TableTalk: Integrating Personal Devices and Content for Commensal Experiences at the Family Dinner Table

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ABSTRACT
This paper joins the ubiquitous computing scholarship that investigates the use of technologies in collocated shared settings like family mealtime. Family mealtimes are an important site for fostering togetherness, sharing everyday experiences, and nurturing familial ties. While technologies, especially television and personal devices are often criticized for disrupting the social aspects of mealtimes, they are widely available and commonly used nevertheless. In this paper, we explore this tension and present a novel system *TableTalk*, which transforms personal devices into a communal shared display on the table to enrich mealtime interactions and experience. Our field study shows that TableTalk does not undermine togetherness, but supports familial expectations and experiences by stimulating conversation, reminiscing, bonding, education, and socializing. We discuss how technology that is sensitive to the needs of family interactions can augment the commensal experience and reflect on design choices and opportunities that contribute, rather than disrupt, family mealtimes.

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H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

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Commensality; food; family mealtime; smartphone.

INTRODUCTION
Despite the evident 'coming together' of individuals and families during mealtime and the proliferation of information and communication technologies (ICTs) in this space, there has been a general resistance to technology usage at the dinner table. It has been accused of encouraging unhealthier food practices [6], detracting from positive familial interaction [13], and taking attention away from enjoyment of the meal [40].

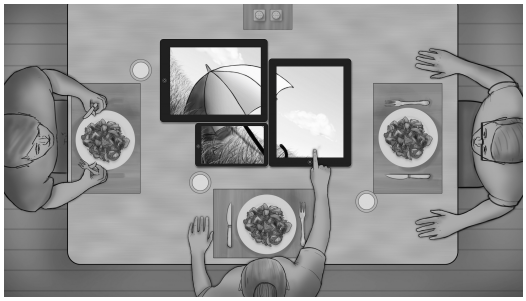


Figure 1: TableTalk. Family members bring their devices (e.g., smartphone and tablets) together to create a single display.

Yet, recent research has demonstrated the potential for positive outcomes from ICT usage during mealtimes. For example, technology can be used to encourage children to eat [14], provoke familial conversation [35], or enhance our experience with the meal through digital augmentation [14, 39].

In this paper, we explore the relationship between technology and our everyday *commensality*, typically defined as "the practice of sharing food and eating together in a social group such as a family" [34]. Commensality is not simply about the act of eating together, but also alludes to shared dependency, accountability, storytelling, planning, socializing children, reciprocal commitment, and other social, political, material, and cultural aspects of the mealtime experience [12]. We extend recent UbiComp and HCI research about commensality [16, 35, 42, 44] and explore the potential scope for interventions in its social and material configuration enacted through the ubiquitous presence of smart-devices at the dining table. We investigate how a detailed understanding of commensality informs the design of new technologies and how such technologies might reconfigure our practices of shared mealtimes.

To this end, we present *TableTalk*, an application that integrates the personal devices of mealtime guests into a single shared display (Fig. 1). The aim here is to enable the sharing of personal content (e.g., photos, music, social media posts) for the collaborative construction of a mealtime experience. TableTalk both embodies elements of commensality in its design (e.g., conversation, accountability, etc.), and also supports commensal experiences through its design (e.g., togetherness,

shared reminiscence, etc.). We do not expect TableTalk to be incorporated seamlessly in for all families or for every meal, nor do we aim to fix the problem of technology being a disruptive force for some families, but hope that our work will reveal novel insights of technology usage during family mealtimes.

Further to presenting the system, we aim to understand how different design aspects impacted commensal experience and the evolving behaviors around this device ecology. Through a field deployment study of TableTalk with nine families, we derive practical insights into how digital technology can be designed as a part of commensal experience to support and configure shared space, data, narratives, and subsequently, interactions. Specifically, we consider the implications of the design on commensality in the (1) physical setup of devices and choice of personal content, (2) familial interaction with and around the technology, and (3) impact upon various aspect of everyday commensality. Finally, we offer new opportunities for design and novel understandings of the potential role of technology for commensality in the family home.

RELATED WORK

Commensality and Technology

The consequences of sharing food with others extend far beyond the food itself. Meals have always been a source of social interaction, heritage, enjoyment, and celebration [4]. Hence, family mealtimes are an important site for the construction of social capital. This in part relates to the organization of food consumption, such as the work done to encourage children to eat [14, 26] or the etiquette of sharing and coordination in eating [12]. But there are additional social manifestations when families come together to share a meal [8]. Eating then does not just serve a biological need for consumption, but is done in a social context and as part of critical social functions [12].

It has been reported that about 50% of the US families have a television in their dining area [7, 17] and as much as 60% families watch television during mealtimes [24, 37]. While these statistics represent predominantly western culture, television is a widely used technology during mealtimes. Recent research has demonstrated the growing presence of mobile networked devices at the dinner table [11, 31] and the emerging trends to augment food and drink with multimodal sensory inputs [39]. What is underexplored here is the possible role and significance of technologies in contributing to togetherness during such commensal meals. If commensality is considered as melding "the public and private spheres" [19] by including some people (who are invited to share the meal) and excluding others (who are not), we ask if the same can be said about associated technology and media consumption. Is technology able to act as a socially integrative force during mealtimes?

James Lull [28], in this regard, shed light on how TV narratives can trigger discussions among the parents and children to reinforce family values. While shared communication technologies (e.g., television, radio, etc.) are often welcomed during family meals [20], personal devices are viewed as creating tension amongst family members and are often managed through varying family norms and restrictions [11]. Moser et al. [31] identified different factors influencing family members' attitudes towards technology usage during mealtimes and argued for incorporating social awareness features into mobile phone systems to alleviate tensions and conflicts among the family members regarding such usage. Hiniker et al. [18], on the other hand, discussed the differences and consequences of restrictions parents impose among their children's technology usage vs. their own during family mealtimes and recommended finer control over contextual constraints regarding technology usage. However, how the presence and usage of these mobile and networked devices have impacted the social settings of family mealtimes remain largely uninvestigated.

Recent research has also explored how such personal devices can often be used as a shared resource [5]. It has been noted that people use technology in shared ways, even when devices are designed for individual use [38]. Yuill et al. [45] investigates the social interactions and associated enjoyment of shared drawing amongst a group of children using one tablet device. Aside from technological affordance, their work demonstrates how the use of personal devices is shifting from solitary work to shared interactions, togetherness in ownership, and the evaluation of content as a group. We ask if such togetherness is also reflected in the social and material configuration of technologies through which commensality is achieved.

Social and Material Configuration at Family Mealtimes

The social and material configuration of participants around mealtimes reflects and influences interactions between them [12]. Commensal experience in the family is typically democratized nowadays [12], with spatial configuration supporting equal opportunity for each member. Hupfeld and Rodden [20] provided a detailed account of the everyday practices associated with domestic food consumption and how it relates to the ecology of mealtime artifacts and spaces - both technological and otherwise. Ferdous [10] also discussed how families configure their dinner space and technologies within to ensure best possible media experience for all members. TableTalk aims to support such equal opportunity for all members both in accessing the shared devices and the content.

Recent studies have also explored the use of technology to create new material configurations for mealtimes. An interesting example concerns remote dining experiences enabled through the use of videoconferencing [23], thus extending the research space from collocated mealtimes to remote sharing of dining experiences. Wei et al. [44] extended this approach further to create a dining table embedded with interactive subsystems to create a sense of coexistence among remote family members. Using existing and available ICTs, Grevet el al. [15] demonstrated that even very minor social connectedness could improve the dining experience of solitary eaters. Nawahdah & Inoue [32] and Tsujita et al. [42] took this further to share video recorded meals with others in a time-shifted environment. Though experimental, these developments highlight the potential of technology to augment the physical/virtual dining space to enhance the commensal experience and opens up to explore how such augmentation impacts the shared narrative and togetherness during family mealtimes.

Sharing Narratives and Content

Mealtimes are a site for the exchange of narrative accounts of personal and collective significance [30, 34]. Through

such exchanges, there is a social construction of shared family knowledge, sensibilities, and moral perspectives [25]. So it is not the family conversation per se as the concern, but the bonding nurtured through such means [12], and other practical (and sometimes intentional) opportunities [8, 12, 34], i.e., family accountability, event planning, educating and socializing children, etc. that have also been of interest.

In the domain of Ubiquitous Computing and HCI, the role of technology, in particular, digital artifacts such as photographs has received significant attention in terms of supporting these activities. Collocated photo sharing in social groups has been used as a means to stimulate conversation [43] and to engage in shared reminiscence [35]. One notable aspect of photo sharing is the asymmetrical nature of interactional control that concerns the ownership of the photo or the device [27], and the conversational asymmetry arising in this context [43].

There are three different approaches to these control dynamics. The first one is **distributed content**, where digital material is pushed to the personal devices of all participants so that everyone views the content independently on their own device, as illustrated by Ah Kun and Marsden [2]. It allows simultaneous viewing, but does not support point-and-tell interactions (since all individuals have separate devices) and takes attention away from a common focus and shared interaction (i.e., mealtime).

A second approach involves using a **shared resource**, for example, a projector or a television screen to display content from all family members, thus utilizing the large screen real estate and off-the-shelf hardware. But not all families have these available in the areas where they eat, and this approach is often criticized for taking attention away from the shared interaction space (i.e., dining table) and from each other. One creative response is the *4Photos* table centerpiece prototype [35, 41]. It consists of a custom-designed 4-faced photo display to fetch and show photos from the Facebook collections of the diners and supports equal viewing and control of the system to all diners around the table. But custom hardware requires extra effort to procure and makes ad hoc deployment very difficult.

The third approach is illustrated by Nielsen et al. [33] who brought together personal devices to create a **shared display** for all users to see. Instead of introducing additional or custom-built technology as in 4Photos [35], a centerpiece can be created by bringing personal smart-devices to the table and connecting them through 'pinching' to make a shared display [36]. Nielsen et al. [33] used this approach to share photos in lab settings without any particular usage context in mind. We extend this concept by introducing multiple digital formats and by taking it to the family dining room. Through TableTalk, we aim to enable the use of family members already available personal devices and content and reconfigure these as a shared resource for family mealtimes. TableTalk seeks to bring family members together spatially, facilitate interaction, and encourage conversation from all members including children.

TABLETALK DESIGN PROCESS

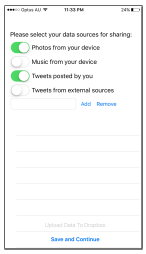
TableTalk was conceived and created through three phases of user-centered design process. Firstly, we sought inspiration through provoking an open discussion in an online user forum (*www.ozbargain.com.au*) by asking, "*Do you use phone, television, or any other device while you eat meals?*" The analysis focused on the commonly used technologies, the social interactions around them, and different family norms or expectations and showed the distinction in technology usage for different social groups, time settings, and the meal itself.

Based on these initial understandings, we designed phase two of this study, conducting an in-depth observation (a home tour, two interviews, and two self-recorded video of family meals) of the existing use of technology during mealtimes in six family homes. We focused our analysis on the family's current mealtime routine, identifying the available technologies and their spatial arrangement during meals, and discussed family norms and practices associated with technology usage along with their impact on commensality. This study highlighted that the attitudes towards technological practice at mealtime reflect the socially enacted values of commensality. This was particularly evident with the use of personal devices at the dining table, which were generally avoided for individual and isolating activity (e.g., browsing social media, gaming, etc.). But when the same technologies were opened up for shared interest or activity (e.g., searching something to support the ongoing conversation, sending a quick text to ensure family's wellbeing), through which various facets of family relationship could be enacted, then their use was held less to account.

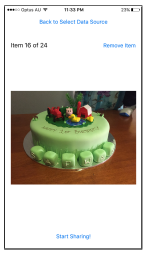
This led to the initial concept for TableTalk - to transform personal devices into shared resources by combining displays whose content and access is negotiated amongst the family (Fig 1). TableTalk exploits our everyday dwelling with these devices and offers a way to bring them together in the context of collocated interaction in shared environments. With this goal in mind, we conducted two design workshops of about one hour each to generate ideas for various design aspects of the TableTalk system. Eight researchers joined each workshop, composed of research students, postdoctoral researchers, and faculty members. The workshops were video recorded and notes were taken about different ideas generated. We developed a prototype of TableTalk and refined it through pilot studies - both in lab settings and family homes, before deploying for the field study (phase four).

THE TABLETALK SYSTEM

Family members open the TableTalk app on their personal device before the meal begins, and make their choice of data sources for sharing, e.g., photographs, tweets, music, etc. (Fig 2(a)). From each device, TableTalk randomly choses 20-30 different items from their approved list of data sources, prioritizing more recent items. Participants then scan each item to confirm that it is suitable for sharing (Fig 2(b)). Those who prefer not to share any data are still able to participate - first for creating the sense of contribution and then increasing the total display space. Family members place their individual devices on a 'Lazy Susan' (or rotating tray) on the dining table so that they are touching each other. A pairwise 'pinch' action (Fig 2(c)) between all devices creates an enlarged single screen that spans all the devices, forming a new integrated shared display (Fig 2(d)). The rotating Lazy Susan facilitates easy viewing from any position (Fig 2(e)). Items from the individ-

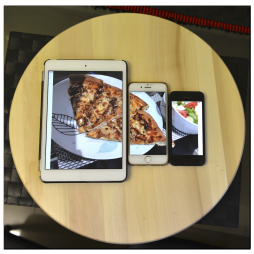


(a) Participants open up the app and choose content sources



(b) Participants moderate the contents before sharing

(c) Devices are placed together and pinched to join screens



(d) Each item is displayed for 30 seconds. Families can rotate the Lazy Susan to have a better look

(e) Family members interacting with TableTalk (published with permission)

Figure 2: Interaction steps for TableTalk. (a & b) denotes activities before the meal, (c, d, & e) are performed during the meal.

ual devices are randomly presented on this enlarged single display. Photos and tweets are displayed for 30 seconds, while music is played for 30 seconds and then faded out. Family members can interact using simple touch and swipe gestures on any device - a single touch pauses the system, a swipe left gesture brings up the next item, and a swipe right gesture allows them to return to an earlier item for reference.

TableTalk utilizes iOS's *Bonjour* zero-configuration network protocol [22] using available Bluetooth or WiFi networking. We used the 'Pinch' framework [36] to join displays of multiple devices and extended it to support tweets and music too.

FIELD DEPLOYMENT

We conducted a field study to examine the ways through which TableTalk influences social interaction during family mealtimes. We were particularly interested in the following aspects: (1) configuring the personal devices for shared physical and social space, (2) familial interactions with and around TableTalk, and (3) influence on different aspects of commensality.

Participants and Protocol

We deployed the prototype with nine families. The families were recruited through university mailing lists, notice boards, authors' extended social networks, and local community Facebook groups. As criteria for participation, families had to regularly engage in shared mealtimes and consist of at least two members (with/out children). As summarized in Table 1, we recruited families from different socio-economic backgrounds, with and without children, aiming for diversity in terms of family dynamics and experiences rather than generalizability.

We began the initial visits at participants' home with an interview with all members of the family including children (aged over 5 years). When available, family members installed the TableTalk app in their own personal iOS device. Otherwise, we offered them iOS devices to use during the study period and assisted them to migrate their data from their smartphone. We discussed the typical organization of mealtime routines in the context of the normal day-to-day life of the family and how these practices might relate to the pragmatic demands and moral order of their family life. We gave the families video cameras to self-record two of their family mealtimes - one during weekdays and one at weekends. We tried to minimize video observation induced bias by asking the participants to place the camera so that it could obtain a complete view of the table and surroundings. The video recordings of the family mealtimes were about 30 to 45 minutes long. Additionally, we collected log data of user interactions using the app and the shared content. We analyzed the first interview along with video and app data, and returned to the family to conduct a second interview. We used this data to generate discussion and focused on any specific episodes that related to their commensal experience. Both the interviews were about 45-60 minutes long. Each family received a $30 iTunes gift voucher.

Data Analysis

We used an inductive, qualitative analysis approach to the data [29]. In particular, we focused on who used TableTalk, how it was used, and how it might support different aspects of commensality. Further we were interested in any relationship between individual interaction and the group dynamic, for example, whether parents facilitated turn-taking, whether they encouraged children to speak, etc. We also noted the spatial arrangements of the devices and other artifacts on the table during these meals. We analyzed the interview transcripts, video recordings, and app data to add detailed notes of all interactions with TableTalk and among the family members. These notes were refined through discussions of the authors. This analysis was done iteratively to identify common themes across families as well as unique family practices.

FINDINGS

Setting Up the Physical Space and the Social Space

Our design goal was to emphasize the shared experience and togetherness through using participants' already available smartphones or tablet devices and the contents within. As noted previously [1], such devices held our personal data in a never-seen-before scale, and we wanted to leverage this opportunity. To the best of our knowledge, collaborative and social use of personal smart-devices during mealtimes has not been investigated before, so we were concerned about how such an arrangement might work in practice.

Physical Arrangement of Devices during Mealtimes

An initial concern was the physical setup of TableTalk at the dinner table, i.e., how families would place their phones and tablets to ensure they are accessible and readable, and how these devices would blend in with other artifacts on the

	Family Members	Devices Used	Number of Items Shared
Family 1	Mother (student), Father (part-time job), 1 Child (1 yo)	iPhone 6, iPhone 5*	Photos(28), Ext. Tweet(17), Music(2)
Family 2	Wife (student), Husband (student)	iPhone 5*, iPad Mini2*	Photos(80), Ext. Tweet(20)
Family 3	Mother (student), Father (full-time job), 2 Child (12 yo & 17 yo)	iPhone 5S, iPad Mini2, iPad 2	Photo(53), Music(4), Ext. Tweet(9), Personal Tweet(4)
Family 4	Husband (student), Wife (Housewife)	iPhone 5s, iPhone 5*	Photo(66), Music(2), Ext. Tweet(14)
Family 5	Mother (academic), Father (businessman), 3 Child (12 yo, 16 yo, & 18 yo)	iPhone 5, iPhone 6Plus, iPad Mini, iPhone 5, iPhone 5	Photo(56), Music(5)
Family 6	Father & Mother (both full-time job), 2 Child (14 yo & 16 yo)	iPhone 6, iPhone 4S, iPhone 5	Photos(44), Ext. Tweet(3), Personal Tweet(4), Music(2)
Family 7	Husband (part-time), Wife (full-time job)	iPhone 6Plus, iPad mini2*	Photos(44), Music(8)
Family 8	Husband & Wife (both full-time job)	iPhone 6, iPad Air2	Photos(34), Ext. Tweet(24), Music(8)
Family 9	Father (full-time job), Mother (Academic), 3 Child (10 yo, 14 yo, &16 yo)	iPhone 6S, iPhone 6, iPhone 4, iPad mini, iPad mini2	Photos(70), Music(10)

Table 1: Description of participants, devices used, and shared data during the study. * Denotes devices given to the participants.

dining table. Overall we found that the system sat comfortably among other mealtime artifacts in the dining table. Participants generally placed the system in the center of the table and reported that it did not interfere with their regular mealtime artifacts, e.g., plates, glasses, etc. Combining the screens of multiple devices provided us with a larger screen space and we observed that the system was within view and arm's reach of all members, allowing them to interact with its contents. Sometimes, families had to wait (a couple of minutes) for the all the devices to sync and to begin the display, but family members generally used this time playfully to banter around.

Another concern with TableTalk was the orientation of the devices, especially for reading tweets. We aimed to ensure equal access to all the family members sitting across different sides of the table (Fig. 2(e)). We considered several alternatives, for example, automatic continuous rotation of screen contents, designing a custom enclosure, etc. Finally, we decided to use 'Lazy Susan', which is basically a rotating tray made of cheap materials like wood or plastic and an inexpensive off-the-shelf hardware (Fig. 2(d)). Many families already had this, and it also added the benefit of providing some protection against food spilling on to the devices. We found that families with only 2 or 3 members (family 1, 2, 4, 7, and 8) did not use it because the family members could sit close to each other and see the TableTalk data without rotating it. On the other hand, larger families with 4 or more members relied on the rotating tray to re-orient the devices to read tweets and view photos.

User Interaction with TableTalk during Mealtime

Our observations of family mealtimes (phase two) indicated that while families use technologies (TV, video streaming in laptop, etc.), they set it up before the meal and do not change the settings often. So to afford easier interaction with TableTalk, at first we implemented simple voice-based commands. We discarded it after the pilot testing, as the experience of false positives (even infrequent) was deemed as very irritating. Despite our initial concerns that the touch-based controls might be unsuitable for mealtime settings, it was later found to work surprisingly well. This is because in the family mealtime space, dining tables are not very large and all the family members were within arm's reach of the system. We also found that family members rarely interacted with the system to pause or go back, but used it to swipe through the remaining contents at the final stage of the meals or when they stayed at the table afterwards. Another finding was that while discussing specific content, people generally did not refer or point back to it, but kept the discussion flowing naturally. Only when they felt it necessary to point at something, or required more information, did they look at the content. So the eye contact remained mostly between the family members and not on TableTalk.

Collective Significance in Technology Usage

The decision to use personal devices caused some setbacks too. It was not always possible to incorporate every person's device due to incompatibility issues (family 3, 6), technical issues with older devices (family 3, 6, 7), absence of family members (family 5), or simply unwillingness to use a smartphone (family 3). However, we found that family members overlapped in their device usage and often collaborated or complemented each other in sharing devices and personal contents. For example, tablets were often shared and thus contained data from multiple family members (family 2, 3, 5, and 9). Even devices that were used exclusively by one user contained photos as well as music of other members. Hence no family member was excluded from the content shared via TableTalk. This in effect demonstrates the multiplexed nature of data among family members and distinguishes family as a social group.

We saw this complementary and collaborative engagement with TableTalk content also in the dinnertime conversations. As one might expect, many of the photos represented events that involved multiple family members. So when one family member had forgotten something about the event, the others could remind him/her and made the story more complete and rich. For example, the following excerpt shows how family 5 collaboratively reconstructed the details of a family holiday:

Mother: "*I think it was in [place] last year. Is that possible?*"
Father: [rotates the Lazy Susan] "*Yeah, I think so.*"
Son: "*It was when me, you, [name of two children] went out for lunch.*" [rotates the Lazy Susan back]
Daughter: "*And we went surfing.*"

We see collectiveness in the physicality of sharing devices as well. The act of taking the device from an individual's own possession (e.g., from pocket) and placing it in the shared table space, has a sense of transformation of (temporary) ownership to the group and has a significance of 'giving away' or 'contributing' to the common self. It conforms to the notion of commensality - the shared experience becomes common for both eating together and using technology together - thus highlighting the *togetherness* on both dimensions. This was evident in family 3, for example. The mother of family 3 generally discusses about their plans for the next week and uses her phone calendar during mealtimes on regular days. But while using TableTalk, she tried to recall from memory, though she could have used her phone (TableTalk would pause and resume later). It was evident in other families too, that no one used their phone for personal use during their meal, though they mentioned that they might otherwise do so. This indicates a commitment to both the research and the shared usage of technologies during commensal experience.

Moderation of Content and Ethical Concerns

To minimize the efforts of participants in setting up, TableTalk would chose content from the approved sources and then allow the participants to remove items that they do not feel comfortable sharing with the family members or the researchers. For most of the study, this worked well. We expected that participants would carefully moderate personal content before sharing. But the study revealed that content moderation was only critical for families with children that actively engaged with TableTalk. Families without children sometimes did not moderate the content (family 2, 7), or they left the moderation to one member of the family (family 1 and 2 during one meal). However, during family meals with children, both the parents and the children usually moderated carefully to share content that would be appropriate for the meal.

Adults were mainly concerned about what content would generate interest among the rest of the family. They removed dull or unnecessary items - snapshots of their daily chores, for example, photos of class-notes, shopping lists, etc. that were purely instrumental. They also removed content that they personally found interesting but that they thought others would not find engaging. Parents also carefully considered the balance of the content they shared, and were concerned that children might feel left out or less represented if there was no content about them. The mother in family 5 illustrated this:

"*I tried to get a balance because a lot of my photos were gymnastics and I thought it is important to represent all of the children fairly, so I tried to make sure I just have one of [youngest child's] gymnastics, then one of something that [middle child] and [father] have been - Tennis, and one of that [oldest child] have been in, because it's not fair if I have like 10 of gymnastics and nothing for the other kids.*"

Although children could share as much personal data as adults, teenage children sometimes were more restrictive in what they shared than adults to protect their privacy. For example, the child in family 5 only shared one photo in each meal. Their parents commented that this was similar to how much their child shared daily life experiences in general.

Father: "*Do you share photos with your family? No! [laugh]*"
Mother: "*He is secretive. He is a teenager. [laugh]*"
Interviewer: "*Do you share photos with your friends?*"
Son: "*Yeah [everyone laughs].*"

On the contrary, children in Family 6 carefully constructed their shared content, while children in family 9 did not moderate at all. TableTalk, therefore, supported individuals' decision-making regarding how much, as well as which data they chose to share with the family group.

Another ethical concern was that news items might contain violent or mature content. To alleviate this, external tweets were disabled in the app version loaded in the children's devices. Though we have not experienced significant challenges regarding this in the course of our study, we paid special attention to how the families would manage if there were conflicts arising from TableTalk usage, especially among the children. We noted some minor incidents (family 3, 5) where the adults interrupted promptly and resolved the issue.

Choice of Media for Sharing

Several types of digital content were recommended based on the first three phases of the study and existing literature; photos, tweets, and music being the most prominent of them. As summarized in Table 1, most often our participants shared photos and tweets from external sources with the expectation that these would engage the family as a whole. Usage of photos as a conversational element amongst familial and friendship groups has been of interest for some time now generally [43] and more recently in the mealtime context [35]. We leveraged the ubiquitous presence of personal smart devices and the entire photo library within rather than custom hardware. In the field study, we found photos to be the most useful content to successfully generate interest in all the families. Participants often captured interesting and spontaneous moments of the day in their smartphone and shared them with others during family mealtime. Older photos also provoked shared reminiscence among the family, as we discuss later.

Personal tweets were shared rarely, either because family members did not tweet frequently (family 1, 2, 4, 7, and 9), or they followed each other's social network and already saw their posts (family 3, 5, and 8). As one special case with family 3, the father does not use a smartphone; hence the mother used his twitter account while configuring TableTalk in her phone so as not to exclude him from contributing. Our study phases one and two revealed certain circumstances where families resort to music as a shared background medium, especially when there are guests in the home. However, during the field study, we found that taste in music differed between partners and between parents and children. Some families enjoyed the music together (family 7 and 9) while in some other families (family 1, 3, 4, and 6), it provoked friendly banter, but no one showed dedicated interest in listening to music.

The first two phases of our study also revealed that family members discuss recent events, for example, interesting news in their locality, events with their friends, etc. during family mealtimes. The parents described the importance of such discussions to make the family meals both instructive as well

as enjoyable. We enabled the use of Tweets to support such discussion as many popular news agencies now have a Twitter presence and regularly tweet recent stories and breaking events. Further, many of them can be customized based on locality and included photos or links for details. The field study revealed that external tweets (from news channel and celebrity accounts) could engage the family as a whole and provoked much conversation. Sometimes, one person read the tweet aloud, and then others responded to it. Popular topics included recent movies, local events, safety and security, etc.

'TableTalk' and the Family Mealtime Interactions

TableTalk often provoked conversation between the family members, but more importantly, it provided content largely without interrupting ongoing interactions in the family.

Provoking Conversation

Unsurprisingly, contents from the TableTalk system provoked interest and conversation among the family members. Family members discussed the photos and tweets, and enjoyed or expressed disapproval of the music choice of others. For example, here is an excerpt from family 3 that illustrates how a simple photo of an empty railway station engaged the whole family and how they related the station's name ('Hartford') with a dialog from a play ('Pygmalion' by Bernard Shaw, plot of the movie 'My Fair Lady') they have all read years before:

Mother and elder daughter together: [looking at screens] "*Hartford! In Hertford, Hereford, and Hampshire, hurricanes hardly ever happen. [laughs together]*"
Daughter 1: "*Have you seen that movie, [name of sister]?*"
Daughter 2: [signals negative]
Mother: "*Why did you go to Hartford, [name of child]?*"
Daughter 1: "*Um..I did not share anything.*"
Mother: "*Oh, that's Hartford, that's where I met [name], when I was in Boston. That's actually Hartford in US.*"
Daughter 1: "*I didn't go near..*"
Mother: "*So yeah, hurricanes might happen there quite (emphasize) frequently.*" [contrary to Hertford in UK]
Father: "*She was in the East Coast, wasn't she?*"
Daughter 1: "*I have not seen the movie, but I studied the play.*"

What was interesting here and in many other occurrences was that the conversation progressed naturally and was not bound in any way by the technology itself. Often the discussion initiated with the contents of the device (e.g., photo or tweet), but then it evolved into the personal experience and other aspects of the family life. The participants generally looked into the devices for only a few seconds and started saying something about it. Sometimes, one person read the tweet aloud, and then others responded to it. But then the discussion moves onto related (or sometimes very distantly related) topics; participants were engaged in conversation and did not pay attention to the next data displayed after 30 seconds. Only when participants referred back to the item to point at something in there or re-read something written did they go back to the previous item. Otherwise the conversation progressed naturally.

Accountability for Shared Content

In each participating family, we identified instances where one or more family members questioned why someone had selected a particular content item for the TableTalk system. The interesting thing here is not that people try to figure out why this content is there or blame someone else for its presence, but rather how family members accounted for their choices and/or how they anticipate what their family would find interesting while they curate content. Selecting appropriate content was particularly difficult for music, because taste in music differed between partners and between parents and children. Furthermore, while visual content could run on TableTalk without evoking attention, music tended to focus attention to the TableTalk system. Hence when the father in family 5 chose some of his favorite music to share with the family, he found himself in a (friendly) situation where he had to account for his choice and taste in music. The following example from family 5 illustrates banter around this:

Father: "*I don't know why I chose this. Sounds funny [laugh].*"
Daughter: "*It sounds like an 80's song.*"
Father: "*It is an 80's song.*"
Mother: "*Poor [name of father] with his music.*"
Father: "*Your music was not much better.*"
Mother: "*Yeah, it was weird.*"

Looking up Information and Coordinating Family Activities

TableTalk did not restrict other ways of using technology at the dinner table, i.e., searching for information instrumental to family activities, or sending a quick text if necessary. However, this did not happen during the study observations. For example, the mother of family 3 generally talks about their plan for the next week and uses her phone calendar during mealtimes on regular days. But while using TableTalk, she tried to recall rather than use her phone, though she could do so (TableTalk would pause and resume later). It was evident in other families too, that no one used their phone during their meal, though they might otherwise do so.

Some families used their phones to look up additional information: for example, family 4 planned a vacation and searched for airfares and hotels. These activities were conducted when other family members had finished (or almost finished) their meals but remained at the dining area to find information and coordinate activities. For example, in family 1 TableTalk showed a tweet about a planned strike of public transport personnel. Hence they searched to see if the strike would affect their travels to work, but waited till they finish their meal.

Ambient Engagement

It is important to highlight that TableTalk was not a constant source of conversation or interruption, but quite often a rather ambient technology that remained in the background for large parts of a meal. While the content of TableTalk changed every 30 seconds, it was up to the family members, if they wanted to, to engage with its contents and to bring TableTalk to the fore. This type of ambient engagement worked well with visual content (photos, tweets), which could be updated without taking the attention away from the dining table and of course, from the social interaction of the family time.

The only exception to ambient engagement was provided by music played through TableTalk. When music started playing, it immediately made TableTalk the locus of attention, causing

surprise and delight sometimes (family 7, 9), but also irritation among some family members. Unlike photos or tweets where change in content did not draw much attention than only minor change in the ambient light from the system, music could interrupt the conversation. In family 3, one child complained about such interruption during the first meal: "*I was saying, before the phone rudely cut us out was I am going to need some money*". As a result, during their second meal, the father suggested his wife to turn off music while configuring the app.

Commensal Activities

We are also interested in how these conversations contributed to commensality through, for example, shared reminiscing, fostering equality and bonding, and stress different roles and responsibilities, i.e., educating and socializing children.

Reminiscing and Bonding

The TableTalk system provoked shared reminiscence among the family members. Such reminiscing also extended to people not present at the table, as in family 5:

Father: [Looking intensely and then pointing to a old family picture] "*Who is that? Is that [name]?*"
Mother: "*I know who that is. I took that photo with [name], my brother. And there was this kid, a merry kid jumping into the water and shouted, "Take a photo! Take a photo of me!" So I took a photo of him.*"
Daughter: "*Oh yeah, that kid was doing this [mimics]*"
Mother: "*yeah [laugh]. Then [name] was saying you got a photo of a random kid on your phone.*"

In many ways, the discussion around the pictures, music, or tweets displayed in the TableTalk system was more than the information within; it emphasized the care and affection family members held for each other and supported bonding. For example, during one of the meals, the mother in family 1 exclaimed, "*How beautiful this picture of the smile of [name of child]*". Here, the one-year old child could not possibly comprehend what his mother was talking about, but we take it as an expression about reinforcing her affection of her baby. This warmth and tenderness remain at the core of family reminiscence, regardless of technology induced or otherwise. For example, another fragment from the conversation in family 2 referring to an old photo shows both reminiscing and bonding:

Wife: "*I was thinner [both laugh], I looked good.*"
Husband: "*You still look good. You did not change much. It just looks so because you were wearing Indian ethnic dresses, now you wear all western clothes.*"
Wife: "*My wristwatch was also working, I had it there.*"

Conscious 'Contribution' to Dinner Talk

The family members contributed to the dinner through TableTalk in multiple ways. First, (temporarily) giving away their personal devices could be considered as a gesture of willingness to 'contribute' towards the mealtime experience. Second, they contributed through sharing their data. For example, some participants took photos of their daily life specially in order to share through TableTalk with other family members. While they also had taken such photos prior to using TableTalk, the system reminded them of this opportunity. These family members mentioned how they kept the other members of the family in mind while taking these photos. For example, the mother in family 3 reported that as she knew TableTalk displays recent pictures more often, she sometime made "*conscious choice*" to take photos that her daughters will find interesting. In another instance, the husband in family 2 used TableTalk to share a photo of a uniquely shaped architectural model from his work and we noted his excitement in anticipation of this contribution. In these contexts, photos were a taken as kind of endowment to other members.

Educational Opportunities

TableTalk provided opportunities for education through discussion around the shared content. Some parents deliberately chose content from local news sources that they thought their children would find interesting as well as instructive. As illustrated below from family 5, some parents sought to channel the conversation to raise interest among their children.

Daughter: [looking at a picture] "*Flamingoes!*"
Mother: "*I know where that was.*"
Mother and Daughter together: "*San Diego zoo!*"
Mother: "*Do you know why they are pink?*"
Daughter: "*I don't know. I thought pink ones are the boy.*"
Mother: "*They are pink because they eat crustacean.*"
Daughter: "*What's crustacean?*"
Father: "*Prawns and stuffs.*"
Mother: "*Shrimps, prawns, and lots of seafood, that makes them pink.*"
Daughter: "*Shrimps and prawns are the same thing.*"
Mother: "*No, they are not.*" (continues)

Dinnertime conversation also included discussion about how to behave and take responsibilities for ones actions. For example, it was a matter of both amusement and instruction in family 4 when the husband included the photograph of a recent handwritten note placed on the windscreen of his friend's car, who had unwittingly parked his car blocking the neighbor's driveway. The husband later explained that he brought up the issue to discuss parking rules with his wife (a learner driver) in a cheerful and humorous way without being patronizing.

Manners and Socialization

TableTalk created opportunities to instruct children about manners and socialization at the dinner table. Firstly, the socialization of children was vividly illustrated through conflicts that emerged during the meal. For example, the mother of family 5 wanted to celebrate a photograph of her son winning tennis trophy; her son, out of shyness, did not. This incident led to a tug-of-war between both of them using the swipe feature to change the image backward and forward, until the mother asked the child to stop interrupting. Similarly, in family 3 a conflict emerged between the two children about who had captured a particular photo displayed in the system. After a while, their mother interrupted by swapping to the next content and in an authoritarian manner she asked them to "*move on*".

Secondly, TableTalk helped to socialize children by encouraging them to wait and to take turns. For example, family 3 mentioned that their younger daughter wanted to share a particular photo (describing two characters from the Harry

Potter movie) with her family, but she had to wait (with disappointment) as the system was showing contents randomly and did not show that photo while they ate. Hence she waited until the end of the meal and skipped to that photo.

Finally, TableTalk shaped table manners by encouraging family members to wait for the meal to finish. While meals are often concluded when all members have finished their meals, we observed how the members in family 1, 2, 3, 4, 7, and 9 stayed at the dining area even when their meals were finished to go through the remaining items in the TableTalk system. For these families, the TableTalk system could have a positive effect on commensality by extending the amount of time the family sits together. During the interview, they explained that they did not want to miss any item that other members have chosen to share. Incidentally, engagement with TableTalk here can also be seen as reinforcing such behavior.

DISCUSSION AND DESIGN IMPLICATIONS

This paper contributes in several ways to our understandings of how ubiquitous computing devices can be used in shared domestic settings. Firstly, it offers *TableTalk*, a novel system to support the sharing of personal devices, content, and experiences during family meals. TableTalk extends previous work that focused on the technical feasibility of creating a shared display using personal devices [36] by incorporating a variety of media formats (e.g., music and tweets) and related work on interaction techniques [33] by designing a system that allows family members to contribute and curate personal content (photos, tweets and songs) and subsequent interactions.

Secondly, the field deployment study contributes towards understandings of how technology can support and sometimes even enrich commensal experiences. This responds to concerns about possible detrimental effects of technology usage at the dinner table [13, 40] and a widespread resistance against personal technologies in this context [18, 20, 31]. With TableTalk, we do not intend to diminish social interaction during mealtime, nor do we aim to replace conversation and other naturally-occurring interactions with technology-mediated interactions or see it as a 'solution' to disruption that may happen in some families. What we have set out in this paper, however, is to design and explore how technologies can support and mediate familial concerns and interests, and contribute to commensality by enriching familial experiences of shared mealtime. It does this by allowing all family members to contribute content and share personal experiences and concerns that are relevant for the family as a unit. TableTalk has also provided children with a *voice* in choosing content to share, and in responding to content from others. These contents sometimes provoked and often supported ongoing conversations between family members. The conversation appeared to flow naturally, and new content (except music) did not disrupt conversations or took attention away from the meal but rather provided an invitation to engage in conversation. What is important here is that we can see a range of commensal activities through these conversations that brought the whole family together.

Finally, what emerged through the design and deployment of TableTalk is a focus on togetherness during the commensal experience. Such togetherness remained at the core of TableTalk usage, evident in both curation and conversation facilitated by TableTalk. In contrast to related work that focuses on the mealtime experiences of individuals connected *through* technologies [32, 42, 44], this study was designed to investigate the shared practices that emerged when TableTalk was used during collocated family meals. The transformation from *personal* to *social* can have significance for the ways family members perceive the ownership of their devices and content. First, by bringing the physical device from the personal space (e.g., taking it out from the pocket) to the shared space (e.g., dining table), it loses its 'personal' quality and become a part of a larger system of multiple-devices, discouraging participants from taking it away before the meal finishes. Second, by discussing personal data in a family group, participants contribute towards shared understanding, memory, and the ongoing constitution of the family itself. The implications of curation of content by family members can be seen in anticipation of what others have shared (and why), careful inclusion of content to represent everyone at the table, or accountability for shared content. Noteworthy here is that, TableTalk allows users to move seamlessly between these states - by having a device as personal when necessary or shared when appropriate.

TableTalk thus finds its success in the nuanced and subtle ways it contributes to the family mealtime experience. It acts as a mechanism to consolidate personal devices and attention, rather than to isolate family members by keeping their focus on their own devices. It also allows everyone to contribute to the group synergy (both through interaction with the devices and conversation around content). Thus TableTalk supports important characteristics of familial interaction (banter, teasing, educating, and even conflict) around mealtimes. Simply, TableTalk encourages families to talk - providing a platform of shared content as a conduit for exchanging their stories. Families responded to this positively and encouraged everyone to participate without awkwardly drawing attention to any particular member. It is notable that no family member turned off TableTalk, or left the table prematurely, but nearly every family extended their stay at the dining table beyond the completion of their meal. So, rather than criticizing technologies for diminishing commensality or trying to stop such usage forcefully [9, 21], this research then highlights the need to design for togetherness and utilize the technological affordances as an opportunity to positively augment family mealtime experiences. Next we discuss ideas of how TableTalk can be further utilized to sensitize researchers and practitioners to the challenges and opportunities involved in designing new technologies for supporting commensality in the family home.

Implications for Curation of Content

Our participants appreciated the random selection of content (while prioritizing recent items), as it decreased their workload. However, we noted how sometimes they took photos of events for sharing later, or considered news worth sharing in the course of their everyday life. This highlights the need to afford both the serendipitous experience from randomly presented content as well as opportunities for planned curation.

One design idea is therefore to allow automated assistance in the collection and curation of contents to be shared with the

family. Throughout the day, smart devices might enable or ask participants to select current media (e.g., photos, music, social media posts, news articles, etc.) for later sharing, thus assist people to curate and plan for the storytelling of everyday life during commensal meals. The recording of the daily sharing of content within TableTalk could also act as an archive in itself - acting as a highlighted reel of a particular day. It would be interesting to see how this process could be supported, perhaps by replaying TableTalk sessions from an earlier dinnertime.

Implications for Supporting Depth in Conversation

TableTalk was designed to provoke and manage conversation among family members while providing equal opportunities for everyone. While recent photos, music, and tweets enabled and encouraged conversation about personal and local events, TableTalk did also provoke discussion and shared remembrance by displaying older content that may otherwise be forgotten. Overall, it provoked conversation about past memories (e.g., old photos), ongoing affairs (e.g., recent news), and future events (e.g., discussion provoked by photos of similar events in the past). One interesting observation was that we needed to balance the breadth and depth of a conversation topic. However, it is challenging to determine whether and how to present content that can extend an existing conversation, or whether to change the topic through new content.

One design idea is then to avoid switching conversation topics or abruptly starting music - for example, by detecting if the family members are discussing the displayed item, TableTalk could stay on that item until they have finished the discussion. A solution might be to detect periods of silence in conversation and change the displayed content in those gaps or switching to music for background ambience. Another improvement might be supporting the depth of conversation, for example, by enabling the system to fetch more data based on the current item (e.g., more photos of that time/place from participants' devices, more music from the same album/artist, related news or social media posts). Such designs will need to adapt to individual family's desires concerning topic exploration or changes.

Implications for Complementary Role of Family Members

TableTalk usage was also confluent with the inclusion and exclusion of members in the commensal meals [12]. TableTalk gave everybody a voice including the children, who otherwise might feel disconnected from adults' conversations. We noted how families carefully included all of the core members, even if they were not present during the meal (e.g., by including photos of the child in family 1 and 5) or when some member did not use a smartphone (e.g., by including tweets of the father in family 3). On the other hand, extended family members and friends were included in turn (in all participating families). One future extension of this work might be to enable extended family members and friends to contribute their content from their own TableTalk system and vice versa, that is, exploring the remote dining experience [3] through TableTalk system.

TableTalk serves to scaffold family interactions in positive ways; the process of curation reflects this. Care is taken to include data that are relevant, interesting, and not too confronting to individual family members, particularly children. Curatorial practices also seek to include all family members, e.g., by ensuring there is 'balance' in the content. These curatorial practices separate family from other social groups. As family members have shared experience throughout their life, data from their personal devices convey information that relates to other members of the family. Also, their knowledge about each other enables them to relate the content (photo, music, etc.) with their past experiences in ways that might not make sense to outsiders. Then, they can play a complementary role in discussing shared memories; one can remind others of the event if they have forgotten specific details.

Thus, another design opportunity for future exploration is the complementary role of family members in collecting data about shared memories. It is possible that multiple members' devices have data (e.g., photos, social media posts, etc.) about a particular event or memory (e.g., a birthday party, a family tour, etc.). So one possible extension of TableTalk can be to search and combine such data from family members' devices and bring them to the fore when they show interest in it.

Limitations of the Study

While appropriate to the exploratory nature of our work, the limited number of participating families precluded us from examining the possible influence of socio-economic status or cultural factors. Also, the novelty of TableTalk may have influenced the experience of the families due to the short duration of the study. However, as discussed above (and similar to O'Hara et al. [35]), we are not investigating the adoption of TableTalk for every family or for every meal, nor are we interested in the differences between meals with and without it. All of these factors warrant further investigation to develop understandings of how families with diverse backgrounds might adopt new devices into their everyday domestic mealtime settings.

CONCLUSION

We have presented the design and deployment of *TableTalk* and explored the ways in which it reconfigured personal data and devices to a shared display, thereby supporting and enriching the commensal experience in the family home. In doing so, we note how the attention shifts from individual to collective significance and the nuanced ways in which technology usage can correspond to different aspects of commensality including reminiscing, educating, socializing, and bonding in the family. While we recognize concerns about ICT usage during family mealtimes, the outcomes of this research are important for UbiComp researchers and designers working on systems for shared domestic settings. We show how careful consideration of various design issues such as the type and amount of content to include, selection and moderation of content by familial members, and interaction with the system help to generate and sensitively support familial interaction during mealtimes. Overall, our study demonstrates that through sensitive design, deployment, and recognition of familial norms, expectations, and responsibilities, technology designers can positively support and enhance interaction at family mealtimes.

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