Embodied Interaction for Mediated Communication between Children and Parents

Svetlana Yarosh and **Gregory D. Abowd**
Georgia Institute of Technology
School of Interactive Computing, GVU Center
85 5th Street NW
Atlanta GA 30332, USA
{syarosh3, abowd}@gatech.edu

ABSTRACT
We present the ShareTable, a system that draws on the paradigm of embodied interaction to support communication between a parent and a child who may be separated by distance. Informed by this paradigm, we leverage existing activities, artifacts, and routines to help families stay connected by acting through the ShareTable system. Our exploratory work with this system has provided some insight into how embodied interaction may be leveraged for maintaining meaningful contact with children, but has also raised questions about the specific trade-offs involved.

Keywords
Children, family, communication, embodied interaction

INTRODUCTION
Our work to support communication between parents and children that live apart is rooted in the philosophy of *embodied interaction*. We begin with a brief background on supporting remote communication with children and provide a working definition of *embodied interaction*. Next, we describe the ShareTable prototype which seeks to support remote communication with between parents and children in an embodied manner. Finally, we discuss the trade-offs highlighted by an exploratory deployment of the system and posit two questions about designing for embodied interaction.

Supporting Remote Communication with Children
The assumption that a parent and child live in the same household is under question due to increasing numbers of families affected by extended travel for work (e.g., military deployment), incarceration, and divorce/separation. Though there is an extensive oeuvre addressing communication in distributed families (e.g., [7,8,9]), only a small subset of this work specifically addresses communication with young children [3,4,6,11]. Explicitly investigating parent/child communication is important because this relationship is fundamentally different from others: it is defined by asymmetry rather than reciprocity, and it is realized through care and play activities rather than verbal communication [2]. Furthermore, explicitly designing for children is important because children are still in the process of developing many communicational and cognitive competencies, requiring different support than adults do [10]. We discuss *embodied interaction* as a promising paradigm for approaching the challenge of supporting remote parent/child communication.

Embodied Interaction
Dourish [5] defines *embodied interaction* as "the creation, manipulation, and sharing of meaning through engaged interaction with artifacts." Systems that support embodied interaction leverage our inherent abilities to function in a physical world and organize our activity in concert with others according to social conventions. In the case of mediating parent/child communication, an embodied approach is one that allows both parties to leverage their experience of interacting with each other in-person to continue building shared meaning while apart. We aspired to this paradigm in developing the ShareTable prototype for supporting parent/child communication, which we discuss next.

SHARETABLE
The ShareTable system consists of a table in the parent's home and another in the child's home connected via broadband. Each table includes standard videoconferencing to support face-to-face audio/video and a camera/projector system to create a shared workspace (see Figure 1). Video of any object on the surface of one table is transmitted and projected in the same location on the surface of the other table. The user can write on the surface using dry-erase markers, and their marks are projected in the appropriate position on the paired surface. Layering video in this manner allows the ShareTable to be used for activities like reading together, helping with homework, playing many games, drawing together, and more. We describe aspects of the design that were informed by the embodied interaction paradigm and give an overview of the initial deployment of the ShareTable prototype.

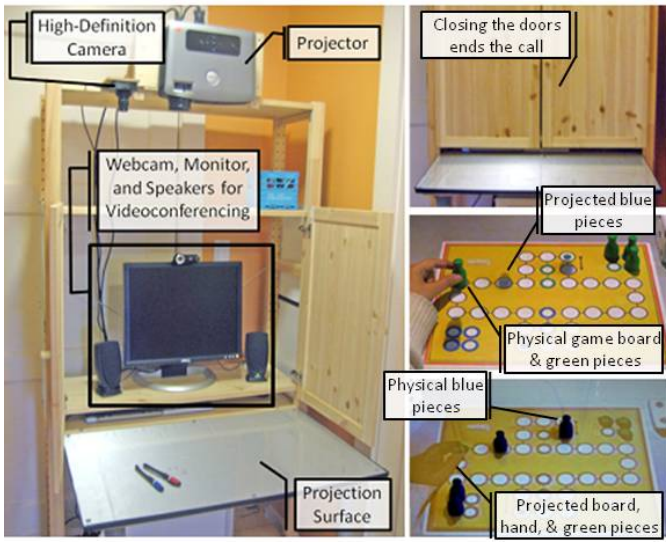

Figure 1. ShareTable with labeled components and surface close-ups demonstrating playing a board game.

ShareTable as Embodied Interaction

Three aspects of the ShareTable design address embodied interaction: (1) interaction through physical artifacts, (2) emphasis on the place where communication occurs, and (3) a physical metaphor for controlling the system.

First, the ShareTable invites the user to share the same physical artifacts they use during in-person interaction. We leverage familiar aspects of interactions like putting pieces on a game board, drawing with a marker, or seeing the other person by looking across the table. There are no modifications required to prepare an artifact for use with the system—anything put on the table will be visible to the other person. The ShareTable does not prevent a user from blocking the view of one item with another, does not enforce rules or turn-taking in games, and does not automatically clear any marks off the table surface at the onset of a new activity. Rather, it relies on cooperation between the two parties and social conventions to moderate these aspects of the interaction.

Secondly, we emphasize the importance of the communication setting by implementing the ShareTable as a piece of furniture with an established location in the home. In doing so, we capitalize on the importance of *place* in mediating interaction in the home and structuring family routines around technology [1]. The ShareTable as a rooted object presents certain boundaries as to where and by whom it might be used. Each family can negotiate these boundaries through the same mechanisms they used to decide the location of a TV, computer, couch, etc.

Lastly, we looked to create embodied ways of controlling the system state. Opening the doors of the ShareTable cabinet answers or places a call to the paired table; closing the doors ends a call. We leverage a physical metaphor to support the child in being able to independently initiate contact and to make it immediately apparent to the users whether the system is transmitting or not.

Preliminary Deployment

We conducted an exploratory lab-based deployment of the ShareTable prototype with 7 pairs of parents and children (ages 7 – 10). The ShareTable was set up in two different rooms at a residential laboratory facility. Each family was invited to use the system to do a worksheet, play a board game, and experiment with the system as they wished. A more complete overview of our findings is presented elsewhere [12], but we discuss a subset of our results here.

We were interested in testing our assumption that management of artifacts, rules, and turn-taking while using the ShareTable would be handled successfully using social conventions. To investigate this, we asked each parent/child pair to play a simple board game. Each side had its own tokens and dice while only the parent's side had the physical game board. According to the rules of the game, when a player moves their token to a space occupied by the opponent's piece, the opponent must return their piece back to start. We were interested in seeing how this interaction would be managed when the opponent's pieces are projected: two pieces physically *can* occupy the same space on the board, and there are no system constraints enforcing the rule of returning the piece to start.

We found that parents and children were quite successful in managing the rules of the game using social convention. Most parent/child pairs explicitly verbally acknowledged the possibility of refusing to move their piece when bumped, but quickly dismissed it as it would "ruin the game" or make the game "no fun." There was a great deal of physical behavior surrounding the bumping of a piece despite the fact that the participants could not physically replace the opponent's piece back to the start. A common behavior was manipulating own game token in a "dancing" motion on top of the projection of the opponents' piece after bumping an opponent. Another key observation was that parents tried to bend the rules of the game to the advantage of the child—children won six out of the seven games played. Parents would do this by giving the child strategy advice and by letting them re-do moves or take extra turns. If we had built explicit game rules into the infrastructure of the ShareTable, this interaction may have been lost. In post-task interviews, two of the parents explicitly mentioned that, despite the lack of access to the opponent's pieces, playing the board game using the ShareTable felt much more similar to playing a board game in-person than using any other computer-mediated channel. The children also demonstrated engagement by requesting to play again and expressing that they wanted to use the ShareTable to play with other remote family members and friends.

Thus, it seems that both parent and children can understand and interact with the mix of physical and projected artifacts provided by the ShareTable. Our exploratory evaluation shows that this approach may be a promising way of

achieving embodied interaction in mediating communication with children. Our current and future work is directed towards a field deployment of the ShareTable to investigate the other two embodied interaction aspects of the system. How will the ShareTable's location be negotiated and how will this decision be reflected in the patterns of its use? Will the physical metaphor for controlling system state be successful in empowering the child to initiate a greater proportion of interactions? Will the current system activation metaphor provide adequate feedback of system state to protect the privacy of its users and non-users?

DISCUSSION

Our work with the ShareTable suggests that the embodied interaction paradigm may be a powerful tool in informing systems for remote parent/child communication. Our design of this system is an interpretation of embodied interaction that highlights a number of trade-offs which may need to be investigated in more detail. We present these trade-offs and posit some questions regarding embodied interaction raised in the course of our work.

Trade-Offs Highlighted by the ShareTable

As designers, we were forced to make particular choices regarding the ShareTable. We were guided by the paradigm of embodied interaction—leveraging existing physical and social skills to support the creation of shared meaning. However, there were three points where the consequences of the trade-off were not clear. These design vectors may benefit from more explicit investigation.

Rooted vs. Portable vs. Mobile System

We made the decision to implement the ShareTable as a rooted system, informed by ethnographic work that emphasizes the role of *place* in domestic communication [1]. Physical arrangements in the home serve to support certain patterns of use, thus a rooted system may be more readily appropriated. However, a portable system (one that can be carried from place to place easily, e.g. laptop) or a mobile system (one that the user could always carry with them, e.g. mobile phone) may be able to provide advantages by better supporting spontaneous exchange, physical activity, and short-term separations (e.g., business travel) [13]. However, portability may increase privacy concerns since such a system can easily be carried to a private area of the home or left unattended, transmitting unnoticed. A mobile system may also increase obligation to communicate, create unwanted expectations of availability, and disrupt household routines. It may be possible to implement asymmetric interfaces for communication (e.g., a rooted system for the child that interfaces with portable system for the parent); therefore, it would be interesting to empirically investigate the portability trade-off independently for each party involved.

Expandable vs. Paired Connection

We made the decision to implement the ShareTable with a dedicated paired connection in order to simplify system use and prevent the possibility of contact between the child and a stranger. However, in the deployment, several children expressed the desire to use such a system with friends Additionally, several parents saw added value in being able to connect the child with a grandparent or another family member. Some of the disadvantages this could introduce may be addressed with small redesigns, for example unique ring tones for each contact could help reduce ambiguity as to who is calling. Instead of resorting to introducing a keyboard or mouse, the physical metaphor could be maintained by providing physical picture tokens representing each contact that the child must place on the system to make a call. However, these solutions do introduce additional complexity that may increase the activation energy required to initiate conversation. More importantly, it may be beneficial for the system to remain a special activity between the child and parent only. As a paired connection, the ShareTable has the potential to become a special routine or ritual for the parent and child, but expanding connections may detract from this "just us" quality. It would be interesting to investigate how systems with paired connections, systems with limited expandability (e.g., four possible connections to assign), and systems with unlimited expandability would be appropriated and negotiated in different ways.

Emulating Physical World vs. Adding Digital Functionality

Our initial assumption in designing the ShareTable was that physical interaction is inherently more embodied than digital interaction—that a game of physical checkers using the ShareTable will be more engaging than a game of checkers played online. The strengths of this approach are in allowing familiar artifacts to be used with the system and in opening the interaction to interpretation and invention (e.g., we can have fun arranging the checkers into different patterns instead of playing the game). However, our approach also introduces some "seams" into the interaction. For example, accidentally moving the physical game board means that the objects and marks on the other side need to be realigned. Some activities are impossible to do with the ShareTable, such as playing a game of cards which requires access to a shared deck. Integrating some digital features could expand system functionality and smooth some of the current seams. For example: using a digital pen instead of a regular marker would allow the system to clear the screen; adding some activity-specific digital accessories (e.g., a digital card deck) would support currently impossible activities; and, implementing modes with specific features (e.g., a "drawing mode" where the projection is always kept aligned to a paper) would make some activities easier. These could potentially lead to richer interaction, but there are also risks in moving away from the open video approach. Introducing modes and digital accessories can increase complexity and detract from the sense of interacting with the physical world that is the current hallmark of the system. However, more investigation would be necessary to understand situations when moving

towards digital interaction is preferable to an overly literal emulation of the physical world.

Questions for the Workshop

In the process of developing and deploying the ShareTable prototype, several questions came up time and again:

1. *How can we measure the degree to which an interaction is embodied?*
   According to Dourish, embodied interaction is achieved in engaging with an artifact when the artifact leverages existing competencies to help the user create and share meaning [5]. It is difficult to translate this definition into a metric. Yet, designers must do so one way or another to make and evaluate decisions on particular trade-off dimensions. Perhaps, identifying antecedents and consequents of embodied interaction may be a first step to being able to design for it.
2. *What are some strategies for increasing the functionality of a system without sacrificing the sense of embodiment?*
   In our work with the ShareTable, it seems that expanding functionality often calls for incorporating additional layers of metaphor and system states that require the user to (at least initially) focus on interacting with the system rather than the activity. The paradigm of embodied computing seems to offer little support in guiding design iteration.

CONCLUSION

Embodied interaction is a powerful paradigm for designing for parent/child communication. It forces the designer to consider how existing skills, knowledge, and routines of the user can be leveraged to support interaction in a new context. The ShareTable prototype aims for embodied interaction in mediating remote synchronous contact between parents and children. It looks to leverage interaction with familiar physical artifacts, a physical metaphor of system control, and the meaning carried by its placement in the home to help families appropriate the system. The ShareTable is at a crossroads where decisions must be made about portability and functionality, but open questions remain about how to gauge the effect of a particular decision on embodied interaction with the system.

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