

# Presence Mediator: Creating Social Presence through Spatial Positioning of Everyday Objects

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## ABSTRACT

In the situation where people live together in one household, the rearrangement of everyday objects (either accidental or deliberate) becomes a trace of social presence that people may use as part of their social interactions. This research aims at simulating that natural phenomenon in the context of a long-distance relationship. That is, mediation of social presence through domestic objects is extended over time and space. Our concept, the Presence Mediator, is an interactive system that is attached to an ordinary domestic object. Participants of a field test were in the belief that two mediating objects are synchronized and spatially representing each other's action in the social relation. In fact, the prototype moved a few times per day at random distance and direction. The results illustrate the complexity mediating objects entail as they bring further consequences for the social relation into play. We discuss the difference between traces of social presence that form part of the common background of attention, versus social interaction as mediated by objects that form the center of attention. Furthermore, we discuss the object as a mediating trace of another person's presence, versus the object as an explicit (anthropomorphic) representation of that other person.

## Author Keywords

Tangible user interface; interaction design; social presence; long-distance relationship; embodied cognition

## ACM Classification Keywords

H5.2. User Interfaces, H.5.3. Collaborative Computing

## INTRODUCTION

Tangible User Interfaces have gained increasing attention within the field of Human-Computer-Interaction in recent years. Tangible Interaction describes concepts that rely on embodied interaction, tangible manipulation, physical representation of data, and embeddedness in physical space [13]. While traditional screen-based solutions enable users

to interact with bare virtual information, tangible interfaces incorporate embodied interaction within the concrete world of physical objects and (other) people. Designing tangible interfaces requires consequently not only a sound understanding of the digital, but also of the concrete world that is inhabited by our body, and in particular the relation between the digital and the "embodied" environment within hybrid systems [22].

Related work on Tangible Interaction has shown various definitions and dominant approaches within different disciplines: Within the field of Computer Science and HCI, the focus lies in the coupling of digital data with the physical representation and manipulation [8]. The product design community, however, is concerned with the domain-tailored design of expressive interaction itself and focuses on the bodily interaction, making use of sensory richness and action potential of physical objects so that meaning is created in the interaction [7, p. 288]. Interactive arts and architecture on the other hand deals with physical interactive installations in large-scale spaces that require full-body interaction [13].

Physical objects embody many different qualities interesting from an interaction point of view as it provides sensory richness for the user. Current research focuses predominantly on tangible user interfaces as a means for embodied input to manipulate digital data. This work however goes beyond the goal of designing a representation of digital data in tangible form [15]. We examine whether and how everyday objects, with both their physical and digital properties taken as a whole, can help to create experiences of social presence between people. On a theoretical level, this study is a research-through-design effort exploring the notion of Socio-Sensorimotor Couplings [22]. A socio-sensorimotor coupling is a theoretical notion that combines social interaction and the physical interaction between body and the local environment. The idea, based on principles of Embodied Cognition [4, 14] and Situated Cognition [21, 3] is that people generally make sense of the world while dealing with objects in the environment, both as part of a social coordination between people, and as part of sustained sensorimotor loops that link perception to action [12]. Together, this process of socio-sensorimotor coupling helps a person to make sense, and act successfully in the everyday world [22]. In what follows, we apply this notion to the concrete case of long distance relationships and in reflection on the design case and the user study we present some insights relevant to tangible interaction design for social interaction.

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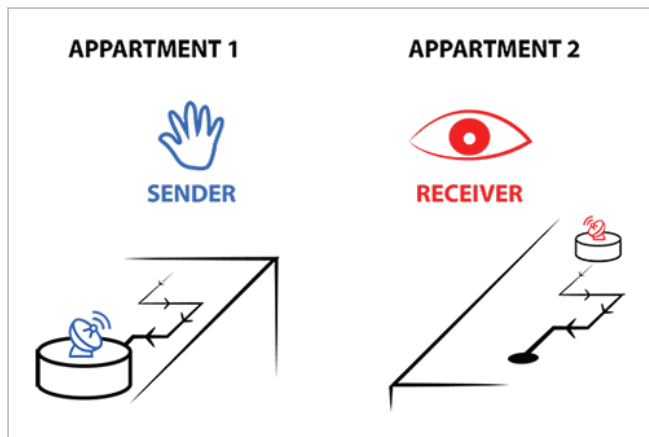
Published in: van Leeuwen, JP, Stappers, PJ, Lamers, MH, Thissen, MJMR (Eds.) *Creating the Difference: Proceedings of the Chi Sparks 2014 Conference*, April 3, 2014, The Hague, The Netherlands.

**TRACES OF SOCIAL PRESENCE**

Everyday objects and the embedding environment play a crucial role on how social interaction takes place [17]. A cohabiting couple in an apartment, for example, rearranges its environment continuously. Each action of an individual has an impact on both and leads to new understanding in how they relate to each other. This ongoing transformation is essential part of living and being together. Everyday objects become thus footprints or traces of existence, action and eventually presence in social interaction [22]. The question is whether we can create digitally augmented objects to create social presence at a long distance scale.

Let’s consider following scenario based on the notion of traces mentioned earlier: It is Monday morning in an apartment of a cohabiting couple. While one of them (A) is getting up quite early to go to work, the other one (B) is still sleeping. A is taking a shower, brushing his teeth, making coffee, preparing dishes, having breakfast and eventually leaving the apartment. After some time B is getting up and able to speculate what has happened this morning: The shower stall is wet, the toothpaste is sticking on the sink, the coffee can is on the counter and so on. This ordinary everyday situation illustrates that meaning in social presence is not only constituted through explicit forms of human-human interaction, but also by the implicit consequences of human action that are left as traces distributed in the environment [22].

In this work we investigated how this notion can be applied to long-distance relationships by using everyday objects as mediators for social presence. In contrast to the previous scenario, let’s consider a couple that is living geographically-separated in two different households. Caused traces by A cannot be perceived by B so that presence is reduced predominantly to its common explicit forms such as phone calls or video chats. In order to overcome this discrepancy, we have developed an interactive system, the Presence Mediator, that is embedded in a domestic object. The Presence Mediator is situated in each household and both are spatially synchronized by sending and receiving each other’s position. A is able to reposition the own mediating object that again gets spatially represented at B at the same time and vice versa (Figure 1).



**Figure 1. Both objects are bi-directionally synchronized and create similar traces over distance.**

Consideration should be given to the ambiguous interpretation of repositioned objects. The objects are intended to convey ambiguity in meaning and open-ended situations over defined utilitarian purposes. This has been investigated with The History Tablecloth, a flexible, screen-printed electroluminescent material [11]. When objects are left on the tablecloth, cells beneath light up that grow over a period of time. The History Tablecloth (Figure 2) elicited rich interpretations among the inhabitants so that local knowledge was co-constructed. Even occasionally erroneous behavior of it led to greater richness in experience, without becoming so random that emergent patterns could not be perceived or interpreted. A distinction can be made between “semantically unspecified” and “semantically ambiguous” systems. The former promises the most latitude to users in determining their own meanings, but risks failing to afford any meaningful semantic relations. The latter requires more sensitivity in how it indicates openness for interpretation [11].



**Figure 2. The History Tablecloth [11] is highlighting the traces of objects in a kitchen.**

**THE PRESENCE MEDIATOR**

The Presence Mediator and its emerging behavior is not meant to convey a single and specific message (the fork moved, so my partner is eating), but rather to create semantic ambiguity that relates to external everyday situations without indicating any judgment about the meaning [20, 11].

The ideal design of the Mediator is based on the given natural cohabiting setting as described in the scenario earlier: It would enable the Mediator to be seamlessly integrated in the environment and share the same appreciation and appropriation of the participant just like any other ordinary domestic object. For example the

mediating technology would be invisibly integrated into an object so that it does not influence participants perception and judgements. Pragmatically speaking, that concerns particularly the visual appearance as well as the kind of movement the Mediator entails. Furthermore, each relationship may require a different object all involved participants can relate to. A and B may share something completely different than A and C do for example.

### IMPLEMENTATION OF THE PROTOTYPE

Instead of using an existing object and extending it by some alien appearance we decided to go rather for a stand-alone and generic design that allows interpretative appropriation by the participants (Figure 3). It is intended to be appropriated through the ways the participants understand it explicitly as well as through their actions [11]. Moreover, it allows to apply the Mediator across different field tests as described later and all participants to customize it in both appearance and functionality.

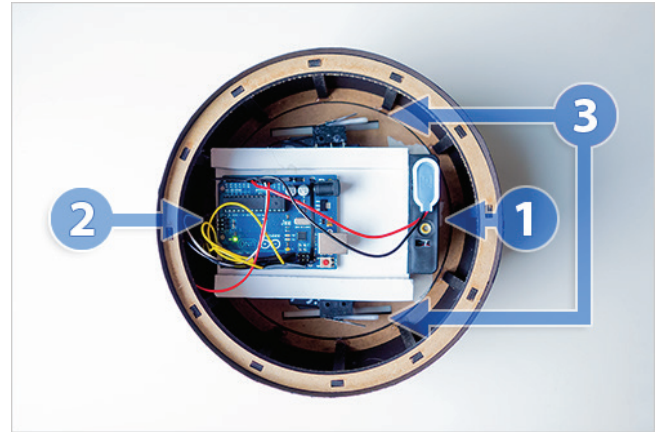
Drawing on The History Tablecloth mentioned earlier, The Presence Mediator for this study does not require to be synchronized over distance nor represent the absolute position in both apartments. Within the frame of the research question it is sufficient to simulate this behavior by moving it randomly a few times per day. All the more important is to make the participants understand and believe that both Mediators are representing each other in time and space: Whenever I move my Mediator in my apartment, your Mediator will move exactly the same way at the same time and vice versa.



**Figure 3. Stand-alone and generic design for individual appropriation**

The final Mediator was made out of medium-density fiberboard (MDF) and cardboard. It was designed in a circular shape and measured 20 cm in diameter and 9 cm in height. The circular shape has a more pragmatic reason in the first place as it supports the movement in case of colliding with adjacent objects. Inside it is equipped with an Arduino and two modified servomotors each equipped with an extended arm. At the bottom of the shell each arm has a slot. If the servo is rotating the arm will hit the ground, lift and move the whole construction. In contrast to wheels arms lift the shell only during the movement and remain otherwise hidden.

Additional sensors could help to capture additional information such as the edge of a table, presence of people or colliding objects. However, as a consequence it would consume disproportionately more power, increase error-proneness and hence rely on the participants attention. By reducing the technical complexity to a reasonable minimum the Mediator was able to last over five days without any maintenance.



**Figure 4. An array of batteries [1] supplies an Arduino microcontroller [2] that controls two servomotors as moving arms [3].**

### FIELD STUDY

In many areas, where technologies are studied in real-world settings, field research and ethnographical analysis have become established practices in research [11]. The purpose of this study was not only to gain knowledge about the artifact itself, but first and foremost to achieve an understanding of what it means to constitute social presence over time and space, mediated by tangible interaction. In particular this study and its interwoven socio-cultural complexity requires a natural environment.

We conducted two user tests in two apartments in northern Germany each lasting for five days. The first test has taken place between the first author, D, and his apart-living partner (whom we shall call P) in a long-distance relationship. The second test has been performed again in a long-distance relationship between D and his parents-in-law, consisting of the mother (M) and the father (H). All participants were acquainted with common presence technologies such as smartphones, e-mails, social media or voice-over-IP services.

The Mediator was put in the home of the participants. The Mediator was set up in a way that it moved randomly three times per day. Each move varied in direction and distance (0,5m to 1,5m) and took place once in the morning, afternoon and evening. The movement itself was adjusted to a very slow speed and hence noise-reduced.

The participants believed there was a second mediator installed in the home of D. The Mediator was introduced to the participants as minimally as possible. All participants were asked to see the Mediator as an integral part of their chosen everyday object. As far as practically feasible both



parts were supposed to be considered as one (mediating) object and not to be detached from each other.

Since this study is about social presence over time and space, no home visits occurred during the study. In both tests all participants had daily obligations and spent most of the day outside the home. It diminished the probability of being home and experience the movement of the Mediator in real-time. That is crucial since the setup of this study is supposed to reflect as much as possible a natural setting of a cohabiting couple, in which a trace of someone else is seen as a trace not when it is created, but only after the fact, as a physical residue of some activity in the past. In contrast, the movement of the Mediator is technologically implemented by servo-motors. Witnessing the thing move could influence participants perception and relation to the Mediator. It would lead to distort the data and most importantly not contributing to the research question.

### The role of the participatory investigator

The participatory role of the first author allowed us to conduct both field tests without organizational obstacles and challenges that might have occurred otherwise. The participants and D share a rather private to intimate relationship that is characterized by mutual trust. This position enables D to gain sensitive information and hence insightful data and added to the credibility of the enacted technological set-up. However, being part of the social relation comes with potential subjectivity issues that need to be considered as well. In order to reduce that influencing factor to a minimum all participants were asked to remain silent with D about the study itself during that time period. Furthermore, we decided to apply auto-ethnographical methods in situ to prevent any intrusive and distorting factors. All participants were asked to record the data in any format they feel comfortable with such as video, text or sketches, using an unstructured diary format [5]. Participants were however encouraged to reflect whenever the artifact had been moved and at least once at the end of the day. A final face-to-face interview was added where detailed questions about the diary entries offered a richer and deeper contextual understanding after each field test [16]. In general, however, this study is not meant to provide objective data of peoples behavior, rather than lay bare some relevant design considerations when using tangible interactive objects for social interaction. Subjective as well as objective insights may add to that understanding [18].

In the first field test P (aged 24) lived in a living community together with another even-aged woman. Both shared a kitchen, bathroom and the entrance area with the corridor. If P was at home she has spent most of the time in her own room on around 18 square meters. It was equipped with a bed, a desk, a dresser, a couch and a wardrobe. Furthermore she had a TV as well as a laptop. She decided to use the Mediator as an underlayment for her fruit bowl and placed it on the floor in her room (Figure 5).

The participants of the second field test are a married couple (both mid-50) living in an apartment on about 120 square meters and five rooms. In consultation with W and H it was decided to use the Mediator as an underlayment for their TV guide and to place it on the floor in their living room area

(Figure 6). We appreciated the decision as they use the TV guide at least every evening in a social context. In the beginning the wife indicated the main interest in the test and played hence a crucial role.

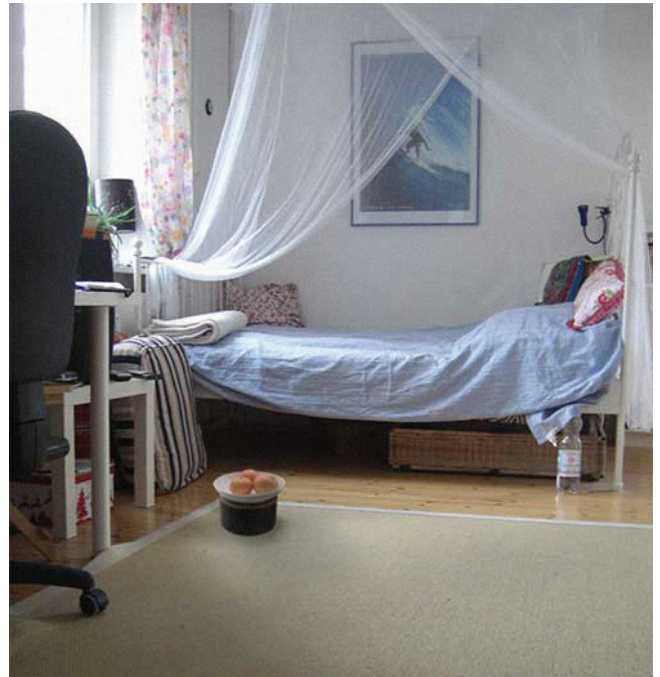


Figure 5. Fruit bowl situated in the participant's room of a living community.

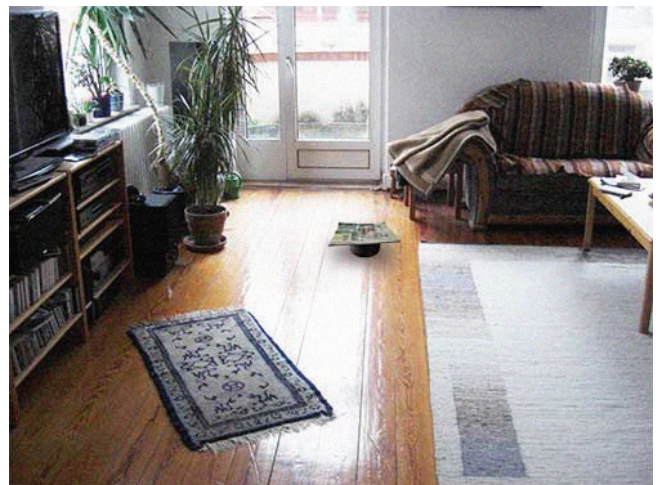


Figure 6. TV guide situated in the living room area of the couple.

## RESULTS

First of all, since the setup of this study allows us to do so, we would like to take the issue of D's subjectivity as an opportunity and reflect on his perceptions. Subsequently we will present and discuss the key results in the light of a natural cohabiting setting as to find in a common household. By doing that we elaborate critically and focus particularly on deviant occurrences in that respect.

The role of the researcher as well as a part of the social relation has been a rather unfamiliar situation to D. On the one hand due to the blurring boundaries between private life

and university research D is not used to. On the other due to the profession of natural science, namely pharmacy, medicine and biology, all participants pursued. That seems to be reflected in their attitude towards design research practices as D felt initial doubt or skepticism. As it turned out it has been the lack of understanding not only towards this study, but also towards design research in general. Two very different epistemologies, the science tradition and practitioner action, have clashed [1]. All the more important was to explain the very fundamentals and the genuine value of design research to society so that it became graspable and meaningful to them personally. By doing that in a rather informal and leisure setting, unlike the specific instructions at a later stage, D was not just able to counteract the initial confusion but also to diminish the participants potential tendency of feeling morally obliged towards D.

Due to the given restrictions of remaining silent about the Mediator there was hardly exchange about the experiences undergone by the participants throughout the actual study. A few times, however, P leaked some thoughts in terms of gladly confirming a received movement at a particular moment in the past. That feedback put D generally in a positive mood but it came on the same time, due to its intended implementation, with a rather artificial overtone. It has put D morally under pressure. On the one hand because D was not telling the story about the actual implementation and implicitly lying. On the other it demonstrates how fake and artificial concepts can be used to elicit intended emotions [10].

According to our expectations both field tests revealed different insights due to the given context the mediating object was embedded in. While the first field test elicited rather returning entries, the second field test provided a different quality in terms of the discussion that has taken place between the couple. In contrast to the first test, the second focuses more on the co-interpretation of emerging phenomena and provides more breadth in that sense. However, particular results can be extracted from both field tests and hence coincide to some extent.

### **Mediator versus Detached Agent**

Already during the instruction and before the test actually started in both cases the participants assigned their mediating object a name (P as Rudolph; W as Kleiner Freund / Little Friend). That demonstrated the bonding process between the seemingly neutral object and the new owner from the very beginning. Previous research has shown that people tend to treat robots as if they were humans without being actually aware of it [19]. According to [23] perceiving an agent to be human-like has important implications for whether the agent is capable of social influence, accountable for its actions (hence capacity of self-control), and worthy of moral care and consideration. In case of the seemingly abstract appearance of the mediating object, the proclivity for anthropomorphizing can be ascribed to the social environment it is situated in and particularly to the mediating character of the relation D and the participants maintain [22, 23]. It is problematic in a sense that the mediating object, intended to act as a mediator in the relation, obtained its own agency. This relationship is not only between D and the participants. Instead, the mediating

object shaped considerably the relation and the experience with its intrinsic properties [6] in a way that it acts as a separate agent in the relationship.

The data reveals this behavior in both field tests. In the first test P "(...) was thinking about Rudolph and got very excited whether he has moved." while W was surprised that He covered a huge distance and even mastered the edge of the carpet. I would have liked to see how you managed that little friend. In both cases the participants refer to the mediating object as a detached agent so that the intended mediating properties of the relation were not reflected in their behavior. This behavior is not constant throughout the data set but returning and changing with the intended mediating function. For example, W infers he [the mediator] didn't move this morning, so D. is probably still sleeping.

### **Mediator as an Ordinary Object**

All participants distinguished to a certain extent, based on the situation, between the Presence Mediator as a means to communicate and the ordinary object as a fruit bowl or TV guide. In the beginning all participants seemed to be very excited and eager about the technology and the seeming fact that it represents each other's actions. Especially in the first day P had the tendency to deliberately check the fruit bowl for any changes several times. Drawing on the diary entries P stated in the interview that it attracted probably more attention than any other surrounding object or an ordinary fruit bowl. That is ascribed not only to the novelty itself but also to its intrinsic properties [6] that are not given in a comparable ordinary object.

These intrinsic properties got reflected in Ps behavior towards the ordinary object the mediator is attached to as well. P states I have probably eaten more apples than I used to do in the past. By asking P in retrospect, eating more apples may be understood as an implicit excuse to move the fruit bowl and hence the mediating object.

### **Expectations and Emotions**

Throughout the five days the emotional state of P changed almost every time she faced the fruit bowl. Most of the times P was acting between the poles of happiness and disappointment paired with curiosity and expectations: You just made me smile. I was really happy about that [the repositioning] (...) In contrast to positive experiences the noticed absence of movement over a longer period of time provoked rather negative feelings. In connection with additional qualifying attributes P underpinned the emotional intensity: "I was very very disappointed that it didnt move while I have been at uni." This entry explicitly refers to the fruit bowl, however, it seems to be caused by the missing response from D. This demonstrates implicit expectations P adopted over time. Although not explicitly claimed, as a consequence, there evolved a sort of obligation on the opposite side to move the fruit bowl more regularly [24].

### **Speculation and Creation of Meaning**

Especially at the later stage of the test P has been thinking about the fruit bowl outside of the home. P states "Sometimes on my way back home, I was thinking about Rudolph and got very excited whether he has moved."



This experience clearly indicates elements of expectation. Paired with curiosity it shapes the basis for pleasant anticipation and provides room for speculation. Once triggered, speculation seems to be an ongoing process and ends once a satisfactory level of meaning is created. Although the fruit bowl relates to external situations, it is still semantically too ambiguous for specific conclusions considering it alone [20, 11]. However, contextual knowledge about the relating partner can play a crucial role in speculation and foster meaningful conclusions. For example, P and D arranged a meeting for the final interview on a Friday at 18:00. P knew the car ride would take D around 1:15 hours. Coincidentally her fruit bowl moved around 16:30 and P concluded that D is still at home. The correlation of gained knowledge is hence food for thought in the creation of coherent meaning.

## DISCUSSION

In a way one could say we failed to design what we intended to do: create interactive traces in the physical environment that signal the presence of others over distance. Instead, what we created turned out to be experienced as an explicit object that people attended to and dealt with in a conscious, deliberate mode of interaction. This object sometimes explicitly represented the other person, like an avatar, and at some points we might even conclude it took on an agency of its own, creating a new social relation between the user and the object itself, as illustrated for instance by the fact that the object was given its own proper name.

Nevertheless we gained important insights that can be of relevance to (tangible) interaction design. In particular, this study underscores that it is as of yet an ill-understood challenge to design for what in phenomenology is called “the background” [9]. With this we mean to design an artifact, whose function is to operate in the background of attention, rather than in our explicit awareness [2]. The phenomenological background operates largely unreflectively and immediate, and it is crucial for being able to make sense of what is in our attention at any particular moment. Against this background explicit objects, that are in the center of our attention, stand out [9]. Most product designers, in contrast, would focus on designing such explicit objects, instead of designing their backgrounds. Backgrounds are generally what is not designed, they are “the situation”, or “the context”, in which the designed object is perceived and acted on. On the other hand, concepts of ubiquitous computing can be said to design for the background, but again in a different way than we mean here. In the ultimate philosophy of ubicomp and ambient intelligence, technology operates completely outside of our awareness, taking care of things without us even knowing it. But when we talk about physical traces of social presence, people do take notice of these traces. They are perceived and acted on, that is, they are taken up within the socio-sensorimotor loop [22]. At the same time, people do not deliberately, and actively, focus on such traces: they are part of the background. In other words, the interactive traces we wish to design for are not completely drawn away from us, but they are certainly also not objects we explicitly attend to.

We feel this intermediate kind of objects to be a tremendous challenge for design. Much more work needs to be done to be able to successfully design technology that takes on such a background role. One direction could be to study in more detail how people, instead of physical objects, can themselves at times be part of the background, and at other times figure in our explicit attention, and to see what concrete interactions between people cause these roles to shift.

## CONCLUSION

The study demonstrates several discrepancies in contrast to ordinary traces in a natural cohabiting setting. Ordinary objects have been transformed by their added interactive properties. The mediating object shifted from a trace of the activity of the other person, to becoming an autonomous agent with its own intrinsic values. As a result participants dealt with it as an explicit communication tool to maintain exchange in the social relation. This comes with a consequence for the social relation as it entails implicit expectations of exchange the one side and obligations on the other.

In terms of design, the theory of socio-sensorimotor coupling provides a new way of looking at social interaction over distance. At present the theory did not directly provide us with the ultimate answer to how to design for physical traces of social presence (yet). But at least it helped draw attention to the difference between 1) designing explicit representations of other people, 2) designing autonomous agents that take on their own social identity, and 3) designing elements in the overall ‘background’ by which people make sense of the world. This background function is shown in the way physical traces operate in the ordinary situation to signal social presence. It is as of yet a challenge for interaction designers to achieve the same effect over distance.

## REFERENCES

1. Archer, B. The nature of research. In *Co-design* (1995), 6–13.
2. Bakker, S., Antle, A. N., and Van Den Hoven, E. Embodied metaphors in tangible interaction design. *Personal Ubiquitous Comput.* 16, 4 (Apr. 2012), 433–449.
3. Clancey, W. J. Situated action: A neuropsychological interpretation. (response to vera and simon). In *Cognitive Science*, vol. 17 (1993).
4. Clark, A. *Being There: Putting Brain, Body, and World Together Again*. The MIT Press, 1998.
5. Corti, L. Using diaries in social research. <http://sru.soc.surrey.ac.uk/SRU2.html>, March 1993. Accessed: 2014-03-10.
6. Dewey, J. *Art as Experience*. Minton, Balch and Company, 1934.
7. Djajadiningrat, T., Overbeeke, K., and Wensveen, S. But how, donald, tell us how?: On the creation of meaning in interaction design through feedforward and

- inherent feedback. In Proceedings of the 4th Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques, DIS '02, ACM (New York, NY, USA, 2002), 285–291.
8. Dourish, P. *Where the Action Is: The Foundations of Embodied Interaction*, first edition ed. The MIT Press, 2001.
  9. Dreyfus, H. *Being-in-the-World: A Commentary on Heidegger's Being and Time, Division I*. The MIT Press, 1990.
  10. Dunne, A., and Raby, F. The placebo project. In 1. Proceedings of the 4th Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques, DIS '02, ACM (New York, NY, USA, 2002), 9–12.
  11. Gaver, W., Bowers, J., Boucher, A., Law, A., Pennington, S., and Villar, N. The history tablecloth: Illuminating domestic activity. In Proceedings of the 6th Conference on Designing Interactive Systems, DIS '06, ACM (New York, NY, USA, 2006), 199–208.
  12. Gibson, J. J. *The Ecological Approach to Visual Perception*. Houghton Mifflin Harcourt (HMH), 1979.
  13. Hornecker, E., and Buur, J. Getting a grip on tangible interaction: A framework on physical space and social interaction. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '06, ACM (New York, NY, USA, 2006), 437–446.
  14. Hutchins, E. *Cognition in the wild*. MIT Press, 1995.
  15. Ishii, H., and Ullmer, B. Tangible bits: Towards seamless interfaces between people, bits and atoms. In Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems, CHI '97, ACM (New York, NY, USA, 1997), 234–241.
  16. Kenten, C. Narrating oneself: Reflections on the use of solicited diaries with diary interviews. <http://www.qualitative-research.net/index.php/fqs/article/view/1314/2> 2010. Accessed: 2014-03-10.
  17. Kerridge, T., Boucher, A., Law, A., and Gaver, B. Form and movement in domestic networked systems. In *Design and semantics of form and movement (DeSForM) (2007)*, 19–29.
  18. Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., and Wensveen, S. *Design Research Through Practice: From the Lab, Field, and Showroom*, 1 ed. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2011.
  19. Nass, C., and Moon, Y. Machines and mindlessness: Social responses to computers. *Journal of Social Issues* 56, 1 (2000), 81–103.
  20. Sengers, P., and Gaver, B. Staying open to interpretation: Engaging multiple meanings in design and evaluation. In Proceedings of the 6th Conference on Designing Interactive Systems, DIS '06, ACM (New York, NY, USA, 2006), 99–108.
  21. Suchman, L. *Plans and Situated Actions: The Problem of Human-Machine Communication (Learning in Doing: Social, Cognitive and Computational Perspectives)*, 2 ed. Cambridge University Press, 1987.
  22. van Dijk, J., van der Lugt, R., and Hummels, C. Beyond distributed representation: Embodied cognition design supporting socio-sensorimotor couplings. In Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction, TEI '14, ACM (New York, NY, USA, 2013), 181–188.
  23. Waytz, A., Epley, N., and Cacioppo, J. T. Social cognition unbound: Insights into anthropomorphism and dehumanization. In *Current Directions in Psychological Science*, vol. 19 (2010), 58–62.
  24. White, M. D. Expectations in relationships: The flip side of obligations. <http://www.psychologytoday.com/blog/maybe-its-just-me/201008/ex> August 2010. Accessed: 2014-03-10.