result in an opposite effect, where participants could get frustrated with each other, feeling like the other is not contributing enough to their team’s success.

## 5 DISCUSSION OF GENERAL DESIGN CONSIDERATIONS AND FUTURE OPPORTUNITIES

Here, we present a discussion of additional design considerations that are applicable across the design strategies. These considerations emerged from the literature discussing participants’ experiences and designers’ reflections based on the same corpus as the

previous section. We also propose some possible solutions to identified challenges and design opportunities for further exploring the potential of technology to support a genuine feeling of connection.

### 5.1 Mind(Set) and Setting

The majority of the existing systems have a single mode of interaction and usually are reduced to sending a singular message. An extreme version of this approach is exemplified in Kaye’s et al. [83] system who showed how intimacy can be communicated in a single bit. Set and setting are critical for the openness to and interpretation of the experience, helping participants get into the right “mindset” conducive for the desired experience. Set and setting are paramount in psychedelic experiences [65], and also have been adopted for design of immersive technology for profound emotions [89]. Designing for a holistic experience with a compelling narrative arc and providing an opportunity to relax and reflect, to reconnect with ones’ somatic experiences can facilitate accommodation and cultivate connection. An excellent example of a holistic narrative design is *Isness* [56]. In this experience, a group of participants is guided through a multi-stage journey including a preparatory stage designed to develop trust and prime the experience of connection, and an integration stage that helps participants accommodate their experience and return to their senses afterwards.

In considering the setting the level of perceived privacy is also important. Connection can be achieved in a public setting as well, but the setting will determine how it will unfold, as public experience takes on a performative quality [70]. Privacy is especially important for supporting connection between people who are in an intimate relationship, especially if the system is not collocated and partners may not be aware of each other’s context while not wanting bystanders to witness their intimate messages (e.g. when one partner is at work or in a public place) [104].

### 5.2 Finding a Careful Balance Between Comfort and Discomfort

Experiencing a moment of a genuine connection with another person relies on affective openness to the closeness of such an experience, often making us feel vulnerable and exposed. To allow for such vulnerability, a system should support a sense of safety and comfort by fostering trust as discussed in the *Mind(set) and Setting* section. However, vulnerability may be an integral part of genuine connection [19]. Overcoming the initial discomfort of getting closer to someone may be essential to achieving a personally meaningful outcome. The strategy of provocation, for instance, specifically relies on nudging participants to expose themselves to experiences beyond their ordinary comfort level. Thus, connection is best facilitated at a careful balance between comfort and discomfort, safety and vulnerability.

An important aspect of designing for such balance is ensuring participants’ *consent* to the experience. While in the research setting, obtaining consent is well-established through rigid procedures, in public art exhibitions and interactive spaces outside of a research lab, consent takes a much more open and implicit form. For example, in installation art, examples such as *exhale* [156], *whispers* [158] and *Body Remixer* [38] participants can approach the installation through a gradual transition beginning as onlookers observing how



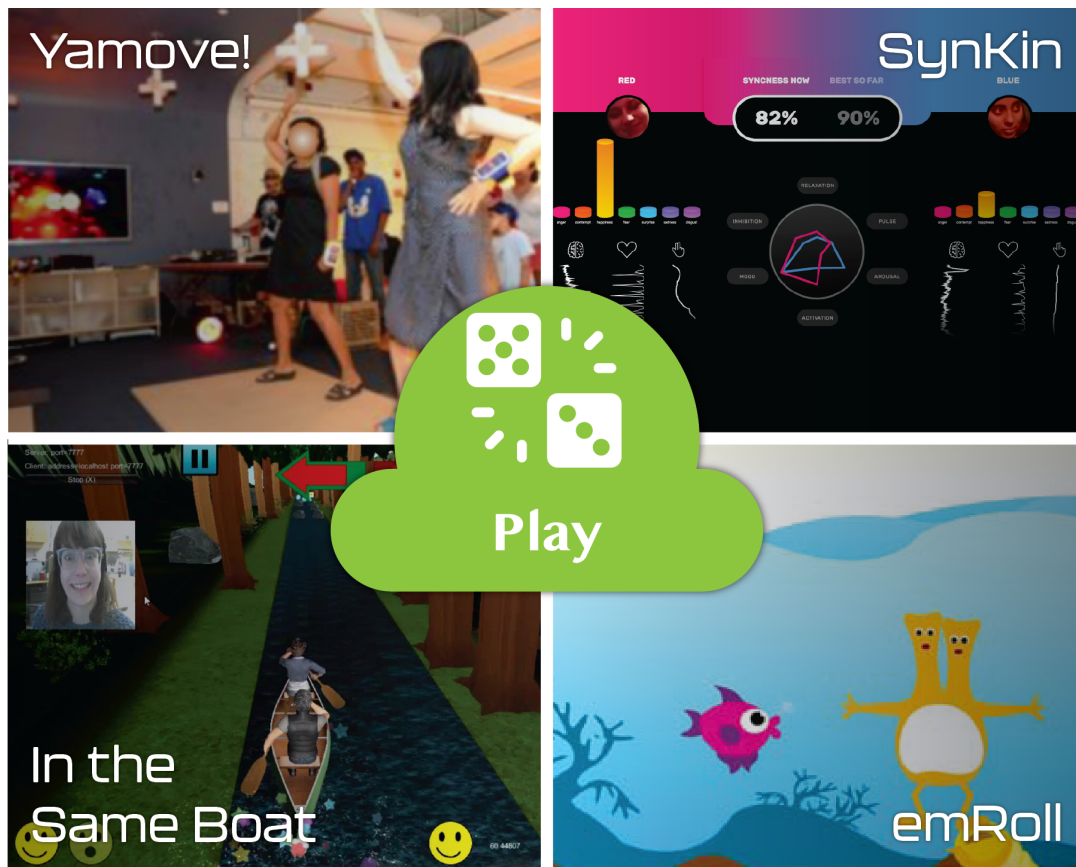


Figure 11: Examples of systems illustrating the strategy of play.

TOP-LEFT: In *Yamove!* players dance together, competing in teams of two. The score is based on synchronizing high amplitude improvised movements ©2016 Isbister et al. [77].

TOP-RIGHT: *SynKin* is a game for synchronizing emotions and biosignals. Players score based on the synchrony of their EDA, ECG, and EEG signals as well as measured emotional states ©2017 Wikstrom et al. [183].

BOTTOM-LEFT: *In the Same Boat* is a game where two players navigate their boat by synchronizing their breathing, heartrate, and emotional expressions ©2019 Robinson et al. [149].

BOTTOM-RIGHT: *emRoll* is a projection-based game where players embody a two-headed character that can only be moved by coordinating halves of their body. Players complete levels by synchronizing and exhibiting certain emotional states ©2010 Zanguei et al. [190].

others interact, then stepping into the space of the interaction, and finally approaching others to connect. Here, participants can also gradually increase the distance from others to “disconnect” from the interaction. However, as Benford et al. [13] discuss, full consent to the degree often sought by research ethics boards might be unattainable, as participants can never fully predict and understand in advance what their experience might be like. This is especially true for VR experiences, where being in the centre of an immersive experience could feel drastically different from watching someone else from outside (e.g. [38, 152, 185]). Moreover, the excitement of the unknown is a desirable aspect of many experiences which supports the discomfort that must be overcome to have such a genuine connection. Fully disclosing the experience in advance would interfere with this critical suspenseful component. Thus, the experience should offer opportunities to leave, should participants

become uncomfortable (i.e. right to withdraw), and facilitators must remain attentive to the experience of participants and be prepared to support them through exiting and unwinding from it, if they are getting overwhelmed.

### 5.3 Reciprocity

Self-disclosure fostering connection is best supported by a reciprocal interaction, where the person sharing the intimate information can feel heard and understood [146]. In the absence of reciprocity, self-disclosure can lead to vulnerability and disappointment. Reciprocity is an important value to cultivate in designs of systems for connection, as was considered in *Empathy Amulet* [20]. However, the amulet had limited support for reciprocity as the message of warmth sent through it did not return a response to the sender,

but rather a response was sent further along to someone else in the network. Often systems that support sending some affective messages, e.g. one's pulse in *United Pulse* [180] rings or *WearBeat* [119], only focus on sending one's message to the other person, without specific affordances for acknowledging their receipt. However, when the message is being sent to a larger audience rather than an individual, where others could choose to respond, as in *Remote Pulse* [111] by Rafael Lozano-Hemmer, the signal itself becomes an acknowledgement of receipt and a new message. The person sharing their heartbeat is aware of the signal's potential to propagate to many viewers. In effect, the reciprocation occurs when participants later see other heartbeats expressed in the sky as they may feel a connection to this unknown individual, seeing their own performance from a different perspective. Designers should consider how their system could support such a positive feedback loop where a user can not only express themselves, but also feel like they are being 'heard', and that others are also willing to share back with them.

#### 5.4 Guiding Attention towards Self and Other

A challenge faced by the designers of systems for social connection is how to guide participants' attention between their own experience (inwards), the other's experience, and their shared experience (outwards). This tension was articulated by Mentis et al. [116] who observed that their *Lega* system designed for affective embodied communication guided users more towards reflection on their own experience recorded by the system, and less so towards the affective experience shared by their partner. Similarly, systems that rely on visual feedback are often criticized for directing attention outward to a visual representation rather than inward to the embodied experience. We suggest that design for intercorporeal connection and engaging different modalities may mitigate this tension. Intercorporeal connection, proposed by Merleau-Ponty [117, 172], and applied to interaction design by Höök [72] and others [46, 140] is an embodied *enactive* form of connection where *self* and *other* are engaged in a co-present interaction in a closed action-perception loop situated in the environment. If a system allows for this closed-loop, a user can experience the other and themselves simultaneously as the other is mirrored in themselves. For instance, this has been explored in performing an opera with humans alongside drones [46].

#### 5.5 Consider Modalities Engaged by the Experience

Most technology is guided by the visual dominance in the West [75, 128, 141], which likely leads designers to use visuals as the primary output of connection systems. However, other sensory modalities, such as tactile and auditory, may allow for a more embodied and pre-reflexive processing of the signal leading to a more intimate and intuitive form of interaction rather than a symbolic one. This might also allow for the visual modality to remain directed towards the other person being connected with. Many systems resort to using visual output on displays or on tangible objects in the form of lights, which was also observed by Lux et al [112]. Vibro-tactile outputs are also prominent, and while it engages the tactile sense, vibrations can often be more associated with technology (e.g. your phone

buzzing) than human contact. The promising output of warmth has only been explored in a very limited sense.

#### 5.6 Consider How to Design for a Diversity of Relationships

Expectedly, the preexisting relationship between participants has a significant effect on how they interpret the mediation of their connection. Thus, unless designers want to restrict the use of their system, they should consider the possible diversity of engagement and interpretation. For instance, in the case of close relationships, biodata could be seen as a personal and affective message that may be imbued with meaning. On the other hand, it may be considered trivial and unnecessary, as it might not provide any new information. Users in close relationships may even feel that such quantified mediation interferes with their connection, distracting them from their intuitive senses. In the case of a distant relationship, such as co-workers, sharing of biodata may instead feel like 'oversharing' and lacking privacy [142]. Meanwhile, for complete strangers, sharing of biodata may gain a different meaning of the shared unity as a living, breathing beings [73]. Thus, designers should consider how the signal is being transmitted to ensure it is conveyed in a way that supports both the potential for rich interpretation, augmenting current interaction and connection, while also supporting anonymity and protecting users' privacy. Similarly, in the case of the playfulness strategy, close partners could readily engage in and may rapidly exhaust the interaction possibilities if they are limited, while strangers may feel more timid to engage at first, and thus could benefit from a gradual onboarding and some measures that provide a sense of safety in the interaction such as obscuring direct eye contact as in *Body RemiXer* [38].

#### 5.7 Consider the Situatedness of the Experience

Experience is always situated in an environment and thus cannot be considered in isolation. Intercorporeal connection [51] emerges through co-experience in a shared environment. Designing for intercorporeal connection should consider the environment in which the user's experience unfolds. This is naturally achieved in collocated experiences such as *Mediated Body* [70], or in immersive VR. But this presents a design challenge for distributed interaction for non-co-located users. Mentis et al [116] attempted to address it by attaching messages to a specific physical location in the museum; however, this resulted in asynchronization of the interaction which introduced delays in the action-perception loop, as the system only allowed discrete messages to either be sent or received, but not co-experienced. One option to explore is retaining the temporality of the interaction by reconstructing the context in a narrative arc, e.g. *SOUL* [130]. The challenge is to give an illusion of simultaneous interaction. Designers can look to cinema or theatre for strategies or creating a sense of participatory potential. For example, through breaking the fourth wall [6] and otherwise acknowledging participants' social presence and potential for interaction.

#### 5.8 Double-edged Sword of Belonging

Everything in human psychology is complex and context-dependent. The self-other dichotomy implies that tightening bonds with an

in-group could lead to more dissociation and aggression towards some other group. Oxytocin, the “love hormone”, released during all types of bonding promotes caring parenting behaviour, trust, empathy, social intelligence and pro-sociality [10, 153]. However, it also facilitates aggression and unconscious biases against out-group members [154]. Empathy is also context-dependent [34] and it doesn’t always lead to connection and empathic actions as a result, but can instead create a negative response of avoidance, and even fear, anger, and aggression when associated with negative experiences [16]. This stresses the importance of considering the experience in a larger context, while avoiding falsely striving for a singular outcome. For instance, participants of the heartbeat bench voiced concerns over potentially hearing a heartbeat of an elderly stranger that may be indicative of illness [73].

## 5.9 Ethics and Care

Careless technology design, even though well-intentioned, can lead to undesired outcomes [59]. While as designers we can never fully design *the use* of our products, as the use will always evolve with a user [145], we can be diligent in how we approach the design process. To ensure that we are designing for the future we want to live in, we must start the design process by reflecting on our core set of values that will provide the foundation for our design. We invite designers to consider positive human experience and care as core values of design practice. We invite researchers to think beyond user experience, towards human experience at large. This requires broader consideration of the human condition, beyond mere enjoyment and usability, but fostering experiential qualities, such as the genuine feeling of connection and unity. This sense of unity can extend beyond the human partners to the world at large, including non-human agents and the environment, especially through the self-transcendent quality of connection. This also prompts designers to switch from quantified-self thinking and to more broadly consider the phenomenology of our experiences and what qualities emerge from it that we will carry into the rest of our lives and communities. Additionally, following the proposal of de la Bellacasa in *Matters of Care* [141], we encourage designers to practice care, as an active outlook in our practice that considers the diversity of who is being touched by our work and how they are affected by it.

## 6 CONCLUSION

In this paper we have explored the intuitive and pervasive concept of the genuine feeling of connection which nonetheless eludes a clear and simple formal definition. We reviewed an array of exemplary systems designed to mediate it to best understand strategies for fostering genuine social connection. This overview of the design landscape presents two key contributions to the design field: (1) a practice-based *definition* of the term *mediated genuine feeling of connection*, and (2) nine *design strategies* that can inspire, inform, and enrich our understanding of the potential of technological tools and interactive technology for affording experiences that can invite a genuine feeling of connection.

Looking at the systems in our analysis that aim to mediate a genuine feeling of connection, we can augment our definition with an

additional set of experiential qualities that outline potential meaning when we talk about the feeling of genuine connection in mediated systems. These experiential qualities may include *reciprocity, emotional sharing, vulnerability, comfort, bodily mirroring, creative playfulness, openness, reflection on unity, diminished ego, compassion, cooperation, warmth, softness, and mutual attention* among others. These qualities can emerge from our mediated interaction, as it is guided by the strategies that designers intuitively employ to elicit mediated connection. As such, the nine design strategies identified here also fill the definition of mediated genuine connection with content that paints its overall scope. The design artifacts that we continue to accumulate in our online corpus<sup>2</sup> that we invite others in the community to contribute to, are themselves the *ultimate particulars* (as per Stolterman [168]), or the “facts” that carry the definition of mediated connection as created in design practice. As new technology and designs come to mediate our interactions transforming our cyborg beings, our definition of the experience of connection will continue to evolve.

We have only begun to scratch the surface of mechanisms underlying these design strategies, design elements that can best support the necessary qualities of the experience, and the critical design considerations to focus on when employing these strategies. Each of these strategies deserves its own in-depth exploration that, in some cases, has been already offered by other authors (e.g. [48, 62, 88, 126]), and can be further built upon and expanded by the design community. While we only presented a brief overview of the design landscape and strategies employed in systems supporting social connection, this overview presents a potential starting point for a design program (as defined by Redström [145]) for technologically mediating the genuine feeling of connection experienced towards specific others, a community, or the world at large.

While dissecting the various types of connection and the approaches suitable for supporting each of them honours the nuances of individual designs and contexts, we propose that each of these strategies can enhance each other. When designing for genuine connection, we should strive to design for connection at large, across many interconnected dimensions. We propose that in order to have a deep and fulfilling connection with another person, we first need to learn to connect with ourselves, the present moment, and our rich embodied experience [86]. This can allow us to pay attention to and nourish our intercorporeal relation with others, and then we can extend this connection with an individual to the larger community, shifting in- and out-group boundaries, making us realize not only that we belong, but that there is much more that unites us as humans, and as citizens of our planet, than any arbitrary divisions may suggest. In return, this feeling of oneness, of global interconnectedness as an inseparable part of the world can strengthen our connection to others as members of this shared, diverse world. Thus, we propose exploring how different approaches can be combined such that systems for intimate connection with others also aim to elicit transcendent emotions and serve as extraordinary experiences that strengthen bonds with both strangers and loved ones.

<sup>2</sup><http://ispace.iat.sfu.ca/project/design-for-genuine-connection/>



## 7 ACKNOWLEDGMENTS

This research was partially supported by Social Science and Humanities Research Council of Canada (R640228). The authors thank Alex Kiston, Thecla Schiphorst, Rimika Chaudhury and Olga Stepanova for their insightful feedback on the manuscript. Additionally the authors thank the reviewers for their exceptionally thoughtful comments and suggestions.

## REFERENCES

- [1] Joshua M Ackerman, Christopher C Nocera, and John A Bargh. 2010. Incidental haptic sensations influence social judgments and decisions. *Science* 328, 5986 (2010), 1712–1715.
- [2] Peter Andersen, Jillian Gannon, and Jessica Kalchik. 2013. Proxemic and haptic interaction: the closeness continuum. In *Nonverbal communication*. De Gruyter Mouton, Berlin, Chapter Chapter 11, 295–330.
- [3] Michael Argyle and Janet Dean. 1965. Eye-Contact, Distance and Affiliation. *Sociometry* 28, 3 (1965), 289–304. <https://doi.org/10.2307/2786027> Publisher: [American Sociological Association, Sage Publications, Inc.].
- [4] Arthur Aron and Elaine N Aron. 1997. Self-expansion motivation and including other in the self. In *Handbook of personal relationships: Theory, research and interventions*. John Wiley & Sons Inc, New York, 251–270.
- [5] Arthur Aron, Elaine N Aron, and Christina Norman. 2004. Self-expansion Model of Motivation and Cognition in Close Relationships and Beyond. In *Self and social identity*, M. B. Brewer & M. Hewstone (Eds.). Blackwell Publishing, New York, 99–123.
- [6] Philip J Auter and Donald M Davis. 1991. When characters speak directly to viewers: Breaking the fourth wall in television. *Journalism Quarterly* 68, 1-2 (1991), 165–171.
- [7] Lisa Feldman Barrett. 2006. Are emotions natural kinds? *Perspectives on psychological science* 1, 1 (2006), 28–58.
- [8] Lisa Feldman Barrett, Batja Mesquita, Kevin N Ochsner, and James J Gross. 2007. The experience of emotion. *Annu. Rev. Psychol.* 58 (2007), 373–403.
- [9] Lisa Feldman Barrett and Christiana Westlin. 2021. Navigating the science of emotion. In *Emotion measurement*. Elsevier, Amsterdam, 39–84.
- [10] Jennifer A Bartz, Jamil Zaki, Niall Bolger, and Kevin N Ochsner. 2011. Social effects of oxytocin in humans: context and person matter. *Trends in cognitive sciences* 15, 7 (2011), 301–309.
- [11] Roy F Baumeister and Mark R Leary. 1995. The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological bulletin* 117, 3 (1995), 497.
- [12] BeAnotherLab. 2012. *The Machine to be Another*. Retrieved September 8, 2021 from <http://beanotherlab.org/>
- [13] Steve Benford, Chris Greenhalgh, Gabriella Giannachi, Brendan Walker, Joe Marshall, and Tom Rodden. 2012. Uncomfortable interactions. In *Proceedings of the sigchi conference on human factors in computing systems (CHI'12)*. 2005–2014.
- [14] Philippe Bertrand, Jérôme Guegan, Léonore Robieux, Cade Andrew McCall, and Franck Zenasni. 2018. Learning empathy through virtual reality: multiple strategies for training empathy-related abilities using body ownership illusions in embodied virtual reality. *Frontiers in Robotics and AI* 5 (2018), 26.
- [15] Frank Biocca, Chad Harms, and Judee K Burgoon. 2003. Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence: Teleoperators & virtual environments* 12, 5 (2003), 456–480.
- [16] Paul Bloom. 2017. Empathy and its discontents. *Trends in cognitive sciences* 21, 1 (2017), 24–31.
- [17] John Bowlby. 1978. Attachment theory and its therapeutic implications. *Adolescent psychiatry* (1978).
- [18] Marilyn B Brewer. 1979. In-group bias in the minimal intergroup situation: A cognitive-motivational analysis. *Psychological bulletin* 86, 2 (1979), 307.
- [19] Brené Brown. 2012. *Daring greatly: How the courage to be vulnerable transforms the way we live, love, parent, and lead*. Penguin.
- [20] Sophia Brueckner. 2018. Empathy amulet: a wearable to connect with strangers. In *Proceedings of the 2018 ACM International Symposium on Wearable Computers*. 248–253.
- [21] Kathleen Glasco Burriss and Ling-Ling Tsao. 2002. Review of research: How much do we know about the importance of play in child development? *Childhood Education* 78, 4 (2002), 230–233.
- [22] David Byrne. 2017. Eliminating the human. *MIT Technol. Rev.* 120, 5 (2017), 8–10.
- [23] John T Cacioppo and Louise C Hawkey. 2009. Perceived social isolation and cognition. *Trends in cognitive sciences* 13, 10 (2009), 447–454.
- [24] Stephanie Cacioppo and John T Cacioppo. 2012. Decoding the invisible forces of social connections. *Frontiers in integrative neuroscience* 6 (2012), 51.
- [25] T. Nikki Cesare Schotzko. 2020. A year (in five months) of living dangerously: hidden intimacies in Zoom exigencies. *International Journal of Performance Arts and Digital Media* 16, 3 (Sept. 2020), 269–289. <https://doi.org/10.1080/14794713.2020.1827206>
- [26] Adrian David Cheok. 2010. Huggy pajama: A remote interactive touch and hugging system. In *Art and technology of entertainment computing and communication*. Springer, 161–194.
- [27] Alice Chirico, Francesco Ferrise, Lorenzo Cordella, and Andrea Gaggioli. 2018. Designing awe in virtual reality: An experimental study. *Frontiers in psychology* 8 (2018), 2351.
- [28] Anna Ciaunica, Luke McEllin, Julian Kiverstein, Vittorio Gallese, Jakob Hohwy, and Mateusz Woźniak. 2022. Zoomed out: digital media use and depersonalization experiences during the COVID-19 lockdown. *Scientific Reports* 12, 1 (March 2022), 3888. <https://doi.org/10.1038/s41598-022-07657-8> Number: 1 Publisher: Nature Publishing Group.
- [29] Emma EA Cohen, Robin Ejsmond-Frey, Nicola Knight, and Robin IM Dunbar. 2010. Rovers' high: behavioural synchrony is correlated with elevated pain thresholds. *Biology letters* 6, 1 (2010), 106–108.
- [30] John W Creswell and J David Creswell. 2017. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications, Thousand Oaks.
- [31] Mihaly Csikszentmihalyi and Mihaly Csikszentmihalyi. 1990. *Flow: The psychology of optimal experience*. Vol. 1990. Harper & Row New York.
- [32] Antonio R Damasio. 1994. Descartes' error: Emotion, rationality and the human brain. *New York: Putnam* 352 (1994).
- [33] Martin Davies. 2011. Concept mapping, mind mapping and argument mapping: what are the differences and do they matter? *Higher education* 62, 3 (2011), 279–301.
- [34] Frederique de Vignemont and Tania Singer. 2006. The empathic brain: how, when and why? *Trends in Cognitive Sciences* 10, 10 (Oct. 2006), 435–441. <https://doi.org/10.1016/j.tics.2006.08.008>
- [35] Emilie Delaherche, Mohamed Chetoui, Ammar Mahdhaoui, Catherine Saint-Georges, Sylvie Viaux, and David Cohen. 2012. Interpersonal synchrony: A survey of evaluation methods across disciplines. *IEEE Transactions on Affective Computing* 3, 3 (2012), 349–365.
- [36] John Desnoyers-Stewart. 2018. *Transcending Perception*. Ph.D. Dissertation. Faculty of Media, Art, and Performance, University of Regina.
- [37] John Desnoyers-Stewart, Ekaterina R. Stepanova, and Bernhard E. Riecke. 2022. Methods for Investigating Social Connection in Technologically Mediated Experiences. *ACM Transactions on Computer-Human Interaction (TOCHI)* (2022). (in preparation).
- [38] John Desnoyers-Stewart, Ekaterina R Stepanova, Bernhard E Riecke, and Patrick Pennefather. 2020. Body RemiXer: extending bodies to stimulate social connection in an immersive installation. *Leonardo* 53, 4 (2020), 394–400.
- [39] Ed Diener and Martin EP Seligman. 2002. Very happy people. *Psychological science* 13, 1 (2002), 81–84.
- [40] Suzanne Dikker, Sean Montgomery, and Suzan Tunca. 2019. Using synchrony-based neurofeedback in search of human connectedness. In *Brain Art*. Springer, 161–206.
- [41] Donald G Dutton and Arthur P Aron. 1974. Some evidence for heightened sexual attraction under conditions of high anxiety. *Journal of personality and social psychology* 30, 4 (1974), 510.
- [42] Ryan J Dwyer, Kostadin Kushlev, and Elizabeth W Dunn. 2018. Smartphone use undermines enjoyment of face-to-face social interactions. *Journal of Experimental Social Psychology* 78 (2018), 233–239.
- [43] Abdallah El Ali, Xingyu Yang, Swamy Ananthanarayan, Thomas Röggla, Jack Jansen, Jess Hartcher-O'Brien, Kaspar Jansen, and Pablo Cesar. 2020. ThermalWear: Exploring Wearable On-chest Thermal Displays to Augment Voice Messages with Affect. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–14.
- [44] Michiel van Elk, M. Andrea Arciniegas Gomez, Wietske van der Zwaag, Hein T. van Schie, and Disa Sauter. 2019. The neural correlates of the awe experience: Reduced default mode network activity during feelings of awe. *Human Brain Mapping* 40, 12 (2019), 3561–3574. <https://doi.org/10.1002/hbm.24616>
- [45] Nicholas Epley and Juliana Schroeder. 2014. Mistakenly seeking solitude. *Journal of Experimental Psychology: General* 143, 5 (2014), 1980.
- [46] Sara Eriksson, Åsa Unander-Scharin, Vincent Trichon, Carl Unander-Scharin, Hedvig Kjellström, and Kristina Höök. 2019. Dancing with drones: Crafting novel artistic expressions through intercorporeality. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–12.
- [47] John Desnoyers-Stewart et al. 2020. *Body RemiXer [online]*. Retrieved September 8, 2021 from <http://ispace.iat.sfu.ca/project/body-remixer/>
- [48] Milou A Feijt, Joyce HDM Westerink, Yvonne AW De Kort, and Wijnand A IJsselstein. 2021. Sharing biosignals: An analysis of the experiential and communication properties of interpersonal psychophysiology. *Human-Computer Interaction* (2021), 1–30.
- [49] Lawrence K Frank. 1958. Tactile communication. *ETC: a Review of General Semantics* (1958), 31–79.
- [50] Jérémy Frey, May Grabli, Ronit Slyper, and Jessica R Cauchard. 2018. Breeze: Sharing biofeedback through wearable technologies. In *Proceedings of the 2018*

- CHI Conference on Human Factors in Computing Systems. 1–12.
- [51] Thomas Fuchs. 2016. Intercorporeality and interaffectivity. *Intercorporeality: Emerging socialities in interaction* (2016), 194–209.
  - [52] Shaun Gallagher, Bruce Janz, Lauren Reinerman, Jörg Trempler, and Patricia Bockelman. 2015. *A neurophenomenology of awe and wonder: Towards a non-reductionist cognitive science*. Springer.
  - [53] Vittorio Gallese. 2007. Before and below ‘theory of mind’: embodied simulation and the neural correlates of social cognition. *Philosophical Transactions of the Royal Society B: Biological Sciences* 362, 1480 (2007), 659–669.
  - [54] Liridona Gashi, Sveinung Sandberg, and Willy Pedersen. 2021. Making “bad trips” good: How users of psychedelics narratively transform challenging trips into valuable experiences. *International Journal of Drug Policy* 87 (2021), 102997.
  - [55] Renaud Gervais, Jérémy Frey, Alexis Gay, Fabien Lotte, and Martin Hachet. 2016. Tobe: Tangible out-of-body experience. In *Proceedings of the TEI'16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction*. 227–235.
  - [56] David R Glowacki, Mark D Wonnacott, Rachel Freire, Becca R Glowacki, Ella M Gale, James E Pike, Tiu de Haan, Mike Chatziapostolou, and Oussama Metatla. 2020. Isness: using multi-person VR to design peak mystical type experiences comparable to psychedelics. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–14.
  - [57] Daniel Gooch and Leon Watts. 2012. YourGloves, hothands and hotmits: devices to hold hands at a distance. In *Proceedings of the 25th annual ACM symposium on User Interface Software and Technology*. 157–166.
  - [58] Amie M Gordon, Jennifer E Stellar, Craig L Anderson, Galen D McNeil, Daniel Loew, and Dacher Keltner. 2017. The dark side of the sublime: Distinguishing a threat-based variant of awe. *Journal of personality and social psychology* 113, 2 (2017), 310.
  - [59] Colin M Gray, Yubo Kou, Bryan Battles, Joseph Hoggatt, and Austin L Toombs. 2018. The dark (patterns) side of UX design. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–14.
  - [60] Roland R Griffiths, Matthew W Johnson, William A Richards, Brian D Richards, Robert Jesse, Katherine A MacLean, Frederick S Barrett, Mary P Cosimano, and Maggie A Klinedinst. 2018. Psilocybin-occasioned mystical-type experience in combination with meditation and other spiritual practices produces enduring positive changes in psychological functioning and in trait measures of prosocial attitudes and behaviors. *Journal of Psychopharmacology* 32, 1 (2018), 49–69.
  - [61] Jens Emil Grønbaek, Mille Skovhus Knudsen, Kenton O'Hara, Peter Gall Krogh, Jo Vermeulen, and Marianne Graves Petersen. 2020. Proxemics beyond proximity: Designing for flexible social interaction through cross-device interaction. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–14.
  - [62] Antal Haans and Wijnand IJsselstein. 2006. Mediated social touch: a review of current research and future directions. *Virtual Reality* 9, 2-3 (2006), 149–159.
  - [63] Edward Twitchell Hall. 1966. *The hidden dimension*. Vol. 609. Doubleday, Garden City, NY.
  - [64] Donna Haraway. 2006. A cyborg manifesto: Science, technology, and socialist-feminism in the late 20th century. In *The international handbook of virtual learning environments*. Springer, 117–158.
  - [65] Ido Hartogsohn. 2016. Set and setting, psychedelics and the placebo response: an extra-pharmacological perspective on psychopharmacology. *Journal of Psychopharmacology* 30, 12 (2016), 1259–1267.
  - [66] Marc Hassenzahl, Stephanie Heidecker, Kai Eckoldt, Sarah Diefenbach, and Uwe Hillmann. 2012. All you need is love: Current strategies of mediating intimate relationships through technology. *ACM Transactions on Computer-Human Interaction (TOCHI)* 19, 4 (2012), 1–19.
  - [67] Louise C Hawkey and John T Cacioppo. 2010. Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of behavioral medicine* 40, 2 (2010), 218–227.
  - [68] Jeppe Hein. 2005. *Modified Social Benches 1-10*. Retrieved September 8, 2021 from [https://www.jeppehein.net/project\\_id.php?path=works&id=126](https://www.jeppehein.net/project_id.php?path=works&id=126)
  - [69] Annabell Ho, Jeff Hancock, and Adam S Miner. 2018. Psychological, relational, and emotional effects of self-disclosure after conversations with a chatbot. *Journal of Communication* 68, 4 (2018), 712–733.
  - [70] Mads Hoby and Jonas Löwgren. 2011. Touching a stranger: Designing for engaging experience in embodied interaction. *International Journal of Design* 5, 3 (2011), 31–48.
  - [71] Katie Hoemann, Zulqarnain Khan, Mallory J Feldman, Catie Nielson, Madeleine Devlin, Jennifer Dy, Lisa Feldman Barrett, Jolie B Wormwood, and Karen S Quigley. 2020. Context-aware experience sampling reveals the scale of variation in affective experience. *Scientific reports* 10, 1 (2020), 1–16.
  - [72] Kristina Höök. 2018. *Designing with the body: Somaesthetic interaction design*. MIT Press.
  - [73] Noura Howell, Greg Niemeyer, and Kimiko Ryokai. 2019. Life-affirming biosensing in public: Sounding heartbeats on a red bench. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–16.
  - [74] Cendri A Hutcherson, Emma M Seppala, and James J Gross. 2015. The neural correlates of social connection. *Cognitive, Affective, & Behavioral Neuroscience* 15, 1 (2015), 1–14.
  - [75] Don Ihde. 2009. *Postphenomenology and technoscience: The Peking university lectures*. Suny Press.
  - [76] Tristen K Inagaki and Lauren P Ross. 2020. A body-to-mind perspective on social connection: Physical warmth potentiates brain activity to close others and subsequent feelings of social connection. *Emotion* (2020).
  - [77] Katherine Isbister, Suzanne Kirkpatrick, Syed Salahuddin, Raybit Tang, Gang Cao, Xiaofeng Chen, and Elena Márquez Segura. 2016. Yamove! A movement synchrony game that choreographs social interaction. *Human technology* 12, 1 (2016).
  - [78] Valerie J Janesick. 2015. *“Stretching” exercises for qualitative researchers*. Sage Publications.
  - [79] Joris H Janssen, Jeremy N Bailenson, Wijnand A IJsselstein, and Joyce HDM Westerink. 2010. Intimate heartbeats: Opportunities for affective communication technology. *IEEE Transactions on Affective Computing* 1, 2 (2010), 72–80.
  - [80] Joris H Janssen, Wijnand A IJsselstein, and Joyce HDM Westerink. 2014. How affective technologies can influence intimate interactions and improve social connectedness. *International Journal of Human-Computer Studies* 72, 1 (2014), 33–43.
  - [81] Simo Järvelä, Benjamin Cowley, Mikko Salminen, Giulio Jacucci, Juho Hamari, and Niklas Ravaja. 2021. Augmented Virtual Reality Meditation: Shared Dyadic Biofeedback Increases Social Presence Via Respiratory Synchrony. *ACM Transactions on Social Computing* 4, 2 (2021), 1–19.
  - [82] Daniel Kahneman, Alan B Krueger, David A Schkade, Norbert Schwarz, and Arthur A Stone. 2004. A survey method for characterizing daily life experience: The day reconstruction method. *Science* 306, 5702 (2004), 1776–1780.
  - [83] Joseph ‘Jofish’ Kaye, Mariah K Levitt, Jeffrey Nevins, Jessica Golden, and Vanessa Schmidt. 2005. Communicating intimacy one bit at a time. In *CHI'05 extended abstracts on Human factors in computing systems*. 1529–1532.
  - [84] Dacher Keltner and Alan Cowen. 2021. A taxonomy of positive emotions. *Current Opinion in Behavioral Sciences* 39 (2021), 216–221.
  - [85] Dacher Keltner and Jonathan Haidt. 2003. Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition and emotion* 17, 2 (2003), 297–314.
  - [86] Matthew A Killingsworth and Daniel T Gilbert. 2010. A wandering mind is an unhappy mind. *Science* 330, 6006 (2010), 932–932.
  - [87] Alexandra Kitson, Alice Chirico, Andrea Gaggioli, and Bernhard E. Riecke. 2020. A Review on Research and Evaluation Methods for Investigating Self-transcendence. *Frontiers in Psychology* (2020). Research Topic: Towards a Science of Complex Experiences.
  - [88] Alexandra Kitson, Mirjana Prpa, and Bernhard E Riecke. 2018. Immersive interactive technologies for positive change: a scoping review and design considerations. *Frontiers in psychology* 9 (2018), 1354.
  - [89] Alexandra Kitson, Ekaterina R Stepanova, Ivan A Aguilar, Natasha Wainwright, and Bernhard E Riecke. 2020. Designing Mind (set) and Setting for Profound Emotional Experiences in Virtual Reality. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*. 655–668.
  - [90] Martijn JL Kors, Gabriele Ferri, Erik D Van Der Spek, Cas Ketel, and Ben AM Schouten. 2016. A breathtaking journey. On the design of an empathy-arousing mixed-reality game. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*. 91–104.
  - [91] Zoltán Kövecses. 2000. Universality in the Conceptualization of Emotions. In *Metaphor and Emotion: Language, Culture, and Body in Human Feeling*, Raymond W. Jr. Gibbs (Ed.). Cambridge University Press, Cambridge, 380–396. <https://doi.org/10.1017/CBO9780511816802.023>
  - [92] Kostadin Kushlev, Ryan Dwyer, and Elizabeth W Dunn. 2019. The social price of constant connectivity: Smartphones impose subtle costs on well-being. *Current Directions in Psychological Science* 28, 4 (2019), 347–352.
  - [93] Simon Lacey, Randall Stilla, and Krish Sathian. 2012. Metaphorically feeling: comprehending textual metaphors activates somatosensory cortex. *Brain and language* 120, 3 (2012), 416–421.
  - [94] George Lakoff and Mark Johnson. 1980. *Metaphors we live by*. University of Chicago Press, Chicago.
  - [95] Michael Larkin, Virginia Eatough, and Mike Osborn. 2011. Interpretative phenomenological analysis and embodied, active, situated cognition. *Theory & Psychology* 21, 3 (2011), 318–337.
  - [96] Jacques Launay, Bronwyn Tarr, and Robin IM Dunbar. 2016. Synchrony as an adaptive mechanism for large-scale human social bonding. *Ethology* 122, 10 (2016), 779–789.
  - [97] Jean-Philippe Laurenceau, Lisa Feldman Barrett, and Paula R Pietromonaco. 1998. Intimacy as an interpersonal process: The importance of self-disclosure, partner disclosure, and perceived partner responsiveness in interpersonal exchanges. *Journal of personality and social psychology* 74, 5 (1998), 1238.
  - [98] Geneviève L Lavigne, Robert J Vallerand, and Laurence Crevier-Braud. 2011. The fundamental need to belong: On the distinction between growth and deficit-reduction orientations. *Personality and social psychology bulletin* 37, 9 (2011), 1185–1201.
  - [99] Richard M Lee and Steven B Robbins. 1995. Measuring belongingness: The social connectedness and the social assurance scales. *Journal of counseling psychology*

- 42, 2 (1995), 232.
- [100] Yi-Chieh Lee, Naomi Yamashita, Yun Huang, and Wai Fu. 2020. "I Hear You, I Feel You": Encouraging Deep Self-disclosure through a Chatbot. In *Proceedings of the 2020 CHI conference on human factors in computing systems*. 1–12.
- [101] Nicholas Leigh-Hunt, David Bagguley, Kristin Bash, Victoria Turner, Stephen Turnbull, N Valtorta, and Woody Caan. 2017. An overview of systematic reviews on the public health consequences of social isolation and loneliness. *Public health* 152 (2017), 157–171.
- [102] Jeff Levin and Lea Steele. 2005. The transcendent experience: conceptual, theoretical, and epidemiologic perspectives. *Explore* 1, 2 (2005), 89–101.
- [103] Mark Levine, Amy Prosser, David Evans, and Stephen Reicher. 2005. Identity and emergency intervention: How social group membership and inclusiveness of group boundaries shape helping behavior. *Personality and social psychology bulletin* 31, 4 (2005), 443–453.
- [104] Hong Li, Jonna Häkklä, and Kaisa Väänänen. 2018. Review of unconventional user interfaces for emotional communication between long-distance partners. In *Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services*. 1–10.
- [105] Jing-Jing Li, Kai Dou, Yu-Jie Wang, and Yan-Gang Nie. 2019. Why awe promotes prosocial behaviors? The mediating effects of future time perspective and self-transcendence meaning of life. *Frontiers in psychology* 10 (2019), 1140.
- [106] Fannie Liu, Mario Esparza, Maria Pavlovskaja, Geoff Kaufman, Laura Dabbish, and Andrés Monroy-Hernández. 2019. Animo: Sharing biosignals on a smart-watch for lightweight social connection. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 3, 1 (2019), 1–19.
- [107] Fannie Liu, Chunjong Park, Yu Jiang Tham, Tsung-Yu Tsai, Laura Dabbish, Geoff Kaufman, and Andrés Monroy-Hernández. 2021. Significant Otter: Understanding the Role of Biosignals in Communication. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (Yokohama, Japan) (CHI '21). Association for Computing Machinery, New York, NY, USA, Article 334, 15 pages. <https://doi.org/10.1145/3411764.3445200>
- [108] Joan Llobera, Bernhard Spanlang, Giulio Ruffini, and Mel Slater. 2010. Proxemics with Multiple Dynamic Characters in an Immersive Virtual Environment. *ACM Trans. Appl. Percept.* 8, 1, Article 3 (Nov. 2010), 12 pages. <https://doi.org/10.1145/1857893.1857896>
- [109] Matthew Lombard and Matthew T Jones. 2015. Defining presence. In *Immersed in Media*. Springer, 13–34.
- [110] Gilad Lotan and Christian Croft. 2007. Impulse. In *CHI'07 Extended Abstracts on Human Factors in Computing Systems*. 1983–1988.
- [111] Rafael Lozano-Hemmer. 2019. *Remote Pulse*. Retrieved September 8, 2021 from [https://www.lozano-hemmer.com/remote\\_pulse.php](https://www.lozano-hemmer.com/remote_pulse.php)
- [112] Ewa Lux, Marc T. P. Adam, Verena Dörner, Sina Helming, Michael T. Knierim, and Christof Weinhardt. 2018. Live Biofeedback as a User Interface Design Element: A Review of the Literature. *Communications of the Association for Information Systems* (2018), 257–296. <https://doi.org/10.17705/1CAIS.04318>
- [113] Neha Mahajan and Karen Wynn. 2012. Origins of "Us" versus "Them": Prelinguistic infants prefer similar others. *Cognition* 124, 2 (Aug. 2012), 227–233. <https://doi.org/10.1016/j.cognition.2012.05.003>
- [114] Kerry L. Marsh, Michael J. Richardson, and R. C. Schmidt. 2009. Social Connection Through Joint Action and Interpersonal Coordination. *Topics in Cognitive Science* 1, 2 (April 2009), 320–339. <https://doi.org/10.1111/j.1756-8765.2009.01022.x>
- [115] Joe Marshall and Paul Tennent. 2017. Touchomatic: Interpersonal Touch Gaming In The Wild. In *Proceedings of the 2017 Conference on Designing Interactive Systems*. ACM, Edinburgh United Kingdom, 417–428. <https://doi.org/10.1145/3064663.3064727>
- [116] Helena M. Mentis, Jarmo Laakso, and Kristina Höök. 2014. My Self and You: Tension in Bodily Sharing of Experience. *ACM Transactions on Computer-Human Interaction* 21, 4 (Aug. 2014), 1–26. <https://doi.org/10.1145/2617945>
- [117] Maurice Merleau-Ponty. 1964. *Signs*. Northwestern University Press.
- [118] Raphaël Millière, Robin L. Carhart-Harris, Leor Roseman, Fynn-Mathis Trautwein, and Aviva Berkovich-Ohana. 2018. Psychedelics, Meditation, and Self-Consciousness. *Frontiers in Psychology* 9 (2018). <https://doi.org/10.3389/fpsyg.2018.01475> Publisher: Frontiers.
- [119] Hyeryung Christine Min and Tek-Jin Nam. 2014. Biosignal sharing for affective connectedness. *ACM*, 2191–2196. <https://doi.org/10.1145/2559206.2581345>
- [120] Kate E. Min, Peggy J. Liu, and Soo Kim. 2018. Sharing Extraordinary Experiences Fosters Feelings of Closeness. *Personality and Social Psychology Bulletin* 44, 1 (Jan. 2018), 107–121. <https://doi.org/10.1177/0146167217733077>
- [121] Robb Mitchell and Laurens Boer. 2017. Move Closer: Towards Design Patterns To Support Initiating Social Encounters. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (CHI EA '17). Association for Computing Machinery, New York, NY, USA, 2781–2787. <https://doi.org/10.1145/3027063.3053230>
- [122] Jelena Mladenović, Jérémy Frey, and Jessica R. Cauchard. 2018. DiÀjimo: Anchoring Our Breath. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*. ACM Press, Montreal QC, Canada, 1–4. <https://doi.org/10.1145/3170427.3186517>
- [123] Stuart Moran, Nils Jäger, Holger Schnädelbach, and Kevin Glover. 2016. Exo-Pranayama: a biofeedback-driven actuated environment for supporting yoga breathing practices. *Personal and Ubiquitous Computing* 20, 2 (Jan. 2016), 261–275. <https://doi.org/10.1007/s00779-016-0910-3>
- [124] Katherine Moriawaki. 2002. *Recoil*. Retrieved September 8, 2021 from <http://www.kakirine.com/?p=14>
- [125] Nima Motamedi. 2007. Keep in touch: a tactile-vision intimate interface. In *Proceedings of the 1st international conference on Tangible and embedded interaction*. 21–22.
- [126] Florian Mueller, Sophie Stellmach, Saul Greenberg, Andreas Dippon, Susanne Boll, Jayden Garner, Rohit Khot, Amani Naseem, and David Altimira. 2014. Proxemics play: understanding proxemics for designing digital play experiences. In *Proceedings of the 2014 conference on Designing interactive systems*. ACM, Vancouver BC Canada, 533–542. <https://doi.org/10.1145/2598510.2598532>
- [127] Florian 'Floyd' Mueller, Frank Vetere, Martin R. Gibbs, Jesper Kjeldskov, Sonja Pedell, and Steve Howard. 2005. Hug over a Distance. In *CHI '05 Extended Abstracts on Human Factors in Computing Systems* (CHI EA '05). ACM, New York, NY, USA, 1673–1676. <https://doi.org/10.1145/1056808.1056994>
- [128] Craig D. Murray and Judith Sixsmith. 1999. The Corporeal Body in Virtual Reality. *Ethos* 27, 3 (1999), 315–343. <https://www.jstor.org/stable/640592> Publisher: [American Anthropological Association, Wiley].
- [129] Rebecca Nowland, Elizabeth A. Necka, and John T. Cacioppo. 2018. Loneliness and Social Internet Use: Pathways to Reconnection in a Digital World? *Perspectives on Psychological Science* 13, 1 (Jan. 2018), 70–87. <https://doi.org/10.1177/1745691617713052>
- [130] Claudia Núñez Pacheco and Lian Loke. 2020. Getting into someone else's soul: communicating embodied experience. *Digital Creativity* 31, 4 (Oct. 2020), 245–258. <https://doi.org/10.1080/14626268.2020.1835987>
- [131] Catherine S Oh, Jeremy N Bailenson, and Gregory F Welch. 2018. A systematic review of social presence: Definition, antecedents, and implications. *Frontiers in Robotics and AI* 5 (2018), 114.
- [132] Thomas Olsson, Pradthana Jarusriboonchai, Pawel Woźniak, Susanna Paasovaara, Kaisa Väänänen, and Andrés Lucero. 2020. Technologies for Enhancing Collocated Social Interaction: Review of Design Solutions and Approaches. *Computer Supported Cooperative Work (CSCW)* 29, 1 (April 2020), 29–83. <https://doi.org/10.1007/s10606-019-09345-0>
- [133] Beste Özcan and Valerio Sperati. 2020. Lokahi: The Wearable Body Pillow to Foster an Intimate Interaction Between Two Users Through Their Heartbeat Awareness. In *HCI International 2020 Late Breaking Posters (Communications in Computer and Information Science)*, Constantine Stephanidis, Margherita Antonia, and Stavroula Ntoa (Eds.). Springer International Publishing, Cham, 421–429. [https://doi.org/10.1007/978-3-030-60703-6\\_54](https://doi.org/10.1007/978-3-030-60703-6_54)
- [134] Susanna Paasovaara, Andrés Lucero, and Thomas Olsson. 2016. Outlining the design space of playful interactions between nearby strangers. In *Proceedings of the 20th International Academic Mindtrek Conference*. ACM, Tampere Finland, 216–225. <https://doi.org/10.1145/2994310.2994344>
- [135] Maria-Paola Paladino, Mara Mazzurega, Francesco Pavan, and Thomas W. Schubert. 2010. Synchronous Multisensory Stimulation Blurs Self-Other Boundaries. *Psychological Science* 21, 9 (Sept. 2010), 1202–1207. <https://doi.org/10.1177/0956797610379234>
- [136] Maja Petric. 2018. *We are all Made of Light*. Retrieved September 8, 2021 from <https://www.majapetric.com/waamol1>
- [137] Sydney Pratte, Anthony Tang, and Lora Oehlberg. 2021. Evoking Empathy: A Framework for Describing Empathy Tools. In *Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction* (Salzburg, Austria) (TEI '21). Association for Computing Machinery, New York, NY, USA, Article 25, 15 pages. <https://doi.org/10.1145/3430524.3440644>
- [138] Sara Price, Nadia Bianchi-Berthouze, Carey Jewitt, Nikoleta Yiannoutsou, Katerina Fotopoulou, Svetlana Dajic, Juspreet Virdee, Yixin Zhao, Douglas Atkinson, and Frederik Brudy. 2022. The making of meaning through dyadic haptic affective touch. *ACM Transactions on Computer-Human Interaction* 29, 3 (2022), 1–42.
- [139] René Proyer. 2013. The well-being of playful adults: Adult playfulness, subjective well-being, physical well-being, and the pursuit of enjoyable activities. *The European Journal of Humour Research* 1, 1 (March 2013), 84–98. <https://doi.org/10.7592/EJHR2013.1.1.proyer> Number: 1.
- [140] Mirjana Prpa, Ekaterina R. Stepanova, Thecla Schiphorst, Bernhard E. Riecke, and Philippe Pasquier. 2020. *Inhaling and Exhaling: How Technologies Can Perceptually Extend Our Breath Awareness*. Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi-org.proxy.lib.sfu.ca/10.1145/3313831.3376183>
- [141] María Puig de la Bellacasa. 2017. *Matters of care: speculative ethics in more than human worlds*. OCLC: 1078220020.
- [142] Chao Ying Qin, Jun-Ho Choi, Marios Constantinides, Luca Maria Aiello, and Daniele Quercia. 2020. Having a Heart Time? A Wearable-based Biofeedback System. In *22nd International Conference on Human-Computer Interaction with Mobile Devices and Services*. ACM, Oldenburg Germany, 1–4. <https://doi.org/10.1145/3406324.3410539>

- [143] Denise Quesnel, Ekaterina R Stepanova, Ivan A Aguilar, Patrick Pennefather, and Bernhard E Riecke. 2018. Creating AWE: artistic and scientific practices in research-based design for exploring a profound immersive installation. In *2018 IEEE Games, Entertainment, Media Conference (GEM)*. IEEE, 1–207.
- [144] Matthew Ratcliffe. 2008. Touch and Situatedness. *International Journal of Philosophical Studies* 16, 3 (July 2008), 299–322. <https://doi.org/10.1080/09672550802110827>
- [145] Johan Redstrom. 2017. *Making Design Theory*. MIT Press, Cambridge.
- [146] Harry T. Reis and Shaver, Phillip. 1988. Intimacy as an interpersonal process. In *Relationships, Well-Being and Behaviour*. Routledge. <https://doi.org/10.4324/9780203732496-5> Pages: 113-143 Publication Title: Relationships, Well-Being and Behaviour.
- [147] Harry T. Reis, Kennon M. Sheldon, Shelly L. Gable, Joseph Roscoe, and Richard M. Ryan. 2000. Daily Well-Being: The Role of Autonomy, Competence, and Relatedness. *Personality and Social Psychology Bulletin* 26, 4 (April 2000). <https://doi.org/10.1177/0146167200266002>
- [148] Miriam Rennung and Anja S. Göritz. 2016. Prosocial consequences of interpersonal synchrony: A meta-analysis. *Zeitschrift für Psychologie* 224, 3 (2016), 168–189. <https://doi.org/10.1027/2151-2604/a000252>
- [149] Raquel Breejon Robinson, Elizabeth Reid, Ansgar E. Depping, Regan Mandryk, James Collin Fey, and Katherine Isbister. 2019. 'In the Same Boat': A Game of Mirroring Emotions for Enhancing Social Play. ACM, INT011. <https://doi.org/10.1145/3290607.3313268>
- [150] Raquel Breejon Robinson, Elizabeth Reid, James Collin Fey, Ansgar E Depping, Katherine Isbister, and Regan L Mandryk. 2020. Designing and Evaluating 'In the Same Boat', A Game of Embodied Synchronization for Enhancing Social Play. In *Proceedings of the 2020 CHI conference on human factors in computing systems*. 1–14.
- [151] Richard M Ryan and Edward L Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist* 55, 1 (2000), 68.
- [152] M. Salminen, S. Järvelä, A. Ruonala, V. Harjunen, G. Jacucci, J. Hamari, and N. Ravaja. 2019. Evoking Physiological Synchrony and Empathy Using Social VR with Biofeedback. *IEEE Transactions on Affective Computing* (2019), 1–11. <https://doi.org/10.1109/TAFFC.2019.2958657> Conference Name: IEEE Transactions on Affective Computing.
- [153] Robert M. Sapolsky. 2017. *Behave: The Biology of Humans at Our Best and Worst*. Penguin. Google-Books-ID: sJKoDAAQBAJ.
- [154] Robert M. Sapolsky. 2018. Doubled-Edged Swords in the Biology of Conflict. *Frontiers in Psychology* 9 (2018). <https://doi.org/10.3389/fpsyg.2018.02625> Publisher: Frontiers.
- [155] Betty Sargeant, Justin Dwyer, and Florian 'Floyd' Mueller. 2020. Designing for Virtual Touch: A Real-Time Co-Created Online Art Experience. In *Extended Abstracts of the 2020 Annual Symposium on Computer-Human Interaction in Play*. ACM, Virtual Event Canada, 129–133. <https://doi.org/10.1145/3383668.3419936>
- [156] Thecla Schiphorst. 2005. exhale: (breath between bodies). In *SIGGRAPH '05 Emerging technologies*. ACM, Los Angeles, CA, 1.
- [157] Thecla Schiphorst. 2006. Breath, skin and clothing: Using wearable technologies as an interface into ourselves. *International Journal of Performance Arts and Digital Media* 2, 2 (Jan. 2006), 171–186. [https://doi.org/10.1386/padm.2.2.171\\_1](https://doi.org/10.1386/padm.2.2.171_1)
- [158] Thecla Schiphorst and Kristina Andersen. 2004. Between Bodies: using Experience Modeling to Create Gestural Protocols for Physiological Data Transfer. Vienna, Austria, 8.
- [159] Thecla Schiphorst, Frank Nack, Michiel KauwATJoe, Simon de Bakker, Stock, Lora Aroyo, Angel Perez Rosillo, Hielke Schut, and Norm Jaffe. 2007. PillowTalk: can we afford intimacy?. In *Proceedings of the 1st international conference on Tangible and embedded interaction (TEI '07)*. Association for Computing Machinery, New York, NY, USA, 23–30. <https://doi.org/10.1145/1226969.1226975>
- [160] Raymond Scupin. 1997. The KJ method: A technique for analyzing data derived from Japanese ethnology. *Human organization* 56, 2 (1997), 233–237.
- [161] Samarth Singhal, Carman Neustaedter, Yee Loong Ooi, Alissa N. Antle, and Brendan Matkin. 2017. Flex-N-Feel: The Design and Evaluation of Emotive Gloves for Couples to Support Touch Over Distance. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17)*. ACM, New York, NY, USA, 98–110. <https://doi.org/10.1145/2998181.2998247>
- [162] Petr Slovák, Joris Janssen, and Geraldine Fitzpatrick. 2012. Understanding heart rate sharing: towards unpacking physiosocial space. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 859–868.
- [163] Meehae Song, Tamiko Tadeo, Ioana Sandor, Servet Ulas, and Steve DiPaola. 2019. BioFlockVR: exploring visual entrainment through amorphous nature phenomena in bio-responsive multi-immersant VR interactives. In *Proceedings of the 2nd International Conference on Image and Graphics Processing - ICIGP '19*. ACM Press, Singapore, Singapore, 150–154. <https://doi.org/10.1145/3313950.3313978>
- [164] Dominic Spohr. 2017. Fake news and ideological polarization: Filter bubbles and selective exposure on social media. *Business Information Review* 34, 3 (Sept. 2017), 150–160. <https://doi.org/10.1177/0266382117722446>
- [165] Jaakko Stenros, Janne Paavilainen, and Frans Mäyrä. 2009. The many faces of sociability and social play in games. In *Proceedings of the 13th International MindTrek Conference: Everyday Life in the Ubiquitous Era on - MindTrek '09*. ACM Press, Tampere, Finland, 82. <https://doi.org/10.1145/1621841.1621857>
- [166] Ekaterina R Stepanova, John Desnoyers-Stewart, Philippe Pasquier, and Bernhard E Riecke. 2020. JeL: Breathing Together to Connect with Others and Nature. In *ACM DIS*. ACM, Eindhoven, Netherlands, 1–14. <https://youtu.be/vwb4jX4x-c4>
- [167] Ekaterina R. Stepanova, Denise Quesnel, and Bernhard E. Riecke. 2019. Understanding AWE: Can a Virtual Journey, Inspired by the Overview Effect, Lead to an Increased Sense of Interconnectedness? *Frontiers in Digital Humanities* 6 (2019). <https://doi.org/10.3389/fdigh.2019.00009>
- [168] Erik Stolterman. 2008. The nature of design practice and implications for interaction design research. *International Journal of Design* 2, 1 (2008).
- [169] Anna Ståhl, Martin Jonsson, Johanna Mercurio, Anna Karlsson, Kristina Höök, and Eva-Carin Banka Johnson. 2016. The Soma Mat and Breathing Light. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '16)*. ACM, New York, NY, USA, 305–308. <https://doi.org/10.1145/2851581.2889464>
- [170] Xiaotian Sun and Kiyoshi Tomimatsu. 2017. Breath Is to Be Perceived - Breathing Signal Sharing Involved in Remote Emotional Communication. In *Distributed, Ambient and Pervasive Interactions (Lecture Notes in Computer Science)*, Norbert Streitz and Panos Markopoulos (Eds.). Springer International Publishing, 472–481.
- [171] Henri Tajfel. 1970. Experiments in Intergroup Discrimination. *Scientific American* 223, 5 (1970), 96–103. <https://www.jstor.org/stable/24927662> Publisher: Scientific American, a division of Nature America, Inc.
- [172] Shogo Tanaka. 2015. Intercorporeality as a theory of social cognition. *Theory & Psychology* 25, 4 (Aug. 2015), 455–472. <https://doi.org/10.1177/0959354315583035>
- [173] Bronwyn Tarr, Jacques Launay, and Robin I. M. Dunbar. 2014. Music and social bonding: "self-other" merging and neurohormonal mechanisms. *Frontiers in Psychology* 5 (2014). <https://doi.org/10.3389/fpsyg.2014.01096>
- [174] Alex S Taylor. 2009. Machine intelligence. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2109–2118.
- [175] Nada Terzimehić, Renate Häuslschmid, Heinrich Hussmann, and m.c. schraefel. 2019. A Review & Analysis of Mindfulness Research in HCI: Framing Current Lines of Research and Future Opportunities. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, Glasgow Scotland UK, 1–13. <https://doi.org/10.1145/3290605.3300687>
- [176] National Theatre. 2020. *Draw Me Closer*. Retrieved September 8, 2021 from <https://www.nationaltheatre.org.uk/immersive/projects/draw-me-close>
- [177] Alison Tonkin and Julia Whitaker. 2021. Play and playfulness for health and wellbeing: A panacea for mitigating the impact of coronavirus (COVID 19). *Social Sciences & Humanities Open* 4, 1 (Jan. 2021), 100142. <https://doi.org/10.1016/j.ssho.2021.100142>
- [178] Sonja Utz. 2015. The function of self-disclosure on social network sites: Not only intimate, but also positive and entertaining self-disclosures increase the feeling of connection. *Computers in Human Behavior* 45 (April 2015), 1–10. <https://doi.org/10.1016/j.chb.2014.11.076>
- [179] Josca van Houwelingen-Snippe, Thomas J. L. van Rompay, and Somaya Ben Al-louch. 2020. Feeling Connected after Experiencing Digital Nature: A Survey Study. *International Journal of Environmental Research and Public Health* 17, 18 (Jan. 2020), 6879. <https://doi.org/10.3390/ijerph17186879> Number: 18 Publisher: Multidisciplinary Digital Publishing Institute.
- [180] Julia Werner, Reto Wettach, and Eva Hornecker. 2008. United-pulse: feeling your partner's pulse. In *Proceedings of the 10th international conference on Human computer interaction with mobile devices and services*. 535–538.
- [181] Mary E. Wheeler and Susan T. Fiske. 2005. Controlling Racial Prejudice: Social-Cognitive Goals Affect Amygdala and Stereotype Activation. *Psychological Science* 16, 1 (Jan. 2005), 56–63. <https://doi.org/10.1111/j.0956-7976.2005.00780.x>
- [182] Brenda K. Wiederhold. 2020. Connecting Through Technology During the Coronavirus Disease 2019 Pandemic: Avoiding "Zoom Fatigue". *Cyberpsychology, Behavior, and Social Networking* 23, 7 (July 2020), 437–438. <https://doi.org/10.1089/cyber.2020.29188.bkw>
- [183] Valtteri Wikström, Tommi Makkonen, and Katri Saarikivi. 2017. SynKin: A Game for Intentionally Synchronizing Biosignals. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '17)*. Association for Computing Machinery, Denver, Colorado, USA, 3005–3011. <https://doi.org/10.1145/3027063.3053195>
- [184] L. E. Williams and J. A. Bargh. 2008. Experiencing Physical Warmth Promotes Interpersonal Warmth. *Science* 322, 5901 (Oct. 2008), 606–607. <https://doi.org/10.1126/science.1162548>
- [185] Harry Robert Wilson. 2020. New ways of seeing, feeling, being: intimate encounters in virtual reality performance. *International Journal of Performance Arts and Digital Media* 16, 2 (May 2020), 114–133. <https://doi.org/10.1080/14794713.2020.1770531>

- [186] R Michael Winters, Bruce N Walker, and Grace Leslie. 2021. Can You Hear My Heartbeat?: Hearing an Expressive Biosignal Elicits Empathy. (2021), 11.
- [187] Ludwig Wittgenstein. 1968. *Philosophical investigations*. Basil Blackwell, Oxford.
- [188] Claes Wohlin. 2014. Guidelines for snowballing in systematic literature studies and a replication in software engineering. In *Proceedings of the 18th international conference on evaluation and assessment in software engineering*. 1–10.
- [189] David Bryce Yaden, Jonathan Haidt, Ralph W. Hood, David R. Vago, and Andrew B. Newberg. 2017. The varieties of self-transcendent experience. *Review of General Psychology* 21, 2 (2017), 143–160. <https://doi.org/10.1037/gpr0000102>
- [190] Farnaz Zangouei, Mohammad Ali Babazadeh, Kristina Höök, Tim Tijs, Gert-Jan de Vries, and Joyce Westerink. 2010. How to Stay in the Emotional Rollercoaster: Lessons Learnt from Designing EmRoll. 10.