

# Examining Sensorial Interfaces as the Stimuli for Remote Affective Communication

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**Abstract.** Current communication technologies have a significant role in providing and maintaining social connections and networking, but have not yet been developed to entirely support interpersonal communication, especially in creating and maintaining intimacy and a sense of connection in an intimate relationship, specifically between young adult children and their older parents. Under the emerging trend of ubiquitous computing, this study examines the possibility of creating new means of augmenting intimacy in remote affective communication between young adult children and older parents. From a small target- group, this exploratory study rooted in family communication activities and family life is exploring the possible themes, cues and artefacts that support family closeness but may be missing in conventional communication (audio and video). By generating a group of concepts and new tools for remote family interaction, the findings of this study offer insights into new means of communication tools for supporting family connectedness.

**Keywords:** Affective communication, remote intimacy, wearable technology, interaction design research, sensory enhancement.

## 1 Introduction

The demands of modern life require, more often than not, that adult children move away from their parents and extended family for various reasons, such as continued education, work or to establish a new family creating a new social phenomenon marked by physical separation and modifying the traditional dynamics between young adult children from their parents [5]. The first consequence of this voluntary separation is the reduced contact with and time spent by family members together, creating a larger disconnect between children and parents, a loss of awareness of each other and the loss of a sense of natural intimacy [1, 18].

Due to the development of communication technologies in this information age, a variety of digital devices, instant messaging and social networking services have emerged that support family communication and interaction on a daily basis. Nowadays digital information transfer is the dominant form of communication (e.g. digital text, audio and video etc.) [4]. People use phones, texts and emails to communicate more frequently and with ease, compared to writing old-fashioned letters. Willis [15] notes that mobile devices are “best suited to support the sharing of personal information such as emotional states”. In addition, wearable computational artefacts [7]

such as clothing, jewellery and other accessories have been shown effective for supporting intimate interactions. Jewellery can provide a meaningful interface to meet people's social, emotional, and aesthetic needs [8]. Compared to other devices and objects, jewellery has more intimate and portable properties, being nestled closely to people's bodies.

However, current technologies might not be fully developed to support affective communication across distances [12, 15, 16]. Verbal and visual communication methods are not, however, substitutes for physical togetherness [3]. In the use of digital communication media forms, some of the emotional content and meaning of the message is often lost, compared to face-to-face interchanges or physical mail. "Emotion is communicated to others using a variety of different cues, such as facial expression, vocal intonation and body language" [10]. Communication that occurs without these cues risks a loss of meaning [15]. Therefore, integrating these cues into communication is important in supporting intimacy.

Researchers have investigated how technology can enhance the quality of family communication based on improving existing communication tools, such as sharing photos via a picture blog [1], and augmenting video-conferencing with a camera-projector system [17]. According to Mark Weiser [14], also known as the Father of ubiquitous computing, "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it". This description predicts that current forms of computing technologies will expand in scope and reach to a point where they will be no longer just communication means but will find their way into people's lives until they identify with them [7]. This predictive perspective applies to the topic of discussion and offers a window of opportunity for studying how to integrate digital interaction with everyday objects that might provide new ways to communicate remotely. Associated with the problem of remote communication among family members, this is an opportunity to study various forms of remote communication that can leverage other communicative sensory enhancements to better support intimacy.

In the context of emerging ubiquitous computing technologies, this study explores the sensory interactions in existing communication methods and other day-to-day intimate activities between young adult children and older parents living apart. By conducting mixed methods research, including diary studies and co-design workshops, the investigation hopes to enhance, support or build new forms of affective communication derived from current communication practices, identify possible future design applications and make design recommendations for enhancing the affective experience of remote intimacy.

This study hypothesizes that, by understanding how people attribute affective meanings to things in their lives, it may be possible to transfer those meanings to new technologies. These potential technologies might be able to facilitate new forms of interaction that leverage other sensory ways of communicating to stay in touch and enhance remote intimacy between older parents and young adult children.

## 2 Methods

### 2.1 Participants

In the preliminary diary study, through a combination of purposive and convenience sampling, 2 groups of participants were recruited by email and through referrals from colleagues and friends. The first group included 7 parents (average 52 years old, 2 men, 5 women) who communicate regularly with their children who no longer live at home. The second group contained 8 students (average 25 years old, 3 men, 5 women), who had moved far away from home, and also communicated with their parents remotely. In the co-design workshops, using the same sampling methods, 4 older parents and 6 young adult children were invited to participate in 3 identical, but separate workshops, with 3 participants who had already done the Diary study (1 parent). The 10 participants were divided into 5 pairs to complete the workshop tasks, and balanced for gender, and for participant roles (parent/child).

### 2.2 Objective

The preliminary Diary study was designed to further the understanding of existing communication patterns and to collect inspirational elements from the participating family members. This research method targeted the use of tools to enable remote communication (i.e., phone and laptop), associated artefacts, themes related to family conversation or emotional experiences. Participants recorded two instances of their communication activities with their parents/children within a specific time frame. They noted the following: who they spoke with, the tools, locations, duration of the communication, and a description of the technical aspects of the communication process. Then, the data from the Diaries was used to generate materials for further investigation in the workshops. For example, 8 participants (4 parents and 4 adult children) recorded that family photos reminded them of the time to be together. Family photos in various forms then became an object for consideration in the subsequent workshops.

The objective of the workshops was to explore whether, by applying new technologies to some of the memorable objects in the participants' daily lives, different kinds of interactive communication tools would emerge. In addition it was important to understand the way people imagined that they would respond to these non-traditional tools.

Each of the 3 workshops consisted of two exercises. The first exercise used card sorting to explore the meanings and nature of different communication messages, and aimed at finding answers to the following questions:

1. What is the nature of these messages and how would respondents categorize them?
2. Which or what types of messages are important to them?
3. Which or what types of messages would they prefer to use in communication?

Based on the first exercise, the second exercise required the participants to create prototypes and scenarios focused on examining the possibilities for creating new interactive tools that they would be willing to use.

1. What type(s) of communication tools would the respondents develop if they could?
2. What would be the imagined inputs and outputs used to represent the conveyed messages?
3. Compared to traditional tools, what type(s) of messages could the respondents convey via these envisioned communication tools?

### 2.3 Materials

MESSAGE CARDS	How are you doing today?	Express my concern
	I miss you	Recall memory
	Is everything ok?	Togetherness/Connected
	Share my emotion	Health
	Kiss	Blessing/Praying
Smile	Birthday celebration	
OBJECT CARDS	Necklace	Lamp
	Bracelet/ Watch	Teacup
	Glove	Family photo
		Other

**Table 1.** Content of Message & Object cards

The materials prepared for this study included: cards for sorting, kits of props,, recording and video recording devices, and instruction sheets. First, 2 types of cards were generated following the input data analysis obtained from the initial Diary study. The first set consisted of “message” cards, which included 13 types of messages used for exercise 1. The other one was a set of “object” cards that the preliminary diary participants found meaningful for demonstrating intimacy; they were used for exercise 2. The content of cards is exemplified in **Table 1**.

The kits of props were also prepared to support the participants' attempt to develop ideas and models inspired by the “object” cards, and included: paperboard, teacups, gloves, mini-flashing lights, sticky notes, markers, scissors and glues etc. They were meant to help participants implement creative ideas in physical forms and share them with others. Additionally, instruction sheets were prepared to help participants understand the tasks more clearly. To record comprehensive data, workshop organizers setup recorders during each workshop.

### 2.4 Procedures

#### (1) Exercise 1:

The first exercise was a card sorting game for both adult children and the parents. Each card contained a message idea derived from the Diary study about what participants might want to communicate, such as “I miss you” or “How was your day?”. They were asked to identify what type of messages were most important to them when communicating with their children or parents. The exercise contained 3 steps, followed by a presentation as described below:

- a) Each group sorted each message into categories and gave those categories names;
- b) They ranked most likely messages that they would use within each category;
- c) They prioritized these categories and discussed which categories would be the most important ones to share with their family member who was far away;
- d) Finally, each group shared their selection/choices with the rest of the participants in the workshop.

**(2) Technology tutorial:**

*a)* After completing the first part, the organizers gave a simple and short tutorial about how technology can enhance any object, including wearable technology, to provide the potential for intimate communication. The idea was to introduce the concept that technologies can be integrated into the types of objects that the Diary participants had associated with their family communications. In addition, this would provide participants with the basic knowledge they might need to participate in the second exercise.

*b)* In the tutorial, organizers discussed how current technologies have been greatly improved, enabling people to explore new ways to approach everyday activities and to communicate. Heart rate monitors and pedometers were used to demonstrate examples of wearable technology. The idea was that participants might already be familiar with items like these, which use computer chips or sensors to add smart functions or new features to wearable devices.

*c)* To ensure participants had the same understanding of technology principles the organizer explained two important elements in designing smart and interactive objects: input and output. The simple example of a flashlight was used to demonstrate the inputs and outputs, and to help them understand how to effectively use them to create the envisioned features and functions for communication. After learning this basic concept, the workshop proceeded to exercise 2.

**(3) Exercise 2:**

In the second exercise, the teams were asked to pretend that they have a magic object that can connect with their family member who is far away. Each team could choose one or more object cards representing an object that they could imagine having in their environment. It would be an object they would like to be able to use to connect with their family member.

*a)* Participants were asked to pretend that the objects they chose could have input and output at both ends that somehow would enable them to send messages to one another in a way that does not use words. They were asked to identify 2 or 3 kinds of “magic” properties that would enable them to share the important messages they identified in the previous exercise. They had 10 minutes to discuss and decide what special functions the object might have and what the inputs and outputs for this way of communicating would be, in terms of what would people do with the object and how they would see it and feel about it.

*b)* After participants decided what they wanted the object to actually do, they used the supplies provided in the kit to make a rough physical model of the object or objects in 10 minutes, making sure that the objects included the input and output features.

*c)* Based on the ideas and models they developed, each team spent 10 more minutes to create a user scenario. They sketched step-by-step pictures to illustrate the ways that they imagined their object would work.

*d)* Finally each team had 5 minutes to act their scenarios out and explain how their object works.

### 3 Findings

#### 3.1 Messages

Rank	Category No.1	Category No.2	Category No.3	Category No.4	Category No.5
Group1	How are they	Share our emotion	Happy times	Say something at the end of a communication	
Group2	Wellbeing	Temporary missing	Emotion casual	Events/Festivals	Blessing
Group3	Express my concern	Recall memory	Togetherness /connected		
Group4	Concern	Special greeting	Daily greeting	Physical expression	
Group5	Personal wellbeing	Communication	Events		

**Table 2.** The categories generated from the card sorting exercise and corresponding three main categories

In the first workshop exercise, participants categorized information based on their understanding of the properties of 13 messages; and the methods they used to prioritize categories referred to their personal preference and the sequence of communication in a colloquial sense, like which message would be used at the beginning or the end of a conversation. The results in **Table 2** outlined the categories created in each group. According to the titles of the categories and their interpretations, these messages were refined to three main categories, which interconnect and illustrate a regular pattern of family remote communication scenario. They were: “Expressing concern & wellbeing”, “Emotion” and “Memory & togetherness” respectively.

#### (1) Expressing concern & Wellbeing:

The first type of message, graded by frequency of preference, was “expressing concern and wellbeing” above any other type of message. It tied in with the inquiries about “health” and “wellbeing” (example: “everything is ok?”). From the 5 groups’ discussions, they all stated that “expressing concern”, “asking about health” and “wellbeing” (is everything ok) were part of the routine of daily greeting at the beginning of a conversation. This type of messages was the most preferred expression that could extend to any other sort of messages or topics.

#### (2) Emotion:

The second type of message was tied to expressing emotion, and they included messages like “I miss you”, “smile”, “kiss” and other emotions. People were unable to share some emotions due to the limitations of current communication methods, or they preferred not to exchange some emotional information so that family members would not worry about them. However, they elaborated in their communication with intimate family members that they wanted to know more information about their relatives. An adult child stated: “with my parents, I rarely share my emotions with them. Especially when I’m not feeling well, so I do not want them to know that, but I would like to find out if my mom is healthy and only then maybe share what is going on with me.”

#### (3) Togetherness & Recalling memory:

Another type of information refers to what can be grouped into the theme of “Memories and Togetherness” content that is more in-depth and personal. Togetherness was best expressed in the time parents and children used to spend together, like a home visit, family activities and other special events. Participants did not place this category at the top of the list because current means of communication do not emphasize memories. However, the preliminary Diary data indicated that togetherness and memories bring people closer together, because by recalling such memories and by sharing similar sensory experiences, family members feel more connected.

### 3.2 Objects

In the second exercise, each group selected one or two object card(s) to develop the ideas of communicating through new tools (Figure 1). Their choices focused on wearable objects (i.e. watch, bracelet and necklace etc.), teacups, and family photo frames.

#### (1) Wearable:

The participants chose the objects in the brainstorming section of the workshops and also identified the portability and accessibility as important factors to consider. The group discussions indicated that watches and other wearables (bracelet and necklace etc.) were chosen most frequently because their portability and accessibility would allow participants to communicate without the limitations of time or location. Group 1 stated they would prefer something that would always be with their children, to make it easier and possible to reach the children anytime they want. Group 2 thought the watch could be a clue for an incoming message.

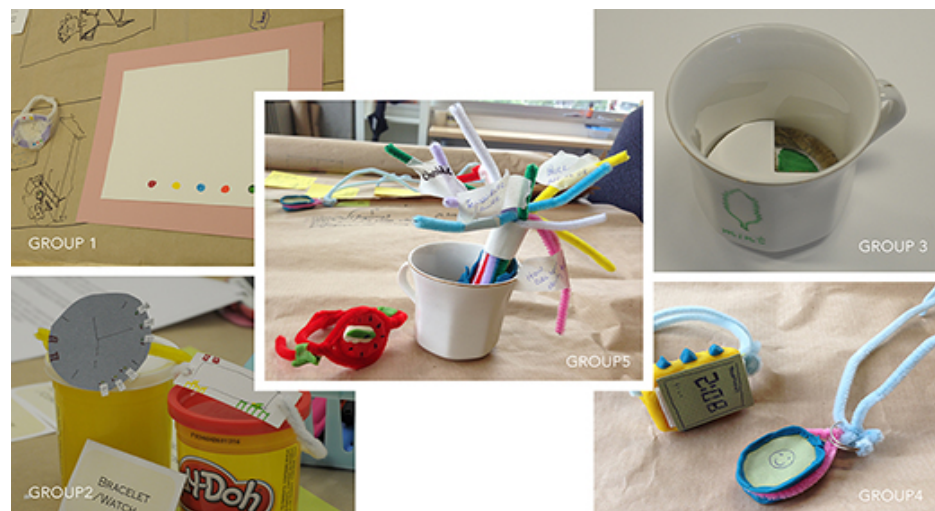


Figure 1. Object models developed by the five groups

#### (2) Teacup:

Two other groups generated the idea of making *magical teacups* as possible means to convey the message of “togetherness” and “recalling memory”. They conceived *teacups* not just for drinking, but also because they triggered rich meanings by associa-

tion, such as togetherness and warmth. From the observation of these groups' discussions, mealtime or teatime past experiences were found to contribute to the creation of memories associated with togetherness. Using tableware like teacups could possibly evoke similar sensory (scent) experiences of those memories, which might create an invisible connection with or elicit an emotional response from a family member.

According to the participants' imagination, different teas/scents represented different meanings. If the teacup had a certain database to recognize these meanings, participants could share emotions, send meaningful messages, or even allow them to drink the same type of tea "together" over the distance. Group 3's concept was a rotating mechanism with a flavour palette and mesh at the bottom of teacups; each type of tea represented a different emotional message (e.g. mint tea is equal to stress and anxiety; strong green tea is equal to trying to stay with your work). Another group created a special dropper tool, which was used to drop different dyes into the teacup. Differently coloured dyes represented different messages participants wanted to convey and send.

### (3) Family Photo Frame:

One group also selected the photo frame as a form to communicate memories, and they stated that family photos represented one of the most direct and familiar means to express yearning for family members. They developed an interactive digital photo frame for the parent, and used the space on the photo frame to create an interactive screen for communication.

### 3.3 Inputs & Outputs

Inputs and outputs in general provide more information for analyzing the features of these conceptual models and the remote interaction process. These inputs and outputs could communicate through related sensory channels [9]. By analyzing the nature of inputs and outputs in the dimensions of sensory modalities (vision, touch, auditory and smell/taste) and their relevant roles (Table 3), two types of inputs were defined: active and passive, as well as separate types of outputs used for presenting signals and actual messages.

	INPUTS		OUTPUTS	
	Active	Passive	Signal	Message
Tactile	Touching/Knocking/Slide Writing/Drawing Pouring/filling liquid	Temperature Heart rate	Vibration	
Visual	Rotating dial (Watch) Rotating flavor palette (teacup) Camera	Color	Flashes/ Light	Colors Graphical image Projected graphic, shape Photo/Video Freehand drawing / text Light: Intensity/Frequency
Smell /Scents		Dyes Tea(i.e.Mint) Smell & scent Database of Favorite Food/drink	Smell	Tea Favorite Scents
Auditory			Alert sound	Voice

Table 3. The Categories of Inputs (Active and Passive) & Outputs (Signal and Messages)



In Table 3, Touch plays a dominant role as an input. There are diverse actions that could enable people to initiate a connection to each other. Active inputs are the actions participants would do to trigger a contact, like touching a button, writing or pouring liquid. A single person usually completes them at the initial stage of a communication. In contrast, passive inputs do not need people's active involvement, they are more like experiencing some physical properties of the objects themselves, sensed by devices, such as body temperature, heart rate and scents etc. These properties decide the expressions of emotion or mood. The comparison between the two types indicates that active inputs concentrate more on the tactile sense; but passive inputs have more variations distributed across multiple senses.

Also, the outputs could convert into 2 categories based on their roles and the order of communication. The initial outputs send the recipients signals that are necessary requirements to establish a connection. This type of output is noticeable by or visible to the receivers, like vibration, flashlight, and alert sound, which are common and already exist in traditional devices. Another variety of outputs represent the actual messages sent. These appear to be more varied by comparison to the signal outputs, using features such as: image, color, handwriting/drawing and scents. Vision and smell are the dominant senses associated with these messages. For instance, Group 2 proposed using handwriting/drawing to communicate on their wearable tools instead of digital text. The parent participant generated the following idea: "Think about if I wake up in the morning, my son just returning something that would show up on my fridge. That would make me happy. Like a drawing or something in his own words that I could see. Almost like texting but it is more intimate and actual, or you could even see them while they are writing, and then I would feel more connected by writing there".

Vision is the most appropriate sense to receive some forms of information such as: colour, shape, image and light intensity/frequency. The participants were consistent in applying colours to implement their ideas, possibly because colours are selectable and distinguishable, thus allowing participants to easily code the message with meanings they wanted to convey. In other words, an ideal interface for a communication tool requires selectable properties in order to present different messages in different scenarios. The diversity of visual outputs could meet such design criteria. For instance, Group 5 used different dyes for the magical teacup and lighting points on the watch representing different interpretations. "Yellow" meant peace/ "All is ok", and "Blue" was "Ken's favourite flower scent".

The models of the novel teacups revealed the potential association with the sense of smell. It could be a sign that in addition to the dominant sense of vision, it is also possible to explore other new types of sensory stimuli to enhance emotional experiences over long distance. Even though scents seem subtle and invisible, they have strong connections to personal memory identification. The magical features about scents that have been explored in this study could constitute an alternative means for sharing emotions and helping people feeling more connected.

Last, the auditory sense was less emphasized than the other senses. Only a few groups in this study mentioned the talking functions and alert sounds, which were similar to conventional means of communication, like the telephone and other instant communi-

cation tools primarily driven by verbal communication. This observation suggests that the participants were successfully removed from traditional verbal means of communication in the workshops, and were able to explore possible non-verbal interactions.

#### **4. Discussion & Conclusion**

***(1) Conventional communication methods cannot convey all types of information; in the future they could be enhanced by different sensory means of communication.***

The study results indicate that conventional means of communication cannot transmit all types of messages that participants would like to send to family members.

Conventional means of communication offer the opportunity to share more concrete meanings and physical content, including greetings, expressing concern, and discussing daily activities, but miss the more personal and emotional information, such as those found in the theme of “Togetherness and Memory”. This theme relates to the meaning of intimate experience in the sense of physical togetherness, which has been used to define intimacy in literature [3]. However, it has also been found through association with memorable artefacts rather than digital devices.

The investigation of emotional expressions also identified some “concerned”, “inquiring” or “speechless” signals in communications, which revealed the non-verbal properties of family communication. Remote intimate sensory experiences are constructed with verbal communication as well as non-verbal communication. Still, non-verbal communications could help build the closeness in a parent–adult child relationship [1]. Current means of communication primarily function by exchanging verbal messages that allow people to express concern. Yet, existing literature and the current study suggest that regular video and audio methods cannot transmit some non-verbal cues of people’s affection [2], such as the sense of togetherness, memories and some less expressive emotions. This study explored a set of new tools, elements, and scenarios to support situations using non-verbal information as an alternative to the current verbal means.

In general, the study identified three main themes used for family interaction over long distance: Expressing Concern, Emotion and Togetherness/Memory. These dimensions, or themes could help to better understand the nature of remote intimate communication between young adult children and older parents. In the meantime, it suggests that current digital communications are limited in conveying intimate meaning, which might otherwise be possibly carried by particular everyday artifacts.. These findings identify a possible gap in current interaction features. That could encourage designers to benefit from the use of memorable objects, and to explore potential new interaction tools that are able to convey richer types of information.

***(2) To augment the behaviour of parents and children through a sensorial interface for engaging in remote intimate experiences, designers need to shift focus from screen-based interfaces to a wider range of sensorial interfaces.***

The concepts for envisioned interactive tools explored in this study provide insights into developing sensorial interfaces that could augment remote intimate experiences between older parents and young adult children. The findings led to an understanding of some elements and features, which could be used in designing potential interactive objects. This study argues that context adaptability and non-screen based forms could be the new ground breaking features that future interfaces are required to have for remote intimate communication.

Context adaptability is particularly relevant to the form of wearable tools. Combining the general context of ubiquitous computing and intimate computing, this study suggested that wearable computing could be an effective form of intimate interaction that enhances intimacy between people and technology, as well as person-to-person relationships/interactions. Wearable objects are context-adaptable due to their portability and ability to connect remote people to each other without time or location constraints. Furthermore, wearable objects can be passive forms to enhance technological abilities [11], to detect affect, and to exchange emotional information by sensing body motion or heart rate.

Integrating both the findings of the present study and the discourse about future trends in technology, the present study proposes moving beyond screen-based interfaces to more diverse forms rooted in daily lives. The variations of these forms can support remote communication in two different ways. First, they could provide more types of sensory feedback and personal information that cannot be supplied by current digital communication, and potentially enhance the extent of intimate awareness [13]. For instance, the results identified that smell channels are strongly tied to the meaning of memories, family stories, and other personal attachments. Teacups were the initial models for communicating scents. Second, natural gestures rooted in daily activities could also be incorporated into new interfaces, not just touching a screen and buttons. These features fit into the general trend to create an integrated experience, a smooth hybrid of real world and digital interactions [6].

### ***(3) The limitations of the study***

Due to the time and resource restrictions, the sample size was small. As a result, the inspirational materials of messages and objects used in the workshops were restricted in forms. These factors limited the diversity and creativity of the concepts when developing new interactive tools. To explore more possibilities and creative ideas for new interaction methods, future studies in relevant areas should aim to involve a broader sample of participants and more variations of materials.

Another limitation was the adaptability and suitability for applying these new means of interaction. This research explored a few user scenarios that might not be suitable for all contexts. Intimate experiences are influenced by cultural/ local background and individual family stories that may not be shared by a larger group. The metaphors and elements explored in this study might have different meanings in different cultural backgrounds. Therefore, to propose these new interactive methods for family communications, designers may need to develop highly customized forms of communication tools associated with personal attachment and preference. In that case, more user

scenarios tied to different cultural backgrounds for intimate interaction would need to be investigated. Future interactive tools should also be more flexible to fit the context.

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